Installation Manual

UL3501/1S/ISA/I4PS

AERO ENGINE
Preface

Thank you for deciding to use a ULPower engine.

Before starting with the engine installation, read this Installation Manual carefully. The Manual will provide you with basic information on correct engine installation, a requirement for safe engine operation.

If any passages of the Manual are not completely understood or in case of questions, please contact the manufacturer or an authorised dealer.

We hope you will have much pleasure and satisfaction flying your aircraft powered by a ULPower engine.

Remarks

The figures in this Installation Manual show the typical construction. They may not represent in full detail or the exact shape of the parts which have the same or similar function.

Specifications are given in the SI metric system with the USA equivalent in parenthesis. Where precise accuracy is not required, some conversions are rounded off for easier use.

In addition to this Installation Manual, please refer to the following:
- Operating manual
- Maintenance Manual
- Illustrated Parts Catalogue

Modifications

The information and components/system descriptions contained in this Installation Manual are correct at the time of publication. ULPower, however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on its products previously manufactured.

ULPower reserves the right at any time to discontinue or change specifications, designs, features, models or equipment without incurring obligation.

Please contact your dealer or check the manufacturers website (http://www.ulpower.com) for any updates or changes concerning the engine and its manuals.

Engine serial number

On all enquiries or spare parts orders, always indicate the engine serial number, as the manufacturer makes modifications to the engine for further development.

The engine serial number is located on the top of the crankcase.
Repeating symbols

This manual uses the following symbols to emphasize particular information. These indications are important and must be respected.

- **WARNING**: Identifies an instruction which, if not followed, may cause serious injury including the possibility of death.

- **Attention**: Denotes an instruction which, if not followed, may severely damage the engine or other components.

- **Note**: Indicates supplementary information which may be needed to fully complete or understand an instruction.
Safety Information

• The engine should only be installed and placed into operation by persons familiar with the use of the engine and informed with regard to possible hazards.

• This non-certified engine is designed for possible application on aircraft used in VFR conditions which have the capabilities of controlled gliding without engine power.

• It should be clear that the choice, selection and use of this particular engine on any aircraft is at the sole discretion and responsibility of the aircraft manufacturer, assembler and owner/user. ULPower makes no warranty or representation on the suitability of its engine's use on any particular aircraft. Furthermore, ULPower makes no warranty or representation of this engine's suitability with any other part, component or system which may be selected by the aircraft manufacturer, assembler or user for aircraft application.

• Use the appropriate tooling when installing the engine.

• Engine is delivered in "dry" condition (without oil). Before putting engine in operation it must be filled with oil according to specifications in the operating handbook.

• Never (test)run the engine without a propeller or flywheel as this will inevitably cause engine damage and present a hazard of explosion.

• Propeller/flywheel and its attachment with a moment of inertia in excess of the specified value must not be used and releases engine manufacturer from any liability.

• Improper engine installation and use of unsuitable piping for fuel-, cooling- and lubrication system releases engine manufacturer from any liability.

• Unauthorized modifications of engine or aircraft will automatically exclude any liability of the manufacturer for sequential damage.

• Do not use a protective device (e.g. a fuse) essential for the engine, to protect any other circuit

• Do not install unnecessary protective devices for the alternator and the regulator rectifier

• Install protective caps to protect switches essential to flight safety such as ECU switch, master switch, ...
# Table of contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>3</td>
</tr>
<tr>
<td>Remarks</td>
<td>3</td>
</tr>
<tr>
<td>Modifications</td>
<td>3</td>
</tr>
<tr>
<td>Engine serial number</td>
<td>3</td>
</tr>
<tr>
<td>Repeating symbols</td>
<td>4</td>
</tr>
<tr>
<td>Safety Information</td>
<td>5</td>
</tr>
<tr>
<td>Table of contents</td>
<td>6</td>
</tr>
<tr>
<td>Engine description</td>
<td>8</td>
</tr>
<tr>
<td>General Description</td>
<td>8</td>
</tr>
<tr>
<td>Specifications</td>
<td>8</td>
</tr>
<tr>
<td>Note:</td>
<td>8</td>
</tr>
<tr>
<td>Description of basic standard engine and accessories</td>
<td>9</td>
</tr>
<tr>
<td>Engine views</td>
<td>10</td>
</tr>
<tr>
<td>Engine views “Forced Cooling”</td>
<td>14</td>
</tr>
<tr>
<td>Technical data</td>
<td>18</td>
</tr>
<tr>
<td>Dimensions of basic standard engine</td>
<td>18</td>
</tr>
<tr>
<td>Weight of basic standard engine and accessories</td>
<td>18</td>
</tr>
<tr>
<td>Centre of gravity of basic standard engine</td>
<td>18</td>
</tr>
<tr>
<td>Preparations for engine installation</td>
<td>19</td>
</tr>
<tr>
<td>Transport</td>
<td>19</td>
</tr>
<tr>
<td>State of delivery</td>
<td>19</td>
</tr>
<tr>
<td>Engine preservation</td>
<td>19</td>
</tr>
<tr>
<td>Engine suspension and position</td>
<td>20</td>
</tr>
<tr>
<td>Note: Take care to protect the rubbers from heat. (Muffler)</td>
<td>20</td>
</tr>
<tr>
<td>Mounting Position</td>
<td>21</td>
</tr>
<tr>
<td>Fuel injection system</td>
<td>23</td>
</tr>
<tr>
<td>Special attention for aerobatic engine</td>
<td>26</td>
</tr>
<tr>
<td>Air intake system</td>
<td>28</td>
</tr>
<tr>
<td>Air filter</td>
<td>28</td>
</tr>
<tr>
<td>Idle speed adjustment</td>
<td>28</td>
</tr>
<tr>
<td>Throttle cable</td>
<td>29</td>
</tr>
<tr>
<td>Exhaust system</td>
<td>30</td>
</tr>
<tr>
<td>Dimensions of the exhaust system:</td>
<td>30</td>
</tr>
<tr>
<td>Exhaust installation:</td>
<td>31</td>
</tr>
<tr>
<td>Cabin Heating:</td>
<td>33</td>
</tr>
<tr>
<td>Cooling system</td>
<td>34</td>
</tr>
<tr>
<td>Cylinder head cooling:</td>
<td>34</td>
</tr>
<tr>
<td>Cylinder head temperature limits:</td>
<td>34</td>
</tr>
<tr>
<td>Oil cooling:</td>
<td>34</td>
</tr>
<tr>
<td>Oil temperature limits:</td>
<td>34</td>
</tr>
<tr>
<td>Helicopter configuration</td>
<td>34</td>
</tr>
<tr>
<td>Testing &amp; evaluation</td>
<td>35</td>
</tr>
<tr>
<td>Lubrication system</td>
<td>36</td>
</tr>
<tr>
<td>Oil Cooler</td>
<td>36</td>
</tr>
<tr>
<td>Oil/Air Separator &amp; Breather (UL350i; UL350iS; UL350iHPS)</td>
<td>39</td>
</tr>
<tr>
<td>Oil/Air Separator &amp; Breather (UL350iSA)</td>
<td>41</td>
</tr>
<tr>
<td>Oil Supply aerobatic engine</td>
<td>41</td>
</tr>
<tr>
<td>Electrical system</td>
<td>42</td>
</tr>
<tr>
<td>1. Single ECU &amp; Ignition</td>
<td>42</td>
</tr>
</tbody>
</table>
2. Double ECU & Ignition ................................................................. 47
ECU ................................................................................................. 52
Ignition Coils .................................................................................. 52
Alternator & Regulator/Rectifier ...................................................... 55
Recommended diagram ................................................................. 57
Starter motor .................................................................................. 58
Battery ........................................................................................... 59
Additional wiring ............................................................................ 59

**Instruments** .................................................................................. 60
Recommended Sensors ..................................................................... 60

**Propeller drive** ............................................................................. 65
Propeller selection ........................................................................... 68

**Annex A** ...................................................................................... 69
Fuel header tank ............................................................................... 69

**Revision** ....................................................................................... 70
**Engine description**

**General Description**
- 4 stroke, 4 cylinder, horizontally opposed
- Electronic spark ignition (variable timing)
- Electronic multipoint fuel injection (pressure and temperature compensated)
- Electronic RPM limiter
- Direct propeller drive
- 6 bearing crankshaft with large thrust bearing (ball bearing type)
- Single central camshaft
- Push rods, Tappets and Over head valves
- Wet sump forced lubrication with integrated pressure regulator
- Ram air cooled cylinders and cylinder heads
- Integrated AC generator, external rectifier-regulator
- Electric starter
- Electric fuel pump and pressure regulator

**Specifications**

<table>
<thead>
<tr>
<th></th>
<th>UL350i</th>
<th>UL350iS</th>
<th>UL350iSA</th>
<th>UL350iHPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement:</td>
<td>3503 cc</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bore:</td>
<td>105.6 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke:</td>
<td>100 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compression Ratio:</td>
<td>8 : 1</td>
<td>8,7:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firing order:</td>
<td>1 - 3  - 2 - 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direction of Rotation:</td>
<td>Clockwise - Pilot's view - Tractor configuration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque (ISA conditions):</td>
<td>305Nm @ 2200rpm</td>
<td>320Nm @ 2400 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power rating (ISA conditions):</td>
<td>120 hp @ 3300 rpm (116hp@ 2800rpm)</td>
<td>130hp @ 3300 rpm (123 hp @ 2800 rpm)</td>
<td>145hp @ 3500 rpm (131 hp @ 3000 rpm)</td>
<td></td>
</tr>
<tr>
<td>Basic standard engine weight:</td>
<td>67 Kg (including starter motor and alternator)</td>
<td>70.2Kg (incl starter motor and alternator)</td>
<td>78Kg (incl starter motor and alternator)</td>
<td></td>
</tr>
<tr>
<td>DC output:</td>
<td>30 Amp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil capacity:</td>
<td>3 L (Min: 2,5L - Max3,5L)</td>
<td>4L (Min: 3,5L - Max4,5L)</td>
<td>3 L(Min: 2,5L - Max3,5L)</td>
<td></td>
</tr>
<tr>
<td>Fuel:</td>
<td>MOGAS min. 95 octane rating AVGAS (100LL) UL 91 ( 95 octa = 87MON = 91AKI )</td>
<td>MOGAS min. 98 octane rating AVGAS (100LL) UL91 ( 98 Oct = 90MON = 94 AKI )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

The UL350iHPS is developed for helicopter applications. This engine is standard with forced air cooling and run at a high Rpm level (3000-3500 rpm).
Description of basic standard engine and accessories

The basic standard engine consists of the following:

• Engine assembly
• Injectors and spark plugs
• Intake manifold, throttle and air filter
• Electric starter motor
• Integrated AC generator
• CPU, ignition coils and electrical wiring
• Fuel pump, pressure regulator and fuel lines
• Exhaust system
• Cooling ducts for cylinders and cylinder heads
• External rectifier-regulator
• Propeller flange

In addition to the basic standard engine, following items are necessary accessories:

• Oil cooler and connections (depend on type of installation)
• Tacho, temperature and pressure sensors, wiring (and gauges)

Only valid for the UL350iSa engine: engines of this type are delivered with an inverted oil system, containing:

• Gravity valve,
• Gravity oil pickup tube in the sump
• Gravity oil - air separator
• Breather adaptor on top of the engine
• Extra weight: 3,2 kg
Engine views

Figure 1

* dimensions for standard prop flange l = 55, different prop flanges are available (see page 54)
Figure 2
Figure 3
Figure 4

Figure 5 (engine with exhaust reverse installed)
Engine views “Forced Cooling”

Optional we offer a “Forced Cooling” for all type UL350 engines.
Dimensions: see below
Extra weight: 11Kg
An oil cooler is integrated in the system.
Front Engine Mount plate is installed. Engine fixing points are the 4 lower points.
A muffler or 4 in one exhaust can be installed.

Figure 6 (Optional "Forced Cooling")
Figure 7 (Optional "Forced Cooling")
Figure 8 (Optional "Forced Cooling")
Figure 9 (Optional "Forced Cooling")
**Technical data**

### Dimensions of basic standard engine

<table>
<thead>
<tr>
<th></th>
<th>pos. (+)</th>
<th>neg. (-)</th>
<th>total Σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>max. dimension in x-axis</td>
<td>83 mm (3.27 inch)</td>
<td>470 mm (18.50 inch)</td>
<td>553 mm (21.77 inch)</td>
</tr>
<tr>
<td>max. dimension in y-axis</td>
<td>367,8 mm (14.48 inch)</td>
<td>367,8 mm (14.48 inch)</td>
<td>735,6 mm (28.96 inch)</td>
</tr>
<tr>
<td>max. dimension in z-axis</td>
<td>182 mm (7.17 inch)</td>
<td>290 mm (11.42 inch)</td>
<td>472 mm (18.58 inch)</td>
</tr>
</tbody>
</table>

### Weight of basic standard engine and accessories

Dry weight of the basic standard engine from serial production: ..................... 66,1 kg (145,73 lb)

The total operational weight depends on the accessories installed. Typical accessories provided by ULPower have the following weight:

- Ignition Coils & leads: ................................................................. 3,0 kg (6,6 lb)
- ECU & wiring loom: ........................................................................... 1,6 kg (3,5 lb)
- Exhaust, bolts, springs & seals: ....................................................... 3,6 kg (8 lb)
- Electric fuel pump: ............................................................................. 0,7 kg (1,6 lb)
- Fuel filters (pre-filter & fine filter): .................................................. 0,2 kg (0,4 lb)
- Oil/Air Separator & hoses: ................................................................. 0,7 kg (1,5 lb)
- Rectifier Regulator: .......................................................................... 0,1 kg (0,2 lb)
- Rubber engine mounts: ....................................................................... 0,3 kg (0,7 lb)
- 3,0 L engine lubricating oil: ............................................................... 2,6 kg (5,7 lb)

Possible fully operational engine weight UL3,5i / UL3,5iS: .................................. 78,9 kg (173 lb)

* Optional Acro: .................................................................................. 3,2 kg (7,01 lb)
* Extra 1L Oil: ..................................................................................... 0,866 kg (1,89 lb)
* Possible fully operational engine weight UL3,5iSA: .................................. 83 kg (181,9 lb)

### Centre of gravity of basic standard engine

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>centre of gravity in x-axis</td>
<td>-165 mm (-6.49” inch)</td>
</tr>
<tr>
<td>centre of gravity in y-axis</td>
<td>1 mm (-0.03” inch)</td>
</tr>
<tr>
<td>centre of gravity in z-axis</td>
<td>-26.5 mm (-1.04” inch)</td>
</tr>
</tbody>
</table>
Preparations for engine installation

Transport

Remove T063030 (Bracket engine lift) after installation.

State of delivery

the engine will be delivered/shipped in a plywood crate with galvanised steel profiles and wooden runners.

Engine preservation

The engine is preserved at ULPower, thus warranting proper protection against corrosion for at least 12 months after date of delivery from ULPower.

This warranty is subject to the following conditions:
• the engine must be stored in the packaging as supplied by ULPower.
• the coverings on various openings must not be removed.
• the engine has to be stored in a suitable (dry) place.

If the engine is stored for longer than 12 months, the following tasks have to be performed every three months:
• crank the engine by hand two complete turns anticlockwise (viewed alternator side).
• inspect for corrosion (e.g. prop shaft). At detection of corrosion, send the engine to the overhauler without delay.
• repack engine into original packaging and seal properly.

⚠️ WARNING : The engine must not be put into service during preservation.

⚠️ WARNING : The maximum storage period is limited to 24 months! Preservation for periods longer than 24 months is only possible after a written permission of ULPower. Should the situation arise, send the engine for inspection to ULPower.
Engine suspension and position

The UL260 engine has 4 mounting points situated at the back of the engine. 8 Rubber Mounts are provided with the engine; to be assembled on both sides of the 4 holes.

The design of the engine mount must take into account the structural loadings, while ending with 4 pins to accommodate the rubber mounts. These should be tightened together with a M8x70 cap screw (8.8 Steel/Din 912) and lock nut between two flanges with the correct pretension (Torque to 25Nm). We suggest the steel Engine Mount Pin (1) and aluminium Engine Mount Washer (2) to be dimensioned as below. This two parts are available as an option from ULPower if needed. (bolt M8x70: UlP Partn° F0208070 / Lock nut: ULP Partn° F5103080)

Note: Take care to protect the rubbers from heat. (Muffler)
Protect them with some shielding
Mounting Position

Figure 5: Mounting points

<table>
<thead>
<tr>
<th>Attachment Point</th>
<th>Y-axis</th>
<th>Z-axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point 1</td>
<td>-125 mm</td>
<td>95 mm</td>
</tr>
<tr>
<td>Point 2</td>
<td>125 mm</td>
<td>95 mm</td>
</tr>
<tr>
<td>Point 3</td>
<td>-125 mm</td>
<td>165 mm</td>
</tr>
<tr>
<td>Point 4</td>
<td>125 mm</td>
<td>165 mm</td>
</tr>
</tbody>
</table>
As an option we can also provide a front engine mount plate.

**WARNING:** The engine installation must be ground run tested before first flight.

Engine Mount Pins can optional be ordered.
Fuel injection system

Accessories such as an electric fuel pump together with a pre-filter and fine fuel filter are provided in the basic package and the fuel pressure regulator is integrated in the engine assembly. A complete fuel connection kit can optionally be obtained from ULPower.

We would like to draw your attention to a few points before installing/connecting the fuel system:
- Use appropriate fuel lines and connections as the fuel injection system requires a constant 3bar fuel pressure.
- A fuel injection system requires a return line of adequate dimensions. Large quantities (100 litres/hour = 26 USgal/h) of fresh fuel circulate through the fuel system of which only little is used and the remainder needs to return to the fuel tank.
- We strongly encourage the use of a fuel pressure sensor and gauge to verify fuel system is working correctly. Too much/little fuel pressure can influence the fuel mixture, possibly causing sudden stoppage or damage to the engine as a result.

Overview

The fuel is drawn from the fuel tank, through a pre-filter (100 micron), to the suction side of the fuel pump. From the pressure side, the fuel flows through a fine filter (15 micron), on to the injectors which inject the right amount of fuel into the inlet manifold. The remaining fuel passes through the pressure regulator, and returns to the fuel tank.

If the aircraft is equipped with more than one fuel tank, which are not connected together, the return line must connect to the same fuel tank of which fuel is drawn from. There are 2 possibilities:
- install a 3 way duplex fuel selector valve which allows for 2 fuel lines to be switched simultaneously and has the provision to return the fuel to the same tank from which it is drawn. However never switch the selection to the "OFF" position!
- install a small separate (± 2.5 / 0.7 USgal) header tank from which the fuel is drawn and also returned, while it is gravity fed from the separate fuel tanks. For ULP header tank, see annex A

For ease of explanation we presume the fuel system is connected to a single tank.

★ Attention: In any case, do NEVER shut off the return line from the engine to the tank! This return line must always stay open.

Installing Pre-filter and Fuel Pump

The fuel pump (1) should be placed as close as possible to the fuel tank (3) as it is much more powerful on the pressure side than on the suction side. The pre-filter (2) is placed between fuel tank and pump to protect the fuel pump from being damaged by any foreign particles.
Pump and pre-filter have the same size ending. A fuel hose with 12mm inner diameter should be used to connect fuel tank with pre-filter and pump to facilitate suction. Simple hose clamps may be used to tighten the hose as there shouldn’t be any pressure build-up in this part or the fuel system.

Verify that the inner diameter of the tube coming out of the fuel tank is not less than 8mm to ensure sufficient fuel flow to the pump. Also make sure that the position of the suction point in the fuel tank allows fuel to be sucked out of the tank in every conceivable flight situation or engine will stop running.

Verify that the inner diameter from the return line is not less than 6 mm.

A bracket to fix pre-filter and fuel pump and a bracket to fix the fine filter are included in the “fuel connection kit”.

The + and - for the electrical connection is clearly marked. Use the appropriate wiring (2,5 mm²) together with a 15Amp fuse. A switch can be installed on the dashboard to provide electrical power to the pump allowing the pilot to manually switch the pump on/off. As an alternative a relay switch (see picture on the right - obtainable from ULPower as an option) can be placed between the pump and Engine Control Unit (ECU), allowing the ECU to determine when the pump should start and stop. This feature has been added for ease of use and extra safety. Once power is supplied to the ECU it will automatically start the pump to build up pressure for about 10 à 15 seconds, after which it will shut down the pump (also saving on battery power) until the pilot engages the starter engine. Once the ECU detects the engine is running, it automatically switches on the pump to provide fuel and leaves it on until it detects that the engine has been stopped. In the event of a crash landing and as a consequence an abrupt engine shutdown, the ECU will automatically shut off fuel pump to reduce the risk of fire.
Optionally a second fuel pump can be installed as a backup. Ideally fuel should be drawn from tank through a second output on the tank, otherwise a T-Joint ø12x12x12 is placed between the tank and each pre-filter and is connected with the same hose and clamps. A non return valve is integrated in the pump/thread extension to prevent pressure loss.

**Important!**

Provision should be made for a separate switch on the dashboard to interrupt power supply to the second (backup) pump. Experience has shown that leaving both pumps running simultaneously can cause one of the pumps to overheat due to insufficient fuel flow through the pump. This can result in a pump failure.

However, no problem to run both pumps together for 15 minutes (max 20 min). So during take-off or landing, for safety reason you can run both pumps together.

Before take-off, make a test to be sure both pumps are working. After take-off and before landing, be sure back up pump is switched off.

Keep in mind that each pump pick up ±5.5 Amperes. That’s the second reason why to switch-off the back-up pump during cruise flight.

★ **Attention:** Be sure that all fuel lines and tank are very clean before start. No pump shall be replaced for claimed defects, where dirt is found into the pump, due to lack of fuel tank cleaning or pump filter replacement.

The aircraft related fuel system parts need to be installed based on aviation standards. The system responsibility remain at the owner / operator

**Connecting fuel lines**

All fuel lines after the pump (except the return line) are under a constant 3 bar pressure. Using the correct type and dimensions of fuel lines and connections is mandatory. We strongly advise against the use of simple hose clamps to connect these fuel lines. Our optional fuel connection kit provides the correct type of hoses and fittings.
★ **Attention:** Clean the fuel hoses extremely thoroughly to ensure no metal, rubber or other particles are inside before connecting all the lines. This is especially important as some of these tubes are downstream of both filters which means that the fuel injectors could be blocked by foreign particles which have not been removed properly.

The best way is to run the fuel pump “before” you connect the fuel line to the engine for a few seconds and so clean all hoses.

The following overview shows how and in what order to connect all the fuel lines. It assumes the use of parts as provided in the fuel connection kit. The engine is delivered with prepared and fitted connections as shown on picture 1. Picture 2 shows how to connect the rest of the fuel lines in case of single pump. Picture 3 shows how to connect in case of double fuel pump.

### Reusable kit

![Picture 1](image1)

![Picture 2](image2)

![Picture 3](image3)

- Picture 1: Fuel from tank
- Picture 2: Fuel return to tank
- Picture 3: Anti return valve

### Special attention for aerobatic engine

Like all fuel injected engines, Ulpower engines require a continuous flow of fuel. The ULPower fuel system requires a pressurized fuel supply (3bar) that can cope with a fuel flow as much as 120 litre/hour.

Therefore the use of high quality lines with an appropriate inner diameter and adapted fuel connectors paramount.

**We strongly advise a thorough testing of your installation for all angles of attack (VERY important for the engines with the aerobatic option!) and possible unporting of your tanks.**

In installation where fuel tanks may “unport” a header tank or other solution must be considered to ensure a continuous supply of fresh fuel. It is the responsibility of the aircraft builder to ensure that fresh fuel without air vapour is delivered to the fuel pumps.

In the event of vapour or air in the fuel stream over the injectors, there is increased risk of ENGINE STOPPAGE!
Follow the instructions below to fix hoses and fittings:

**Step 1**
- Band masking tape tightly around the hose at the required length and cut through using a fine-tooth saw blade or cut-off wheel, leaving tape on both ends so that it retains the braid. Clean any debris from both the cup ends and inside the hose.

**Step 2**
- On a clean flat surface, disassemble the fitting. This consists of 2 parts:
  - Socket (Red)
  - Main Fitting Body (Blue)

**Step 3**
- Hold the socket in a smooth jaw vice and feed one end of the hose into the socket by turning clockwise and pushing until the hose finishes just behind the socket threads.

**Step 4**
- Holding the main body in the vice, lubricate the threads and pull the hose and socket over the nipple end and start to thread the socket onto the fitting by hand.

**Step 5**
- Finish tightening the socket onto the fitting using a good quality wrench until the socket is one full turn from the back of the fitting.

**Step 6**
- Pressure test.

Use a copper sealing ring on both sides of a banjo and tighten with banjo bolt or hex cap nut. Do not over-torque (max. 15Nm) the bolts as this could cause damage to the aluminium thread in the connecting parts.

Keep the nipple while tightening the bolt/nut for example: fuel pump connector. (See Picture)

A check valve (non return valve) is installed recommended in the return line. This is an extra safety measure in case of fire in the engine compartment. If not installed, fuel could run from tank to engine through a leaking fuel line even when fuel pump is switched off.

**Remark**

The fuel pressure regulator is integrated in the right fuel block (between cylinders 1 and 3). It is connected to the inlet manifold with a cloth braided rubber tube and a small banjo (in front of starter motor) in order to regulate fuel pressure ±3 bar above inlet manifold pressure. Regularly check for wear (particularly on the parts where it might rub against the casing or inlet tubes) of this tube because if it has worn through, not only can the fuel pressure regulator not do its intended work, (regulating the fuel pressure to 3bar above the manifold pressure) but also the fuel mixture may become (too) lean and the idle speed may also increase because air could enter the manifold through another route instead of only through the throttle plate.
Air intake system

The air intake system is specifically designed for this engine. This system reduces the noise to an acceptable level on the intake side. Unless otherwise agreed, this air intake system will be delivered as a standard part of the engine.

Take care to bring fresh air from outside the cowling to the inlet air filter/manifold.

Air filter

Only ULPower approved air filters may be used. These air filters can be purchased by ULPower.

Idle speed adjustment

The throttle lever stop (1) is factory set to a position that should correspond to a warm engine idle speed of approx. 800 rpm.

★ Attention: The idle speed of the engine should not be less than 700 rpm as rough turning could cause damage to the engine. We recommend a minimum of at least 800 rpm.

With a cold engine, the user should apply a little throttle so the idle speed is at least 1000 rpm during warm-up. Only when the engine is at operating temperature, a minimum idle speed can be tested/set.

★ WARNING: Adjusting idle speed should always be done while the engine and master switch are switched off.

★ WARNING: Take great care when adjusting throttle lever stop as the engine will be hot.

If the warm idle speed of the engine is unsatisfactory, adjust as follows:

• If idle speed is too low: While the engine is running, apply throttle to the desired engine rpm. Set friction to keep the throttle in position and turn off engine. Loosen throttle lever stop screws (3) with a 2.5mm Allan Key and move the throttle lever stop (1) towards the left until it touches the throttle lever (2). Tighten throttle lever stop screws (3) to maximum 3 Nm (2.25 ft lbs).

• If idle speed is too high, firstly verify if the throttle lever (2) is completely against the throttle lever stop (1). If not, stop aircraft throttle system are not set correctly. Adjust according to aircraft manual or manufacturer. Otherwise loosen throttle lever stop screws (3) with a 2.5mm Allan Key and move the throttle lever stop (1) a few mm towards the right. Tighten throttle lever screws (3) and test engine idle. Idle rpm will probably be too low; readjust as described above.

• A spring brings the lever back to “wide open”. This is for safety reason, in case of a broken cable.

Note: Do not leave throttle lever stop screws (3) loose while engine is running to test idle speed.

The throttle cable may NOT go straight from engine to cockpit. (Or first fixing point.)
**Throttle cable**

**Reason**
Because the engine moves against the firewall (because of rubber mounts) while running, the throttle position keeps on changing in case of “straight” throttle cable. This may lead to bad running and even engine stop!
**Exhaust system**

Unless otherwise agreed, the motor will be delivered with the UL power exhaust system. The system is designed to reduce the noise to an acceptable level without losing power.

**Dimensions of the exhaust system:**

1) With muffler
The final exhaust tube (2) (ULP partn° BE093506) is delivered with separate 2 brackets (3) to fix the spring. The tube can be installed one way or the other in the muffler (1). Even the tube (2) can be cut according wishes. This way, customer has the freedom to change the distance between centreline engine and centreline outlet tube from 80mm to 250mm. After installation, custom has to weld himself the brackets (3) to the tube.

Exhaust installation :

The 4 exhaust tubes are fitted to the cylinder heads with 4 screws. Between the cylinder head and the flange is an exhaust gasket. (See Parts catalogue “Exhaust system”)

Because ULP have to tighten the exhaust pipes during the final test run of your engine, the gaskets are deformed and have to be replaced. (4 spare parts are in the box)

Procedure :

- Unscrew the 4 “M6” screws from each exhaust pipe.
- Replace the gasket by a new one.
- Refit the exhaust tube, but DO NOT TIGHTEN the screws!
- After the engine is installed in the plane, install the muffler. (Glide the exhaust tube in the muffler)
- Fix the muffler with the brackets to the engine and install the springs.
- Tighten the screws (16x) to fix the exhaust tubes to the cylinder heads.
**Attention!!!**

To avoid cracks on the muffler it is required to support the final exhaust tube. Connect the final exhaust tube with a flexible bracket (spring) to the fuselage. Also Keep the length from the exhaust tube as short as possible.

*Installation muffler brackets:*
Cabin Heating:

As an option we can also provide a cabin heating unit. For more information, see website accessories/parts, illustrated parts catalogue or contact ULPower.

2) With 4 in 1 collector


**Cooling system**

UL Power engines are cooled by air and liquid (oil). Indeed, the oil is not only used to lubricate the engine, but also to cool it.

A big oil pump pumps a big amount of oil through the engine and brings oil to the rocker arms/valves to cool them as well. Oil leaving the crankschaft bearings and conrod bearings is guided direction bottom piston to cool it.

**Cylinder head cooling:**

Ram air ducts/chamber should guide the incoming air equally over the cylinders and cylinder heads. Sufficient amount of fresh air keeps the temperatures within the limits of operation. Describe ram air ducts and amount of air that should pass over the cylinders and cylinder heads.

An opening both sides from the cowl from average 80cm² is required to keep cylinder heads temperature under control.

**Cylinder head temperature limits:**

See Operating manual

**Oil cooling:**

The oil cooler should be placed in fresh airflow. For further information we refer to the lubrication system description.

**Oil temperature limits:**

See Operating manual

**Helicopter configuration**

For helicopter configurations, as an option we can offer a forced cooling system. In this system there is a fan fixed behind the alternator disc. The air flow generated by this fan blows into the ram air boxes, and through the integrated oil cooler. Additional weight of this system is ca. 11 kilo. For more information, contact ULPower.
Testing & evaluation

For new installations the pressure drop across both Ram air ducts must be checked. The following is a guide to evaluating an engine installation to see if it meets minimum cooling requirements.

The easiest way to measure the air pressure drop across the engine and oil cooler is using a U tube manometer. It is basically a piece of clear tube with an inner diameter of 6 mm bent into a “U” and half filled with water.

For Cylinder head air pressure, connect one side of the tube to a static port inside the ram air duct, and the other side of the tube inside the cowl near the outlet.

For the pressure drop across the oil cooler plumb one side of the tube against the front of the cooler and fix the other side of the tube inside the cowl near the outlet.

For the cylinder head cooling and oil cooling there have to be a pressure fall of at least 20 mm. at 120 km/h TAS.

**Note:**
The tubes must be fitted in the same place each time to ensure you get consistent measurements.

The change in air temperature is nearly the same as the change in CHT. If you do this test at 10°C but sometimes you want to fly at 30°C your CHT will be 20°C higher.
Lubrication system

Oil Cooler

Depending on the aircraft and climatic conditions, an optional oil cooler will be necessary. A complete oil cooler kit is available from ULPower.

The oil cooler can be connected on the interfaces of the sandwich plate with integrated thermostat which is situated at the front left side of the engine. Unscrew oil filter (1) and oil filter screw (2). Put the oil filter in a clean place so it can be reused - new oil filter is not provided with the oil cooler kit.

The image below shows the items of the oil cooler kit and in what order they should be connected.

![Image of oil cooler kit]

The integrated thermostat shut off the oil flow to the oil cooler until the oil temperature reaches ± 80°C (176°F). This is necessary to warm up the engine quickly in winter time.

Connecting oil filter sandwich plate

- Insert the male adaptor bits (3) together with a copper sealing ring (4) into the oil filter sandwich plate with integrated thermostat (5) and gently tighten. A torque of max. 25Nm should be sufficient to ensure proper sealing.
- Place the sandwich plate where you unscrewed the filter; with the rubber seal facing towards the engine casing.
- Insert the oil filter adaptor screw (6) in engine casing through the sandwich plate.
- Rotate sandwich plate to desired position and tighten screw with spanner (again a torque of max. 25Nm should be sufficient).
- Lubricate the oil seal of the filter a little and screw filter onto the sandwich plate. The filter should only be tightened by hand.
Positioning oil cooler

- The standard oil cooler provided with the oil cooler kit has a matrix width of 115mm and is 16 rows high. If necessary, other sizes are available from ULPower upon request.
- Install the oil cooler in a place where cold outside air is forced through the cooler. For the best results be sure to guide the air to the cooler and that all air can only go through the cooler and not escape around it!
- The oil cooler can be placed in any direction (horizontal, vertical, upside down, …), whatever suits best to obtain a good and neat looking installation.
- Depending on where the cooler will be installed, you will need to make some brackets to attach the cooler to engine or aircraft. We strongly advise to use rubber dampers so that it is less subject to vibrations, which otherwise could cause cracks and leakage.

UL Power offer a “oil cooler kit” to fix the cooler in front of the engine / connection upper site

- 1 bracket, 2 supports and 4 silent blocks are included in the “oil cooler kit” to fix the cooler in front of the engine (see picture below)
- Connect the bracket (1) to the engine casing. Using 2 bolts M10x25 (3) and the locking disc springs (2).
- Choose carefully the position you wish to install the cooler (Using holes A, B, C or D).
- If you need holes B, C or D, cut the upper side from the bracket (Eliminate the holes A, B or C)

★ Attention: We strongly propose to install the oil cooler as low as possible to abort that the spinner push the air away from the cooler.

- Fix the cooler to the bracket using 2 shock absorbers (4). Use the hexagon nuts (6) and the washers (5). Choose position using holes E, F, G or H.
- Install the connections for the oil lines on the upper side.
- The bracket is preformed to install the cooler with an angle from 20°.
- You can change the bending according your wishes.
- Install both shock absorbers on the lower side and both “supports” (7). Remove 2 bolts from the oil sump to fix the supports to the engine. Bend them according the oil cooler position and choose which of the holes Ø6 you will use. Cut the support.
- Connect oil lines to oil thermostat. Keep the nipple with a hexagon key 27 while tightening the oil lines connections.
- Of course it’s allowed to fix the cooler on any other place, but be sure that there is enough air flow over the cooler (see “testing & evaluation page 29)
**Attention:**

It's customer responsibility to install an oil cooler efficient enough to cool the engine.
Assembling oil lines

When sandwich plate and oil cooler are in place, the aluminium hose fittings can be screwed on to measure the correct length of oil line needed. Take into account that the minimum bend radius of the hose is 90mm (3.5 inch).

Oil lines and fittings are reusable ones (see website: “accessories/kits section). In any case: one straight, one 45°, one 90° and one 150° fitting are provided with the oil cooler kit.

If necessary (for ease of installation) different angles can be obtained from ULPower upon request. Available angles:

![Oil line fittings angles](image)

0°  45°  90°  120°  150°  180°

Instruction to fix the reusable hoses and fittings: see page 23
Instruction to fix the push-on hoses and fittings: see page 24

Connecting oil lines

Connect oil lines to the sandwich plate and the oil cooler. There is no particular in/out direction on the cooler so you are free to connect them in the most suitable way. Gently tighten with a spanner to ensure proper sealing. There is no need to pull as hard as you can and as a result possibly damaging thread or connections.

Care must also be taken when connecting the oil fittings. Smear the threads and sealing surfaces with a thin film of general purpose grease. The fitting on the body of the oil cooler must be supported with a wrench when tightening the hose fitting connections.

End note

When engine is completely installed and is started up for the very first time, check for leaks in the oil cooler assembly. Tighten where necessary.

Oil/Air Separator & Breather (UL350i; UL350iS; UL 350iHPS)

A breather tube is provided on the engine (picture 1). Connect this tube with provided hose to the oil/air separator. An “oil return tube” is also provided on the engine (picture 2). Connect this tube with the provided hose to the “return” side of the oil/air separator. The breather on an engine is necessary to prevent any pressure build-up inside the engine casing due to normal leakage of blow-by gases through the piston ring gaps. It lets the air or over-pressure escape from the engine through a tube into the free air (outside the aircraft).

In most circumstances the breather not only pushes out air, but is also very likely to blow out some oil that is scattered around inside the engine. To prevent too much oil (or any at all) being lost and blown out into the free air, an oil/air separator is connected to the breather. The oil/air separator is provided with the engine and “filters” out oil and lets it return to the engine before the air leaves the aircraft.
The oil/air separator bottle is connected as follows:

![Diagram showing connections]

The oil/air separator bottle can be mounted onto the firewall and must stay in its upward position as shown above. It should be positioned as high up as possible, at least above the centre of the crankshaft. Both hoses can be cut to length as required to have a clean installation.

Make sure the hose coming from the engine (emerging on the top of the engine, coming from between the cylinders) goes straight into the oil/air separator and the hose returning to the oil sump follows a nice line going downwards to the sump. There should be no "bucket" bend in the hoses enabling oil to stay in the hose.

![Diagram showing correct and incorrect hose connections]

Be sure to keep the return line to the oil sump away from the exhaust; eventually use some shielding.

If for any reason or after a time period specified in the maintenance manual the hose must be replaced, be sure to use the correct type. It must be fit for oil and must be able to withstand a temperature of at least 120°C (250°F). If not, oil line might melt and all oil will leak from engine!
Oil/Air Separator & Breather (UL350iSA)

For the installation of the oil/air separator on the UL350iSA (aerobatic), follow the instructions below.

It is important that the oil/air separator is mounted exactly vertically!

Oil Supply aerobatic engine.

A continuous oil supply and oil pressure is needed to keep your engine running.

ULPower Engines in general and Aerobatic engines in particular have ingenious oil supply system keeping the engine well lubricated, however while performing certain aerobatic figures/manoeuvres, it is possible that there is a temporary drop in oil pressure.

To cover the time the engine is running with an oil pressure drop, it is required to add a bottle of Teflon oil additive (part number : L0100120). This an additive that was developed by ULPower and is not available on the general market.

However, this Teflon oil additive does not permit you to fly more than 5 seconds without minimum oil pressure. If an oil pressure drop lasts longer than 5 seconds, there is an increased risk of ENGINE STOPPAGE!

DON’T ADD THIS DURING THE FIRST 15 HOURS. Only to be added after the first oil change.

In the event of an oil pressure drop longer than 5 seconds, there is an increased risk of ENGINE STOPPAGE!
**Electrical system**

The engine is delivered with the “ECU Wiring loom engine” installed. Wires and connectors which have to be connected during the installation are explained below.

The ECU and the “ECU wiring loom cockpit” are delivered separate.

1. **Single ECU & Ignition**

1. Connect to ECU
2. Ground for cable shielding
3. PC Connector for optional Aux box
4. Connect to coil 1
5. Ground
6. Connect to coil 2
7. Ground

! The standard length of the wiring loom is 1000 mm. This means that, if you want to install the ECU on the firewall, the maximum distance between back plate engine and firewall is 400 mm. Optionally a longer wiring loom is available.
1. Blue shrink sleeve : Battery - / Put all 5 wires together 

2. Red shrink sleeve : Battery + / Put all 6 wires together to a switch, install a fuse 15A and use a wire from minimum 2.5mm² (14AWG)

3. Green shrink sleeve : “+” and “-” to optional fuel pump relay

4. Brown shrink sleeve : Ignition switches : white/blue and white/white to ignition switch coil 1 white/blue and white/red to ignition switch coil 2

   **Attention:** Open contact = coil ON !
   Closed contact = coil OFF !

5. Grey shrink sleeve : 3 wires : (Not used in case data transmission along RS232 or canbus to Efis)
   - white/white : RPM signal (2 pulses/ rev. 0 - 9V)
   - white/blue : Fuel consumption (Injector pulse).
     Output is a duty cycle. 100% is equal to 48l/Hr
   - white/red : fuel consumption (pulses/litre)
     48l/Hr = 170Hz (170 pulses/sec)

6. Yellow shrink sleeve : 4 wires:
   - white/green : Common (-): Not used
   - white/red : warning signal in case of ECU over temperature (not used)
   - white/blue : warning signal in case of battery low (<12.5V)
   - white/white : check light :
     When the engine run correctly, the led doesn’t light up.
     When there is a problem with one of the following sensors, the led light up.
     a) Oil temperature sensor b) Inlet air temperature sensor c) Throttle position sensor
d) Altitude sensor (Integrated in ECU)
e) Hall sensor engine start (Sync/Hall1)

7. Ground for cable shielding

8. PC Connector for RS232 data transmission, UL Read (Male)

9. PC Connects for CANBUS data transmission (Female)

10. Connect to the ECU
ECU Electrical Wiring Diagram for single ECU
Detailed diagram, for maintenance only
2. Double ECU & Ignition

For safety reason we offer a completely redundant, dual channel ECU combination. In this case the engine is equipped with double oil temp sensors, double air intake temp sensors, double throttle pos sensors, double hall sensors, double wiring loom and double ECU.

The engine is delivered with 2 x “ECU wiring loom - engine” installed (Picture 1). Wires and connections which have to be connected during installation are explained below.

2 ECU - boxes and 2 x “ECU wiring loom - cockpit” are delivered separate.

1. Connect to ECU
2. Ground for cable shielding
3. PC Connector for aux box
4. Connect to coil
5. Ground
1. Blue shrink sleeve: Battery - / Put all wires together

2. Red shrink sleeve + ECU: Battery + / Put all 4 wires together

3. Red shrink sleeve + injection: Battery + / Put the 2 wires together

   **Attention:** Do not connect 2 en 3 together to the same +12V! Use separate switches!

4. Green shrink sleeve: “+” and “-“ to optional fuel pump relay

5. Grey shrink sleeve: 3 wires: (Not used in case data transmission along RS232 or canbus to Efis)
   - white/white: RPM signal (2 pulses/rev. 0 - 12V)
   - white/blue: Fuel consumption (Injector pulse). Output is a duty cycle. 100% is equal to 48l/Hr
   - white/red: fuel consumption (pulses/litre)
     
     48l/Hr = 170Hz (170 pulses/sec)

6. Yellow shrink sleeve: 4 wires:
   - white/green: Common (-): Not used
   - white/red: warning signal in case of ECU over temperature (not used)
   - white/blue: warning signal in case of battery low (<12.5V)
   - white/white: check light:
     When the engine run correctly, the led doesn’t light up.
     When there is a problem with one of the following sensors, the led light up.
     a) Oil temperature sensor b) Inlet air temperature sensor c) Throttle position sensor
d) Altitude sensor (Integrated in ECU)
e) Hall sensor engine start (Sync/Hall1)

7. Ground for cable shielding

8. PC Connector for RS 232 data transmission / UL Read (Male)

9. PC connection for CANBUS data transmission (Female)

10. Connect to ECU
ECU Electrical Wiring Diagram for double ECU
Detailed diagram, for maintenance only
Connection “ECU wiring loom cockpit”, for maintenance only

<table>
<thead>
<tr>
<th>Pos</th>
<th>AWG</th>
<th>Signal</th>
<th>Pin</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>Switchoff ign 1</td>
<td>A</td>
<td>White / White</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>Switchoff ign 2</td>
<td>T</td>
<td>White / Red</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>Switchoff common</td>
<td>U</td>
<td>White / Blue</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>RPM</td>
<td>f</td>
<td>White / White</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>Consumption pulse/litre</td>
<td>j</td>
<td>White / Red</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>Consumption pulse/litre</td>
<td>g</td>
<td>White / Blue</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>Common -</td>
<td>W</td>
<td>White / Green</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>Sensor fail</td>
<td>Y</td>
<td>White / White</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>ECU over temperature</td>
<td>Z</td>
<td>White / Red</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>Battery low</td>
<td>G</td>
<td>White / Blue</td>
</tr>
<tr>
<td>11</td>
<td>20</td>
<td>Fuel pump relay -</td>
<td>J</td>
<td>White / Blue</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
<td>Fuel pump relay +</td>
<td>e</td>
<td>White / White</td>
</tr>
<tr>
<td>13</td>
<td>20</td>
<td>Health</td>
<td>h</td>
<td>White / Red</td>
</tr>
<tr>
<td>14</td>
<td>20</td>
<td>Engine data TX232</td>
<td>B</td>
<td>White / Blue</td>
</tr>
<tr>
<td>15</td>
<td>20</td>
<td>Engine data common</td>
<td>C</td>
<td>White / White</td>
</tr>
<tr>
<td>16</td>
<td>20</td>
<td>12 V Battery injectors</td>
<td>c</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>20</td>
<td>12 V Battery injectors</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>20</td>
<td>12 V Battery +</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>12 V Battery +</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>12 V Battery +</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>20</td>
<td>12 V Battery +</td>
<td>d</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>20</td>
<td>12 V Battery -</td>
<td>K</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>20</td>
<td>12 V Battery -</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>20</td>
<td>12 V Battery -</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>20</td>
<td>12 V Battery -</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>20</td>
<td>12 V Battery -</td>
<td>b</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>CAN H</td>
<td>E</td>
<td>White / White</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>COMMON -</td>
<td>V</td>
<td>White / Orange</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>CAN L</td>
<td>D</td>
<td>White / Blue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eng data out A</td>
<td>D</td>
<td>N.U.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eng data out B</td>
<td>E</td>
<td>N.U.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eng data out common</td>
<td>F</td>
<td>N.U.</td>
</tr>
</tbody>
</table>
ECU

ULPower advise to use “positive lock” connectors for all electrical connections to ensure that connection not become loose because of vibrations.

Make sure ECU and Ignition switches are of adequate quality and are designed for at least 20 Amp DC current. The reason for this is that DC current tends to create a spark each time you switch, which deteriorates the contact points and can cause cheap/low quality switches to fail in time.

Mount the ECU unit in a place where temperatures do not reach over 65°C (preferably on the cabin side of the firewall). Take great care when putting the wiring loom through the firewall not to damage the wiring. Use rubber around the hole and the wiring loom to protect it when installed.

- Use the delivered “silent blocs” to fix the ECU to avoid vibration.
- On the ECU is a small connector for a hose. This is for the “altitude sensor” integrated in the ECU. Install a hose and bring it close to the inlet air filter. (Certainly when you use an extra “Inlet air box”)

Ignition Coils

Mount the Ignition coils on the firewall or the engine mount (on a flat surface). We advise not to mount them right beside the ECU to avoid any possible electrical disturbance. Also don’t mount them on a place where vibrations are generated. This leads to loose contacts inside the coil. The distance between ignition coils and ECU must be at least 100 mm. Also the distance between each of the eight cables and the ECU must be at least 100 mm. Do not mount the plastic back side of the coils straight on the firewall, but leave a small gap by using the brackets (see picture) with which are provided with the coils. Do not exaggerate tightening the 3 bolts holding down the ignition coils in order not to internally distort/twist the units causing possible failure.
Connect connectors on wiring loom as shown below to any of the two coils.

Make up the ignition leads according to the length needed. The necessary parts (covers, clamps and lead) are provided with the engine.

As ignition works with a “lost spark”, you can switch connection 1 and 2 and/or switch connection 3 and 4.
The provided copper clamps are used on one end of each lead and screw into the ignition coil cover. Strip only a few millimetres of the outer plastic of the ignition lead to unveil the inner core. It is advisable to solder the copper clamp onto the lead for good contact. The ignition lead is held and guided behind the point of soldering so no bending and as a result cracking should occur on the soldering.

Push in the lead with the clamp all the way into the ignition coil cover and then screw on the cover with a couple of turns. Make sure the lead is fixed tightly and it cannot be pulled out by a small force.

The ignition coil cover clicks onto the ignition coil. Make sure you get the correct leads going to the correct spark plugs.

The other side of the lead is screwed in the spark plug cover. Cut the lead to the requested length. Do not strip the plastic, but screw the spark plug cover into it. Do not forget to first slide the rubber sealing over the lead before attaching it to the spark plug cover. When attached pull back the rubber to cover the joint and make it moisture proof.

Slide the bottom rubber over the spark plug cap and click the cap onto the corresponding spark plug.

Each cylinder head has 2 spark plugs; each going to a different coil for redundancy.

Cylinder numbering is done from the propeller backwards. See numbering below.
Attention:
First start after installation / maintenance.

- Start the engine with only coil 1 (and ECU 1 in case of redundancy)
- When the engine run very well, stop the engine and start again with only coil 2 (and ECU 2 in case of redundancy)
- When the engine run very well, you can run with both coils together. (ECU1 and ECU2 in case of redundancy)

If you have made a mistake and connect an ignition cable to the wrong spark, you can damage the engine. That’s why you have to test both coils separate.

Alternator & Regulator/Rectifier

Attention!

Because the ULP engine needs continue power to the ECU to run, it’s very important that current is available at any moment. We strongly advise to use a good battery and to measure the voltage. Also install a warning system to warn the pilot if the voltage drops below 12 VDC. When the alternator fails, you are able to fly another 40-45 minutes with a good and full charged battery.

Note: while starting the engine in cold weather, the voltage can drop temporal under 12V and generate a warning signal. When the alternator work properly, the warning signal must disappear after 10-20 sec while running at 1500 Rpm or higher.

Do not install unnecessary protective devices for the alternator and the regulator rectifier.

The UL350 has a permanent magnet 3-phase alternator (1) integrated at the back of the engine. It provides current to all connected electrical consumers and/or charges the battery. The AC output from the alternator is converted and regulated into approximately 14.5V DC by an external regulator/rectifier that is provided with the engine.

The regulator/rectifier or RR (2) should be placed on the firewall (or elsewhere) in such a manner that the rear metal surface makes good contact over the entire surface with the metal firewall in order to aid in dissipating the heat coming from the RR. Special thermal interface material or “thermal pads” between the bottom (shiny surface) of the RR and the metal fire wall can help to increase heat transfer.
Connect regulator/rectifier to the battery and the 3 electrical wires (3) (which are usually grouped together in a protective sheath) coming from the alternator as shown on the right (plastic connectors and metal pins are provided).

Make sure all wires, pins and connectors are properly connected and make good contact. Use electrical conductors with a cross section of at least 12AWG to connect to battery. Fasten wires to engine mount/firewall in such as way to minimise vibration. Vibration is a major cause of connection and wire breakage. Keep them well away and shielded from the exhaust.

Since the permanent magnet 3-phase alternator provides a constant current, which is only depending on engine rpm, a “shunt’ regulator/rectifier is used. As the overall power usage for the engine and accessories used in recreational aircraft is usually relatively low, the use of a shunt type is the simplest and most reliable type of regulator with fail safe characteristics. A disadvantage of a permanent magnet alternator is that it is always providing the electrical current associated with the rpm which is independent of the actual current needed at any particular moment, making it run hotter than it would actually need to be. After the engine’s starting and once the battery is again fully charged and its voltage reaches a certain fixed value, the thyristors in the shunt regulator actually short the generator windings to ground (dump the load) in a pulsating like fashion which generates heat in the regulators components and which must be dissipated by its outside surfaces to the surrounding environment to prevent the regulator/rectifier from overheating and malfunctioning.

Although the cooling fins of the RR are presumably large enough to ensure proper cooling on their own, the RR manufacturer would undoubtedly expect that the RR is placed in a well ventilated and relatively cool environment. If the firewall is made of wood or other non heat conducting material with the fire proofing obtained by use of special coatings, metal foil etc. it is possible that this type of surface does little or nothing to aid in heat transfer. Placing the RR in the cabin against a surface covered with carpet for example, could create serious troubles. As with most electrical components, overheating will cause failure!

Therefore the RR must be situated in a relatively cool area of the engine compartment with sufficient cool air ventilation. Ideally the RR should be placed in a constant stream of cool air to make sure heat dissipation is always at its maximum. The pictures on the right show an example of cooling air being ducted from the cylinder head baffles directly on top of the RR.
Recommended diagram

Attention:
Output regulator must always be connected to the battery! Do not run the engine when regulator is disconnected from the battery, this should destroy the regulator. If you want, for any reason, run the engine without charging the battery, you have to disconnect (or install a switch) the 3 wires from the alternator.

We advise to install a capacitor 68.000 µF (ULP n° E053010) parallel on the battery to ensure power to the +12V bus in case of open contact in the battery.
Starter motor

The electric starter engine (1) is mounted on the top of the engine and drives the ring gear (2) at the back of the engine. The motor is activated by engaging the starter button (the master switch has to be on) which trips the integrated solenoid (3), hence current flows from the battery to the motor.

Connect the plus terminal coming from the battery to the solenoid (see image below left) with a cable of at least 25mm² (3AWG). Use an M8 lock nut. Wiring for the starter button should be at least 1.5mm² (14AWG or smaller). Make sure to insulate both connections to prevent short circuit by touching with a metal object and making contact with the engine/ground!

Ground to starter motor and solenoid is provided via engine block. Ground cable is attached to engine mount plate with an M6 bolt (see image above right). Cable thickness should be at least 25mm² (AWG 3).
Battery

In a standard installation there has to be one battery of 12V/18Ah. / Starting current 140A
Battery must always be connected to the system however, for safety reason, you can install a capacitor parallel on the battery (see also “recommended diagram)
Explanation: ECU need a “flat” voltage power to want properly running the engine without battery. (Or with an open constant in side) should let to a bad working ECU and maybe engine stop. Also the regulator should fail. The capacitor taken over the function of the battery to “flat” the voltage power.

Additional wiring

The ECU (Engine Control Unit) used for the UL350 engine has been specially developed, and thoroughly tested. Every possible “over voltage” or short-circuit has been simulated to be sure that the ECU goes on working in every condition.
However, for extreme safety, we offer a completely redundant, dual channel ECU combination. (See Double ECU)
**Instruments**

**Recommended Sensors**

In order to operate the engine within the specified limits of the operating handbook, operator should at least monitor following parameters:

- RPM
- Oil Pressure
- Oil Temperature
- Fuel Pressure
- CHT
- EGT (optionally)
- Manifold Pressure (optionally)
- Battery Voltage / ECU Voltage
- Amp (optionally)

UL Power install standard following sensors:

- RPM
- Oil Pressure
- Oil Temperature
- Fuel Pressure
- ECU Voltage
- Inlet air temperature
- Throttle Position
- ECU Temperature
- Atmospheric Pressure

A. Having an EFIS, all this data can be transmitted along RS232 or canbus from the ECU to the EFIS. The only sensors customer need to install are: CHT and EGT (+ optional MAP).

Note: UL Power offers optional an “AUX Box”. In this case UL Power install CHT, EGT and MAP sensors and connect them to the “AUX Box” which is connected to the ECU. Having an EFIS, all necessary data is transmitted and customer do not have to install any sensor.

B. If data transmission along RS232 or canbus is not possible, not desired, customer have to install himself recommended sensors.

In this care you have to order K10 000 01: Oil & Fuel pressure kit – NO EFIS
Oil Temperature

Recommended specifications
- Range up to at least 130°C (266°F)
- Thread 5/8"-18UNF or M10; M10x1; M12x1,5; 1/8NPT if adapter plug (option) is used.

The oil temperature is measured on the left side of the crankcase. (See picture)

A temperature sensor with 5/8"-18 UNF thread combined with a sealing ring can be screwed in. This sensor will indicate the oil temperature in the cockpit. Sensors with M10; M10x1; M12x1,5 or 1/8 NPT thread can also be used with an adaptor plug. These adaptor plugs are available from ULPower if needed. (See accessories/parts)

Make sure nuts/sensors are properly sealed, making sure that the oil can’t leak of the engine!

Oil Pressure

Recommended specifications
- Range 0-10bar (0-150psi)
- Thread 1/8"NPT

The oil and fuel pressure sensors shown are passive analogue sensors of the resistive type. Active 12V solid state sensors are more expensive but are much less sensitive to vibration and therefore more reliable. However only certain instruments will accept active pressure sensors.
The oil pressure sensor should not be directly screwed into the engine block, and is therefore connected by means of a flexible pressure line in order to avoid sensor failure due to engine vibrations. The sensor can be attached to the engine mount frame or the firewall.

Oil pressure is measured in the main oil gallery at the top side of the engine casing, where M12x1.5 thread is foreseen.

An oil pressure sender line kit consisting of 1m Stainless Braided PFE Hose, Oil Pressure Sensor Adaptor (2), 90° Reusable-3Jic Swivel (3) with nipple (4) and Copper Sealing Ring (5) comes with the option. The length of the line will depend on where you would like to install the sensor. Determine the length and assemble the line as follows:

- Apply tape around the hose at the point you wish to cut it to length. This way the stainless steel braid will stay in position and doesn't unravel; a cleaner cut is obtained.
- Cut hose with a metal saw or grinding disc in such a manner that a nice straight end is obtained.
- Unscrew the socket screw (4) of the oil pressure sensor fitting (6). Be careful not to lose the brass cone (5) that sits inside.
- Before removing the tape, slide the socket screw over the hose including the stainless steel braid.
- Remove the tape.
- Open the stainless steel braid towards the outside to free the end of the inner plastic tube. As shown on the image above. Do not unravel the braid too much.
- Slide/push the brass cone (5) over the plastic tube all the way to the end.
- Push the oil pressure sensor adaptor fitting (6) into the tube.
- Pull back the socket screw towards the fitting and screw onto the fitting as far as possible. Make sure the steel braid does not go in between the thread. Use two spanners - one to hold fitting, the other to tighten the lock screw.
- Repeat on other side with the banjo fitting.
- Clean the oil pressure line thoroughly to ensure no metal, rubber or other particles are inside before connecting the line.
Once oil line is assembled, connect it to the engine. Tighten banjo bolt and washers to ensure proper sealing. However, be careful not to damage thread in casing by over tightening the banjo bolt.

**Fuel Pressure**

Recommended specifications for fuel pressure sensor:
- range: 0-5 bar (0-80 psi)
- thread: 1/8"NPT

Change banjo bolt (F2551200) from the fuel connection kit to the banjo bolt with 1/8NPT (E064502). This bolt is screwed on top fuel fine filter.

The pressure sensor need to be screwed in the banjo bolt. (see picture)

**CHT**

Ideally all 4 CHTs should be measured. Alteratively at least 2 CHTs (the hottest one on each side of the engine; most probably CYL3 and CYL4 in a tractor configuration) should be monitored and kept within limits.

CHT Bayonet style probes by ULPower are recommended. See accessories/kits. Bayonet adaptor (3/8"UNF) is integrated. Each cylinder head has a pre-drilled hole close to the exhaust port to monitor CHT.

It is very important that a “spring loaded” sensor is used to be sure the sensor really touch the aluminium in the bottom of the hole.

Alternatively 14mm gasket ring type CHT-probes can be used under sparkplugs, but cooling air flow over the cylinder heads can give different readings when compared to CHT probes which are sunk into the cylinder head material.

★ **Attention:** It is recommended to measure all cylinder heads as temperatures can fluctuate according to the airflow over the cooling fins. Checking the individual temperatures can also give an indication of arising problems so precautionary measures can be taken.
EGT

Although one cannot do much (apart from changing the throttle) on the ULPower engine to influence the EGT, monitoring all EGTs will provide the pilot with an immediate indication that things might not be normal. If one EGT reading becomes substantially higher or lower, this is an indication that something is wrong. A higher than normal EGT could mean less fuel (leaner and hotter mixture) is being supplied - which could be caused by a partially blocked fuel injector. Perhaps there is a leak in the induction manifold and extra air is being drawn into this cylinder making its mixture leaner and hotter. Lower than normal EGTs are indicative of richer than normal fuel mixtures. This could be caused by a fuel injector which does not close completely in between cycles, or a blockage in the inlet manifold causing less air to be drawn into the cylinder.

Measuring one EGT can only tell you that that specific cylinder is running properly or not. It might be wrong to conclude that what you measure is representative for all cylinders.

No holes are predrilled in the exhaust so you are free to choose the type you prefer (probes with clamps or thread), however we recommend to use the ULPower EGT probes. See accessories/kits. Usually temperatures are measured roughly 7cm (3in) from the beginning of the exhaust piping.

Manifold Pressure

A MAP sensor can optionally be installed to give you an indication of how much power you are actually using. The power produced is a function of the MAP and engine rpm. A suitable flexible hose connected to a MAP sensor can be attached to the manifold with a double banjo to the inlet collector, (option) instead of the single one supplied for the fuel pressure regulator.

Battery Voltage

Battery voltage will indicate if the alternator is working properly. If it is charging, the voltage should be above 14V. If you are consuming more that what the alternator can deliver or in the rare event the alternator or regulator/rectifier has failed, the battery voltage will drop. If voltage goes below 12V be warned and land as soon as possible. Engine will stop once battery voltage goes below 10V!

Electrical Current

An amp meter can also be installed to precisely measure the amount of electrical current the alternator is delivering.
**Propeller drive**

The UL350 is a direct drive engine. The propeller is mounted on the propeller flange which is directly connected to the crankshaft; no gearbox or belt reduction is used. The propeller flange is fixed to crankshaft with a splined connection to take the torque loads and is held in position by a single central bolt. The bolt is locked with a special locking washer. A large ball bearing is used as thrust bearing which is held in position by two disc springs and a spacer ring. This assembly allows engine to be used in either tractor or pusher configuration. Engine turns clockwise when seen from cockpit in tractor configuration.

The propeller must be carefully selected to match the airframe and the engine characteristics. The hub of the propeller must be drilled with holes to match the flange. 6 propeller drive lugs are provided with the engine. These are made to have a tight fit in the propeller flange holes.

ULPower offers different types of propeller flanges.

1. **Standard Flange**
**Attention**: When not using the ULP standard flange, please make sure to install propeller reduction and propeller flange (See Picture)

Installation of item 2 is mandatory for a good propeller performance

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Propeller Flange</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Propeller Reduction</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Drive Lug</td>
<td>6</td>
</tr>
</tbody>
</table>

1. SAE I - F – Flange: **E022550 L055 / E022550 L090 / E022550 L110 = assembly**

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Partnumber</th>
<th>Name</th>
<th>Plasty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E022520C</td>
<td>Propeller flange SAE</td>
<td>L = 55 F - Flange 1</td>
</tr>
<tr>
<td></td>
<td>E022521C</td>
<td>Propeller flange SAE</td>
<td>L = 50 F - Flange 1</td>
</tr>
<tr>
<td></td>
<td>E022522C</td>
<td>Propeller flange SAE</td>
<td>L = 110 F - Flange 1</td>
</tr>
<tr>
<td>2</td>
<td>E022535A</td>
<td>Propeller reduction F - Flange</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>E022602A</td>
<td>Drive lug F - Flange (SAE 1)</td>
<td>6</td>
</tr>
</tbody>
</table>
2. SAE VI - B – Flange : \textit{E022551 L055 / E022551 L090 / E022551 L110 = assembly}

![Diagram of SAE VI - B Flange]

<table>
<thead>
<tr>
<th>No.</th>
<th>Part Number</th>
<th>Name</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E0225510A</td>
<td>Propeller flange SAE VI or VII L = 55 B or C Flange</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>E0225510A</td>
<td>Propeller flange SAE VI or VII L = 90 B or C Flange</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>E0225510A</td>
<td>Propeller flange SAE VI or VII L = 110 B or C Flange</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>E0225510A</td>
<td>Drive lug B - Flange (SAE VI)</td>
<td>6</td>
</tr>
</tbody>
</table>

3. SAE V - C – Flange : \textit{E022552 L055 / E022552 L090 / E022552 L110 = assembly}

![Diagram of SAE V - C Flange]

<table>
<thead>
<tr>
<th>No.</th>
<th>Part Number</th>
<th>Name</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E0225520A</td>
<td>Propeller flange SAE V or VIII L = 55 B or C Flange</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>E0225520A</td>
<td>Propeller flange SAE V or VIII L = 90 B or C Flange</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>E0225520A</td>
<td>Propeller flange SAE V or VIII L = 110 B or C Flange</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>E0230300A</td>
<td>Drive lug C - Flange (SAE V)</td>
<td>6</td>
</tr>
</tbody>
</table>

Propeller selection

Propeller with Rotational Moment of Inertia of up to 0.8kgm² has been used with no known problems up to date.

An all wooden propeller is recommended to absorb engine vibrations. However a few composite propellers have been used with no known problems up to date.

**WARNING:** Never use the engine without a propeller. Damage will occur in this state.

In case of using a ‘constant speed propeller”, only an electrically commanded propeller can be used. ULPower can optionally deliver a bracket to mount the electrical contacts.

Part n° E022007

Install the bracket as shown in the picture. Starting from these you have to build up another bracket according to your propeller and the electrical contacts.
Annex A

Fuel header tank

ULP Partnr.: E066030
Revision

Revision 8 (2015-12-15)
- Fuel Injection system
  + Pg 21: Electrical Wiring Diagram
  + Pg 22: Keep the nipple ... + Pictures

- Lubrication System
  + Pg 35, 36: New oil cooler kit
  + Pg 35: Keep the nipple ... + Pictures

- Electrical system (single ECU)
  + Pg 41 No5: White/White: RPM Signal (2 pulses/ Rev 0-9V)
    White/red : fuel consumption (pulses/litre)
    48l/Hr = 170Hz (170 pulses/sec)
  No8: PC connector for Data transmission.
  + Pg 41: ECU Electrical Wiring Diagram for Single ECU

- Electrical system (double ECU)
  + Pg 48: No5: White/White: RPM Signal (2 pulses/ Rev 0-9V)
    White/red : fuel consumption (pulses/litre)
    48l/Hr = 170Hz (170 pulses/sec)
  No8: PC connector for Data transmission
  + Pg 52: Detailed diagram for maintenance only
  + Pg 54: Use Silent Blocs on the ECU BOX
  + Pg 59: Recommended diagram

Revision 09 (2016-09-15)
- Pg 16: new version of the Engine mount pin
- Pg 21: remark under “Attention”
- Pg 24: use “press-on kit” => Push on kit is delete
- Pg 29: the way of install the exhaust tube on the muffler.
- Pg 29: The 4 in one collector
- Pg 34: “a remark” above the “end note”
- Pg 39: A new acro system.
- Pg 46: Fuse 15A (20A)

Revision 10 (2017-10-19)
- Pg 8: Specifications
- Pg 14 - 17: Engine Views HPS
- Pg 18: Weight of basic standard engine and accessoires
- Pg 46: e (nr6): Hall Sensor engine start
- Pg 53: e (nr6): Hall Sensor engine start
- Pg 59: Titles “ECU” and “Ignition Coils”
- Pg 59: Attention
- Pg 61: battery: => Explanation
- Pg 75: Propeller selection: 0,8km² (0,6km²)
Revision 11 (2018-06-01)

- Pg 08: Fuel : UL91
- Pg 19: Transport picture
- Pg 20: Note
- Pg 24: Electrical Wiring diagram
- Pg 25: Important...
- Pg 26: Press-on kit is deleted
- Pg 26: Reusable Kit Nr 3.: =>1/8NPT to connect (Fuel Pressure Sensor deleted) = anti return valve
- Pg 42: Nr 3. PC connector for UL-Check, prog ULP deleted
- Pg 43: Nr 8. + UL Read
- Pg 43: Nr 9. PC connects for Canbus data transmission
- Pg 43: new wiring loom
- Pg 44: ECU Canbus
- Pg 45: Aircraft wiring deleted
- Pg 45: Oil Pressure Sensor + Fuel Pressure Sensor + ECU Canbus
- Pg 46: Nr 3.: Pc connector for AUX-Box
- Pg 47: Nr 8.: PC connector for UL-Read
- Pg 47: Nr 9. PC connects for Canbus data transmission
- Pg 47: new wiring loom
- Pg 49: 2x Fuel Pressure Sensor and 2x Oil Pressure Sensor + 2x ECU Canbus
- Pg 49-50: Aircraft wiring deleted
- Pg 51: Indicative Altitude sensor
- Pg 52: Connection Spark plug
- Pg 56: Recommended diagram
- Pg 57: Cable thickness 25mm² was 16mm² (5AWG => 3AWG)
- Pg 58: Picture battery connected:
- Pg 59-62: Instruments

Revision 12 (2018-12-01)

- Pg 26: Special attention for aerobatic engine
- Pg 28: Air intake system: Take care to bring fresh air ...
- Pg 41: Oil Supply aerobatic engine
- Pg 41: Distance oil sump - oil air separator
- Pg 43: nr 5: not used in case data transmission ...
- Pg 47: nr 5: not used in case data transmission ...
- Pg 65: Attention + Picture