



Installation manual
SPIRIT and
SPIRIT Turbo engines

Document
E-DMA.E10.1

Edition
A

Revision
3



INSTALLATION Manual for
SPIRIT and
SPIRIT Turbo engines

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In-flight use of the engine certifies that the user has read and understood the contents of the installation manual and the operating manual. Failure to follow the instructions contained herein can cause serious injury and even death. Refer to the aircraft instruction manual for additional information.

All information, illustrations, instructions and technical data contained in this manual has been upgraded before printing. MWfly reserves the right to modify, correct or upgrade general data at any time without any obligation or prior consent from third parties. Publication of any part of this document without written consent of MWfly is strictly prohibited. This Manual forms part of the engine and must be kept safe. It must accompany the engine in case of sale to a new owner. The original document

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is written in Italian and this language will be used to settle any dispute of a legal or technical nature.

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01-00-00 INTRODUCTION

The **SPIRIT** and **SPIRIT Turbo** series of engines are designed and manufactured using the most modern motor technology with the purpose of achieving good performance combined with a high level of passive safety. If the engine is used correctly it will return years of pleasure and reliable service.

Please read this manual carefully before using the engine and apply all safety standards contained in it, in addition to those that your experience and common sense suggest.

MWfly will be happy to provide additional information and all the technical support you will need.



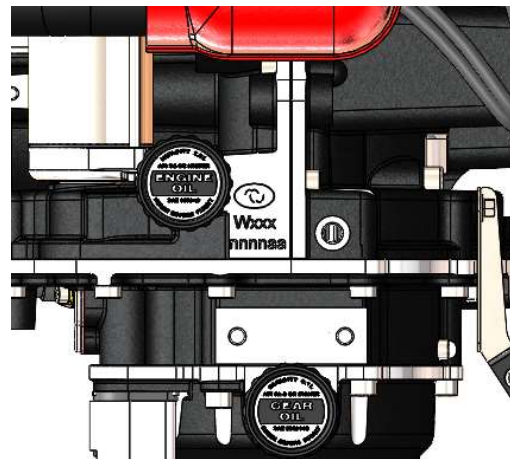
Unless otherwise specified, the engine is delivered without engine oil, gear oil and coolant. Before starting the engine, you must fill of systems.



The engine must be started only after the installation is completed and with propeller mounted: not doing so will cause serious damage to the starter system.

01-01-00 Identification Data

The engine serial number is stamped on the top of the engine, near the gearbox. It consists of the model identification code (72-02-C) followed by a six-digit number, of which the first four indicate the serial number and the last two indicate the year of manufacture.



01-01-P

Removing or modifying the serial number will revoke any warranty and obligation by MWfly toward current owner.

Provide the serial number on any request for an engine part or technical information.

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01-02-00 Documentation

01-02-01 Notes for Consultation

This manual describes how to install the **SPIRIT** and **SPIRIT Turbo** series of engines. Prior to commencing work on engine installation, it is crucial to read and understand the contents of this document. This manual contains all basic information for correct installation and safe operation.

If any steps prove difficult to understand or there is any doubt, please contact an authorized MWfly Service Centre.

For additional or more detailed information consult the Operational Manual, the Maintenance Manual and the Additional Maintenance Manual.

It is fundamental to integrate the information of this manual with the safety precautions of the aircraft manufacturer and with safety conditions from your personal experience.



This engine has not received any certification for aeronautical use. It must be used exclusively on experimental aircraft where an engine failure will not compromise flight safety. Its use in cetified aircraft is strictly prohibited.



Engine installation must be done taking into consideration the governing aviation law, rules and regulations in force in the country where the engine will be used.

This manual was originally printed in Italian. This will be the only language used for any reference or dispute.

The manual is divided into chapters; each chapter is divided into sections; each section is divided into paragraphs; within each paragraph there may be a further subdivision into topics. The title of each chapter, section, paragraph or topic is highlighted as follows.

CHAPTER

Section

Paragraph

Topic

The numbering system of the contents of the manual consists of a numerical code using the following criterion.

The content of each document is numbered and divided as follows.

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CC-SS-PP

where

CC indicates the chapter of the document
SS indicates the section of the document
PP indicates the paragraph of the document

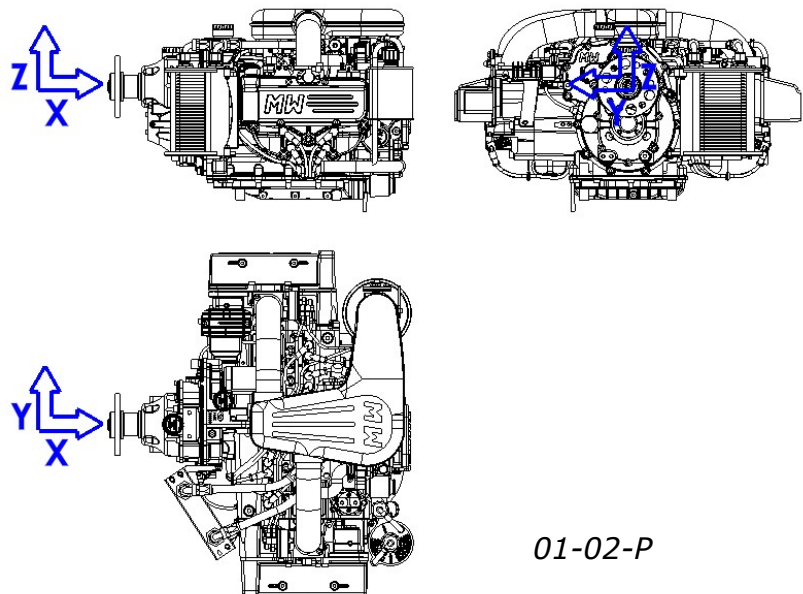
The subdivision into CC (chapters) will follow the ATA-100 scheme. The subdivision of the first digit of each section will also respect the ATA 100 scheme; the second digit of each section is assigned by MWfly, to correctly subdivide the topic.

Within each section, the numbering in paragraphs will follow a progressive numbering, starting from number 01.

The illustrations in this manual depict naturally aspirated engines if the information provided is common to turbocharged versions; if the information applies only to turbocharged engines, the illustrations depict the latter.

The identification of the figures and tables shows the chapter number and a progressive number, followed by the letter P for the figures and the letter C for the tables (e.g. 21-03-P).

The triad of reference axes used in the manual is a right triad that originates on the helix axis, at the intersection with the helix support plane: the x axis originates on the support plane of the flange itself and is positive in the direction of the engine, the y axis is positioned with origin on the centre line of the engine and is positive in the direction of the cylinder bank # 1, the z axis originates on the propeller shaft and is positive upwards, on the intake manifold side.



01-02-P

Symbols used in this manual have the following meaning.



WARNING: Not following this instruction can cause severe personal injury or loss of life.



CAUTION: Not following this instruction could cause severe damage to the engine or other components and cause the engine to stop.

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NOTE: Refers to supplementary information to completely or fully understand the instruction.

- 1., 2., ... This numbering is used to list tools and consumables needed to run an installation or maintenance; it is also used to bring in parts lists or engine parts shown in the illustrations.
- a., b., ...** This lettering is used to indicate a list of actions or subjects with relation to inclusion: all of the actions or options listed must be verified.
- This symbol is used to indicate a list of actions or subjects with relation to exclusion: only one of the actions or options listed with this symbol must be verified.
- This symbol is used to list the general characteristics of the engine, component specifications or options for installation or maintenance.
- (...) A text enclosed in brackets clarifies an aspect, or constitutes an example or a reference to a chapter of the same or another document (e.g. DMB.E10.2.3).

01-02-02 Unit of Measure

All the units of measurement reported in this and other MWfly manuals are expressed in technical units (ST), judged to be more usable and understandable than the units of the International System (SI). Table 01-01-C shows the conversion factors between the technical units used in compiling the manuals, the equivalent units of the International System and the equivalent units of the Imperial System. To obtain from the quantities expressed in technical units the corresponding value in For S.I. or Imperial simply multiply by the coefficient shown in the tables. As an example, we report some conversions.

$$100CV = 100 * 0,735kW = 73,5 \text{ kW}$$

$$100CV = 100 * 0,986Hp = 98,6 \text{ Hp}$$

$$82 \text{ Kgf} = 82 * 9,81 \text{ N} = 804,42 \text{ N}$$

$$82 \text{ Kgf} = 82 * 2,205 \text{ lb} = 180,8 \text{ lb}$$

If in doubt about the meaning of the measurements, their value or interpretation, contact an authorized MWfly service centre. If measurements made on the engine or relating to it refer, these must be expressed in units consistent with the Technical System used in the manuals, which is the only one adopted by MWfly.

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CONVERSION FACTORS BETWEEN MEASUREMENT SYSTEMS			
Type of measurement	ST Unit	S.I. Unit	Anglo-saxon unit
<i>Length</i>	cm mm	m = 100cm = 1000mm	ft = 30,48cm = 304,8mm in = 2,54cm = 25,4mm
<i>Surface</i>	cm ² mm ²	m ² = 10 ⁴ cm ² = 10 ⁶ mm ²	sq ft = 77,42cm ² = 7741,9mm ² sq in = 6,45cm ² = 645,16mm ²
<i>Volume</i>	cm ³ mm ³	m ³ = 10 ⁶ cm ³ = 10 ⁹ mm ³	cu in = 16,3871cm ³ cu ft = 28316cm ³
<i>Capacity</i>	L	m ³ = 10 ³ L	gal (UK) = 4,5461L gal (US) = 3,7854L
<i>Mass</i>	Kg g	Kg = 10 ³ g	lb = 0,453Kg = 453g
<i>Weight</i>	Kgf gf	N = 9,81Kg = 9814g	lb f = 2,205Kgf = 2205gf
<i>Density</i>	g/cm ³	Kg/m ³ = 10 ⁻³ g/cm ³	lb/ft ³ = 62.43g/cm ³
<i>Flow Rate</i>	m ³ /h m ³ /min m ³ /s	m ³ /s = 1/3600*m ³ /h m ³ /s = 1/60*m ³ /min	cu ft/s = 0,0284 m ³ /s
<i>Force</i>	N	N	lbf = 4,448N
<i>Pressure</i>	bar mbar	Pa = 10 ⁻⁵ bar = 10 ⁻² mbar	psi = 0,0689bar = 68,9mbar in Hg = 0,0338bar = 33,8mbar
<i>Torque</i>	Kgm	Nm = 9,81Kgm	ft lb = 0,138Kgm
<i>Power</i>	CV	kW = 0,735CV	Hp = 0,986CV
<i>Fuel Consumption</i>	g/CVh	g/kWh = 1,359g/CVh	lb/Hph = 447,59g/CVh
<i>Time</i>	s min h	s = 1/60min = 1/3600h	s
<i>Velocity</i>	m/s Km/h	m/s = 1/3,6Km/h	kn = 1,852Km/h = 0,514m/s
<i>Temperature</i>	°C	K = °C-273,15	°F = (1,8*[°C])+32

01-01-C

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Table 01-02-C shows the conversion between the section of the electrical cables, expressed in square millimetres, and the corresponding AWG measurement, most commonly used by installers.

ELECTRICAL CABLES SECTION CONVERSION									
<i>mm²</i>	21,200	13,300	8,350	5,270	3,310	2,080	1,310	0,820	0,519
<i>AWG</i>	4	6	8	10	12	14	16	18	20

01-02-C

01-02-03 Technical Documentation Available

The technical documentation and directives are to be considered a necessary tool for personal training, but they cannot in any way replace adequate specific instruction, both theoretical and operational

The information provided in the following manuals contains procedures and checks that can be carried out by qualified professionals operating in the sector.

- DMA.E10 - Installation manual: contains the information necessary for the proper installation of the engine.
- DMB.E10 - Operating manual: contains the information necessary for the proper use of the engine.
- DMC.E10 - Ordinary maintenance manual: contains the information necessary for the compliant execution of scheduled maintenance.
- DMD.E10 - Extraordinary maintenance manual: contains the information necessary for the execution compliant with unscheduled maintenance, i.e. determined by failures.
- DME.E10 - illustrated spare parts catalogue: contains the list of spare parts and accessories expected.
- DSL.E10 - service letter: contains information aimed at improving the product or use of the same.
- DSB.E10 - Service bulletin: reports the substitutions, checks or warnings to be applied within the indicated deadline.



The variety of installations can make the information contained in the aforementioned manuals inapplicable, inadequate or insufficient.

The illustrations in this manual do not represent in detail the details of the engine, but provide an indication of their function and structure: for these reasons it is not possible to deduce dimensional information or verify details from the published illustrations.

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All further necessary documentation is however available at the MWfly authorized service centres.

01-03-00 Safety

Just reading this manual will not eliminate the hazards connected to the installation and use of the engine. However, understanding and applying the information herein is essential for proper and safe use of the engine.

The onus to install this engine is at the sole discretion and responsibility of the Original Manufacturer, Home Builder or Aircraft Owner. MWfly cannot assume responsibility for a successful installation in a specific airframe due to the variety of designs existing in the market. For this reasons MWfly declines responsibility regarding damage to engine parts, accessories or aircraft structure during the installation and use of this engine. The owner accepts the responsibility and the risk in using this engine.

The information, components, system descriptions, pictures, tables and technical data contained in the present manual are correct at the time of publication. MWfly, however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on its products previously manufactured: should such an eventuality arise, MWfly, through its distribution and assistance network, as well as through the website www.mwfly.it, will disclose the mandatory nature of any update.

MWfly reserves the right to make changes at any time, without notice and without incurring any obligation. No part of this publication may be reproduced without written permission.

To carry out installation or maintenance work, use the consumables, accessories and tools specifically provided and detailed at the beginning of each paragraph.

For your safety, here are some important tips, suggested by common sense and by the usual norms of prudence, without however being able include all of the situations or behaviours that constitute opportunities for potential risk.



Installation or any kind of adaptation not performed in accordance with the technical requirements of the manuals or by staff not authorized to operate on the product itself are a source of grave danger and releases MWfly from any obligation and responsibility to the user.



Never operate the engine in an enclosed space. The exhaust fumes contain carbon monoxide, a very poisonous gas, which if inhaled in excessive quantities quickly leads to loss of consciousness and death.



Carry out an adequate inspection before starting the engine for the first time: this helps to prevent accidents or damage. In case of doubt about installation first contact an authorized service centre.

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MWfly SPIRIT engine is not suitable for aerobatics.



The technical documentation and guidelines are considered a necessary tool for staff training, but cannot in any way substitute for adequate specific instruction, either theoretical or operational.



For the engine installation, strictly follow all laws and national and local regulations.



Only authorized and technicians trained on the product are qualified to work on the engine.



Before starting the engine for the first time, make sure you have filled up the engine with engine oil, gear oil and coolant.



This engine has received no airworthiness certification, nor is it subject to any aeronautical standards. Its use is intended for experimental aircraft or certificates, on which a possible engine failure does not affect the flight safety. You assume all risks arising from the use of the engine and recognize and are aware of the foregoing.



The engine is intended for daytime use only.



Do not start the engine without the propeller: this may cause serious damage to the engine.



Do not use, under any circumstances, propellers with moment of inertia greater than specified: this will release MWfly from any liability and all warranty obligations.



Improper installation and the use of unsuitable components for the fuel supply system, the cooling and the lubrication system releases MWfly from all liability.



All caps placed to protect against the entry of foreign bodies into the engine must be removed during installation just before connecting the accessories.

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This installation manual is part of the technical documentation and must be integrated with the operating manual, the maintenance manual, the heavy maintenance manual and the illustrated spare parts catalogue. When reading this manual, pay attention to references to parts of other manuals.

When there are differences between what is specified in this manual and local regulations, you must proceed under the more stringent rule.

01-04-04 Modifications and Accessories



Any change or removing parts of the engine is potentially dangerous: in particular the replacement of engine parts with non-original parts can seriously affect the technical characteristics and reliability of the engine.



Any type of modification, replacement or removal of the engine parts that are not approved in advance in writing by MWfly, causes the immediate revocation of the guarantee and releases MWfly from any further obligation or liability to you.

MWfly accessories have been specifically designed and tested for use with this engine: since MWfly cannot proceed to test all aftermarket accessories, you are responsible for the proper selection, installation and use of the above. For the correct accessory choice, pay attention to the following requirements.



Carefully examine and verify that the accessory does not interfere with any moving part of the engine, especially with the throttle and the propeller.



For no reason intercept or modify the electrical wiring of the engine, or change the mapping tables of the ECU (engine Control Unit).



Avoid installing accessories that hamper the flow of the engine coolant.



In the installation of electrical or electronic equipment, check that the total requirement does not exceed the electrical output from the generator.

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Any electrical load must be connected to the battery terminals with the interposition of a suitable fuse, better still, a restorable type (breaker).



The use of non-original accessories and those not specifically approved in writing by MWfly, causes the immediate suspension of the guarantee and releases MWfly from any further obligation to you.



Mounting accessories in points not indicated that involve the removal or loosening of clamping screws, causes the immediate suspension of the guarantee and releases MWfly from any further obligation or liability to you.



For the installation and maintenance activity use the consumables, detailed accessories and tools listed at the beginning of each paragraph.

In particular, the user assumes all risks arising from the use of the following accessories, if not original:

- exhaust system
- anti-vibration mounts
- water radiator and related pipes
- engine oil cooler and related pipes
- gearbox oil cooler and related pipes
- fuel pump
- fuel filter
- air filter
- auxiliary generator
- Turbo engines – intercooler and silicone pipes connecting to the engine

01-05-00 Tools and Consumables Required

Below is the list of the minimum set of tools and consumables required to complete the installation. Before starting work make sure that you have everything you need.

01-05-01 Tools Needed

- T-handle allen key 3 mm
- T-handle allen key 5 mm
- T-handle allen key 6 mm
- T-handle allen key 8 mm
- Open end wrench 7 mm
- Open end wrench 10 mm
- Open end wrench 13 mm

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- Open end wrench 17 mm
- Open end wrench 19 mm
- Torque wrench 20-100 Nm
- PHILLIPS screwdriver 4 mm
- Slot head screwdriver 4 mm
- Half-round nose plies

01-05-02 Consumables needed to complete the installation

- Medium threadlocker
- Weak threadlocker
- Technical Vaseline

01-05-03 Materials Needed to Complete the Installation

- 4 screws - M10x1.5 to fix the engine with self-locking nut and locknut and shim
- 1.2mm accelerator cable with relative terminals
- Hose 8mm internal diameter for fuel system 3.5 bar and its clamps
- 4 banjio and 4 banjio bolts M12x1.5 for fuel system
- 1 banjio and 1 banjio bolts M12x1.5 for crankcase vapor vent hose (blow-by)
- Ground cable AWG 5 (17 mm²)
- Power cable for starter AWG 5 (17 mm²)
- Ethylene glycol ~5 L
- Engine oil ~4 L
- Gear box oil ~1 L
- Fuel valve
- Master key switch
- 2 ON-OFF latching panel switches
- Start button
- 2 20A braker for fuel pumps
- 1 20A ON-OFF switch for auxiliary fuel pump
- 2 LEDs for ECUA and ECUB status lights

If you do not use all the original components provided in the catalogue, in addition to the above-mentioned material you must add the following:

- Coolant radiator
- Pipes, fittings and clamps for liquid cooling system internal diameter 32 mm
- Coolant radiator
- Pipes, fittings and clamps for oil cooling system inside diameter 7 mm
- Oil cooling system radiator
- Exhaust system complete with manifolds muffler, springs and clamps
- Turbo Engines - Possible silicone hoses for remote intercooler positioning

The characteristics of these materials are reported in the respective paragraphs of this manual.

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01-06-00 Storage

When stored in the delivery condition, the engine is protected against corrosion for a maximum period of 6 months from date of shipment.

The corrosion warranty is valid for maximum storage period 6 months and under the following conditions.

- a.** The engine should be stored in its original packaging and unopened.
- b.** All covers to protect the engine must not be removed.
- c.** The storage and transport temperature must never exceed 45 °C, nor go down below -10 ° C.



In case of a prolonged period of storage before installation over 6 months, it is necessary to carry out all the required checks and operations.

01-06-01 Protection Covers

All openings are protected against ingress of foreign bodies: it is recommended to not remove the caps until installation is completed. Keep the covers for future reuse.

List of Protection Covers

- Crankcase vent door
- Cylinder exhaust opening (aspirated engines) or on the exhaust terminal (Turbo engines)
- Inlet and outlet fuel line of the fuel distributor
- Inlet and outlet pipe cooling system to the water pump cover
- Inlet and outlet lubrication line (only in the case that the OC-m is not pre-assembled)
- Plastic bag on air filter
- Turbocharged engines – Compressor outlet and airbox inlet port
- Main engine wiring harness connector



The protective covers must be used only for transport and for installation and must be removed before engine use.

01-07-00 Engine Handling

The engine is delivered in a wooden box, which is screwed through four threaded holes on the oil sump: The oil cooler (if requested) is already installed; the cooling radiator, if applicable, and the exhaust system are delivered separate from the engine. Turbo engines are delivered with the exhaust system fully installed and the intercooler and its fittings separate from the engine.



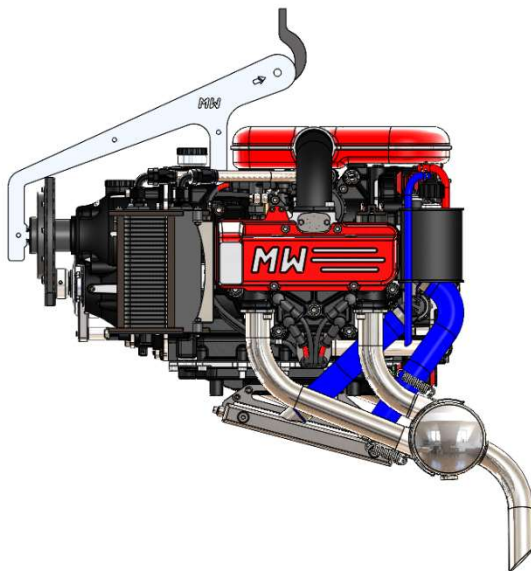
The screws used to attach the motor to the crate are to be used solely for transport and may not be reused.

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A Secure the crate to avoid any damage or overturning during transport.

A The attachment points on the engine where it attaches to the crate can be used to attach accessories, such as the radiator, to the engine, but cannot be used to fix the engine to the aircraft.

A Pay attention while moving the engine, use caution to prevent injuries and material damage.



01-03-P

To lift the engine, use the hook (code X299) provided. The hook is wedged in the propeller flange and fixed to a through hole at the top/front engine casing with an M8x55 mm bolt. Lift the engine from the shaft indicated by the arrows. The position of the shaft is in line with the centre of gravity, the propeller axis will be almost horizontal.

In case the hook is not available, it is possible to lift the engine using a rope around the propeller shaft and the top rear mounting point.

A The rope should be long enough to pass over the intake manifolds to avoid damage.

A Avoid passing the lifting ropes below the heads, to avoid damaging spark plugs and spark plug cables.

01-08-00 MWfly Authorized Service Centres

For more information on maintenance or on the spare parts, please contact the nearest MWfly service centre (check on www.mwfly.it).

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10-00-00 ENGINE INSTALLATION

The following notes should be considered precautionary measures to be followed for the installation in order to avoid injury or damage to the engine.

A good installation produces, as a consequence, safer use of the engine by increasing the operational life. It is therefore necessary to proceed carefully, as much as possible, by following the rules and instructions specified in this manual and integrating with the information contained in other documentation

In particular, it is necessary to verify that the installation allows the engine to reach, and not to exceed, the temperature and pressure operating limits: for this purpose, it is recommended to use a data acquisition system that can be connected to the ECU's CAN line, to record all the engine parameters that can be combined with the flight parameters.



Start up the engine only when the installation is completed and with the propeller mounted. Not following this procedure can cause serious damage to the engine.

10-01-00 Mounting Position

The architecture of the **SPIRIT** and **SPIRIT Turbo** engines allows dynamic balancing of the engine shaft to be almost perfect. This peculiarity allows balance of 100% of the inertia forces of the first and second order, besides the inertia of the first order moments. The vibrations of the engine will then be caused by the imbalance of only second order moments that are of minimum entity, with a frequency that is the double of frequency of explosion in the combustion chamber and with very low amplitude.

Another source of vibrations, predominant at low speeds, is related to the pressure forces on the pistons, in other terms the forces produced by the combustion. These forces produce low frequency vibrations and medium amplitude especially at idle or slightly higher engine speed: the antivibration suspension, designed for boxer engines, must be able to absorb the vibrations induced by the combustion, because the one produced by dynamic loads are of very modest entity, and of higher frequency and therefore less noticeable and less hazardous to the structure of the aircraft.

For a good vibration isolation, it is desirable to have the vibration-damping elements with the yielding axis horizontal and transversal to the propeller shaft, by this way the allowed movement does not produce movements of the propeller outside of the plane of rotation: by doing that no additional stress will be produced on the propeller and on the propeller shaft, with an advantage for comfort and safety of the flight. For this reason, it is appropriate to use wall mounting, which provides a more advantageous arrangement of vibration-damping elements as opposed to bed mounting.

Finally, it is appropriate that the anti-vibration elements are positioned between the engine and the engine frame, with the dual aim of isolating the aircraft from vibrations

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and reducing the unsprung weight: keep in mind these benefits if you want to use the front support F, for which there is no housing for antivibration.

The engine must be fitted on the fuselage with the propeller axis horizontal or slightly inclined, only a small deviation is permitted. In all cases the engine sump must remain at the bottom.

The **SPIRIT** and **SPIRIT Turbo** exist in both pulling and pushing configurations, with right and left rotation: the relevant product codes are shown in table 72-02-C.



Make sure that no part of the aircraft touches or can accidentally touch the engine hot parts (pay particular attention to the area around the exhaust system).

Thanks to the absence of carburettors and the adoption of the electric fuel pump with safety valve, there needs to be no special precautions taken regarding the engine position with respect to the fuel tanks in order to avoid hydraulic lock of the cylinders due to the fuel drainage in the engine. It is recommended however, also to simplify the maintenance operations and increase the level of safety of the installation, to adopt a valve on the fuel supply circuit, especially in applications of high-wing aircraft.

To counteract the lateral thrust of the propeller (drift), which tends to make the aircraft deviate in the opposite direction to that of rotation, it is advisable to rotate the propeller's traction axis in the direction of rotation of the propeller: for example, in the case of engine with left-hand spinning propeller (cabin side view, which corresponds to right rotation side propeller side view), the engine itself must be rotated to the left. Usually about 2 degrees of deviation is sufficient to have an adequate straightening effect. The optimum angle must be found experimentally, whereas an insufficient rotation will produce an excessive intervention of left pedal during take-off, while excessive rotation will limit the speed performance of the aircraft and the controllability in transition between minimum and maximum power. The drift effect compensation must also be balanced by the use of a compensating flap on the rudder (trim). However, there are no operating limits for the angle of lateral deviation of the propeller shaft with respect to the longitudinal axis of the aircraft.

Ideal deviation on a vertical axis is such that the propeller axis will be above the CoG by 15/20 cm. Normally this angle is close to 0 or can be out by 1 to 2 degrees in a nose down configuration. Even in this case, the optimum angle can be found by experiment, verifying that subsequent to an increase in engine power the aircraft responds with a change of trim to pitch. To attain good lubrication the engine angles must never exceed data reported in table 10-7-C of the present manual.

The layout of the two cylinder heads with reference to the horizontal line is 0 deg. In case of the specific need where one cylinder head is positioned lower than the other do not exceed the max angle indicated to avoid excessive oil build up in the lower cylinder.

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10-02-00 Fixing Points

10-02-01 Position of the Engine Fixing Points

Built into the engine, there are nine mounting points. In a standard wall installation, the mounting points are on the rear side labelled R. For standard bed installation use the four lower attachment points labelled L, whose supports are supplied as optional (BM-m); a combination of L and R attachment points can also be used to install the engine into the airframe.

The rear and lower fixing points are machined to house the rubber dumpers: all engines are delivered with 8 dampers and relative aluminum spacers.

On the front top part of the engine, labelled with an F there is an additional attachment point. The F attachment point should be used in combination with at least two R or two L attachment points. Using the F attachment point it is mandatory to use a damping element between the engine and the engine frame.

The type of attachment of the engine is mainly determined by the design of the aircraft.

The coordinates of the attachment points are indicated in the following tables, for both Direct and PSRU versions and are the same for turbocharged engine.

Direct Version				
Coordinates wall attachment point [mm]	<i>Point R1</i>	<i>Point R2</i>	<i>Point R3</i>	<i>Point R4</i>
X	541	541	541	541
Y	100	137,5	-100	-137,5
Z	-135	165	-135	165

10-01-C

Direct Version				
Coordinates bed attachment point [mm]	<i>Point L1</i>	<i>Point L2</i>	<i>Point L3</i>	<i>Point L4</i>
X	149,9	463,3	149,9	463,3
Y	98	98	-98	-98
Z	-157,3	-157,3	-157,3	-157,3

10-02-C

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Direct Version	
Coordinates front attachment point [mm]	<i>Point F</i>
X	203,6
Y	± 20
Z	174

10-03-C

PSRU Version				
Coordinates wall attachment point [mm]	<i>Point R1</i>	<i>Point R2</i>	<i>Point R3</i>	<i>Point R4</i>
X	617	617	617	617
Y	100	137,5	-100	-137,5
Z	-218,2	81,8	-218,2	81,8

10-04-C

PSRU Version				
Coordinates bed attachment point [mm]	<i>Point L1</i>	<i>Point L2</i>	<i>Point L3</i>	<i>Point L4</i>
X	225,9	539,3	225,9	539,3
Y	98	98	-98	-98
Z	-240,5	-240,5	-240,5	-240,5

10-05-C

PSRU Version	
Coordinates front attachment point [mm]	<i>Point F</i>
X	279,6
Y	± 20
Z	90,8

10-06-C



To install the engine on the air frame use bolt class 8.8 or superior grade. Do not use stainless steel or titanium bolts.

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The tightening torque is essentially determined by the aircraft design. It is suggested to use a tightening torque of 35÷45 Nm.

The following drawing indicates the dimensions of engine attaching point holes for both versions with or without gear box.



If the R fixing points are used, it will not be possible to use the rear L points (L2 and L4); vice versa, using the L fixing points, it will not be possible to use the lower R points (R1 and R3).



If the fixing points R are used, the design of the engine mount must consider the compliance of the anti-vibration damper: as a consequence, the engine undergoes a downward inclination of about 1 degree, corresponding to a displacement of the propeller flange of about 10 mm down.

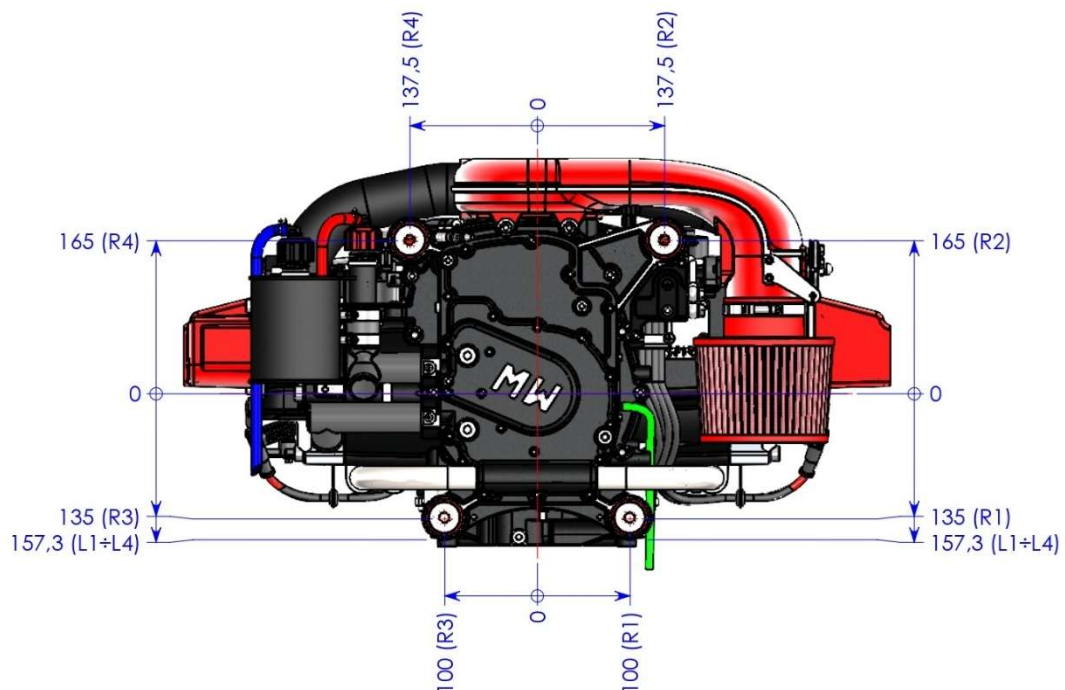
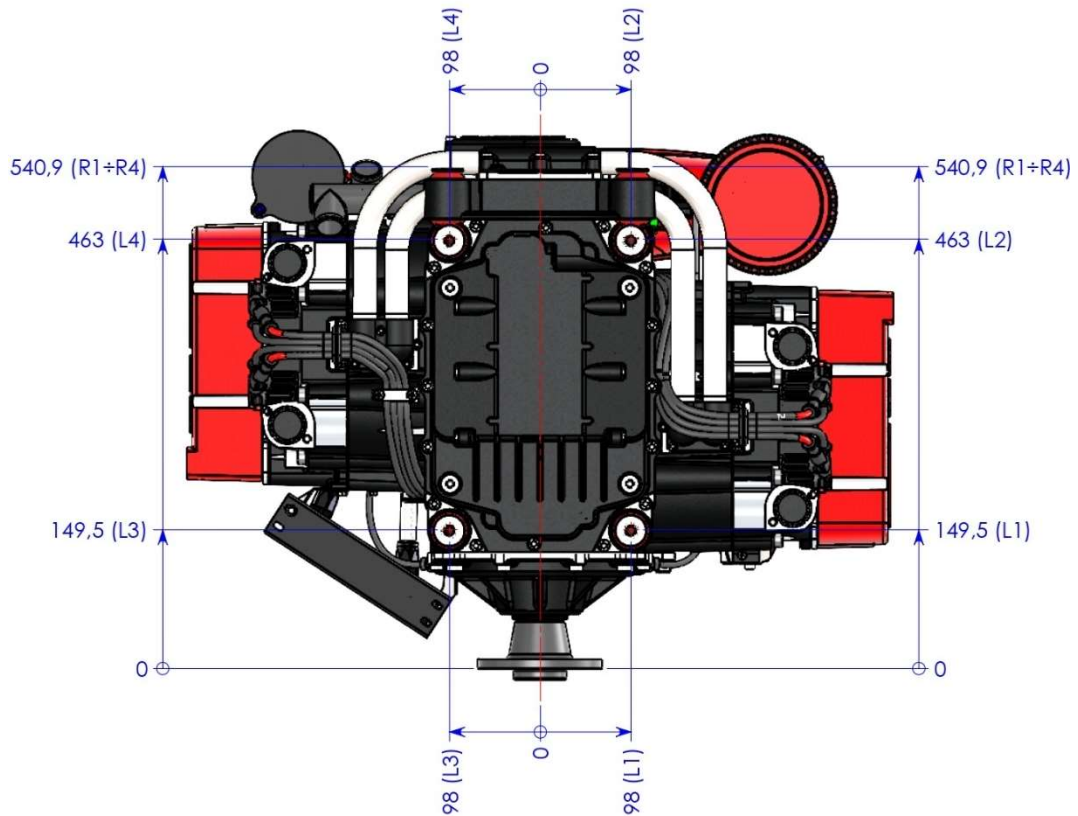


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ATTACHMENT POINT DIRECT VERSION



10-01-P

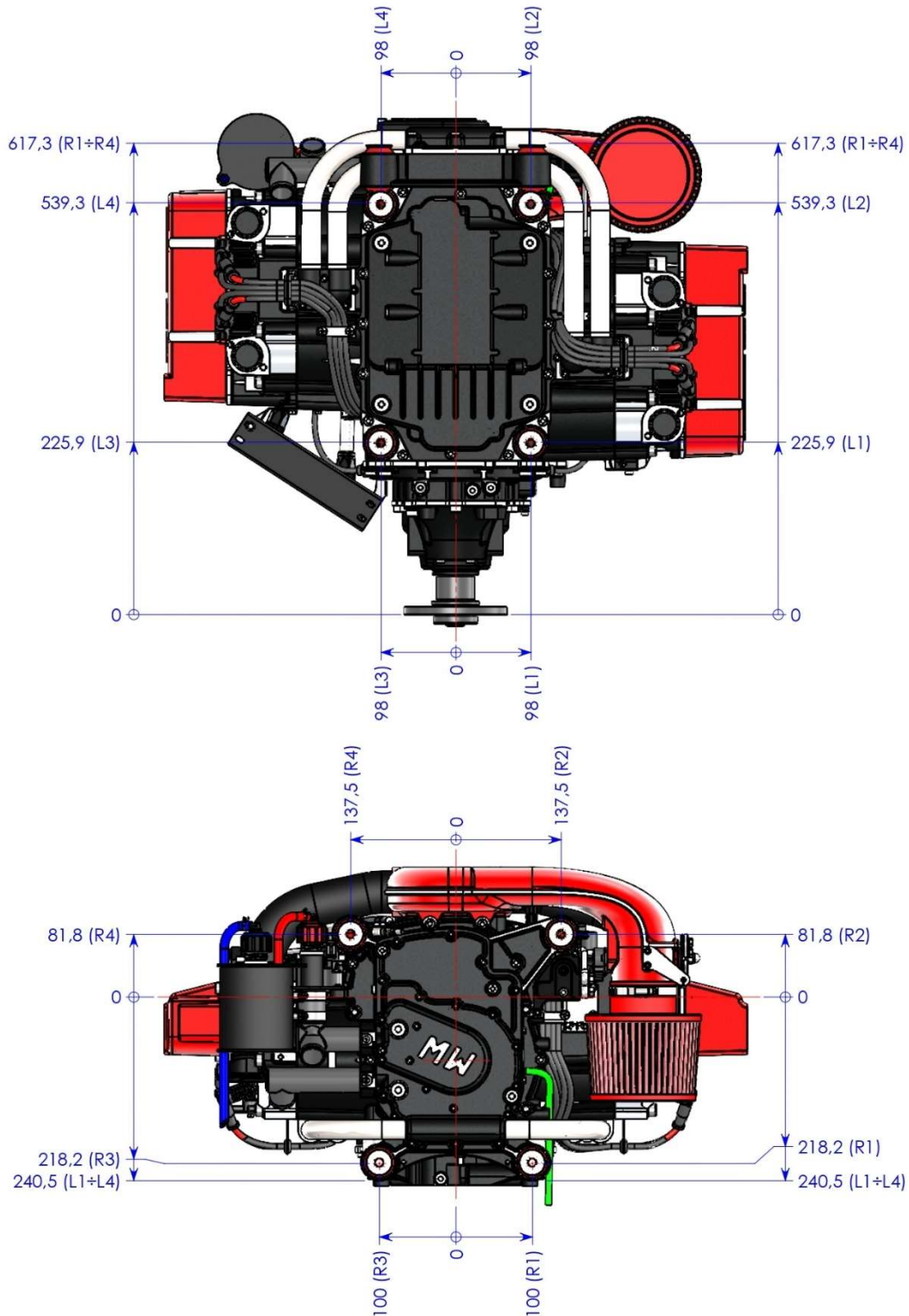


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ATTACHMENT POINT PSRU VERSION



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10-02-02 Permitted Deviation Angles

To enable appropriate operation of the engine lubrication circuit, it is necessary during installation and in flight, to observe the following table, which specifies the maximum angles on the ground and in flight of the engine with respect to a horizontal plane.

The symbol – placed before pitch angle denotes a propeller angle below the horizontal line, the symbol + on the upper side, the symbol - in front of the roll angle defines angles that rotate cylinder bank 1 upward, the symbol + at angles that lead it downward.

The table below refers to an engine used on a tractor or push configuration and shows the values determined by the minimum (2,8 litres) and maximum (3,55 litres) oil level.

All Versions			
Maximum angle of rotation [deg]	<i>On ground</i>	<i>In flight</i>	
		<i>Min</i>	<i>Max</i>
<i>Pitch axis</i>	+10/-10	+35/-22	+30/-27
<i>Bank angle</i>	+10/-10	+45/-45	+50/-50

10-07-C



The oil level must be checked without screwing the filler cap back in.



For engines pulling pitch and yaw angles greater than specified may cause oil leaks from the crankcase breather.



Exceeding deviation angles specified in above table can cause great danger.

10-02-03 Position of Fixing Points for Accessories

On the gearbox there are various holes, called "G", for fixing accessories or the pre-rotation mechanism of the gyros: all these holes have a M8X1.25 thread, with a minimum useful length of 12mm. In addition to these holes, the holes called "E" can be used for the same purpose, with M10x1.5 thread and a minimum useful length of 20mm, designed for the union between crankcase and gearbox (PSRU versions) or between crankcase and front cover (Direct versions).

On the Direct versions the only holes available for fixing accessories are the "E" type holes.



It is not possible to use any point other than those indicated for fixing accessories or mechanisms.

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The tightening torque of the "G" screws is at the discretion of the installer: however, it must not exempt the value of 22 Nm. The tightening torque for the "E" screws must be 35nm and a medium threadlocker compound must be applied on them.



In the case of use of "E" point, it is necessary to interpose between hole and accessory special bushings with external diameter 18mm and 10mm height, to ensure that the tightening takes place between planes.

The coordinates of the fixing points are shown in the following table: The value in square brackets [] refers to Direct type engines.

Coordinates of Accessory Attachment Points			
	X	Y	Z
<i>E1</i>	191 [114,6]	-92	-147,7
<i>E2</i>	191 [114,6]	92	-147,7
<i>E3</i>	191 [114,6]	-92	-17,2
<i>E4</i>	191 [114,6]	132	-20,4
<i>G1</i>	125,7	-37	-153,2
<i>G2</i>	125,7	37	-153,2
<i>G3</i>	125,7	55	-153,2
<i>G4</i>	82,2	-40	-49,4
<i>G5</i>	82,2	40	-49,4
<i>G6</i>	167,9	133,2	2,7
<i>G7</i>	164,5	-26	74
<i>G8</i>	164,5	26	74

10-08-C



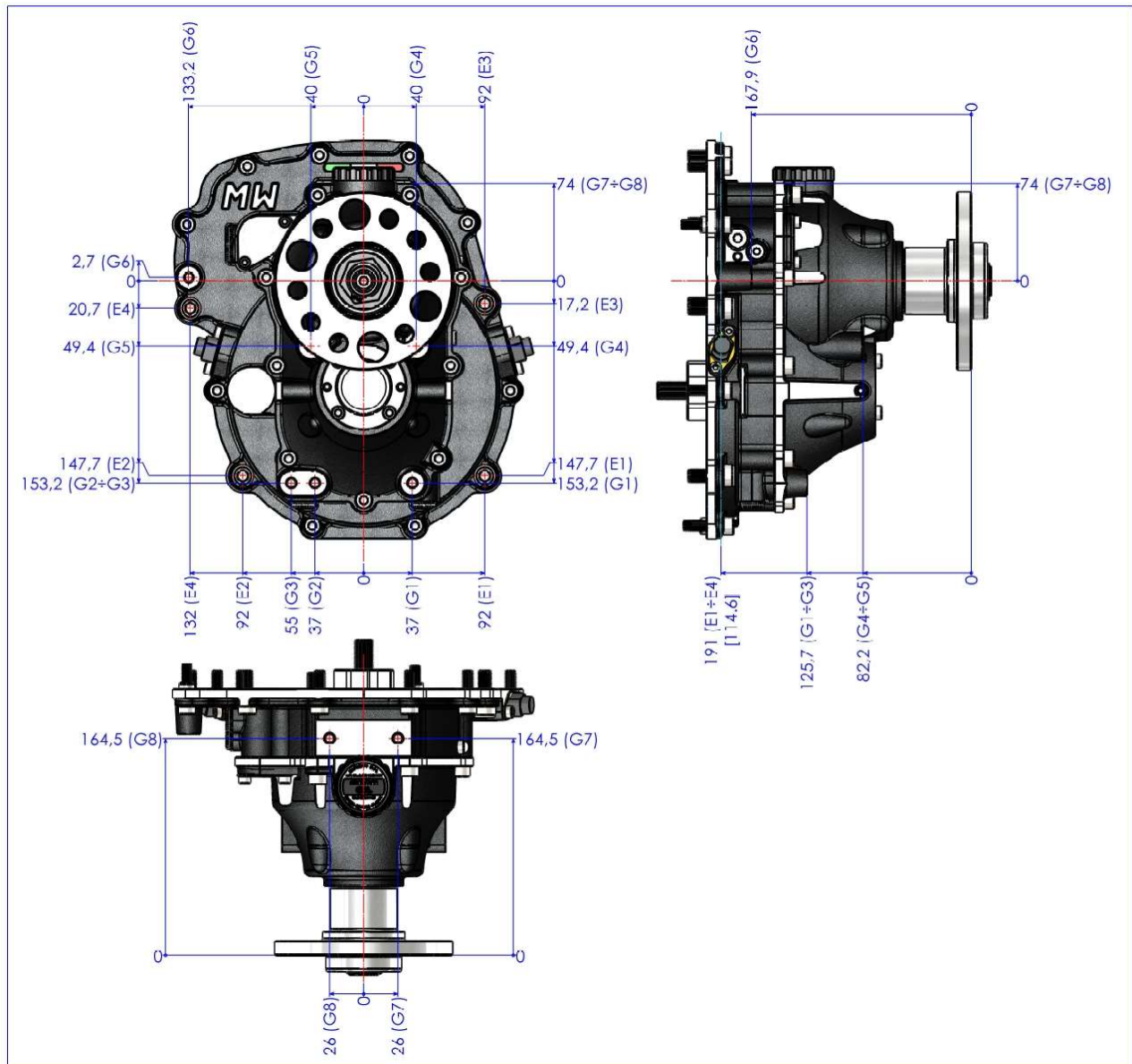
On the PSRU versions, use the "G" point preferably.

The following drawing shows the quotas of the fixing holes accessories on the engine; Also, in this case, the value between square brackets [] refers to Direct type engines.



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10-02-04 Maximum Load Permitted on the Attachment Point

Each mounting point can be subjected, during operation, to a maximum load that does not exceed that specified below. The engine frame must therefore be designed in such a way as to distribute the load of force resulting from contingency conditions of the aircraft, having care during the design and tuning stage to be in compliance with operating limits below.



The engine mount should be designed to not exceed the max allowable load on the attaching point.

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"R" Engine Attachment Points

To attach the engine, use only M10x1.5 class 8.8 bolts, partial threaded (shank) minimum length 70 mm plus the length of mounting point on the engine frame. The measurement is rounded up. For tightening of each screw, it is recommended to use a plane nut overlapping and self-locking nut (nut and locknut). Alternatively use screws with transverse hole for the insertion of a safety split pin.

The max allowable load on each R attachment point is:

- In X direction 9000 N
- In Y direction 40000 N
- In Z direction 22000 N

In case of a multi-directional load, the max allowable load is fixed by the vectorial combination of the above load. Those maximum loads cause elastic deformation. Considering that the material of the attaching point has a small plastic deformation range (less than 5%) it is mandatory to respect the above limit.

In the case of uniform distribution of the load on the rear 4 points, the same are able to withstand without permanent deformation an inertial load up to 6 G, supposed applied independently in each of the three main directions to the centre of gravity of the engine, with a safety factor equal to 2; in the case of cargo, that is the result of the vector composition of the same.

"L" Engine Attachment Points

To attach the engine, use only M10x1.5 class 8.8 bolts, partial threaded (shank) minimum length 70 mm plus the thickness of mounting point on the engine frame. The length is rounded up. For tightening each screw, it is recommended to use a plane nut superimposed by a self-locking nut (nut and nut). Alternatively, use screws with a transverse hole, special nut and cotter pin.

The adapters (code S039), prepared to house the damper, should be screwed into the engine at the 4 lower corners of the engine crank case using the screws supplied with the adapter at a tightening torque of 22Nm and using a medium threadlocker.

The max allowable load on each "L" attachment point is:

- In X direction 7500 N
- In Y direction 7500 N
- In Z direction 3000 N

In case of multi-directional load, the max allowable load is fixed by the vectorial combination of the above load. Those maximum loads cause elastic deformation. Considering that the material of the attaching point has a small plastic deformation range (less than 5%) it is mandatory to respect the above limit.

In the case of uniform distribution of the load on the rear 4 points, the same are able to withstand without permanent deformation an inertial load up to 6 G, supposed applied independently in each of the three main directions to the centre of gravity of

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the engine, with a safety factor equal to 2; in the case of combined loads, the load is the of the vector composition.

"F" Engine Attachment Points

To attach the engine, use only M10x1.5 class 8.8 screws, partial threaded minimum length 40 mm plus the thickness of fixing point on the engine frame.

The max allowable load on each F attachment point is:

- In X direction 15000 N
- In Y direction 10000 N
- In Z direction 15000 N

In case of multi-directional load, the max allowable load is fixed by the vectorial combination of the above load. Those maximum loads cause elastic deformation. Considering that the material of the attaching point has a small plastic deformation range (less than 5%) it is mandatory to respect the above limit.



Using the F attachment point it is mandatory to use a damping element between the engine and the engine frame to prevent stressing the aircraft frame with excessive vibration.

"E" Accessories Attachment Points

For tightening, use only M10x1.5 class 8.8 screws, with partial threaded and minimum length of 25 mm increased by the thickness of the accessory and the spacer.

The maximum allowable load on points and is:

- In X direction 15000 N
- In Y direction 5000 N
- In Z direction 5000 N

In case of multi-directional load, the max allowable is the vector composition of the three above limit.

"G1÷G3" and "G6" Accessories Attachment Points

For tightening, use only M8x1.25 class 8.8 screws, with partial threaded and minimum length of 12mm increased by the thickness of the accessory.

The maximum allowable load on points and is:

- In X direction 5000 N
- In Y direction 2000 N
- In Z direction 2000 N

In case of multi-directional load, the max allowable is the vector composition of the three above limit.

"G4÷G5" Accessories Attachment Points

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For tightening, use only M8x1.25 class 8.8 screws, with partial threaded and minimum length of 12mm increased by the thickness of the accessory.

The maximum allowable load on points and is:

- In X direction 8000 N
- In Y direction 8000 N
- In Z direction 8000 N

In case of multi-directional load, the max allowable is the vector composition of the three above limit.

"G7÷G8" Accessories Attachment Points

For tightening, use only M8x1.25 class 8.8 screws, with partial threaded and minimum length of 12mm increased by the thickness of the accessory.

The maximum allowable load on points and is:

- In X direction 10000 N
- In Y direction 10000 N
- In Z direction 15000 N

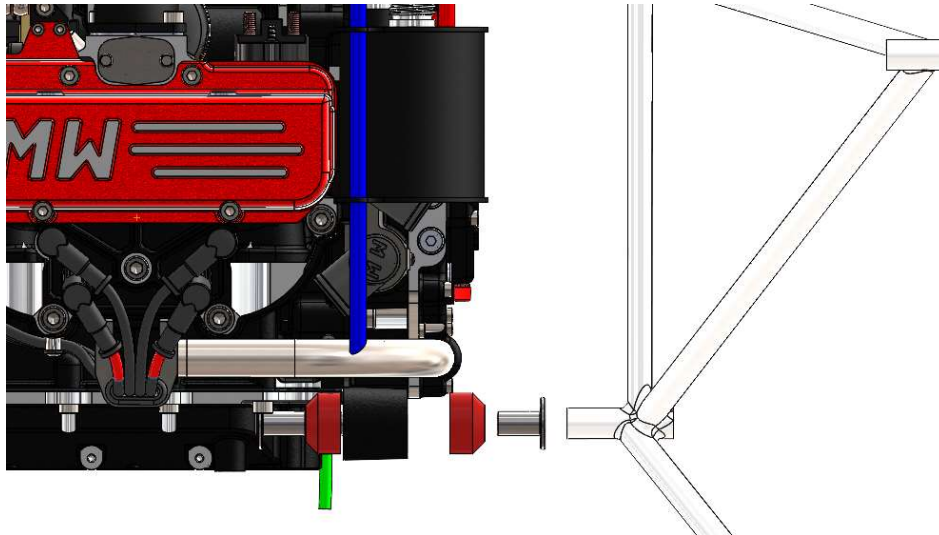
In case of multi-directional load, the max allowable is the vector composition of the three above limit.

10-03-00 Attachment on Engine Frame

The installation of the engine must be done as described below.

Necessary Tools and Materials

1. Torque wrench 20÷100 Nm
2. T handle allen key 6mm
3. Hex wrench 17 mm
4. Special hook to lift the engine cod. X299
5. Crane to lift the engine with at least a maximum load >150 Kg
6. Medium threadblock
7. Vaseline grease
8. General tools according to the installation

*10-04-P*

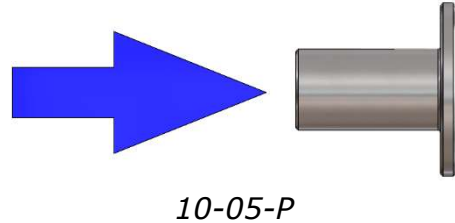
- a.** Mount [2] the lifting tool [4] on the engine. Alternatively, provide a system for lifting the engine, making sure that no parts of the wiring, the spark plug cables or the spark plugs themselves are stressed during the operations.
- b.** To lift the engine with the crane, position the crane [5] close to the engine frame and adjust the high of the crane to align the attachment points on the engine to the corresponding attachment points on the engine frame. In bed mounting align the engine 2 cm above the engine frame.
- c.** Insert the dampers into the attachment points on the engine, to ease this operation it is better to spread Vaseline grease [7] on the dampers.
- d.** Insert the spacer in the damper: use Vaseline grease [7] to ease this operation.
- e.** Insert the four fixing screws in the holes in the engine mount and on the engine mounts.
- f.** Screw [3] the four bolts to align and pull the engine closer to the engine frame. While turning ensure that the dampers stays inside their housings in the attachment points
- g.** Gradually tighten the four screws up to the tightening torque indicated by the air frame manufacturer (normally between 35 and 45 Nm) using threadlocker [6].
- h.** Remove [2] the special hook [4] from the engine .



The dampers are made of a plastic material. They are perishable and sensitive to atmospheric and chemical agents and to temperature. Check the condition of the dampers regularly and replace them at time interval indicated in the maintenance manual or at any appearance of damage.

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The standard pre-load on each damper is 0.5 mm. To increase the stiffness of the engine installation, it is necessary to machine down a small quantity on the side indicated in picture



10-04-00 Installation Verification Test

After completing the installation of the engine, all its components and instrumentation and before flying, a test must be performed on the ground to verify the adequacy of the mountings and correct operation within the operating limits of the engine.



Before starting the engine for the first time, it is necessary to carefully read the operating manual in its entirety.

Before starting the engine, make sure you have filled the cooling system and the required oil supplies.

The engine test is an essential phase of installation: it must therefore be approached with caution and attention to any signal that may indicate operating anomalies or defects in the installation. In case of doubts about the actual functionality and safety, do not fly or continue the test before having improved the installation or removed the cause of any anomalies.



Never run the engine indoors. Exhaust gases contain carbon monoxide, a particularly poisonous gas, which, if inhaled in excessive quantities, rapidly leads to unconsciousness and death.



On the ground, in the presence of observers, use the engine carefully and make sure you have a complete view of the danger area.



Never leave the aircraft while the engine is running.



In the event that faults or discrepancies from the normal operating condition described occur during the pre-flight tests, do not continue with the test, nor use the engine in flight before having identified and resolved the cause.



Before starting the engine, make sure that each component of the engine is firmly fixed, so as to prevent it from being accidentally lost in flight.

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Do not start the engine without the propeller: this can cause serious damage.

Prepare the engine as follows.

- a.** Check in advance that the instrumentation is functioning properly and that all installations are correctly completed and the components are fixed.
- b.** Be sure that the battery is fully charged.
- c.** Ask the help of a second person who will stay on the ground away from the aircraft and propeller in a safe area.
 - d.** Equip them with a fire extinguisher suitable for fuels. The fire extinguisher will be kept and used by the person who will help you on ground. You must carefully read the instructions for the extinguisher.
- e.** Prepare the tools needed to purge the cooling system
- f.** Move the aircraft in an open space.
 - g.** Place it away from any obstacles that may impact on the propeller or on the aircraft.
 - h.** Stop the aircraft by placing a pair of chocks on each main landing gear wheels.
 - i.** Before starting the engine verify the fuel pressure system is working in accordance with the requirements indicated.

10-04-01 *First Start-up*

Only for the first start-up of the engine it is necessary to follow all the below instructions:

- a.** Switch on the master relay to power on the electrical system.
- b.** Switch on the instrumentation.
- c.** Check that the sensor values on your instrumentation are coherent.
- d.** With both ECUs switched off, make the engine run 5 sec using engine starter. That helps to arm the oil pump.
- e.** Purge the fuel circuit.
- f.** Switch on the both ECUs (kill switch 1 and 2 ON).
- g.** Switch on the auxiliary fuel pump and check that the fuel pressure rises to approximately 3.5 bar.
- h.** Try to start the engine keeping the throttle in the idle position: normally the engine will start within two tries. If the engine does not start in two tries it could be an electrical problem or a problem in the fuel line.



In case of a prolonged stop of the engine, it is necessary to check the correct operation of the injectors: in fact, they could be blocked by fuel residue, making starting difficult or impossible.

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- i.** After engine start, turn off the auxiliary fuel pump.
- j.** When the engine starts, it automatically goes to 1300 RPM, and then (after about 5 seconds) the RPM rises and goes between 1700 and 1900 RPM. It is possible that at the first start-up of the engine it will stay at the lower RPM with an excessive vibration. In this case, help the engine by opening the throttle just a little and then bring throttle back to idle position.
- k.** Verify that the oil pressure rises over 4.0 bar within 5 seconds after the engine start: if it does not rise, stop the engine and find and resolve the reason for the problem.
- l.** Keep the throttle in idle position and complete a warm up cycle, verify that oil temperature and coolant temperature rise gradually. When the temperature of the engine has reached the operating value (coolant temperature 72°C and oil temperature 60°C) the engine will automatically decrease to about 1200 RPM.



In the event that the accelerator lever is not set to the minimum position, the starting procedure will not be carried out and the engine will operate irregularly.

- m.** Slowly open the throttle and bring the engine regime up to 3200RPM and then put the throttle back to the idle position, repeat that operation three or four times. That operation helps to eliminate the air from the coolant circuit.
- n.** Turn off the engine by acting on the injection switches (in sequence kill switch 2 off and then kill switch 1 off) and proceed to purge the coolant circuit.
- o.** Start the engine and bring it to 2700 RPM, use both ECUs on to start the engine.
- p.** At the regime, switch on the secondary pump to check it and to check if the fuel circuit has the correct the fuel pressure which should not change by more than 0.4 bar. If the change is greater than that then the dimensions of the fuel circuit tube is not correct. Modify the tube or the fuel line.
- q.** Switch off the auxiliary ECU (kill switch 2 off): no significant regime change should happen.
- r.** Switch on the auxiliary ECU (kill switch 2 on) and turn off the main ECU (kill switch 1 off). You may feel a slight change in regime initially after which the system is set to the initial value. Turn on the main unit.
- s.** Switch off the master switch (master off) to disconnect the battery from the electrical system: The engine should continue to run without any anomalies or irregularities. It is possible to see a small increase in voltage on the voltmeter gauge, usually less than 0.2-0.3 volts. If the engine stops or begins to run unevenly, you should carefully check the wiring harness.
- t.** Reconnect the battery (master on) to the electrical system, reactivating the master relay, bring the engine to idle and check that it remains regular and

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without producing excessive vibrations: in the event of anomalies, it is necessary to check the installation of the accelerator cable.

- u.** With the engine at idle, switch off the auxiliary control unit (kill switch 2 off): there should be no speed variation; turn the auxiliary control unit back on (kill switch 2 on) and turn off the main control unit (kill switch 1 off): in this case the idle speed must rise up to about 1700 rpm.



Increasing the idle speed prevents unwanted engine shutdown in the event of the battery disconnected from the system (see manual B)

v. When the engine is warmed up, turn it off and the start it up again. Turning off and starting up should happen without vibrating and jamming.

w. Try to start the engine with one ECU per time, try with primary ECU and then with the auxiliary ECU, in both cases the starting up should happen without problem.



Starting the engine with only the auxiliary control unit is deliberately only possible when the engine is warm.

x. When the engine is turned off, check that there is no leakage of coolant or oil. In case there is a leakage of coolant or oil find the origin.



In the first hours of operation there can be a slight blowby of refrigerant or, more rarely, of lubricant from the drainage tube placed in the rear of the engine on side #1. This is normal and is caused by settling of the mechanical seal and oil seal.

10-04-02 Verification and Validation

The installation tests have two different goals. To look for problem connected to the engine but also to perform the trial stage for the mechanical components of the engine: only after the installation tests is the engine ready to guarantee the maximum performance. After 15 operative hours, the engine is considered to be run in.



During the test it is important to continue to check the engine temperature and pressure parameter, stopping the test if any anomaly occurs.

Ground Test

Each engine is built and assembled using high precision components and procedures. After assembly each engine is subjected to a cycle of tests necessary to evaluate the compliance with the project requirements and to enable a gradual breaking in of the

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mechanical components. Even though it is not strictly required, it is good practice to test a new engine on the ground after installation to verify that the installation is complete and highlight the any defects that would cause safety issues-Follow the procedure below:

- a.** Mount the cowling.
- b.** Start up the engine and frequently and slowly change the regime of engine; keep checking coolant temperature, oil temperature. These parameters should not pass the admitted limits. This test can be done in both a fixed-point condition or in a taxi condition.
- c.** At the end of any test check for the total absence of any coolant or oil leakage, the total absence of any sign of overheating in any components inside the cowling and the total absence of any sign of friction or stretching off the wire harness or on the fuel line (due to the engine vibration).

The ground test should last at least half an hour, or longer, depending on the complexity of the installation.



On the ground avoid to running the engine over 3200rpm for more than 1 minute since the cooling flow may be inadequate and cause a failure in engine component.

Max Power Test

Before executing the first flight, it is advisable to check that the engine can deliver the maximum power in order to avoid dangerous situations in the first take off. The verification must take place by adjusting (only for variable pitch propeller) the propeller at the pitch angle indicated by the manufacturer and checking if the max rpm of the engine is in compliance with the rpm indicated by the propeller manufacturer. This value should be within a tolerance of approximately 5%, which means, a power deliver tolerance of 15%. The fact that the pitch measurement of the blade is quite difficult and may be inaccurate and therefore even small variations of the angle may cause large power variations as a function of propeller profile. The test is performed once the engine has completed the warm up phase and must be repeated three times. The first with both ECU's switched on, the second with only ECU A switched on and the third with only ECU B switched on. It is also important to check the variations in maximum engine rpm when the second fuel pump is turned on as this is a sign that the fuel system is not properly tuned. A final test should be done with a full electrical load on the aircraft.



It is normal that after the first 15 hours of use of the engine the maximum RPM should increase because all mechanical components, at this point, are run in. It is possible that the first maximum power test, completed after the ground test, can give a maximum power result lower that the expected one, or respect an engine already run in.

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Flight Test

After completing the previous steps, it is recommended, for the first 10 hours of flight, to limit running the engine at max rpm at take off only and for a period no longer than 60 seconds. Similarly, if using a variable pitch propeller avoid keeping the propeller at max pitch for a long period as this could thermodynamically stress the engine. Instead use a propeller setting less stressful to the engine. The table below indicates the main precautions to follow in the first 15 hours of flight.

Main caution for the first 15 hours of flight	
RPM	Keep the engine at maximum RPM within 60 seconds, and only in take off condition In flight condition keep the engine at least 300 RPM under the max continuous power with MAP lower than 15% of max value indicated
Oil Temperature	Keep under 110 °C
Coolant temperature	Keep under 95 °C
MAP	In flight, favor propeller settings with high rpm and low MAP value
Type of flying for test	Do short flight , with frequent take off and landing

10-09-C



The above caution for the first 15 hours of flight should not be limiting in respect to flight safety: so, in case of emergency, feel free to use the engine at the maximum power for all the time it is necessary and use a setting of the propeller that is different from the one suggested. In case of emergency feel free to use the engine as you need.

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21-00-00 AIR CONDITIONING

21-40-00 Cabin Heating Circuit

The cabin can be heated by using the engine coolant and by providing a suitable radiator at the inlet of the cabin ventilation air intake. In the rear part of the engine, on the cooling pump cover, there are the predispositions for the connection of the delivery and return pipes of the heating fluid to the cab radiator.



The point of withdrawal of the coolant is upstream of the thermostatic valve, so that the heating will start working from the first moments after the engine is started.

21-40-01 Characteristics of the Components

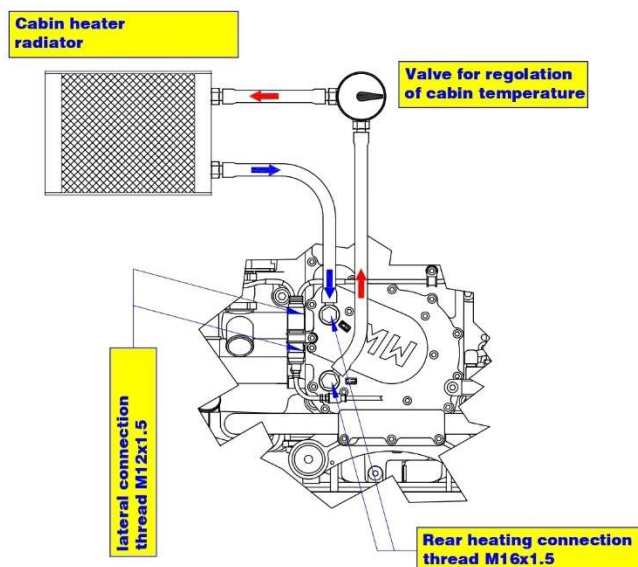
- Rear heating connection thread M16x1.5
- Side heating connection thread M12x1.5
- Typical internal diameter of heating pipes 10mm
- Maximum length of heating pipes 2x500mm
- Typical heating radiator area 300 cm²
- The radiator must have a vent hole in the upper part



With a correctly sized ventilation air intake, the cab heating is sufficient even at low speeds and in cold climates. To increase the effectiveness of the system it is possible to equip the radiator with an electric fan.

21-40-02 Criteria for the Construction of the Cabin Heating Circuit

The system must be made according to the scheme of the following figure.



21-01-P

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Necessary Materials

1. Torque wrench 50 Nm
2. 6 mm Allen key
3. 8 mm Allen key
4. Tools according to the products to be installed

The heating radiator must be installed as close as possible to the engine, preferably in the engine compartment itself: this is to interfere as little as possible with the correct functioning of the cooling system. To regulate the temperature in the cabin, it is necessary to provide a valve on the radiator fluid delivery branch: the same valve must be able to completely close the flow to the radiator if hot air is not desired in the cabin. Drain the cooling system if it is already filled.

- a.** Empty the coolant circuit.
- b.** Remove [3] the plugs from the two M16x1.5 pre-setting holes, located in the rear part of the engine. Alternatively, it is possible to use the side predispositions (thread M12x1.5): the caps must in any case be removed [2].
- c.** Secure the radiator [4].
- d.** Make the connections between the radiator and the engine, paying attention not to reverse the flow direction: the lower fittings carry hot fluid to the radiator, the upper fittings carry cooled fluid back to the engine. The rear fittings must be tightened [1 + 4] to 30 Nm; the side fittings must be tightened [1 + 4] to 18 Nm.
- e.** Fill the system, taking care to eliminate the air also from the heating radiator.

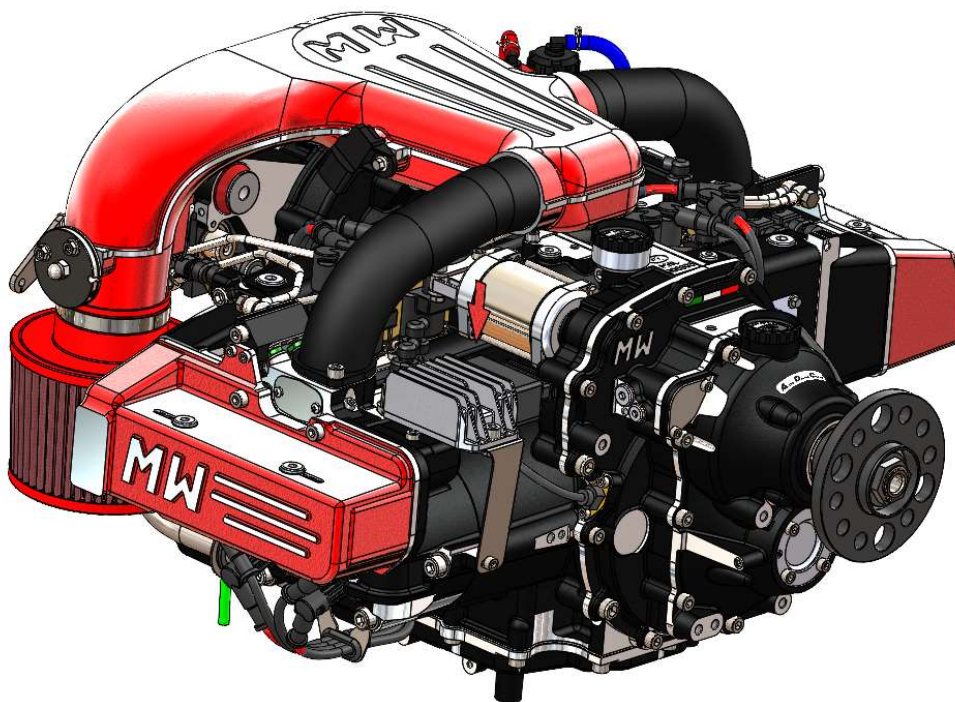
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24-00-00 ELECTRICAL POWER

24-30-00 Main Recharge System

The engine is equipped with a direct current recharging system, consisting of a permanent magnet generator and a current regulator associated with it: the connection between the regulator and the generator is already made; the connection between the regulator and the engine electrical system is also already made. By respecting the attached wiring diagram, the engine will be able to operate regularly, both with a generator failure and with a battery failure. In the first case the autonomy is between 10 and 50 minutes, depending on the capacity of the battery installed and the power consumption of the electrical devices; in the second case the autonomy is unlimited, but the engine must operate above 1500 rpm. A good practice, in both cases, is to land as soon as possible to repair the failure. In particular a prolonged operation of the voltage regulator without a battery connected can damage it: after events of this type it is necessary to check the integrity of the regulator.

The voltage regulator is fixed to the engine with two screws in such a way as to be grounded.



24-01-P



Do not start the engine with the voltage regulator disconnected: this can seriously damage the regulator and the generator, which then must absolutely be checked and replaced if necessary.

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A possible failure of the generator does not affect the operation of the engine but limits the autonomy: if the electric system is done according to diagram.

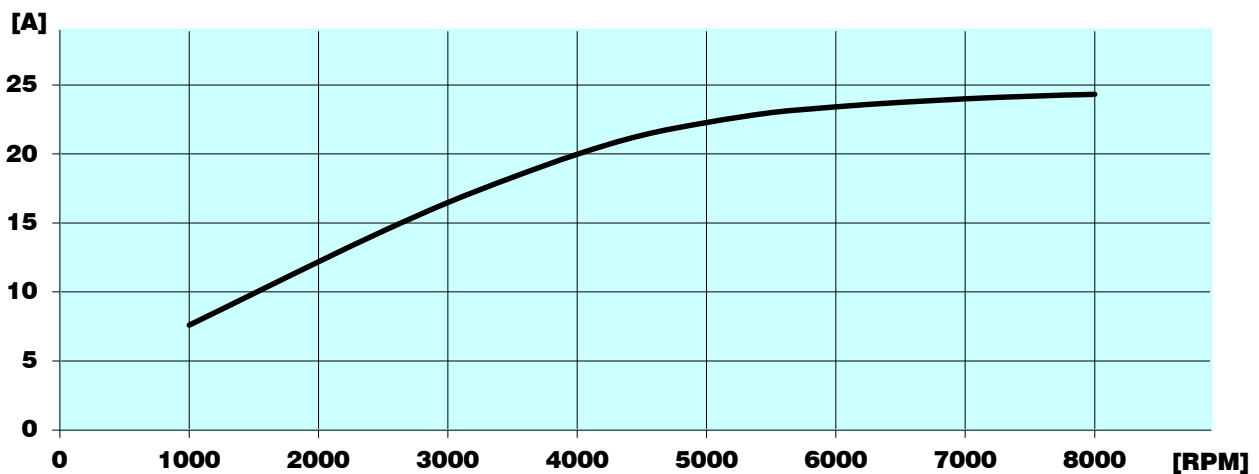
24-30-01 Internal Generator Features

- Internal rotor with permanent magnet and counterphase windings
- Nominal recharge voltage 14 V
- Max recharge current 24 A
- Nominal recharge power 300 W
- Recharge power at 1000 rpm 95 W
- Recharge power at 4200 rpm 250 W
- Max operating temperature 130 °C
- Weight 2000 g



24-02-P

The following figure shows the charging curve as a function of rpm, measured with a constant charging voltage of 12.5 V and generator at 20 ° C temperature.



24-01-C

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The normal operating temperature of the generator is similar to the engine oil temperature (~ 100 ° C): at 90° the performance of the generator is at least 15% lower than that shown in the graph.



In case the engine is running with the generator disconnected from the voltage regulator, it may be necessary to replace the generator.

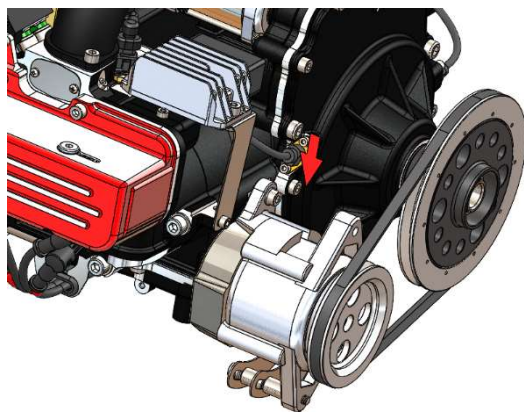
24-30-02 Voltage Regulator Features

▪ Type of bridge	antiphase
▪ Nominal recharge voltage	>14 V
▪ Max recharge current	26 A
▪ Protection fuse (pre-installed in the IN-m group)	30 A
▪ Max operating temperature in flight	75 °C
▪ Minimum operating temperature in flight	-20 °C
▪ Standard operating temperature in flight	40 °C
▪ Max temperature (not in use)	110 °C
▪ Weight	290 g

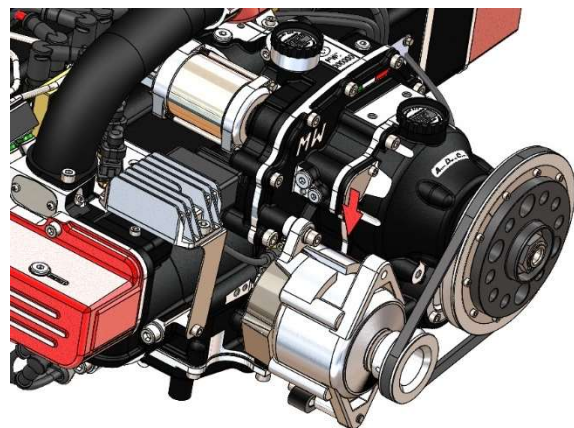
The above characteristics are related to the optimal cooling conditions of the voltage regulator.

24-31-00 Auxiliary Generator Module (AG-m)

All engines, both in the direct version and in the version with gearbox, are designed for the attachment of an auxiliary generator with stator with wound fields: in both cases the auxiliary generator is housed in the front part of the motor, bank side # 1



24-03-P



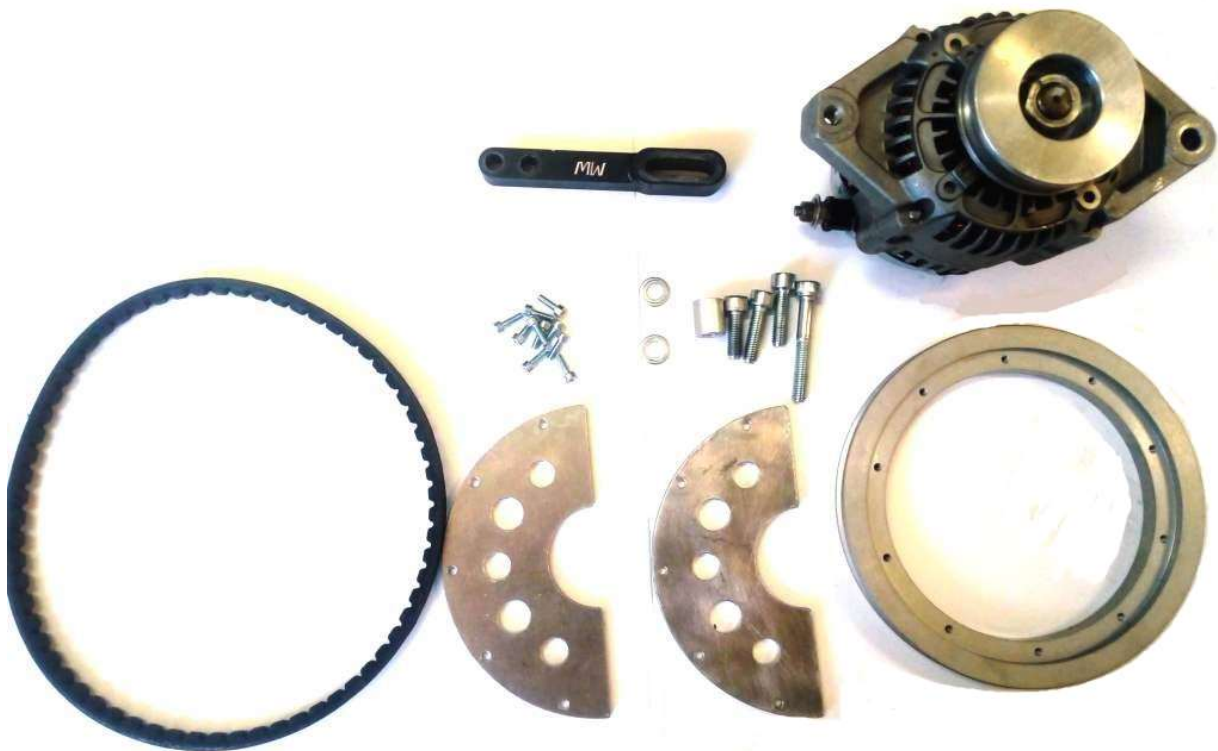
24-04-P

If the auxiliary generator is used, it is advisable to install a second battery for the on-board systems, recharged, through an independent circuit, by the auxiliary generator itself: using a "cross switch", it is possible to connect the two circuits in case of emergency on one of the two generators.

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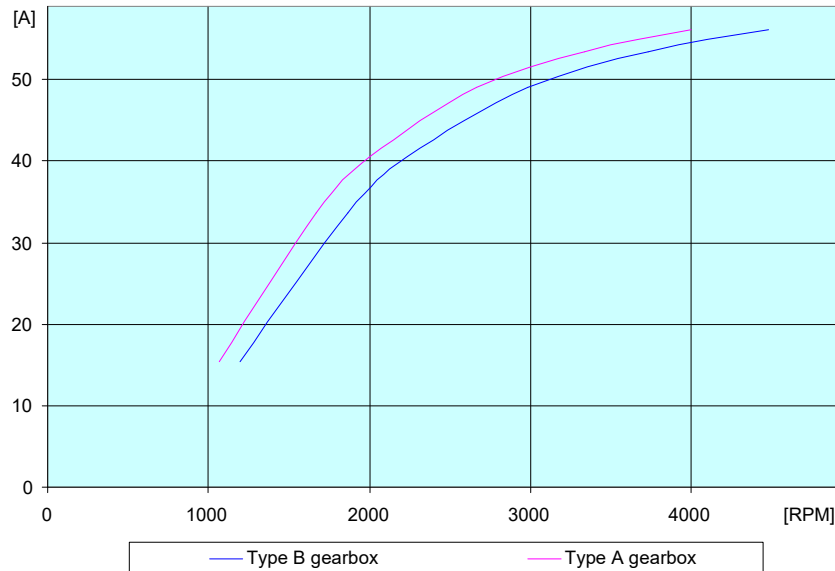
24-31-01 Generator Features

▪ Nominal recharge voltage	13.8 V
▪ Max recharge current	56 A
▪ Recharge power at 1200 rpm (at 13.5V, version with gearbox B)	e200 W
▪ Recharge power at 4200 rpm (at 13.5V, version with gearbox B)	740 W
▪ Breaker	80 A
▪ Max operating temperature	80 °C
▪ Max rpm	6300 RPM
▪ Generator weight	3050 g
▪ Accessory and bracket weight	1030 g
▪ Total weight	4080 g



24-05-P

The following figure shows the recharge curves as a function of the engine revolutions, for the versions with type A reducer and for the versions with type B reducer: the curves are measured with a constant charge voltage equal to 13.5 V and generator at 20 ° C.



24-09-C

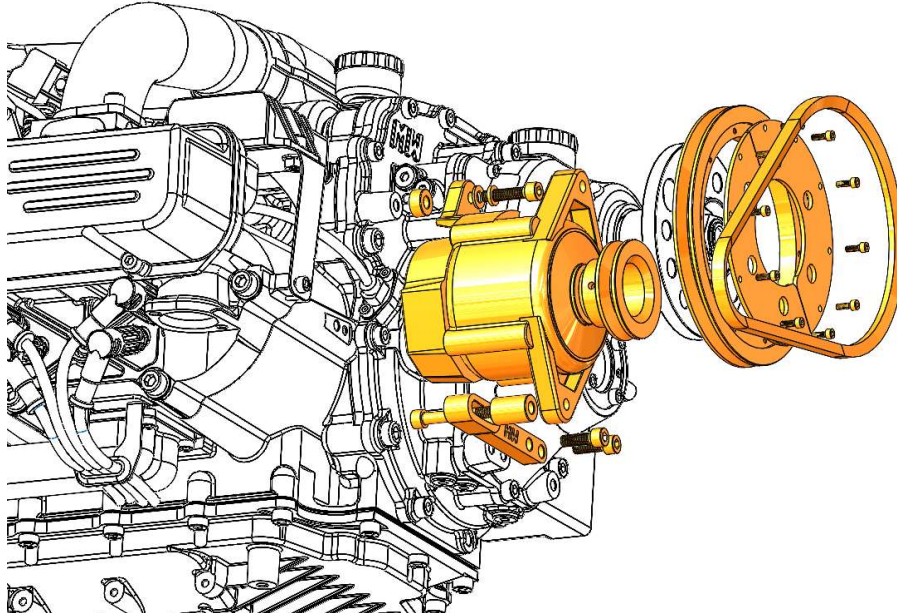


As an alternative to the auxiliary generator described, a 24V-70A or 12V 140A auxiliary generator is also available. The following installation instructions are the same for all types of auxiliary generators available.

24-31-01 Installation

All parts necessary for installation are supplied together with the AG-m.

The following refers to the assembly of the kit for motors equipped with gearbox: the assembly of the kit on direct motors has some differences with respect to what is reported.



24-06-P

Necessary Materials

1. Torque wrench 1÷10 Nm
 2. Torque wrench 20÷100 Nm
 3. Allen key 3 mm
 4. Allen key 6 mm
 5. Open end wrench 13 mm
 6. Medium threadlocker
 7. Keys in relation to the type of propeller mounted
-
- a.** Remove the propeller [7].
 - b.** Insert the generator drive pulley on the propeller flange, taking care to keep the side of the pulley with the reduced diameter for housing the fixing half-moons in the front position.
 - c.** Screw [3; 6] the two fixing half-moons to the pulley, so that they are positioned between the propeller flange and the engine: they are identical and have no preferential mounting direction; tighten [1 + 3] to 3 Nm.
 - d.** Screw [4; 6] the tensioning rod of the auxiliary generator to the front part of the gearbox, interposing the washers provided, using the shorter M8 screws (supplied with the kit); tighten [4 + 2] to 25Nm.
 - e.** Fit the supplied drive belt onto the groove of the drive pulley.
 - f.** Fit the propeller onto the flange and hold it in place.
 - g.** Approach the drive pulley to the rear part of the propeller flange, taking care to align the holes for the fixing screws with those on the flange.
 - h.** Depending on the type of propeller fixing used:

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- with ARP502 type fixing insert the 6 1/2 "screws in the rear part of the drive pulley, fit the propeller on the flange and tighten [7 + 2] the fixing screws according to the specifications of the propeller manufacturer;
- alternatively, insert the six drive columns D13 mm in the rear part of the drive pulley in such a way as to insert them fully even in the holes provided on the propeller; insert the six fixing screws into the columns, fit the propeller on the flange and tighten [7 + 2] according to the specifications of the propeller manufacturer.

The drive pulley must be screwed to the propeller flange by means of the same tightening screws as the propeller.

- i.** Insert the medium length M8 screw on the rear upper connection of the generator, interposing the large washer; insert the lower spacer of the two supplied on the screw.
- j.** Screw [4; 6] the screw to the upper hub on the gearbox, without tightening.
- k.** Insert the longer M8 screw supplied in the rear part of the tensioning rod, interposing the washer.
- l.** Screw [5; 6] the screw to the generator, without tightening.
- m.** Fit the drive belt on the generator pulley.
- n.** Tension the transmission belt by moving the generator outwards: a correct tension is the one that allows the belt to have a maximum deflection of about 8 mm in the intermediate part.
- o.** Once the correct tension has been found, tighten [4 + 2] the upper screw of the generator and then [5 + 2] also the lower one; for both the prescribed torque is 22 Nm.
- p.** Screw [5] the supplied nut to the protruding part of the lower screw, and tighten [5 + 2] to 22 Nm keeping the screw in position with a second wrench.
- q.** Make the electrical connections as shown in diagram 24-03-C and 24-04-C. The auxiliary generator must be connected to an auxiliary battery which will power an electrical circuit (called circuit B) to which various electrical users of the aircraft will be connected. The main battery will be connected to the electrical circuit (called electrical circuit A) to which the electrical circuit of the engine, the petrol pumps, and the internal generator must be connected. The two electrical circuits can be connected by means of a suitable switch in case of battery or generator failure of circuit A.

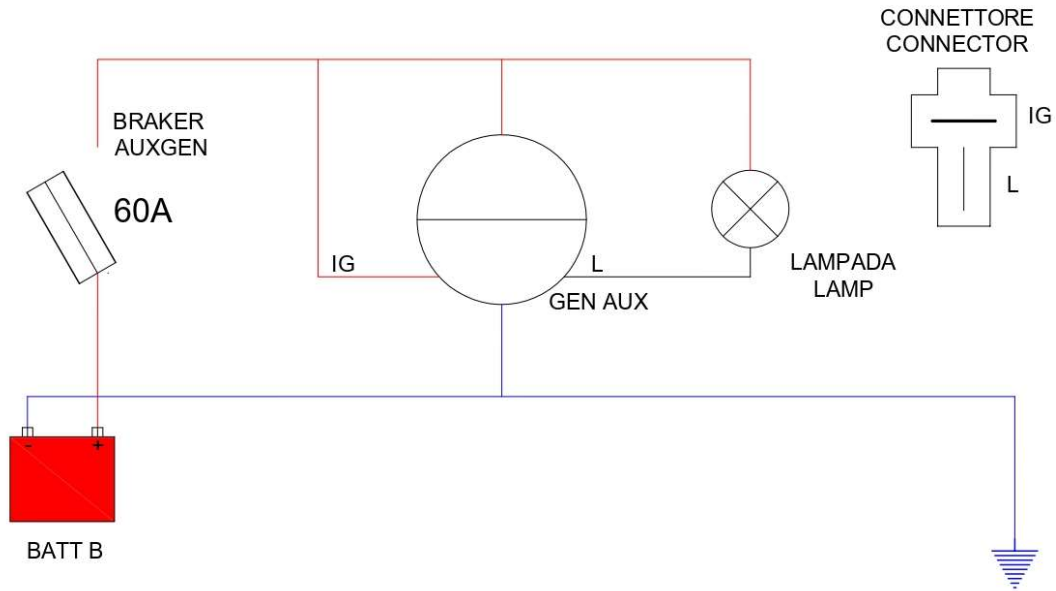


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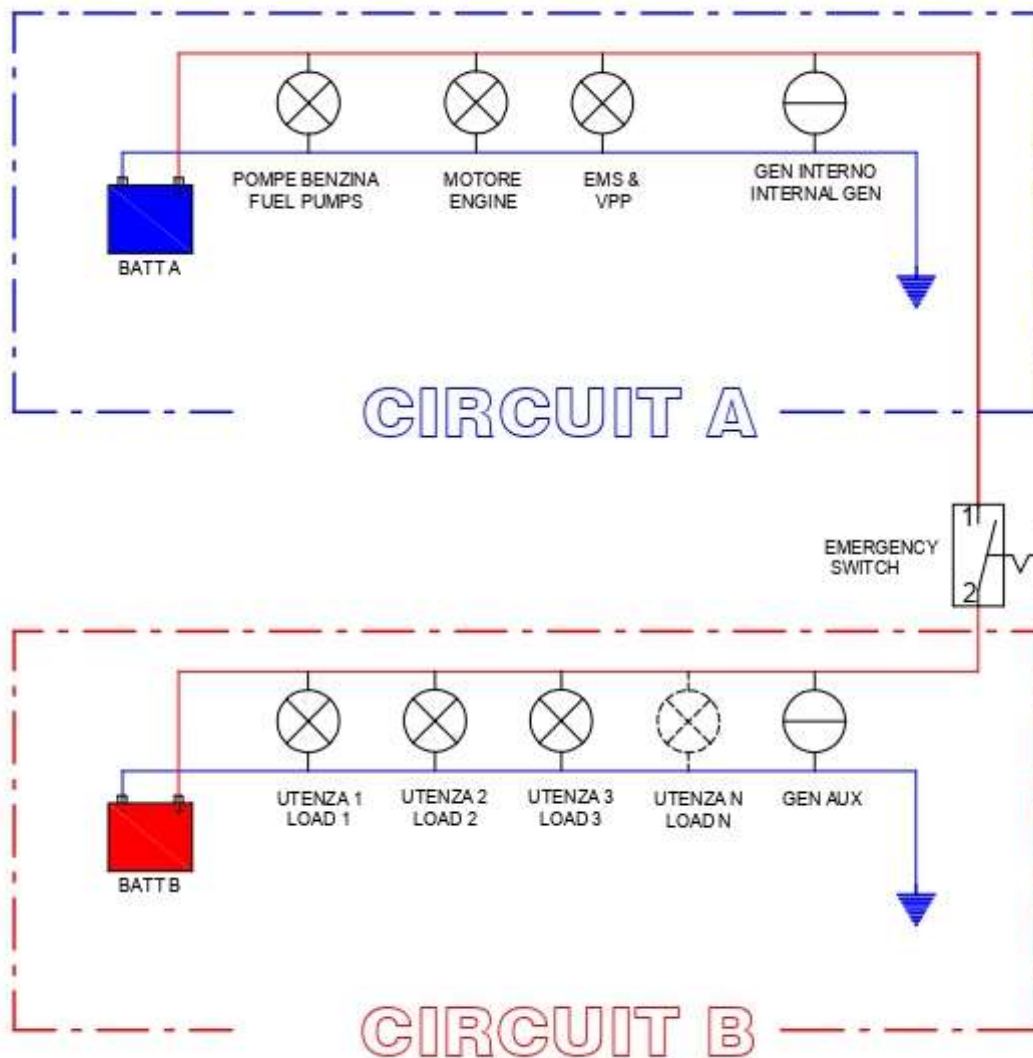
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24-03-C



24-04-C

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The direct connection of the auxiliary generator on the circuit of the internal generator could cause a failure of the latter or of the voltage regulator

A

Periodically it is necessary to check the tension and the state of use of the transmission belt of the auxiliary generator.

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Diagram 24.04.C is only valid for 12V auxiliary generators. In case of a 24V auxiliary generator, the 24V and 12V electrical circuits must be separate. Connecting the 24V to the ECUs could cause irreversible damage to the ECUs.

61-00-00 TRANSMISSION

SPIRIT and **SPIRIT Turbo** engines are available in direct version or with gearbox.

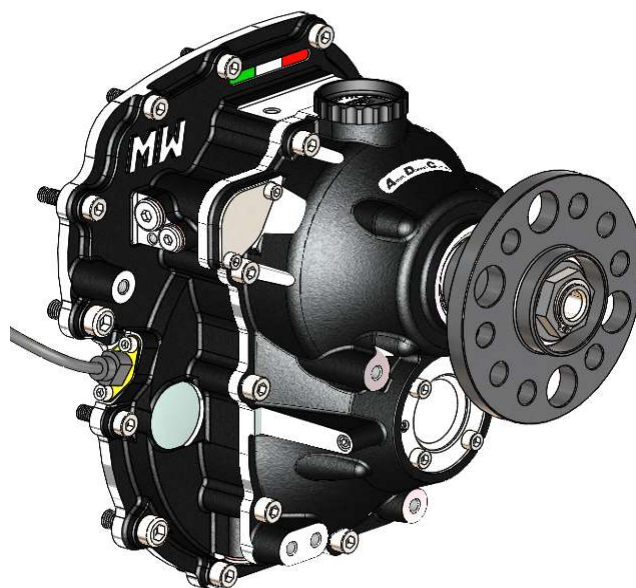
61-01-00 Description

In engines with direct transmission to the front of the block, a cover is connected that includes the shaft and the propeller flange: this cover supports the loads deriving from the propeller through two ball bearings of considerable size; the cover is also sized to support the loads deriving from belt drive, often used in rotary wing aircraft. In engines with direct transmission, the propeller revolutions are equal to the engine revolutions and there is no type of flexible coupling between the propeller and the crankshaft. The propeller shaft bearings are lubricated by splashing, using engine oil.

The engines that use the Gearbox instead of this cover mount, the PSRU reducer group, consisting of a pair of helical tooth gears; the propeller shaft is equipped with front cam flexible couplings, to reduce torsional stresses; each shaft is supported by two ball bearings of considerable size. The pair of gears rotates in an oil, and can be easily inspected through the large hole prepared for the introduction of the oil present in the upper part of the casting. The lubrication oil is not the same as that used for the engine: this choice was made to reduce the risk of contamination of the engine oil by metal



61-01-P



61-02-P

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particles produced by the rotation of the gears, and at the same time use a lubricant more suitable for the conditions of high specific pressure that occur in the contact between the gear reducer teeth.



The gearbox lubricating oil, like the engine oil, must be adequately cooled, according to the indications in section 61-04 of this manual.

A one-way breather valve is located between the reducer and the motor body.

All gearboxes are equipped with a PG-m (Propeller Governor module): this device constitutes a constant speed propeller control system, with electro-hydraulic control with digital speed setting. On the other hand, it is not possible to use hydraulic governors with centrifugal control keyed on the propeller shaft.

It is also possible to mount electrically controlled variable pitch propellers in flight, with a rotating feed motor in the hub and sliding contacts. This solution is also the only one that can be used on direct drive engines.



If the propeller hits the ground or any other obstacle while the engine is running you need to overhaul the gearbox in order to verify the integrity of gears and housings.



For any reason, loosen or replace the union screws between the body and the cover of the gearbox or between the gearbox or front cover (for direct drive version) and the engine: therefore, avoid using them to fix engine's components or accessories, such as radiator, air intakes or other. Failure to comply with this requirement releases MWfly from any obligation and liability towards the user, and causes the automatic revocation of the guarantee.



In the case of electric pitch drives, before assembly make sure that the control power of the electric actuator is sufficient to overcome the reaction torque of the blades: the latter, characteristic of each type of blade, must be supplied by the manufacturer of the propeller, and calculated in reference to the power of the engine you want to install.

61-02-00 General Characteristics

All engines have been designs to work with both pushing and tractor applications.

- Maximum gearbox oil temp. in flight conditions (with HG-m) 130 (110) °C
- Typical gearbox oil temp. in flight conditions (with HG-m) 105 (90) °C
- Minimum gearbox oil temp. in flight 20 °C

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Using the engine with gear box oil temperature over the limit indicated will cause an excessive increase of the gap between the gears. This will cause an unusual wearing of the gear.

- Reduction ratio

Direct drive	1÷1
Type A	1÷1.731
Type B	1÷1,958

- Max prop speed

Spirit 100 Direct R/L	3500 rpm
Spirit 115 Direct R/L	3500 rpm
Spirit 122 PSRU R/L	2450 rpm
Spirit 135 Direct R/L	4750 rpm
Spirit 135 PSRU R/L	2425 rpm
Spirit 140 PSRU R/L	2450 rpm
Spirit 160 Direct R/L	4750 rpm
Spirit 160 PSRU R/L	2425 rpm
Spirit 180 Direct R/L	4250 rpm
Spirit 180 PSRU R/L	2450 rpm
Spirit 210 Direct R/L	4250 rpm
Spirit 210 PSRU R/L	2450 rpm
Spirit 240 Direct R/L	4250 rpm
Spirit 240 PSRU R/L	2450 rpm

- Max torque on propeller shaft

Spirit 100 Direct R/L	207 Nm (21,1 Kgm)
Spirit 115 Direct R/L	238 Nm (24,3 Kgm)
Spirit 122 PSRU R/L	364 Nm (37,1 Kgm)
Spirit 135 Direct R/L	210 Nm (22,1 Kgm)
Spirit 135 PSRU R/L	411 Nm (41,9 Kgm)
Spirit 140 PSRU R/L	450 Nm (45,9 Kgm)
Spirit 160 Direct R/L	260 Nm (26,5 Kgm)
Spirit 160 PSRU R/L	509 Nm (51,9 Kgm)
Spirit 180 Direct R/L	301 Nm (30,7 Kgm)
Spirit 180 PSRU R/L	521 Nm (53,1 Kgm)
Spirit 210 Direct R/L	351 Nm (35,8 Kgm)
Spirit 210 PSRU R/L	608 Nm (61,9 Kgm)
Spirit 240 Direct R/L	409 Nm (41,7 Kgm)
Spirit 240 PSRU R/L	708 Nm (72,2 Kgm)

- Max polar moment of inertia

vers. Direct	5500 Kgcm ²
vers. PSRU	8500 Kgcm ²

- Min polar moment of inertia

vers. Direct	3000 Kgcm ²
vers. PSRU	5500 Kgcm ²

- Max static load (propeller weight)

	15 Kg
--	-------

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- Max dynamic imbalance 0,15 IPS



The type A gearbox is fitted as standard on the PSRU engines of the Skyline series and turboline (Spirit 122 and Spirit 140, Spirit Turbo 180 PSRU, Spirit Turbo 210 PSRU, Spirit Turbo 240 PSRU); the type B gearbox is fitted as standard on the PSRU motors of the Redline series (Spirit 135 and Spirit 160).

61-02-01 Gearbox Oil Capacity

- Quantity of gearbox without governor 400 cm³
- Quantity of gearbox oil with governor* 550 cm³
- Tolerance on oil level ±50 cm³

* referred to an installation with MW Hydropitch propeller without spacer.



The amount of oil to be introduced into the gearbox with VPP can significantly increase depending on the type of hydraulic hub used or in the case of using a propeller spacer: in these cases, it is necessary to establish the amount of oil to be used for refuelling the gearbox, based on the feedback provided by the level screw after having operated the propeller governor.

61-02-02 Permissible Loads on the Transmission Shaft

The following table shows the max/radial and max/axial load on the propeller/transmission shaft.

Max load on the shaft [N]	<i>Version Direct</i>	<i>Version PSRU</i>
<i>Max axial continuous load</i>	2000	2000
<i>Max axial load</i>	9000	7000
<i>Max radial continuous load</i>	8000	5000
<i>Max radial</i>	32000	19000

61-01-C

Maximum continuous loads above are calculated for a minimum bearing life of 2200 hours for the standard versions, and for 1000 hours for the version for helicopter (max rpm 4500 without gearbox).

In a standard engine application or fixed-wing aircraft the load on the propeller shaft is normally under the limit indicated in the table, provided you use appropriate and approved propellers and well balanced both statically and dynamically and do not perform aerobatic manoeuvres.

In applications on rotary wing aircraft it is necessary to evaluate the loads induced by any pre-rotation or transmission systems (belts), both radially and axially (due for example to misalignment of the pulleys); in these applications it is of absolute

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importance to quantify and contain the loads due to the torque impulse generated by the large inertia of the main rotor and by the presence of a possible free wheel on the transmission: for this purpose it is advisable to install a slipping clutch or of a flexible coupling.



Failure to comply with these prescriptions can cause serious damage to the transmission system and to the engine structure.

61-03-00 Gearbox Cooling Radiator Group (GC-m)



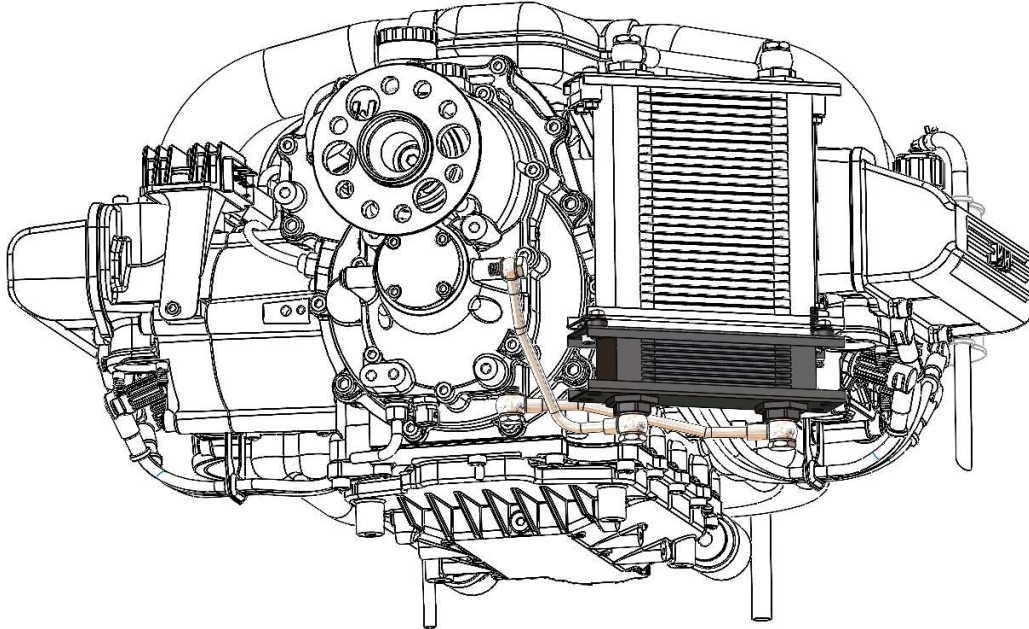
61-03-P

The GC-m (Gearbox Cooler Module) cooling radiator is available as an option. The radiator, made entirely of aluminum, is suitable for most traction applications and ensures adequate cooling of the gearbox, provided an efficient air intake is created under all operating conditions.

61-03-01 Description

The radiator is supplied with pipes, fittings, and small parts for connection to the gearbox.

The radiator is attached to the lower part of the oil cooler using the components supplied with the radiator itself.



61-04-P

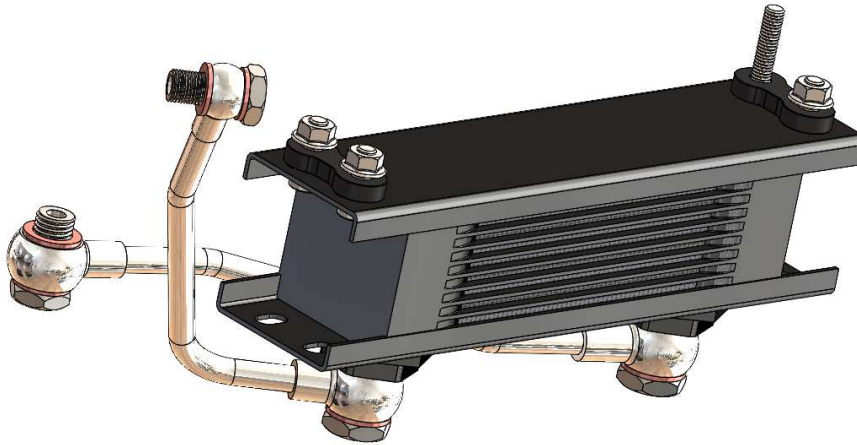
61-03-02 Component features

▪ Radiator dimensions	210x52x50 mm
▪ Radiator cooling surface area	49 cm ²
▪ Typical radiator cooling flow rate	0.08 m ³ /s
▪ Tube internal diameter	8 mm
▪ Oil volume in radiator and tubes	0.16 l
▪ GC-m weight:	0.6 kg

61-03-03 Installation

Needed tools

1. Torque wrench 0-50 Nm
2. 5 mm L-shaped Allen key
3. 6 mm Allen key
4. 10 mm socket
5. 14 mm socket
6. 17 mm socket
7. 19 mm socket

*61-05-P*

Install the radiator as described below.

- a.** Remove [3] the oil from the gearbox.
- b.** Unscrew [2] the cap located on the right side of the pump compartment on the gearbox.
- c.** Unscrew [3] the cap on the far right of the lower part of the gearbox.
- d.** Remove [2;4] the lower screw securing the engine oil radiator to its bracket.
- e.** Place the gearbox radiator against the lower part of the engine oil radiator, inserting the two plastic spacers.
- f.** Secure [2;4] the two radiators together using the screws and nuts provided: the longer screw must be mounted in correspondence with the support bracket. Tighten [2;1+4] to 8 Nm.
- g.** Mount [7] the two connecting pipes as shown in figure 61-05-P on the radiator without tightening the screws: insert the copper washer provided on each side of the eyelet.
- h.** Position the oil supply pipe from the radiator to the lower part of the gearbox and screw it [6] into place, inserting the copper washers; tighten [1+6] to 22 Nm.
- i.** Position the oil return pipe from the radiator to the side of the gearbox and screw it [5] into place, inserting the copper washers; tighten [1+5] to 15 Nm.
- j.** Tighten [1+7] the two collar screws on the radiator to 25 Nm.

After the first start-up, check that none of the fittings have oil leaks.

61-04-02 Radiator

The shape, size and position of the radiator depend mainly on the available space.

- Typical radiator cooling surface ~50 cm²
- Typical cooling flow on the radiator 0,08 m³/s

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If the radiator is too far from the engine and the pipes do not have an adequate diameter, a high pressure drop in the system will occur, which can compromise the correct functioning of the variable pitch propeller.



Position the radiator and fittings in such a way as to avoid any accidental contact with hot parts of the engine, such as the exhaust system, which could alter their integrity.



Under no circumstances should the screws connecting the crankcase to the gearbox be used to secure the radiator or air intake. Failure to comply with this requirement releases MWfly from any obligation or liability and automatically voids the warranty.

61-04-03 *Air intake sizing*

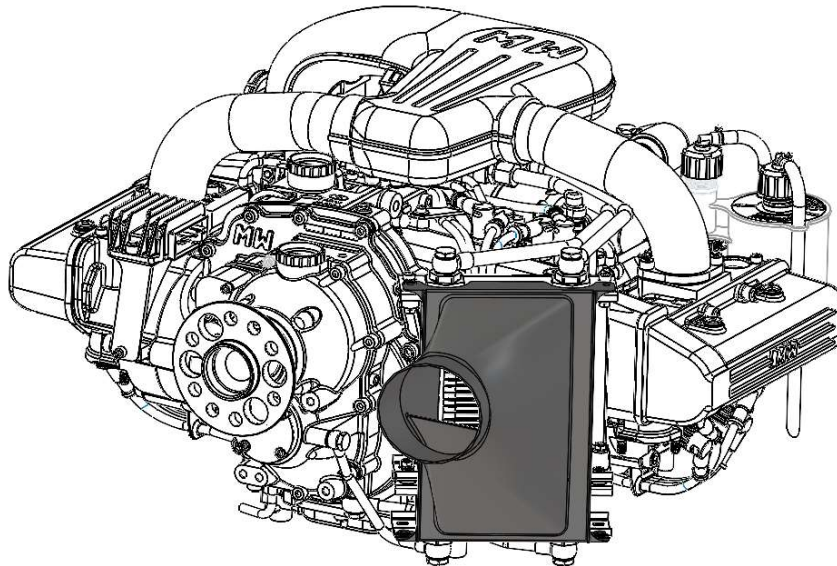
- The air intake should be positioned to the right of the propeller (for an observer viewing the aircraft through the propeller) and as close as possible to the propeller's plane of rotation.
- The height and width of the air intake should ideally be approximately 80% of that of the radiator. The same air intake can be used to feed both the engine oil cooler and the reduction gear cooler.
- Create a duct made of aluminum sheet metal or fiberglass between the radiator and the air intake on the engine cowling to ensure a rapid supply of fresh air to the radiator.
- To improve radiator efficiency, it is advisable to seal any gaps between the air intake, the duct, and the radiator itself.
- The total area of the cowling's air extraction window must be at least three times greater than the sum of all the cowling's air intakes, whether cooling, fuel, or ventilation.
- It is advisable to shape the edge of the extraction window like a spoiler, to divert the air that touches the bonnet and create a depression area.

61-04-04 *Circuit installation*

The circuit to be created must connect the gearbox to the radiator through the two ports located on the far right in the lower part of the gearbox itself: of these, the

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port on the far right is the inlet to the pump, the other the outlet from the oil tank.



61-06-P

The system pipes must be connected using M12x1.5 threaded fittings, tightened to a torque of 22 Nm. These fittings must ensure adequate oil flow to the radiator, especially considering the fact that the radiator itself operates on an intake system. For circuits with particularly long runs, rigid pipes (aluminum) with hemming should be used to prevent the fittings from coming loose.

The radiator must be positioned lower than the oil level in the gearbox; otherwise, a constant flow to the pump would not be guaranteed.

All cooling system components must ensure safe and stable operation of the system itself.

The size and arrangement of the system components must allow the engine's operating temperatures to remain within the limits: favour large-section pipes, with wide-radius bends and without significant variations in cross-section; use new radiators with tube bundles of adequate cross-section, preferably with horizontal flow.

61-05-00 Recommended Lubricant

The gearbox has separate lubrication from the engine, with a separate oil pump and lubricant. The oil in the gearbox is used to lubricate the gears and remove heat from them. Since the lubrication of transmission gears is particularly stressful, the lubricating oil used for the gear unit has different characteristics than that used for the engine. The recommended gear box oil should be an oil for a hypoid gear with a thermal degree 80W / 90 API GL5.

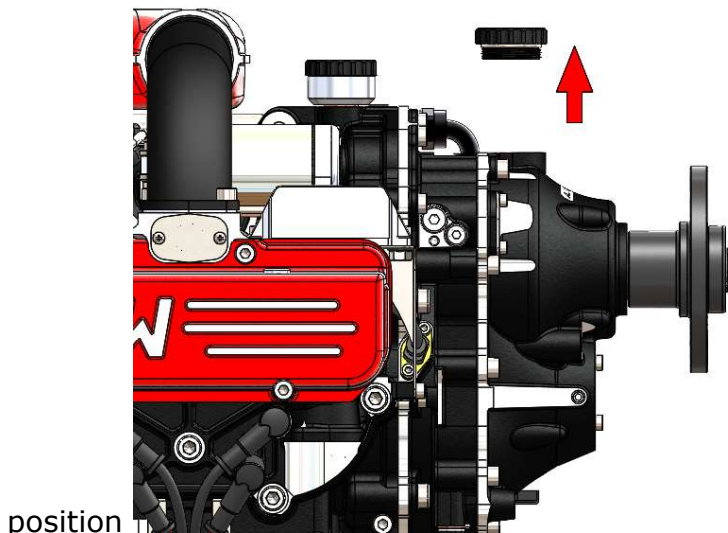


After the first 25 hours of operation it is necessary to replace the gearbox oil: if not replaced it will cause damage to the gears or the variable pitch propeller control system, if installed.

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61-06-00 Refilling Reduction Gear Box

The oil must be refilled by unscrewing the cap positioned above the reducer and one of the two level control caps located on the sides of the reducer in a symmetrical



61-07-P

Fill the gear box with the indicated quantity of the recommended oil: the correct oil level is reached when the oil starts to drain from level oil plug on the side of the gearbox.



61-08-P

Screw the cap back on by hand until it bottoms with the reducer plane; before screwing in again, at the first oil supply, it is advisable to grease the sealing ring on the cap with oil, to prevent the gasket from hardening.

Through the refuelling hole it is also possible to check the wear of the gearbox gears.

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Check the oil level in the gearbox and the condition of the gears at the recommended intervals and in all cases where excessive noise is heard.

61-10-00 Propeller

The propeller is the most important accessory of the entire installation, as it can boost or depress the performance of your engine: to choose the most appropriate propeller carefully read the following notes.

The choice can be made based on a few essential requirements as summarized below.

- Propellers that allow the engine to reach too high an rpm cause the early intervention of the rpm limiter and therefore do not allow a good utilization of the engine, as well as damaging the engine itself.
- Propellers that do not allow the engine to reach, at least 90% of the maximum speed on the ground, cause a loss of performance in the take-off.
- At the same engine rpm, small-diameter and large pitch propellers are better for obtaining high speed performance, but those propellers have poor climbing and acceleration performance.
- Increasing the number of blades increases propeller traction at low speeds, favouring short take-offs and steep climbs, but sacrificing speed performance.
- At the same engine rpm, large diameter propellers and low pitch propellers facilitate climbing performance and acceleration, but reduce speed performance.
- Tapered propellers are better for high speed performance.
- Propellers with a higher pitch are better for high speed performance.
- In flight, variable pitch propellers combine the features of large diameter propellers to those of high pitch value propellers.
- Avoid the installation of propellers with excessively flexible blades, as they cause the occurrence of low-frequency vibrations that are particularly noticeable in reduced percentages of engine power.
- Propellers with wooden hubs require more frequent tightening compared to those equipped with aluminum or composite hubs.



MWfly declines any responsibility for damages or injuries caused to things or people deriving from the use of unapproved, badly installed or unbalanced propellers. This eventuality causes the immediate cancellation of the guarantee.



MWfly does not allow the use of clutch or damper devices or devices other than those provided and original. MWfly prohibits modifying or adding any device that modifies the transmission mechanism in PSRU engine version.

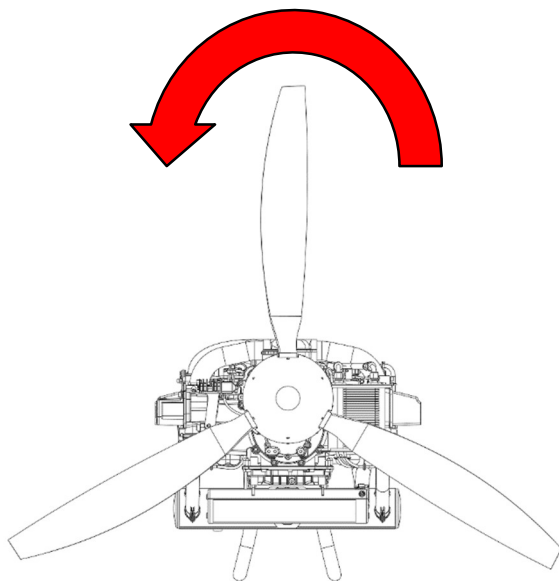
61-11-00 Propeller General Features

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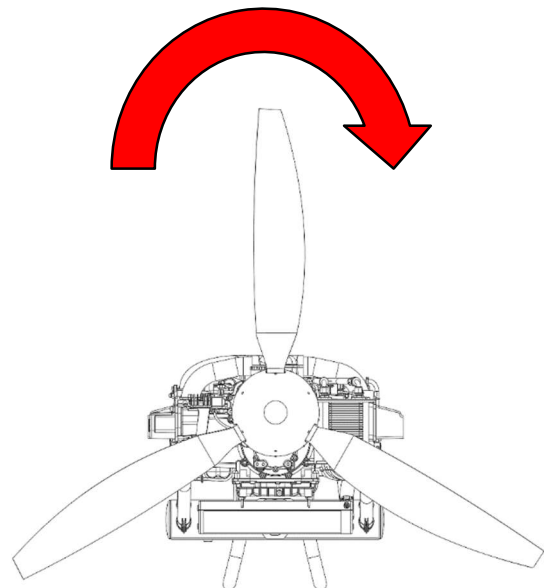
61-11-01 Rotation Direction

The direction of rotation of each version of engine (both with gearbox and direct) is defined with respect to an observer located in front of the propeller, who sees the engine behind it, according to the SAE J824 standard: therefore a propeller that moves in a clockwise direction it rotates to the right (motor "R" right), a propeller that moves in an anticlockwise direction rotates to the left (motor "L" left).

For greater clarity refer to the following figures.



61-06-P



61-07-P

Counter clockwise rotation = left engine (L)

Clockwise rotation = right engine (R)



Never manually rotate the propeller in the opposite direction. This operation can damage the automatic timing chain tensioners and also disengage the system on the engine starter.



In engines with right rotation, the rotation of the propeller produces a drift to the right of the aircraft, to be contrasted on the ground with the left pedal, and to be adequately balanced in flight with the aerodynamic compensation surfaces. The opposite rule applies to the versions with left rotation.

61-11-02 Weight Polar Moment of Inertia

The gear box has been designed to support the load produced by the propeller that a weight not exceeding 15kg and that has a polar moment of inertia admitted must

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be between 5500 and 8500 Kgcm². In the case of motors without gearbox, the polar moment of inertia must be between 3000 and 5500 Kgcm².

Theoretically the propeller with a high value of polar moment of inertia increases the regularity of the engine at low RPM and facilitates the engine start up.



For any reason, use propellers with mass or polar moment of inertia that do not comply with the requirements: this eventuality causes the immediate revocation of the guarantee and frees MWfly from any further obligation towards the user.



The use of propellers with inadequate structural rigidity can cause dangerous vibrations in the transmission system, with consequent damage to the gearbox.

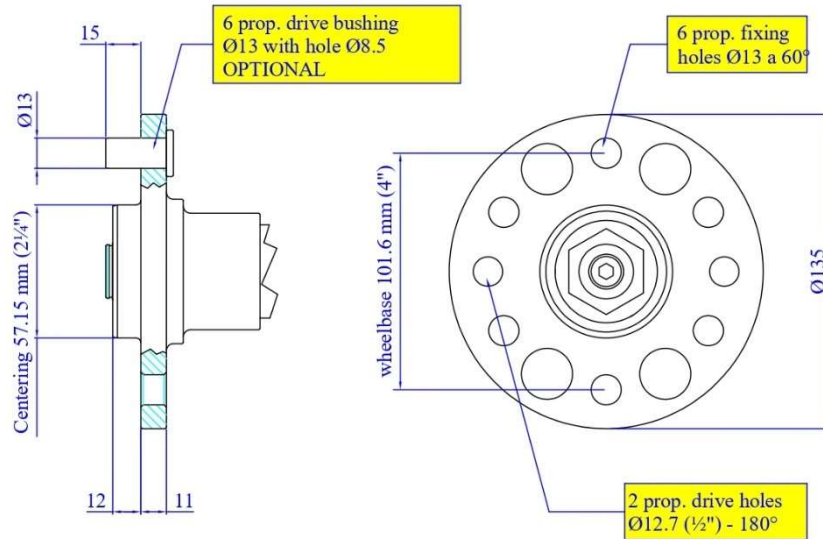
61-12-00 Installation

61-12-01 Engine Flange

In direct drive engine the propeller flange is keyed to the output propeller shaft through a forced coupling and a large nut; in engine with PSRU, the propeller flange is made of one piece with the propeller shaft. In both cases it is made of high-strength steel, and is passivated against corrosion: this protection is sufficient to avoid oxidation in most uses. However, if the engine is used in highly salty environments (coastal locations) or heavily polluted, it should be greased periodically with anti-corrosion oil. Also avoid carving or abrading the surface of the propeller flange to preserve the integrity of the surface treatment.



In direct drive engine the propeller flange must not be removed for any reason: failure to comply with this requirement is a potential source of danger and frees MWfly from any obligation or liability towards the user.



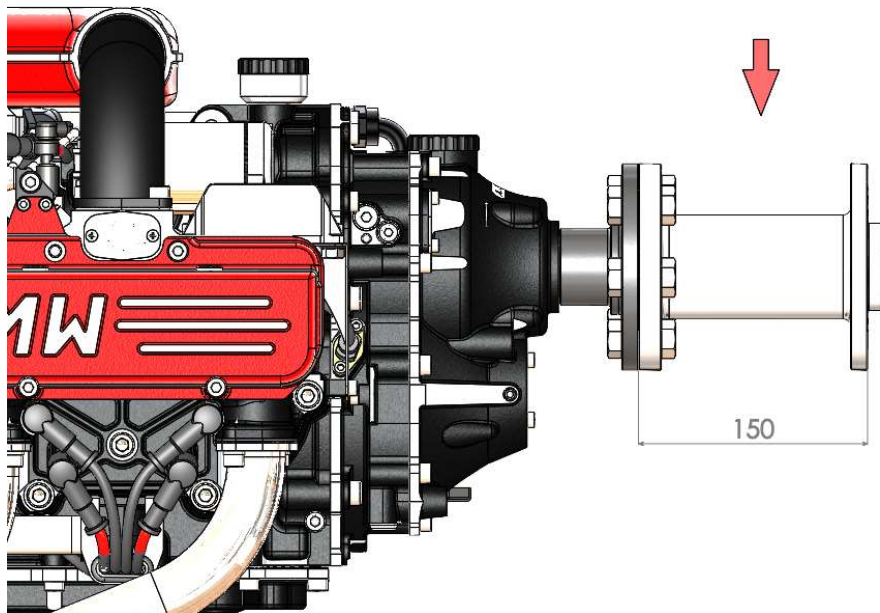
61-11-P

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Type ▪ External diameter ▪ Boss diameter for propeller ▪ Propeller fixing hole ▪ Propeller drive ▪ Max overhang from flange | <p>ARP 502</p> <p>135 mm</p> <p>2 ¼" (57.15 mm)</p> <p>6 holes D13 on D4" (101.6 mm)</p> <p>2 holes ½" (12.7 mm) on D4" (101.6 mm)</p> <p>150 mm</p> |
|--|--|

Figure 61-11-P represents the flange of direct drive engines: however all the dimensions indicated are identical also for PSRU engines. The propeller is tightened by means of 6 ½" screws inserted in the 6 holes D13, the drive is done using two ½" pins; however, it is possible to insert 6 D13mm bushing in the same holes and use 6 M8 screws to fix the propeller; in this case the dragging is ensured by the bushes, and therefore the half-inch dragging pins must not be used.

61-12-02 Extension

It is possible to use a 150 mm maximum extension on the propeller shaft both in direct drive engines and in engines with PSRU. The extension should be perfectly coaxial and concentric with the propeller shaft to avoid any imbalance load on the propeller shaft.



61-12-P



Longer extensions than the maximum allowed can cause an overload on the ball bearings of the gear box, with the risk of stopping the ball bearing.



The rearmost point of the blade profile must be considered as the plane of rotation. The height of 150mm is therefore to be understood as inclusive of any overhang already contained in the propeller hub.



In case of using a propeller spacer in combination with a hydraulically operated propeller, it is advisable to make the spacer itself with a central hole for the passage of small diameter oil, to reduce the amount of oil needed to drive the propeller.

61-12-03 Implementation



If a fixed pitch propeller made of wood is used, we recommend a mounting hole type ARP 502, which ensures greater stability and safety.

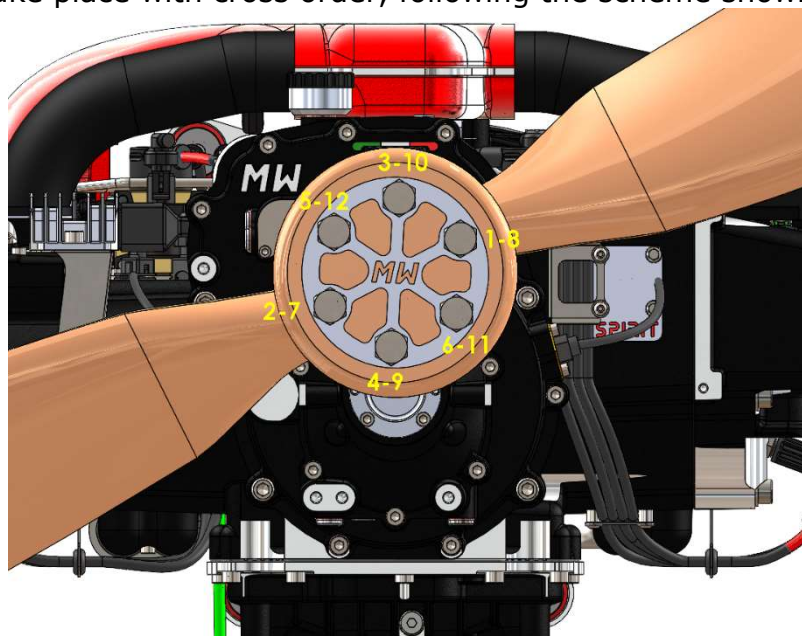
Necessary Materials

(The steps for mounting a propeller with M8 locking screws and D13 drive sleeves are shown in brackets).

1. Torque wrench
2. Open end key 19 mm (Allen key 6 mm)

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3. Open end key 19 mm (Open end key 13 mm)
 4. Threadlocker medium
- a. Carefully clean the propeller surface and the flange surface that will face each other and remove any debris caused by the previous assembly.
 - b. Insert the two half-inch drive pins into the two pre-drilled holes. (insert the 6 dragging bushes into the 6 holes D13.)
 - c. Fit the propeller on the flange and on the centring hub, so that the drive bushes fit effortlessly into the seats made on the propeller.
 - d. If a wooden propeller is mounted, it is necessary to overlap with the hub an anti-sinking dish, which avoids the wood to dent following the tightening imposed on the screws.
 - e. Depending on the propeller type
 - Hub with passing holes (generally a fixed step propellers): insert the six tightening screws through the propeller holes, screw [4] on each the nut and shim and tighten [3; 1+2] at 35 Nm (22 Nm), or minor, if otherwise prescribed by the propeller manufacturer or in the case of use of wooden propellers; The tightening must take place with cross order, following the scheme shown in the figure.
 - Hubs with generally propelled propellers with variable pace: insert the six tightening screws from the back of the propeller flange and then screw them [3; 4] in the 6 holes of the propeller; Tighten [1+3] at 35 Nm (22 Nm), or minor, if otherwise prescribed by the propeller manufacturer; The tightening must take place with cross order, following the scheme shown in the figure.



61-13-P

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- f. After tightening, check the tracking of the blades: the maximum deviation must comply with what is reported.

61-12-04 Balance and Tracking

To minimize vibration and mechanical stress on the transmission components it is essential to install the propeller perfectly balanced both statically and dynamically. For the same purpose it is necessary to check the tracking of the blades, the maximum deviation between the rotation plane of the blades, measured at the vertex of each blade; in the case of propellers with more than 2 blades, it is calculated as the difference between the rearmost blade and the most advanced blade. A final check, in the case of variable pitch propellers, concerns the maximum keying error between the blade with the highest incidence and the one with the lowest incidence.

- | | |
|--|---------------|
| ▪ Maximum dynamic safety unbalance | 0,15 IPS |
| ▪ Maximum dynamic unbalance of comfort | 0,07 IPS |
| ▪ Maximum tracking error | ± 1,6 mm |
| ▪ Maximum pitch error of blade keying | ± 0,8 degrees |



Propeller balancing and tracking are very important for the safety and durability of the transmission system; MWfly declines all responsibility for breakages or damage caused by inadequate and improper assembly of propellers.



In the event of an accidental impact with the ground, it is necessary to check and rebalance the propeller before resuming flight.



The use of well dynamically balanced propellers reduces vibrations due to rotation and significantly increases flight comfort.

61-20-00 Constant Speed Electro-Hydraulic Governor HG-m

On each engine equipped with a gearbox it is possible to add a constant speed propeller governor, with open circuit electro-hydraulic control: this device is composed of a trochoidal pump that moves the gearbox lubrication oil, a safety valve, a valve pressure relief and a step-by-step electric actuator and a metal mesh filter.

The governor allows, with a minimum weight increase and a minimum complexity, to have a completely automatic, fast and safe propeller pitch variation system, which increases performance both in take-off and in level flight. The governor can also be mounted at a later time, with a very little invasive intervention on the engine.

The setting of the desired revs for the flight is done through the EM-m instrument panel or, in the case of cockpit with analogue instrumentation, through the PG-m instrument: these instruments are connected to the engine electrical system via the CAN line. For a description of the functions and how to install these tools, refer to VPP manuals.

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60-20-01 Characteristics of the Components

▪ Pump flow rate	16 l/min @ 4000 rpm
▪ Operating pressure	14 bar
▪ Type of electric valve control	Step by step
▪ Number of steps	1696
▪ Error un RPM target	±20 rpm

61-20-02 Installation

For the installation of the governor, refer to the DMA.A01 manual.

61-40-00 Verification and Validation

61-40-01 Vibration Check

The propeller must be selected in accordance with the requirements set forth in section 61-11 of this manual. Furthermore, it is important to ensure that the propeller used does not generate abnormal vibrations throughout the entire rpm range, after having properly balanced it dynamically. Proceed as follows:

- a.** Start the engine, and after the warm up, keep the engine at 1500 RPM: stay away from the propeller and the propeller plane, and observe if the propeller blades stay in the rotation plane and do not bend.
- b.** Repeat the above test with the engine 3000 rpm.
- c.** Perform a flight test an hour before the sunset and flying with the sun at the back and observe the reflection of the sun light on the propeller blades: you should observe there is no vibration of the reflection at any engine speed.

If the above conditions are not met then the propeller is too flexible or there is a dynamic instability that can cause a resonance phenomenon that can be very dangerous. In this case it is better to use a stiffer propeller.



Check the tightness of the propeller mounting screws using the deadlines provided for in the maintenance schedule or in a shorter time period if prescribed by the propeller manufacturer.



After the first flight, check the tightening of the reducer closing screws, as indicated in the maintenance manual: in case of loosening, carefully check the balance and tracking of the propeller; in the case of using variable pitch propellers, also check the blade pitch error.



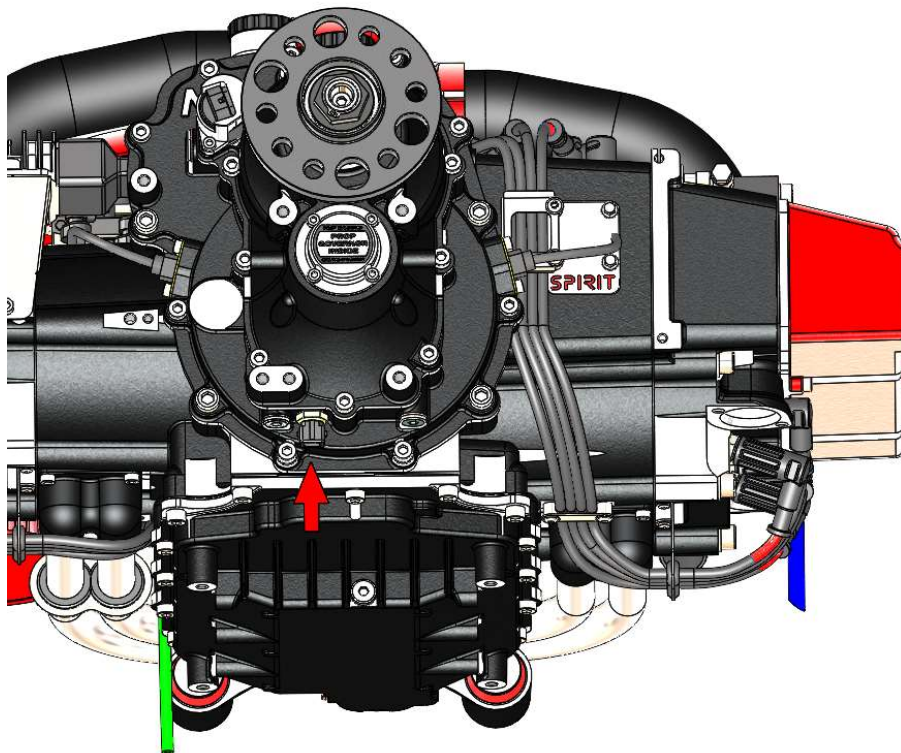
Before flight check the propeller and transmission components by rotating the propeller manually: you should not hear any noise or feel any jamming. Before you do this, make sure that the injection system is not powered.



Do not rotate the propeller in the opposite direction to that of normal rotation of the engine: doing so can damage the tensioning system of the distribution chain and the starter system.

61-40-02 Gearbox Oil Temperature Measurement

The measurement of the gearbox oil temperature is done by means of the appropriate sensor, located in the lower part of the gearbox.



61-14-P

To assess the operating temperature of the reducer, it is necessary to perform a flight in significant climatic conditions (ambient temperature above 30 ° C) and check the maximum temperature reached during operation or immediately after the engine is switched off. This temperature must comply with the limits indicated. If the temperature is over the indicated limit, it is necessary to prepare an inlet intake on the cowling in correspondence of the lower part of the gear box.

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In addition to cooling problems, a higher than normal gear oil temperature can be associated with problems in the transmission gears or the torsional vibration damping system.



The use of the engine with too high a reducer lubricant temperature causes an increase in noise and wear of the gear teeth.

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72-00-00 ENGINE

For simplicity and clarity, only the information relevant to installation is reported in this manual. If necessary, complete the information with the operation or routine maintenance manual.

72-01-00 Description

72-01-01 *Intended Use*

The **SPIRIT** and **SPIRIT Turbo** engines have been designed to equip ULM, Experimental or LSA category aircraft with two or three axes, with the required power in accordance with the power delivered by the engine.

The use of these engines is therefore intended for recreational purposes only, in installations where a sudden stop of the engine does not affect safety.



In order to use the engine safely, in addition to the operating limits, it is also necessary to comply with the maintenance deadlines indicated in the scheduled maintenance program.



In no way can the guarantee and safety specifications be extended to uses other than those mentioned above. MWfly declines all responsibility for damage or injury caused to people or things resulting from failure or sudden stop of the engine. Improper use of the engine causes the immediate revocation of the warranty and frees MWfly from any further obligation towards the user.



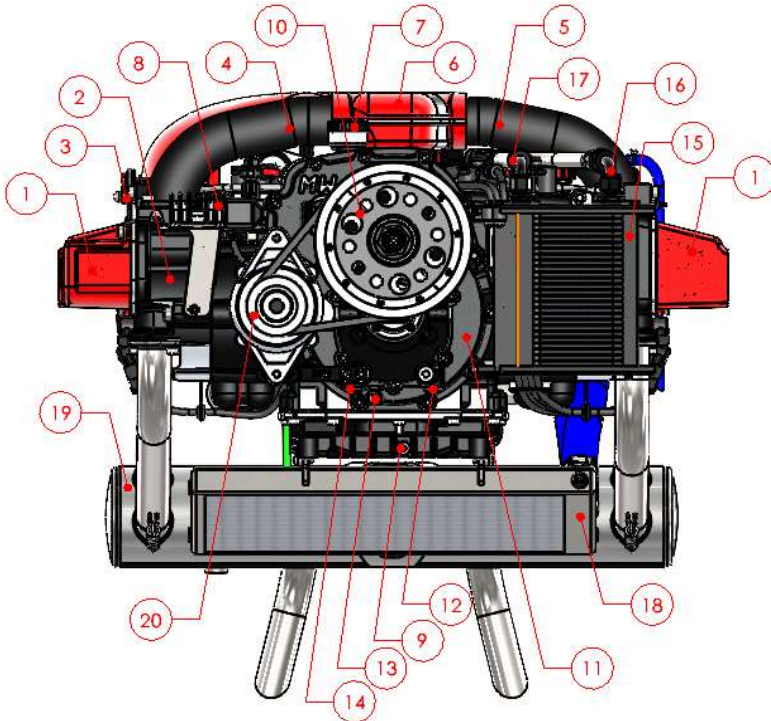
The engine can be used within and not beyond the time limits imposed by the TBO: after this period, it is necessary to have the engine completely overhauled at an authorized service centre before using it again.



To safeguard the integrity of the engine it is necessary to install and use it properly. It is therefore important to verify, through the instrumentation, that the reported operating limits are respected in all operating conditions.

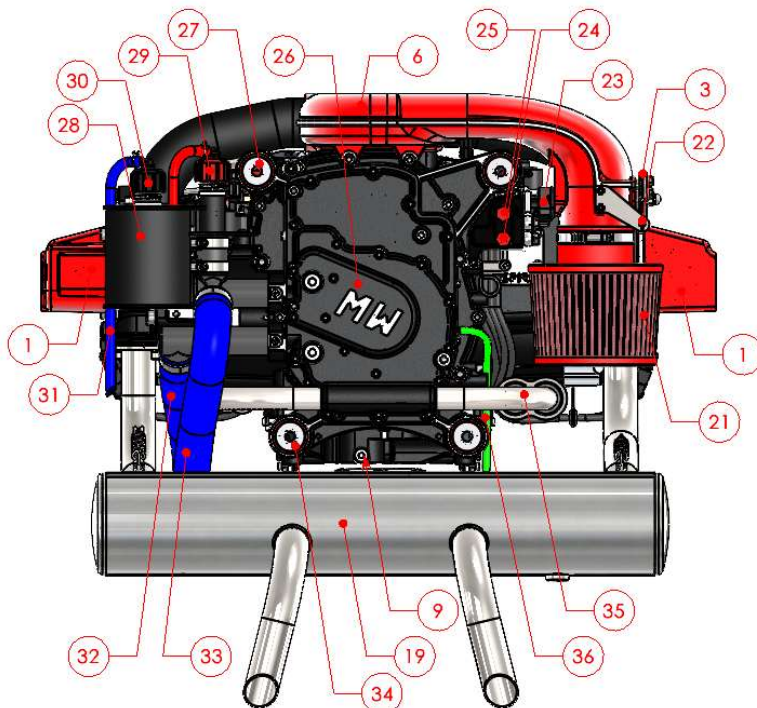
72-01-02 *Location and Component Identification*

Parts and engine components are named and located as shown in the following figures. The letter (o) identifies an optional component; the letter (v) identifies components present only in some versions; the letters A and B respectively identify the main circuit and the auxiliary circuit of injection / ignition.



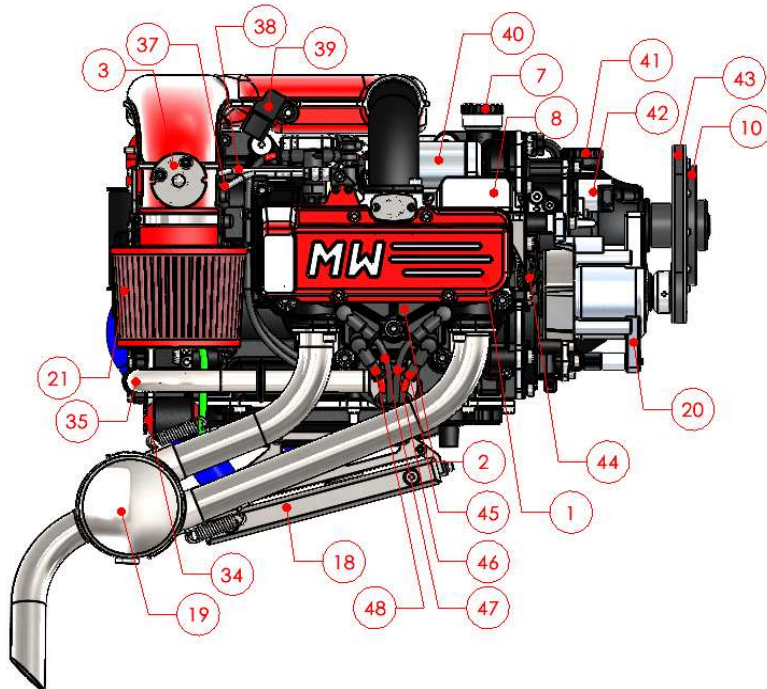
72-01-P

1. Head cover
2. Head
3. Throttle cam
4. Air intake manifold #1
5. Air intake manifold #2
6. Airbox
7. Engine oil filler cup
8. Voltage regulator
9. Oil plug output
10. Propeller Flange
11. Gearbox (v)
12. Gearbox oil plug output (v)
13. Gearbox oil temperature sensor
14. Safety valve VPP (o)
15. Engine oil radiator (o)
16. Inlet oil radiator hose (o)
17. Outlet oil radiator hose (o)
18. Water radiator (o)
19. Exhaust system (o)
20. Auxiliary generator (o)



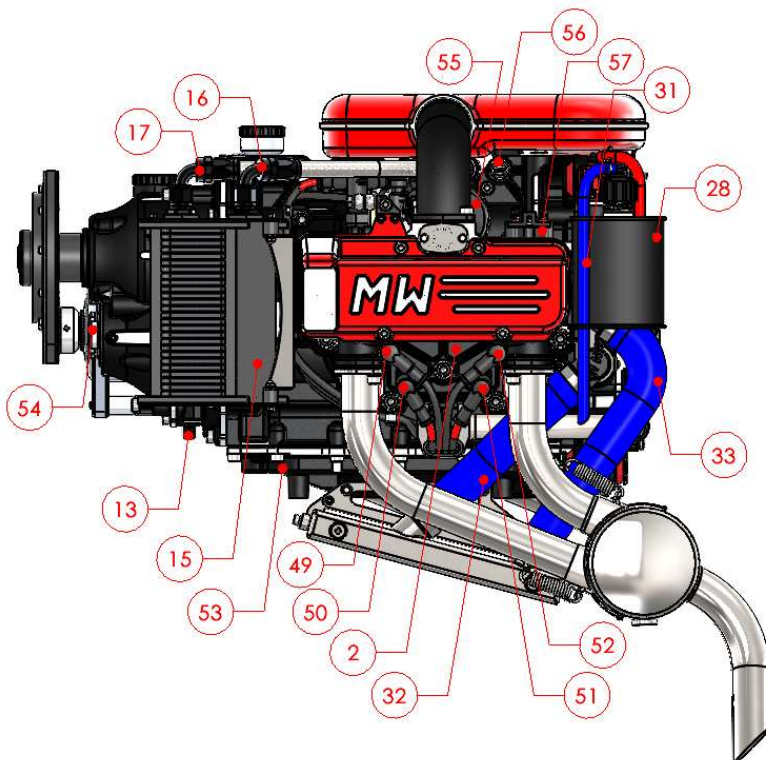
72-02-P

21. Air filter
22. Throttle cable locking
23. Throttle position sensor
24. Fuel inlet line port
25. Fuel outlet line port
26. Water pump
27. Upper attachment points for wall mounting (2x)
28. Expansion water tank
29. Pressurized cup for water circuit
30. Expansion tank cup
31. Expansion tank vent
32. Inlet water radiator hose (o)
33. Outlet water radiator hose (o)
34. Lower attachment points for wall mounting (2x)
35. Water circuit line
36. Water pump vent



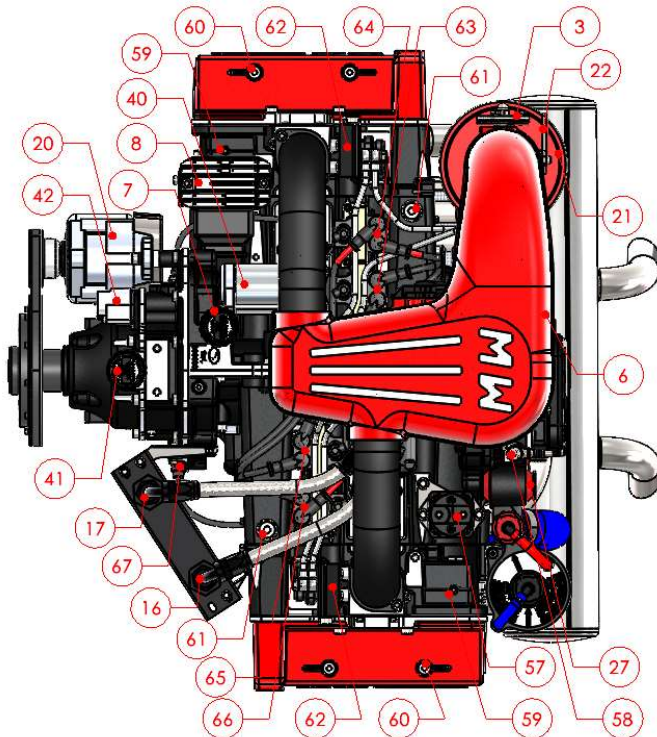
72-03-P

- 37. Fuel delivery pipe
- 38. Fuel return pipe
- 39. Air intake pressure and temperature sensor
- 40. Starter
- 41. Reduction oil filler cap
- 42. Stepper motor for VPP (o)
- 43. Auxiliary generator belt (o)
- 44. Rpm sensor circuit B
- 45. Spark plug cable cyl.1 circuit B
- 46. Spark plug cable cyl.1 circuit A
- 47. Spark plug cable cyl.2 circuit a
- 48. Spark plug cable cyl.2 circuit B



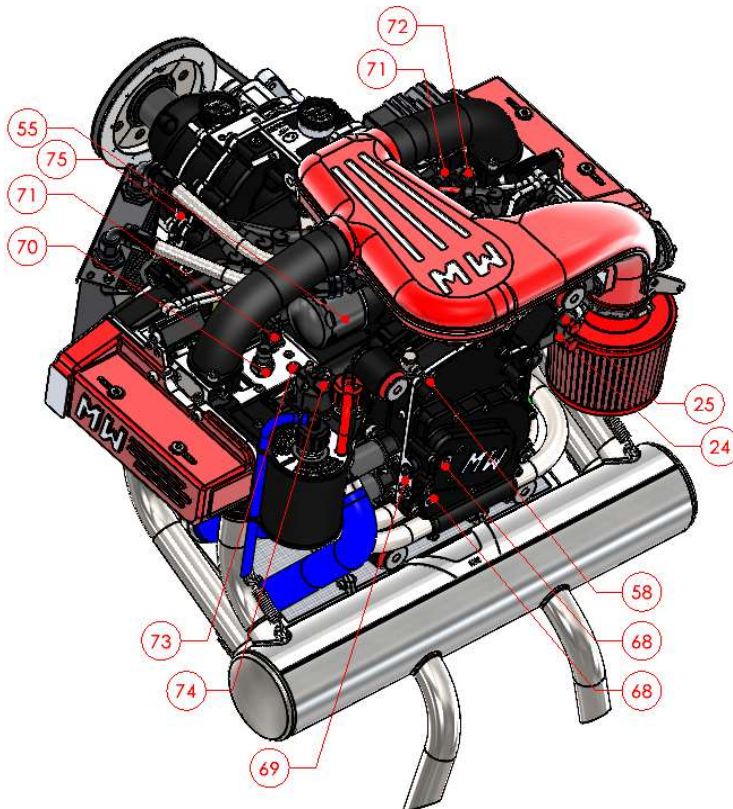
72-04-P

- 49. Spark plug cable cyl.3 circuit A
- 50. Spark plug cable cyl.3 circuit B
- 51. Spark plug cable cyl.4 circuit B
- 52. Spark plug cable cyl.4 circuit A
- 53. Oil sump
- 54. Pump for VPP (o)
- 55. Engine oil filter
- 56. Engine oil pressure switch (v)
- 57. Start relay



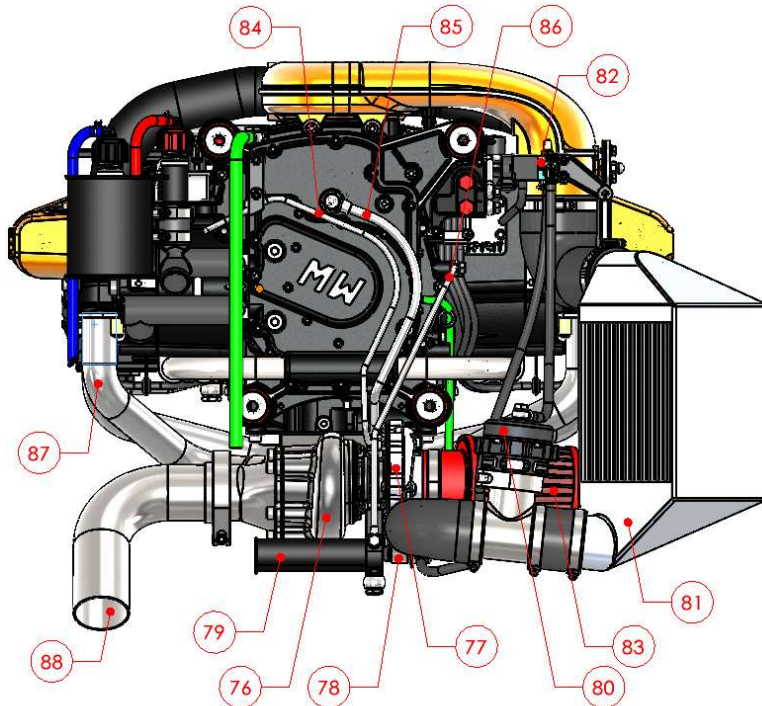
72-05-P

- 58. Crankcase vent
- 59. Water circuit vent
- 60. Timing inspection cap
- 61. Aerobatic oil circuit predisposition
- 62. Fuel injector group
- 63. Ignition coil cyl.1 e cyl.3 circuit A
- 64. Ignition coil cyl.1 e cyl.3 circuit B
- 65. Ignition coil cyl.2 e cyl.4 circuit A
- 66. Ignition coil cyl.2 e cyl.4 circuit B
- 67. Rpm sensor circuit A



72-06-P

- 68. Rear cabin heater predisposition
- 69. Side cabin heater predisposition
- 70. Engine oil pressure sensor (o)
- 71. Water temperature sensor
- 72. Oil temperature sensor
- 73. M10x1 predisposition for liquid temperature sensor (1 on each bank)
- 74. Terminal for starter cable
Gearbox oil check level cup



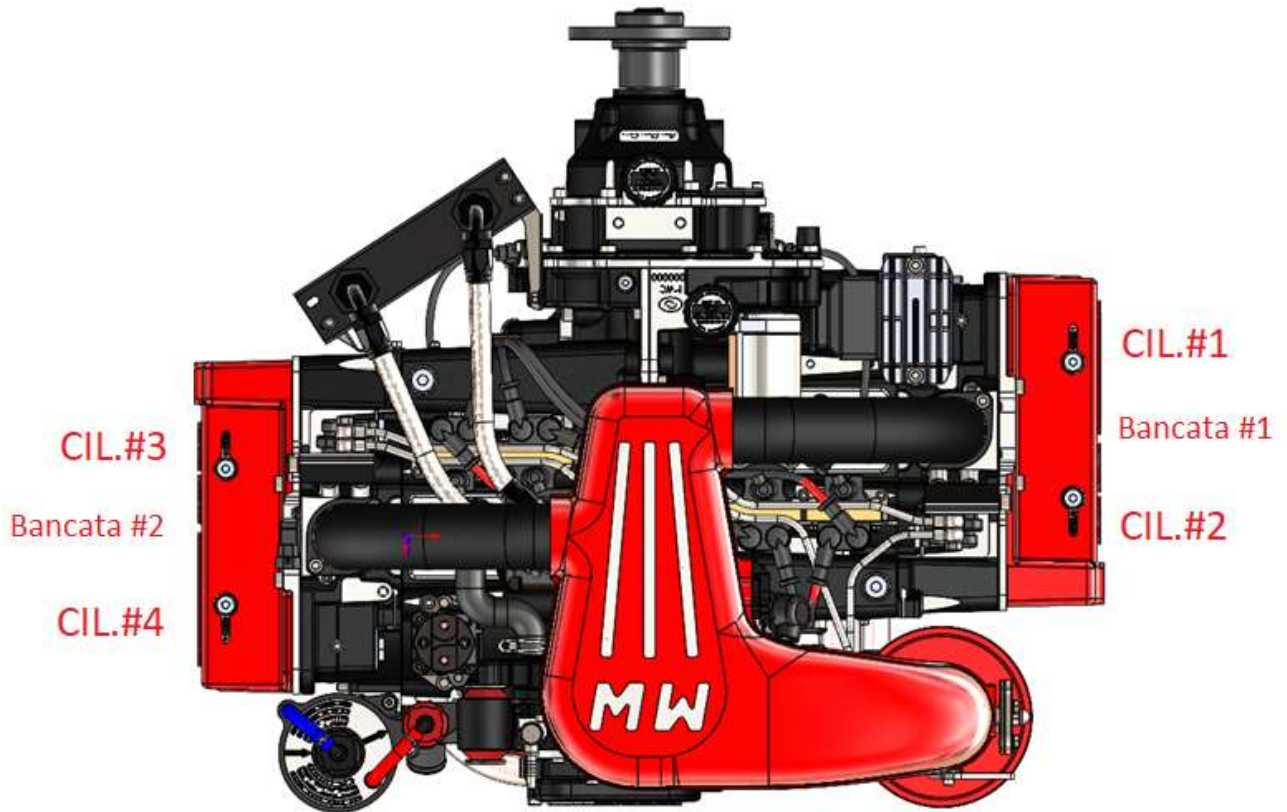
- 75.Turbina
- 76.Compressore
- 77.Valvola waste gate
- 78.Serbatoio turbocompressore
- 79.BOV (blow off valve)
- 80.Intercooler
- 81.Valvola overboost
- 82.Filtro aria
- 83.Tubo mandata olio a turbina
- 84.Tubo aspirazione olio da turbina
- 85.Tubo sfiato turbina
- 86.Collettori di scarico
- 87.Terminale di scarico

72-07-P

72-01-03 Designation of the Cylinders

The designation of the cylinders is that shown in the following figure, and is the same for both engines with right rotation and for engines with left rotation. Looking at the engine from above with the propeller flange up, cylinder # 1 is the first on the top right, cylinder # 2 the second on the right, cylinder # 3 the first on the left and cylinder # 4 the second on the left; bank # 1 (cylinders # 1 and # 2) is the one on the right and bank # 2 (cylinders # 3 and # 4) the one on the left.

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The ignition order for direct counterclockwise or geared hourly engines is 1-2-3-4; the ignition order for direct or counterclockwise geared hourly engines is 4-3-2-1.



The user assumes all risks deriving from the use of non-original accessories, as they can compromise flight safety or alter the characteristics of the engine.

72-01-04 *Original Accessories*



Before deciding the position of the engine on the aircraft, it is necessary to establish which accessories you want to use, to be able to predict their size and weight in the installation phase.

The following table shows a list of the main accessories with their description: the use of these accessories considerably simplifies installation and increases safety. The installation and maintenance required for some of these accessories is integrated in the engine manuals.

<i>Acronym</i>	<i>Meaning</i>	<i>Description</i>
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AG-m	Auxiliary generator module	External auxiliary generator
BM-m	Bed Mounting module	Adapter for bed mounting
CC-m	Can to can module	CAN interface that receive the data from the CAN line of the ECUs and send the data on a second CAN line with aerospace protocol used by standard aviation instrumentation
CR-m	Cooling radiator module standard	Standard engine liquid cooling radiator
EM-m	Engine monitor module	8" Display for engine and flight data
EX-m	Exhaust module	4 in 1 exhaust system
FD-m	Fuel delivery module	Fuel pumps and filter groups (2+2)
GC-m	Gearbox cooler module	Radiator of gearbox oil
OC-m	Oil cooler module	Engine oil cooler
HC-m	Hydraulic controller module	Hydraulic variable pitch propeller system
PG-m	Propeller monitor module	Hydraulic constant speed propeller control display

72-01-C

72-02-00 General Characteristics

- 4 stroke Otto cycle
- 4 cylinder boxer
- SOHC (Single Over Head Camshaft) distribution, gear and chain driven, taper with synthesized register shim, 2 valves per cylinder
- Water cooling system with water pump and double involute, water tank expansion integrated thermostat, stainless steel pipe line
- Forced lubrication system with gerotor pump, semi dry oil sump, all lubricant system ducts integrated inside the engine.
- Turbine versions with turbine lubrication tank and recovery pump.
- Electronic ignition with inductive coil, fully f(RPM, TPS) mapped with correction with engine and air temperature, and altimetric correction
- Electronic fuel injection, fully f(RPM,TPS) mapped, with correction with engine temperature and altimetric correction
- CAN aerospace protocol data transmission
- Fuel system with electric fuel pump, the main fuel pump is controlled automatically by the ECU, the auxiliary fuel pump is provided with the FD-m, fuel pressure regulator and steel pipes are integrated on the engine
- Integrated gearbox with separate splash lubrication, helical tooth gears, predisposition for hydraulic propeller pitch control (not present in the versions without reducer)
- Front cam dissipative torsional damping system with return springs
- ADC (Active Damping Control) anti-kickback system in starting and stopping

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- Electric start system, with start relay integrated on the engine and with, oil-centrifugal decompressor and safety clutch
- Charging system with permanent magnet generator, oil cooled and external current regulator
- Turbine versions with turbocharger, integrated wastegate, and pneumatically operated blow-off valve
- Turbine versions with air-to-air intercooler

72-02-01 Version Available

Each motor model is available with right or left rotation.

The direction of rotation of each version of engine (both with gearbox and direct) is defined with respect to an observer located in front of the propeller, who sees the motor behind it, according to the SAE J824 standard: therefore a propeller that moves in a clockwise direction it rotates to the right (engine "R" right), a propeller that moves in an anticlockwise direction rotates to the left (engine "L" left).

Each engine model is also available in a pulling or pushing version: in the following table, replace the product code with "x" and "0" for pulling applications and "1" for pushing applications. The following table summarizes the main features of the **SPIRIT** and **SPIRIT Turbo** engines series

Name	Product code	Max power [CV]	Max continuous power [CV]	Max engine rpm [rpm]	Max prop axel rpm [rpm]
<i>Spirit 100 Direct L</i>	Wx11	100	100	3400	3400
<i>Spirit 100 Direct R</i>	Wx12	100	100	3400	3400
<i>Spirit 115 Direct L</i>	Wx13	115	115	3400	3400
<i>Spirit 115 Direct R</i>	Wx14	115	115	3400	3400
<i>Spirit 135 Direct L</i>	Wx17	135	120	4700	4700
<i>Spirit 135 Direct R</i>	Wx18	135	120	4700	4700
<i>Spirit 160 Direct L</i>	Wx23	160	142	4700	4700
<i>Spirit 160 Direct R</i>	Wx24	160	142	4700	4700
<i>Spirit Turbo 180 Direct L</i>	Wx33	180	150	4200	4200
<i>Spirit Turbo 180 Direct R</i>	Wx34	180	150	4200	4200
<i>Spirit Turbo 210 Direct L</i>	Wx35	210	170	4200	4200
<i>Spirit Turbo 210 Direct R</i>	Wx36	210	170	4200	4200
<i>Spirit Turbo 240 Direct L</i>	Wx37	240	185	4200	4200
<i>Spirit Turbo 240 Direct R</i>	Wx38	240	185	4200	4200
<i>Spirit 122 PSRU L</i>	Wx15	122	110	4200	2425
<i>Spirit 122 PSRU R</i>	Wx16	122	110	4200	2425
<i>Spirit 135 PSRU L</i>	Wx19	135	115	4700	2400
<i>Spirit 135 PSRU R</i>	Wx20	135	115	4700	2400
<i>Spirit 140 PSRU L</i>	Wx21	140	125	4200	2425

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<i>Spirit 140 PSRU R</i>	Wx22	140	125	4200	2425
<i>Spirit 160 PSRU L</i>	Wx25	160	137	4700	2400
<i>Spirit 160 PSRU R</i>	Wx26	160	137	4700	2400
<i>Spirit Turbo 180 PSRU L</i>	Wx27	180	150	4200	2425
<i>Spirit Turbo 180 PSRU R</i>	Wx28	180	150	4200	2425
<i>Spirit Turbo 210 PSRU L</i>	Wx29	210	170	4200	2425
<i>Spirit Turbo 210 PSRU R</i>	Wx30	210	170	4200	2425
<i>Spirit Turbo 240 PSRU L</i>	Wx31	240	185	4200	2425
<i>Spirit Turbo 240 PSRU R</i>	Wx32	240	185	4200	2425

72-02-C



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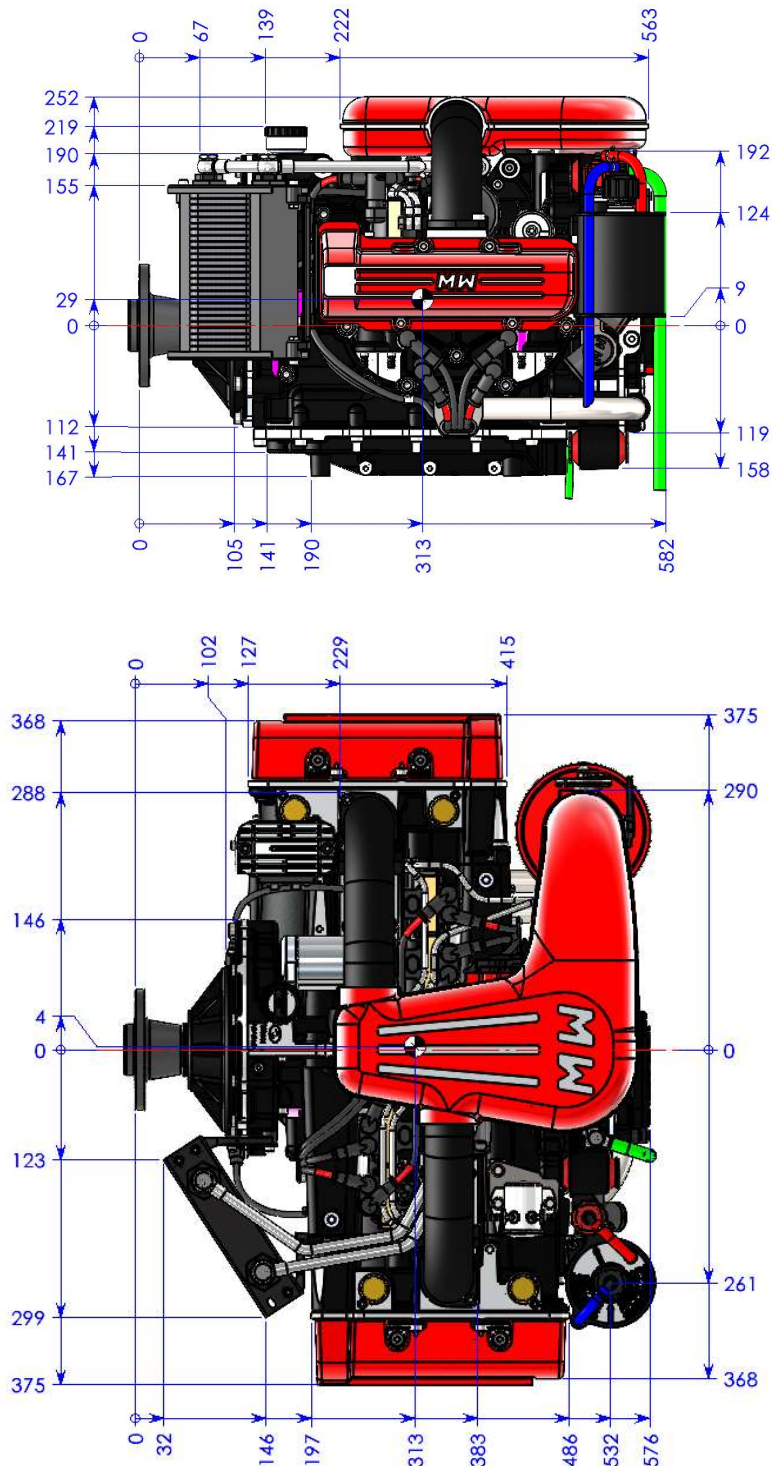
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72-02-02 Dimensions

Dimension Direct Version



72-09-P

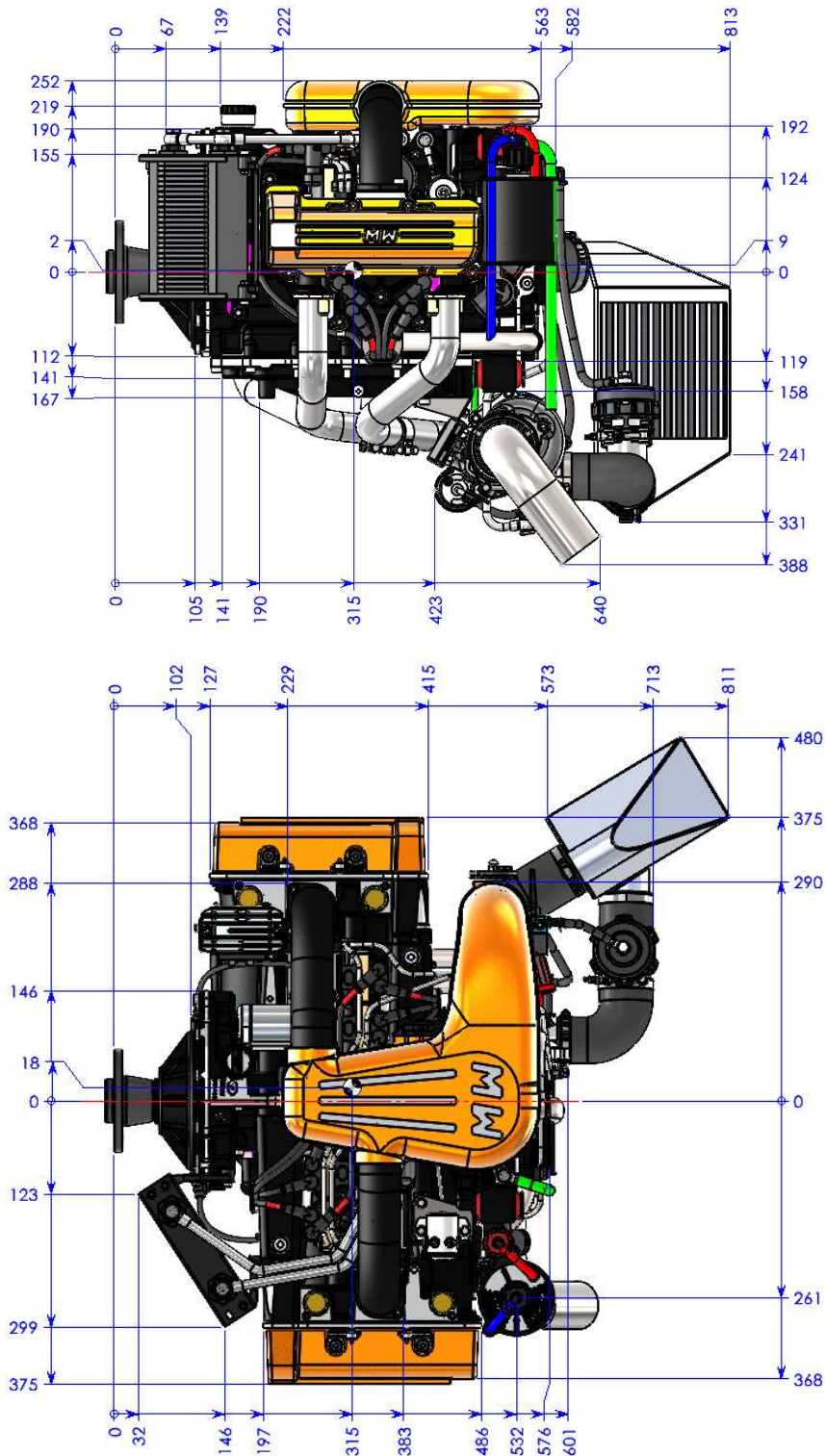


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Dimension Direct Turbo



72-10-P

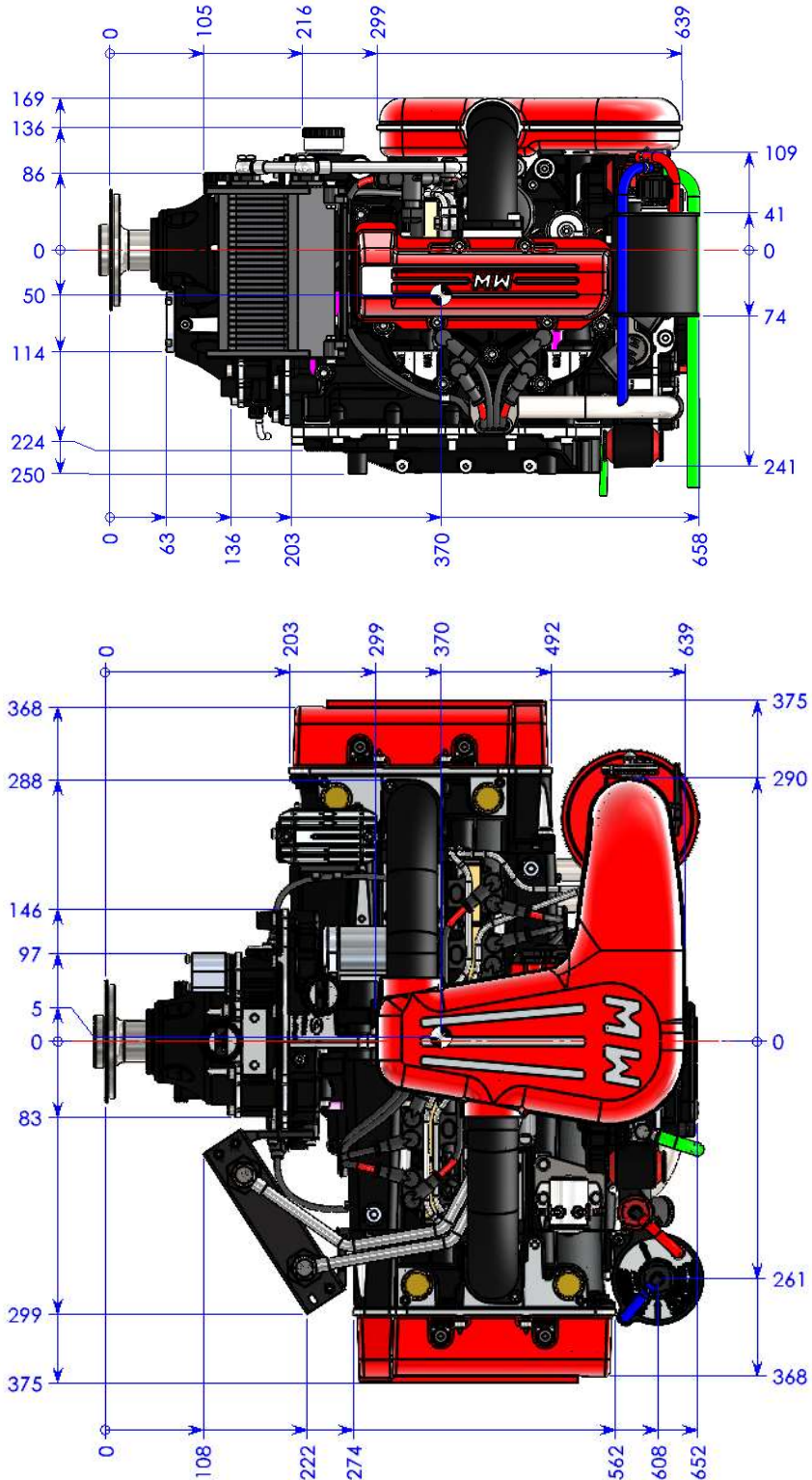


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Dimension PSRU version



72-11-P

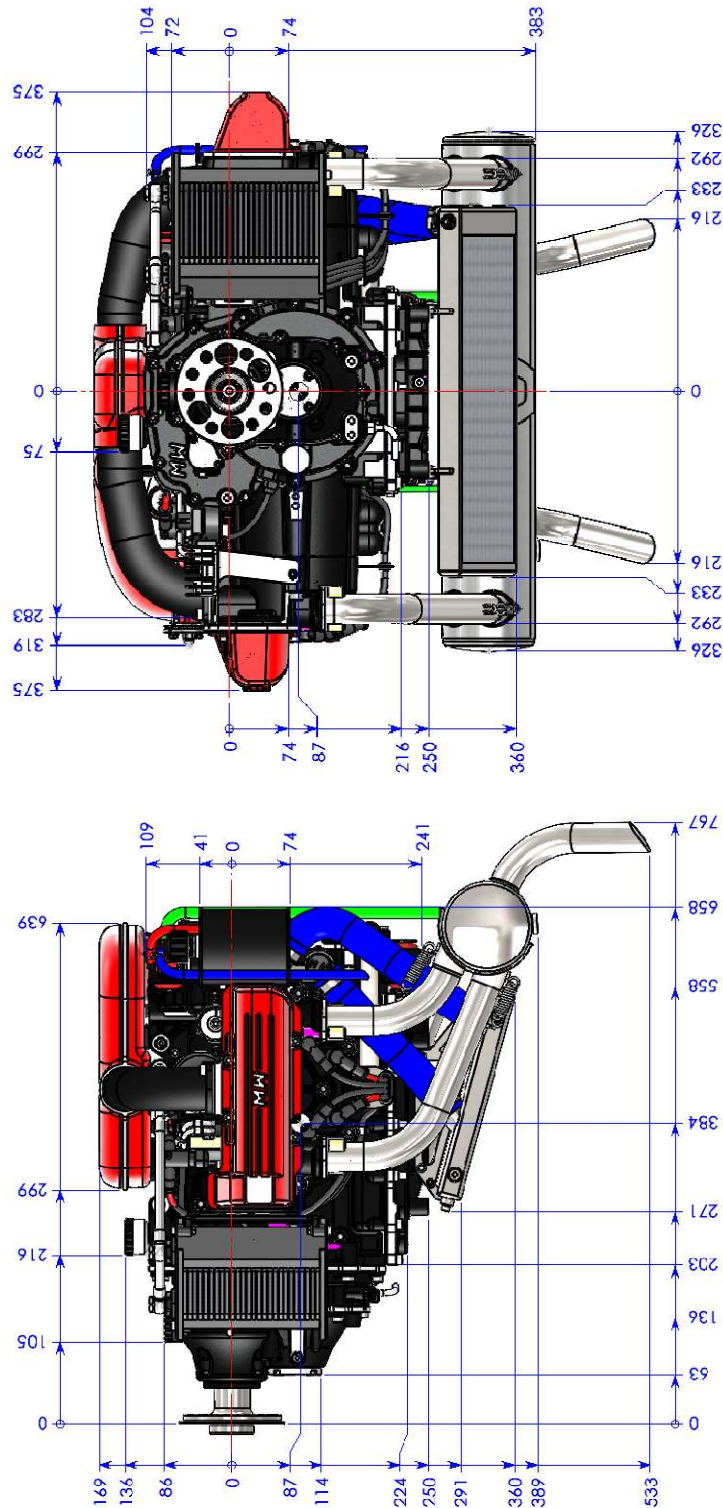


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Dimensional PSRU version +CR-m STD + EX-m



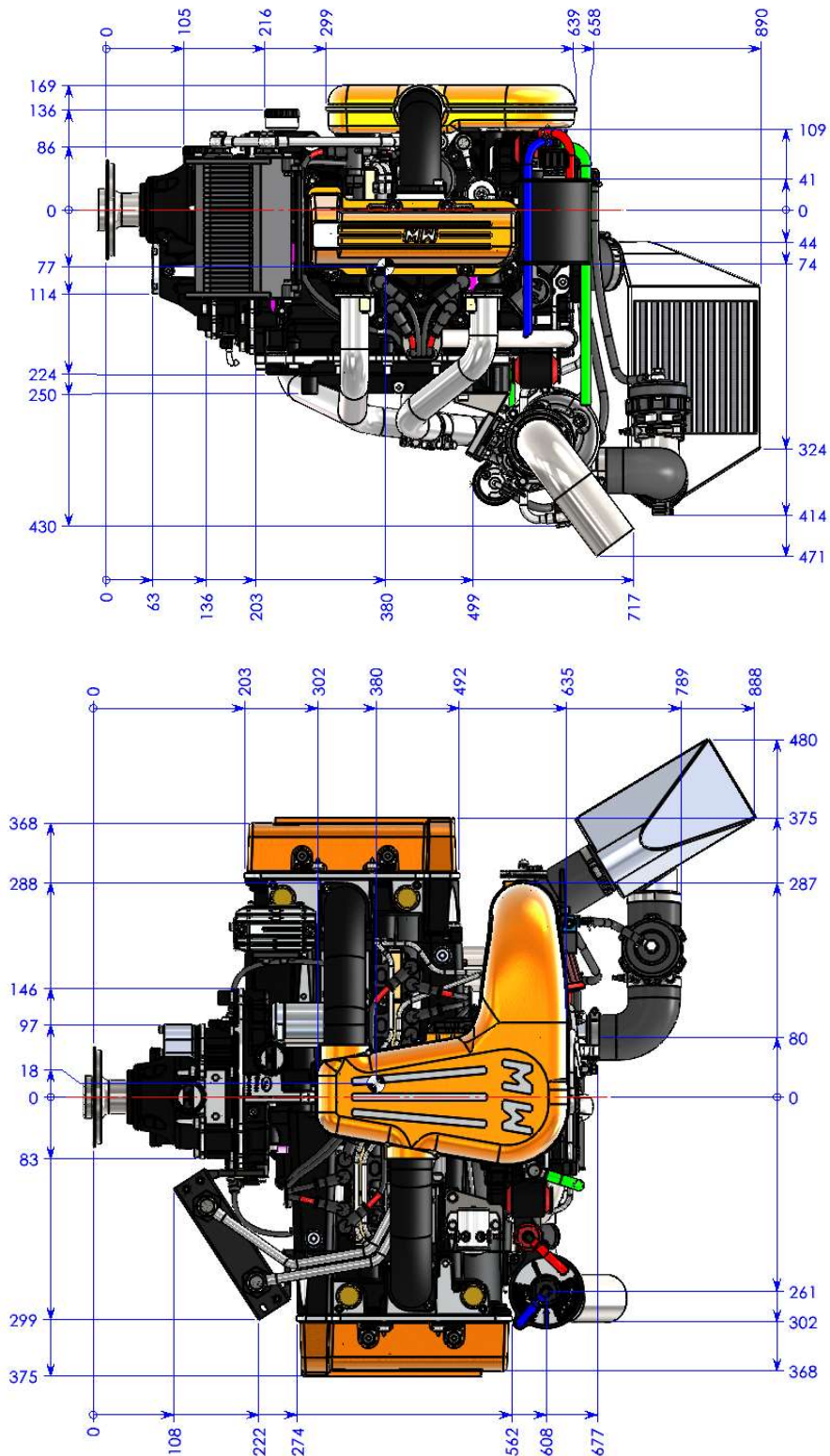
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Dimensionale versioni PSRU Turbo



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Direct Version engine			
Max dimension [mm]	<i>direction -</i>	<i>direction +</i>	<i>total</i>
<i>Maximum along the x axis</i>	12	582	594
<i>Maximum along the y axis</i>	375	375	750
<i>Maximum along the y axis</i>	167	252	419

72-03-C

Direct Version with Radiator and Standard Exhaust			
Max dimension [mm]	<i>direction -</i>	<i>direction +</i>	<i>total</i>
<i>Maximum along the x axis</i>	12	693	705
<i>Maximum along the y axis</i>	375	375	750
<i>Maximum along the y axis</i>	442	252	694

72-04-C

Version Direct Turbo			
Max dimension [mm]	<i>direction -</i>	<i>direction +</i>	<i>total</i>
<i>Maximum along the x axis</i>	12	713	725
<i>Maximum along the y axis</i>	375	375	750
<i>Maximum along the y axis</i>	347	252	599

72-05-C

Version with PSRU			
Max dimension [mm]	<i>direction -</i>	<i>direction +</i>	<i>total</i>
<i>Maximum along the x axis</i>	15	658	673
<i>Maximum along the y axis</i>	375	375	750
<i>Maximum along the y axis</i>	249	169	418

72-06-C

Version with PSRU and with Radiator and Standard Exhaust			
Max dimension [mm]	<i>direction -</i>	<i>direction +</i>	<i>total</i>
<i>Maximum along the x axis</i>	15	767	782
<i>Maximum along the y axis</i>	375	375	750
<i>Maximum along the y axis</i>	533	169	702

72-07-C

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Version PSRU Turbo			
Max dimension [mm]	<i>direction -</i>	<i>direction +</i>	<i>total</i>
<i>Maximum along the x axis</i>	15	789	804
<i>Maximum along the y axis</i>	375	375	750
<i>Maximum along the y axis</i>	430	169	599

72-08-C

The tolerance on these dimensions is ± 5 millimetres.

72-02-03 Weights

The following table shows the dry weight of the engine and the weight with lubricants. The weight includes all the accessories needed to fly (internal generator, voltage regulator, starter relay, thermostat, water expansion tank, wiring loom, rubber mounting, air filter)

Weight [Kg]	<i>Dry</i>	<i>With oils</i>
<i>Spirit 100 Direct R/L</i>	81	84,5
<i>Spirit 115 Direct R/L</i>	81	84,5
<i>Spirit 135 Direct R/L</i>	81	84,5
<i>Spirit 160 Direct R/L</i>	81	84,5
<i>Spirit Turbo 180 Direct R/L</i>	95,5	99,5
<i>Spirit Turbo 210 Direct R/L</i>	95,5	99,5
<i>Spirit Turbo 240 Direct R/L</i>	95,5	99,5
<i>Spirit 122 PSRU R/L</i>	86,5	90,5
<i>Spirit 135 PSRU R/L</i>	86,5	90,5
<i>Spirit 140 PSRU R/L</i>	86,5	90,5
<i>Spirit 160 PSRU R/L</i>	86,5	90,5
<i>Spirit Turbo 180 PSRU R/L</i>	101	105
<i>Spirit Turbo 210 PSRU R/L</i>	101	105
<i>Spirit Turbo 240 PSRU R/L</i>	101	105

72-09-C

Accessories not included in the weight

▪ Air filter (Turbo versions)	420 (240) g
▪ Sensor kit	150 g
▪ Starter relay	300 g
▪ Current regulator	450 g
▪ Anti-vibration suspension	360 g
▪ Injection and ignition control unit group	2600 g
▪ AG-m: External Auxiliary Generator	4100 g
▪ BM-m: Lower Motor Connections (4 pieces)	730 g
▪ CR-m STD: Standard Radiator	2100 g

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- CR-m STOL: STOL Aircraft Radiator 3400g
- EM-m: Display 8" 1230g
- EX-m: Exhaust System 5850 g
- FD-m: Fuel Pumps and Filter Groups 2750 g
- OC-m: Engine Oil Cooler 1450 g
- HC-m: Variable Pitch Propeller Hydraulic System 460 g
- PG-m: Instrument for the VPP RPM targeter setup 150 g

Power/Weight Ratio

The following table shows the power-to-weight ratio values of each engine version, in the dry condition and with lubricants.

Power/weight ratio [CV/Kg]	<i>Dry motor</i>	<i>Motor with lubricant</i>
<i>Spirit 100 Direct R/L</i>	1,23	1,18
<i>Spirit 115 Direct R/L</i>	1,42	1,36
<i>Spirit 135 Direct R/L</i>	1,67	1,60
<i>Spirit 160 Direct R/L</i>	1,97	1,89
<i>Spirit Turbo 180 Direct R/L</i>	1,88	1,81
<i>Spirit Turbo 210 Direct R/L</i>	2,20	2,11
<i>Spirit Turbo 240 Direct R/L</i>	2,51	2,41
<i>Spirit 122 PSRU R/L</i>	1,41	1,35
<i>Spirit 135 PSRU R/L</i>	1,56	1,49
<i>Spirit 140 PSRU R/L</i>	1,62	1,55
<i>Spirit 160 PSRU R/L</i>	1,85	1,77
<i>Spirit Turbo 180 PSRU R/L</i>	1,78	1,71
<i>Spirit Turbo 210 PSRU R/L</i>	2,08	2,00
<i>Spirit Turbo 240 PSRU R/L</i>	2,38	2,28

72-10-C

72-02-04 Position of Centre of Gravity CoG

Direct Version		
Position of centre of gravity CoG [mm]	<i>Engine only</i>	<i>Engine with standard exhaust system and radiators</i>
<i>X axis</i>	313	323
<i>Y axis</i>	4	0
<i>Z axis</i>	29	-9

72-11-C

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Version Direct Turbo	
Position of centre of gravity CoG [mm]	<i>Engine only</i>
<i>X axis</i>	315
<i>Y axis</i>	18
<i>Z axis</i>	2

72-12-C

Version with PSRU		
Position of centre of gravity CoG [mm]	<i>Engine only</i>	<i>Engine with standard exhaust system and radiators</i>
<i>X axis</i>	370	384
<i>Y axis</i>	5	0
<i>Z axis</i>	-50	-87

72-13-C

Version PSRU Turbo	
Position of centre of gravity CoG [mm]	<i>Engine only</i>
<i>X axis</i>	380
<i>Y axis</i>	18
<i>Z axis</i>	-77

72-14-C

The values shown, referring to the "Engine only" condition, are to be considered valid in good approximation even in the presence of lubricants.

72-03-00 Limits

72-03-01 Operating Limits

During the installation phase, it is necessary to measure various engine parameters, first on the ground and then in flight, verifying that in all operating conditions they comply with the values shown in the following table: the detailed tables according to the engine version are given in the operating manual. The installation and connection of the sensors necessary to verify the operating parameters (in flight) listed above must be performed by referring to the specific paragraphs in this manual.

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Maximum Revs [rpm]	<i>Maximum power</i>	<i>Overrevs limit</i>
<i>Spirit 100 Direct R/L</i>	3400	3500
<i>Spirit 115 Direct R/L</i>	3400	3500
<i>Spirit 122 PSRU R/L</i>	4200	4250
<i>Spirit 135 Direct R/L</i>	4700	4750
<i>Spirit 135 PSRU R/L</i>	4700	4750
<i>Spirit 140 PSRU R/L</i>	4200	4250
<i>Spirit 160 Direct R/L</i>	4700	4750
<i>Spirit 160 PSRU R/L</i>	4700	4750
<i>Spirit Turbo 180 Direct R/L</i>	4200	4250
<i>Spirit Turbo 180 PSRU R/L</i>	4200	4250
<i>Spirit Turbo 210 Direct R/L</i>	4200	4250
<i>Spirit Turbo 210 PSRU R/L</i>	4200	4250
<i>Spirit Turbo 240 Direct R/L</i>	4200	4250
<i>Spirit Turbo 240 PSRU R/L</i>	4200	4250

72-15-C

Operating Limits	<i>Min</i>	<i>Max</i>	<i>Typical</i>	<i>Max difference between banks</i>
<i>Maximum revolutions [RPM]</i>	---	---	---	---
<i>T water [°C]</i>	72	102	90	5
<i>T engine oil [°C]</i>	60	130	100	---
<i>T gearbox oil (+governor) [°C]</i>	20	130 (110)	105 (95)	---
<i>T fuel [°C]</i>	---	65	40	---
<i>T air intake manifold [°C] (turbocharged version)</i>	-20	65 (50)	35	---
<i>T ECU [°C]</i>	-20	80	35	---
<i>T voltage regulator [°C]</i>	-20	75	40	---
<i>Manifold Airintake Pressure (MAP) [in/Hg]</i>	---	28,5	25,5	---
<i>P engine oil [bar] (rpm<2200)</i>	1,5 (0,8)	4,5	2,5 (1,5)	---
<i>P Fuel [bar]</i>	3,3	4,2	3,9	---
<i>Battery voltage [V]</i>	11,7	15	12,9	---

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- The oil temperature is strongly influenced by the water temperature and is normally slightly higher than that of the water.
- Since the engine is provided with the thermostat on the cooling circuit, the change in the temperature of the cooling liquid between summer and winter is very limited, as long as the circuit is well done, letting the thermostat adjust the flow to the radiator during normal operation.
- The engine oil pressure is strongly influenced by the temperature of the oil: it is completely normal, therefore, to read high pressure values when oil is cold, and getting lower as the oil temperature rises. The oil circuit is protected from overpressure by a relief valve, which limits the maximum pressure to about 7.0 bar.
- The minimum battery voltage shown is in normal flight conditions: in prolonged idle speed this voltage may be lower than the minimum reported without this implying damage to the charging system.



Installations that cause the engine to overheat above these temperature values are absolutely to be avoided, as they are likely causes of engine failure.



If the temperature of the injection control unit exceeds the value shown in the table, the control unit is irreparably damaged, causing possible malfunctions in the engine. In this case it is essential to have the control unit checked at an authorized MWfly service centre.



The cooling system must be designed to guarantee that the engine will work at a temperature that is lower than the max temperature indicated in the table in any operating condition. When the engine is operated outside of the parameter range indicated in the table the engine guarantee will be null and void and this will release the engine manufacturer from any liability.



In the event of over temperature, the injection system alarm light will turn on, signalling the critical condition: if this condition persists for more than 30 seconds, the injection system will record the event in the non-labile memory. During the revision this memory will be checked, and eventually the guarantee will be cancelled.



The injection system can continue to operate up to voltages of approximately 8.5 volts: however, in the event of voltage below the minimum reported during the cruise, it is advisable to land as soon as possible.

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72-03-02 *Operating Limits of the Components*

In order to obtain the best performance from the engine, it is advisable to provide a flow of fresh air to the air filter, in running conditions with partialized gas, that provides air temperatures never higher than $35 \div 40$ ° C in all weather conditions. The operating temperature of some components not directly cooled by the cooling system must also be limited to the values indicated below.

- ECU 85 °C
- Voltage regulator 75 °C
- Start Relay 80 °C
- Gearbox 130 °C
- Exhaust system 750 °C
- Exhaust system (Turbo engines) 900 °C
- Fuel pumps and filters, and fuel circuit pipes 55 °C
- Shock absorber 80 °C
- Wiring loom 65 °C



Flying with temperatures higher than the listed limits, affects the reliability and durability of the components and constitutes a cause of potential danger.

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73-00-00 FUEL AND CONTROL

The fuel metering system consists of the injection system and the air intake system.



Gasoline and gasoline vapours are highly flammable and harmful by inhalation. Any operation that takes place in the presence of gasoline or its vapours should be carried out in an open or well-ventilated place and away from open flames or heat sources.

73-01-00 Air Intake System

73-01-01 Description

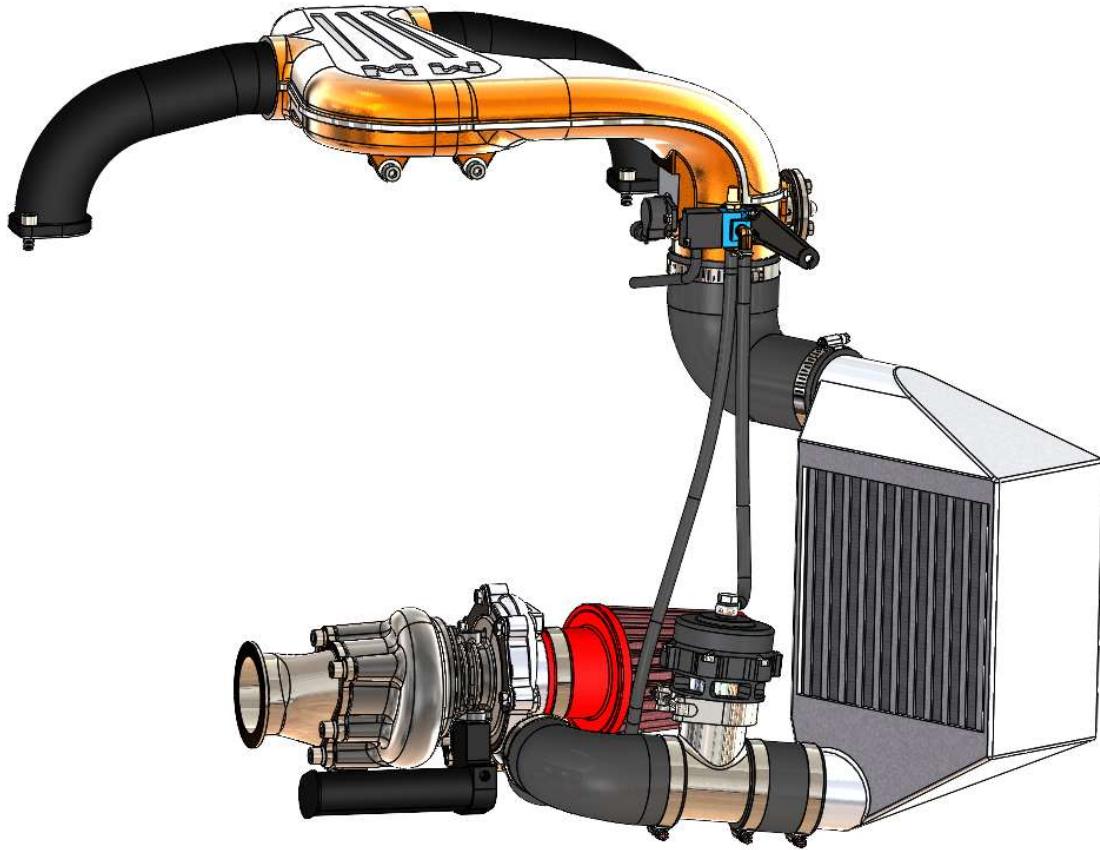
The intake system of natural aspirated engines consists of an airbox and two manifolds (one for each bank): these pipes are connected to the airbox in a floating manner and to the heads through the interposition of gaskets; a temperature and pressure sensor for the supply air is fixed on the airbox; the throttle, the throttle control cam itself and the injection system potentiometer are housed in the lower part; a large air filter is fixed to the airbox inlet, kept in position by means of a hose clamp.



73-01-P

The intake system of turbocharged engines, in addition to what is described above, also consists of an axial compressor equipped with an internal waste gate valve, an aluminum air-to-air intercooler, a pressure relief valve (BOV) mounted on an aluminum fitting, an electric actuator to control the waste gate opening and all the

related silicone rubber fittings. In turbocharged engines, the filter is located at the compressor inlet rather than near the throttle valve (as in the illustration).



73-02-P

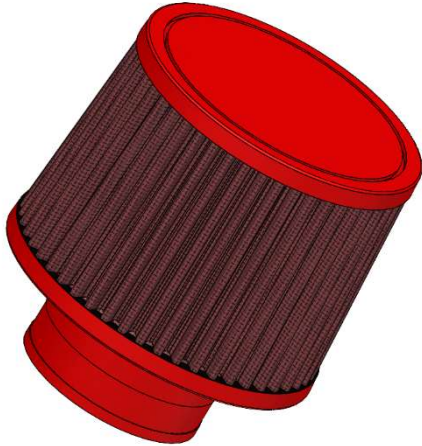


Any modification in the intake system causes imbalances in the power supply of the engine, and must be avoided.

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73-01-02 General Characteristics

Air Filter



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The original air filter, with cotton filter element, ensures the right filtering and flow to the engine, in order to obtain maximum performance. It is recommended to replace the filter at the scheduled intervals in order not to worsen the performance of the engine.

Another task of the air filter is to reduce the intake noise.



Under no circumstances run the engine without air filters: this can cause foreign matter to enter, resulting in serious damage to mechanical parts.

The main characteristics are listed below.

- | | |
|---|--|
| <ul style="list-style-type: none"> ▪ Filtering element ▪ Filtering surface (turbo version) ▪ Filtration degree ▪ Minimum flow rate (with $\Delta P=35\text{Pa}$) | <ul style="list-style-type: none"> hydrophobic pre-impregnated multi-layer cotton fibre with reinforcing metal mesh ~ 1000 (~ 700) cm^2 $5 \div 10$ μm 19 m^3/min |
|---|--|

Manifolds

The length and arrangement of the intake manifolds has been calculated to obtain the best performance from the engine. For no reason change the length or section of the intake manifold, as it is a fundamental parameter for obtaining the rated power.

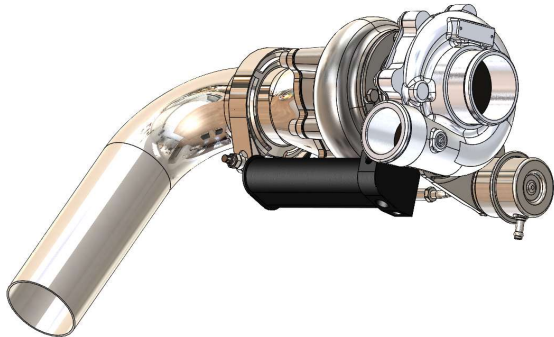


Changing the length or conformation of the intake manifolds alters the fluid dynamic efficiency of the powerplant, and thus both performance and carburetion. Any such modification can only occur if approved by MWfly in writing.

Throttle Command

See section 76-10-00 of the present manual.

Turbocharger (Turbo engines)



73-04-P

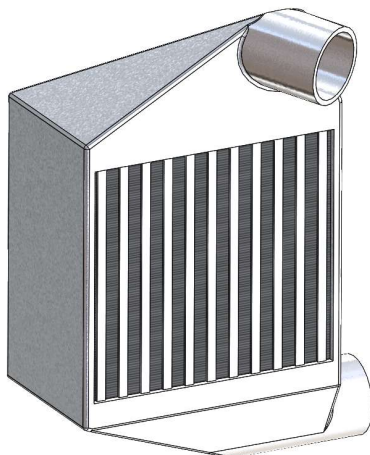
The turbo engines are equipped with a single-stage axial turbocharger, with an oil tank and an integrated pneumatically operated waste gate valve. The main features are listed below (data for the 180 HP version is in brackets).

- | | |
|---|--|
| <ul style="list-style-type: none"> ▪ Compressor A/R ratio ▪ Turbine A/R ratio ▪ Waste gate setting ▪ Maximum overpressure ▪ Maximum flow ▪ Weight | <p>0.59
0.64 (0.55)
0.5 bar (0.25)
3.4 bar (3.7)
27.5 kg/sec (22.8)
6.7 kg</p> |
|---|--|



Any modification to the calibration of the Waste Gate valve will void any warranty.

Intercooler (Turbo engines)



73-05-P

All Turbo engines are equipped with an air-to-air intercooler as standard. The main features of this component are as follows:

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Dimension ▪ Cooling surface area ▪ Pressure drop ▪ Inlet/outlet port diameter ▪ Weight | <p>355x241x130 mm
390 cm²
20 mbar
60/60 mm
2.9 kg</p> |
|--|--|

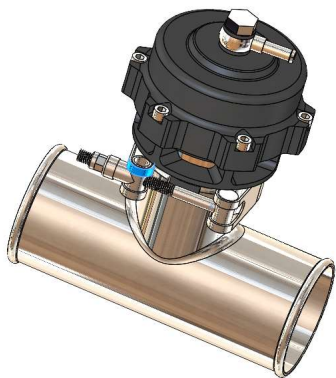
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If necessary, different intercoolers can be used, as long as their characteristics do not change the air flow conditions to the engine.



If using intercoolers other than the original one, it is necessary to check that the MAP pressure does not vary significantly from the maximum expected value so as not to change engine performance: in particular, the use of intercoolers that cause a MAP pressure higher than expected is forbidden.

Blow Off valve (Turbo engines)



73-06-P

The BOV (Blow Off Valve) is located between the compressor outlet and the intercooler and serves to limit the pressure supplied by the turbocharger at low altitude.

The upper port with hose holder must be left exposed to the air. The valve's characteristics are as follows:

- | | |
|---|-----------------------------|
| <ul style="list-style-type: none"> ▪ Valve diameter ▪ Inlet/outlet diameter ▪ weight | 50 mm
60/60 mm
0,7 Kg |
|---|-----------------------------|

Waste Gate actuator (Turbo engines)



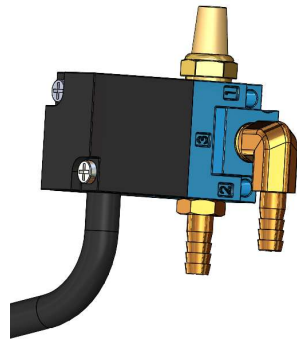
73-07-P

The Waste Gate actuator is pneumatic and opens the bypass door inside the turbine stator to prevent excessively high supply pressures. The air inlet must be connected to the compressor outlet. The valve characteristics are as the follows.

- | | |
|---|--|
| <ul style="list-style-type: none"> ▪ control pressure ▪ hoses holder diameter ▪ weight | (Spirit 180 HP) 0,25 bar
(Spirit 210 e 240 Hp) 0,5 bar
6 mm
0,22 Kg |
|---|--|

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Overboost valve (Turbo engines)



73-08-P

The overboost valve is an electronically controlled pneumatic valve: its function is to control the opening of the BOV (Blow Off Valve), in order to maintain the boost pressure within the expected parameters as the altitude and throttle opening vary. The hose coming out of the compressor (after the 3-way fitting) must be connected to port 2; the hose carrying air to the BOV must be connected to port 3. The valve's characteristics are as follows.

- | | |
|-------------------------|--------|
| ▪ Control type | PWM |
| ▪ Hoses holder diameter | 6 mm |
| ▪ Weight | 0,1 Kg |

Hoses (Turbo engines)

They are made of black silicone rubber with a 4-layer nylon inner weave. The hoses kit includes the following:

- | | |
|-------------------------|-----------|
| ▪ Type 1 | 90° elbow |
| ▪ Inlet/outlet diameter | 51/60 mm |
| ▪ Type 2 | steight |
| ▪ Inlet/outlet diameter | 60/60 mm |
| ▪ Type 3 | 90° elbow |
| ▪ Inlet/outlet diameter | 60/76 mm |

Below is a summary of the common data for the 3 types.

- | | |
|------------------------------|------------|
| ▪ Brust pressure | 7 bar |
| ▪ Working temerature min/max | -60/260 °C |
| ▪ Total weight | 1,2 Kg |

73-02-00 Removal and Installation of Vacuum System

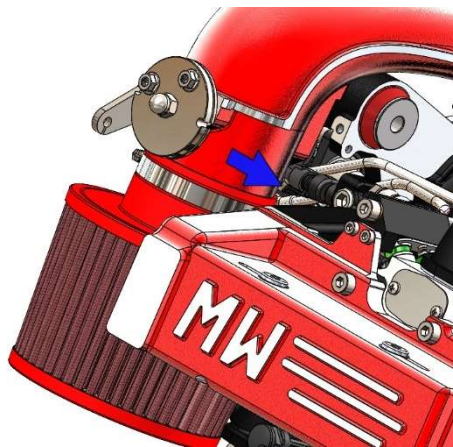
Necessary Materials

1. Torque wrench
2. 6 mm Allen wrench with ball head
3. 4 mm blade screwdriver
4. Cover for suction port

To perform some installation operations, it is necessary to remove the intake system: for removal and subsequent installation, proceed as described below.

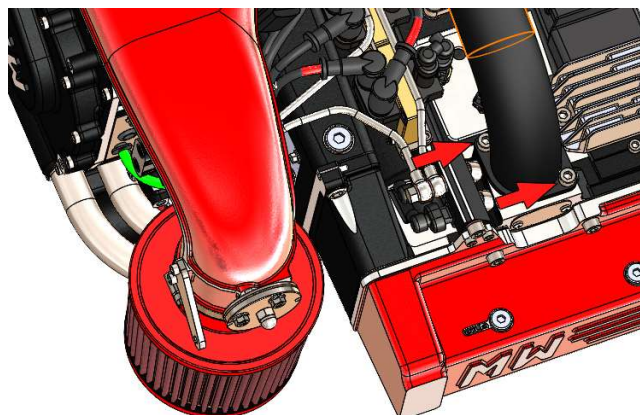
73-02-01 Removal

- a.** Remove the connector from the air pressure and temperature sensor by prying [3] below the present attachment clip on the connector.
- b.** Remove the connector from the throttle angle sensor by lifting [3] the clip located on the sensor itself. In the case of turbo engines, remove the pipes and connector from the overboost valve, or alternatively, unscrew the valve itself from its mounting.



73-09-P

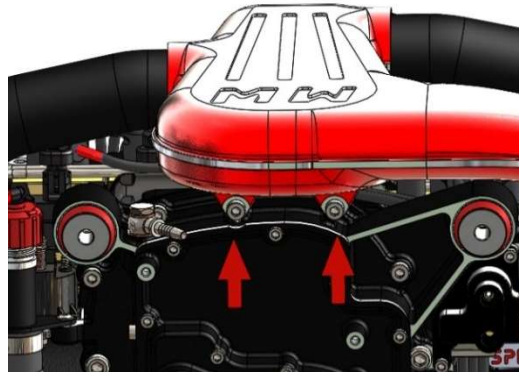
- c.** If necessary, remove the throttle control cable.
- d.** Unscrew [2] the two manifolds from the headers, progressively proceeding on both clamping screws. Be careful not to lose the gasket located below the manifold flange.



73-10-P

- e.** Remove the air filter from the airbox; in the case of turbo engines, remove the connecting pipe between the airbox and the intercooler
- f.** Unscrew [2] the two rear airbox fixing screws.

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- g.** Protect the intake port on the cylinder head from the possible entry of foreign matter by inserting the appropriate plastic cover [3] or a clean cloth over the throttle valve.



Unless necessary, avoid moving or pulling the intake manifolds from their respective seats on the airbox.

73-02-02 Installation

Refer to the figures in the previous paragraph.

- a.** Overlap the intake assembly to the headers and hold it in place by lightly screwing [2] the rear airbox screws.
- b.** Place the two gaskets of the manifolds on the fixing plane located on each header, having previously checked their integrity: if they are damaged, they must be replaced.
- c.** Insert the two fixing screws into the holes on each manifold; in case the holes on the second manifold do not match, it is necessary to introduce or extract it from its seat on the airbox.
- d.** Tighten [2] the screws on the manifolds, starting with the innermost screw and proceeding progressively on both manifolds.
- e.** Tighten [1+2] the two rear M8 screws of the airbox to a torque of 22 Nm; in case the screws do not match the seat on the rear cover, it is necessary to slide the airbox over the two manifolds so that it is centred on the holes.
- f.** Tighten [1+2] the two screws on each manifold, taking care to check that the plane of the manifold itself reaches the header plane: if not, slightly unscrew the rear airbox screws.
- g.** Engage the connector on the air pressure and temperature sensor mounted on the airbox: check after engagement that the safety spring is properly engaged on the connector.

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- h.** Similarly, mount the connector on the throttle angle sensor, making sure that the safety clip is properly engaged.
- i.** After the first ignition and warm-up, check the tightening [1+2] of the fixing screws and the possible presence of leakage from the gaskets on the cylinder head.

73-03-00 Criteria for the Construction of the Supply Air Intake

Engine performance is strongly influenced by the temperature of the inlet air: to this end, it is advisable to keep the inlet air temperature as low as possible, and therefore to provide one or more air intakes on the engine hood to ensure that fresh, oxygen-rich air flows to the intake filter, without it arriving after crossing hot surfaces (radiator or exhaust system).

Avoid direct contact of rainwater or foreign bodies with the air filter. Also, avoid installing so-called dynamic air intakes, which pressurize the air before it enters the intake system. This is not only unnecessary, but can actually be counterproductive to maximizing engine performance.

Injection fuel systems, unlike carburetor-based systems, are less likely to experience icing. Furthermore, the raised, lower position of the throttle valve is specifically designed to minimize any condensation in the intake system. For these reasons, in most installations, no special precautions are necessary to prevent icing in the intake ducts.

73-03-01 Normal aspired engines

The air intake must ensure the following characteristics in flight.

- Maximum in-flight power temperature 65 °C
- Minimum in-flight power temperature -20 °C
- Typical in-flight power temperature 35 °C
- Minimum inlet flow 0,35 m³/s

The air reaching the filter must be as cold as possible, to ensure the engine gets the best possible performance.

73-03-02 Motori Turbo

In the case of turbocharged engines, it is necessary to provide two air intakes: the first will serve to supply fresh air to the air filter, the second will be directed to the intercooler, so as to cool the air entering the engine after it has been compressed by the turbocharging system.

Intake for air filter

Ensure a minimum flow to the air filter of 0.55 m³/s.

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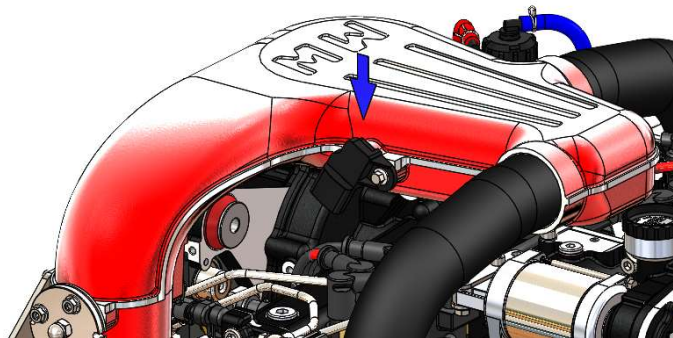
Intake for intercooler

- Max air intake temperature in flight 50 °C
- Min air intake temperature in flight -20 °C
- Typical air intake teperature in flight 35 °C

73-04-00 Verification and Validation

73-04-01 Measurement of Supply Air Temperature and Pressure

The intake system airbox is equipped with a sensor for measuring the temperature and pressure of the intake air. This sensor is housed on the side of the airbox near the bank #1 manifold.



73-12-P

The data provided by the sensor is transmitted to the injection control unit, which processes carburetion and advance adjustments according to these parameters.

In case an EM-m instrument or similar EFIS instrument connected to the ECUs in CAN mode is used, this data is available in the transmitted data protocol. Alternatively, a second air pressure sensor can be installed.

Tuning of the intake system should be accomplished as follows.

- a.** Carry out a test flight in warm weather (above 30 °C), verifying in flight that the temperature in the intake manifold does not exceed the ambient temperature by more than 10 degrees centigrade: if not, arrange appropriate air intakes to lower the temperature in the engine hood.
- b.** Carry out take off tests in warm weather (above 30°C), verifying that the MAP read at maximum rpm and at speeds above 90 km/h, is not less than the barometric pressure by 3 %.
- c.** If the pressure reading is lower, it is possible that the engine hood is working excessively under pressure, or, conversely, that the excessive overpressure is disturbing the pressure waves inside the manifolds. If this is the case it will be necessary to modify the air or exhaust vents on the hood.
- d.** Also check the condition and permeability of the air filter and replace it if necessary.
- e.** Once on the ground, turn off the engine and wait about 15 minutes.

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- f. Before restarting the powerplant, measure the temperature reached in the intake system, which must be below 75 °C to avoid difficult starts; if not, prepare an air vent at the top of the hood.

73-04-02 Temperature Measurement of Components

The temperature of the engine components can be measured by placing irreversible adhesive thermometers on the surface of the components, which will detect the maximum temperature reached during operation or after shutdown. To perform this measurement, it is important that the installation is finished and the engine cowl is installed; perform a flight session, shut down the engine, and wait about 30 minutes; remove the engine cowl and note the temperature measured by the thermometers, which is the maximum temperature reached by the components (probably a few minutes after the engine is shut down).



In particular, the max temperature reached by the ECUs, current regulator, and starter relay should be checked since these are components particularly sensitive to the effects of overheating.

If any value exceeds the limits, it is necessary to increase the heat removal from the hood, either by letting in more air or by letting out the hot air formed inside the hood: for this purpose, it is advantageous to make openings in the upper part of the hood.

Surveys should be carried out with the highest possible ambient temperature in the operational area of the aircraft. If this is not possible, the increased heating of all components operating in warmer climates should be considered.



When performing measurements on the engine and exhaust system take great care to avoid contact with hot surfaces, which can cause even serious skin injury.

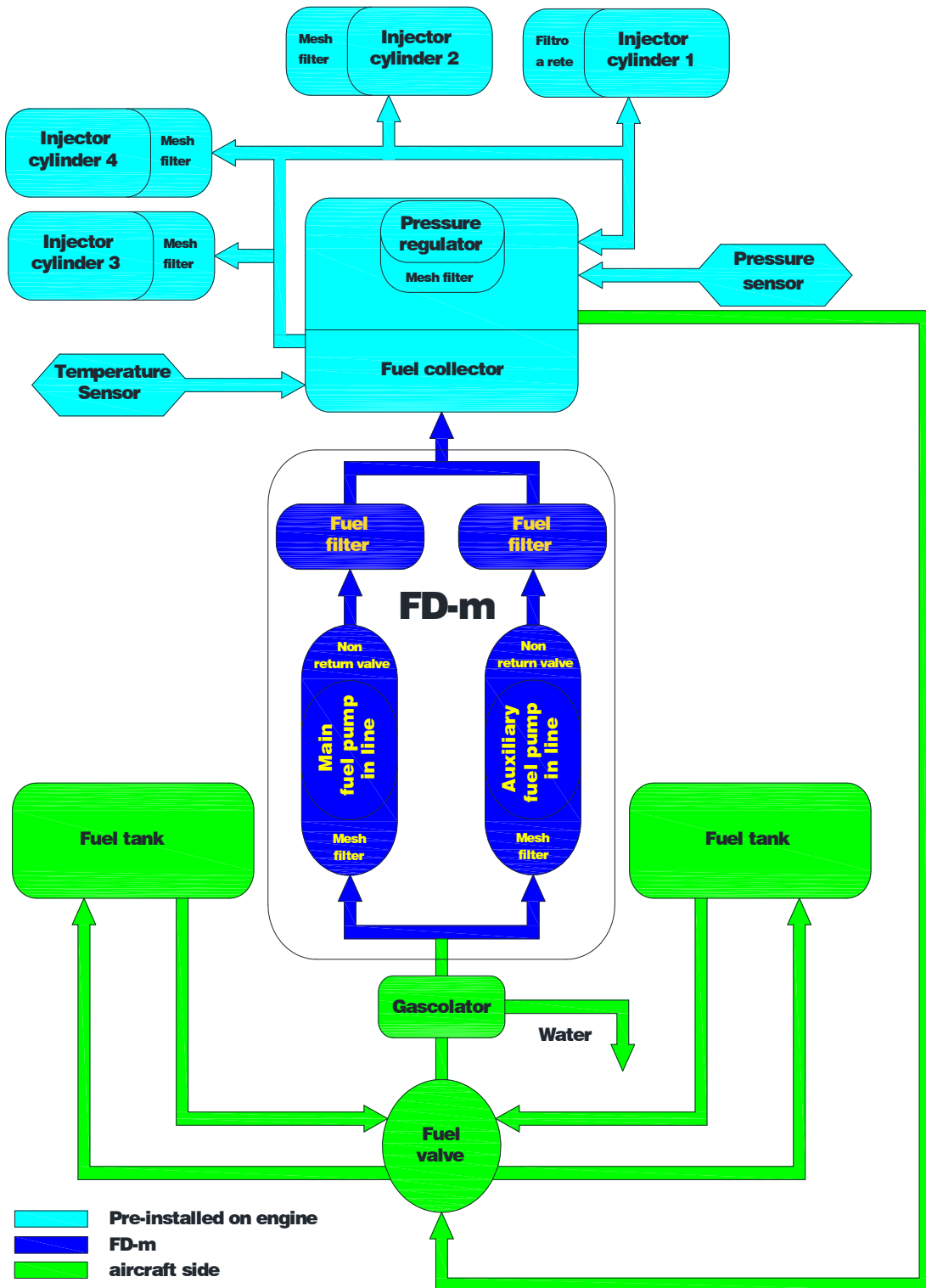


In case the limit on components has been exceeded for values above 10 °C, it is necessary to test them before using them again.

73-10-00 Fuel System

SPIRIT engines use a pressurized fuel injection system. The fuel supply pressure is regulated through a fuel pressure regulator, which is barometrically compensated. The fuel supply system is partly already installed on the powerplant, but must be completed by the installer in accordance with the diagram below.

73-11-00 System Description



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As shown in the diagram, the components of the system are as follows, listed along the direction of fuel flow.

- Tank
- Fuel circuit valve
- Water decanter filter (Gascolator)
- Fuel pumps
- Pressurized filters
- Fuel distributor
- Fuel pressure sensor
- Fuel temperature sensor
- Injectors
- Pressure regulator

The components installed on the engine are as follows.

- Fuel distributor
- Pressure regulator
- Injectors
- Fuel distribution pipes to the banks
- Pressure sensor
- Fuel temperature sensor

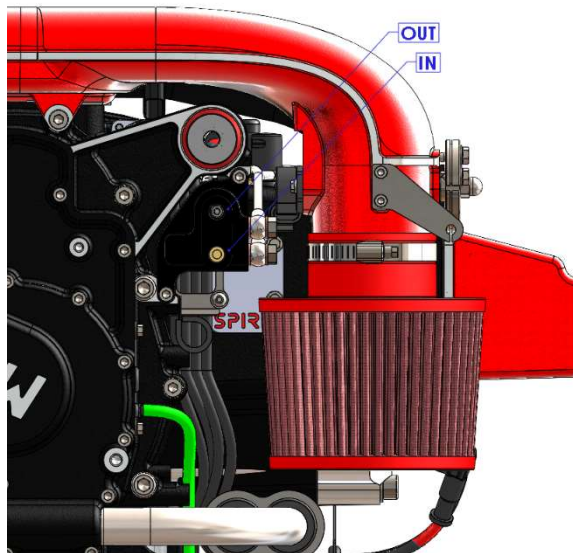
A pump and filter assembly called FD-m is available as an optional component, making installation work much easier.



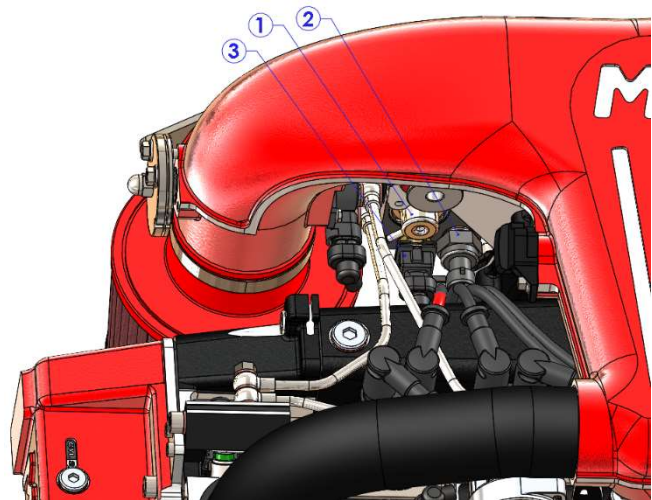
MWfly does not authorize the use of fuel pumps and filters other than those prescribed.

The fuel distributor is located at the rear of the crankcase on the right side. The pressure regulator (ref. 1) is installed on the distributor, which provides constant fuel pressure as conditions of use change. The pressure regulator is a mechanical component, so it does not require any electrical connection to function. In case of fuel pressure below or above the limits, malfunctions occur in the engine, starting difficulties, high fuel consumption or decrease in maximum power or unmotivated engine shutdowns: if this happens, it is necessary to restore the correct pressure before going into flight.

The pressure sensor (ref. 2) and fuel temperature sensor (ref. 3) can also be installed on the fuel distributor.



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73-14-P

Metal pipes for fuel circulation to the engine leave from the fuel distributor. Two pipes should be attached to the fuel distributor by the aircraft manufacturer: the first one carries the pressurized fuel coming from the pump (ref. "IN"), the second one (ref. "OUT") is the return to the tank of the excess fuel, i.e., not consumed by the engine, after passing through the pressure regulator: the fuel inlet and outlet ports are also identified by means of arrows placed on the fuel distributor itself.



The fuel inlet and outlet ports should not be interchanged as it would produce serious engine malfunction.

All other components of the system must be chosen and assembled by the installer, who will design and size the system.

73-12-00 General Characteristics

The fuel circuit characteristics must ensure the functionality of the powerplant within the operating limits:

- | | |
|---|---------|
| ▪ Maximum fuel pressure in flight | 4,2 bar |
| ▪ Minimum fuel pressure in flight | 3,3 bar |
| ▪ Typical in-flight fuel pressure | 3,9 bar |
| ▪ Minimum fuel pressure for starting | 3,0 bar |
| ▪ Maximum fuel temperature in flight | 55 °C |
| ▪ Typical in-flight fuel temperature | 40 °C |
| ▪ Maximum fuel temperature for starting | 65 °C |
| ▪ Fuel inlet and outlet thread | M12x1.5 |

To ensure operation within the operating limits given above, it is very important to take care of the sizing of pipes and fittings, avoiding bends or particularly pronounced cross-sectional variations in the passages.

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The choice of system components must follow safety and serviceability criteria, and must comply with the requirements given.

73-13-00 Installation of Original Pump and Filter Module (FD-m)

73-13-01 Description

To facilitate the execution of the fuel system, the FD-m (Fuel Delivery module), available as an accessory, can be used. The unit consists of two pumps and two fuel filters, mounted in parallel inside a stainless-steel cabinet with cover and connected hydraulically and electrically.



73-15-P

Quick latches are provided on the top of the cabinet to facilitate inspection before take off.

The position of the hydraulic connections on the locker can be changed according to the installation, bringing them both to the right, both to the left, or alternately one to the right and the other to the left. The hydraulic connection of the pump assembly to the aircraft fuel system is made through two fittings with M12x1.5 threading, both at the inlet and the outlet.

Attachment of the pump assembly to the firewall bulkhead is through 4 screws of 6 mm diameter, not supplied.

73-13-02 Component Characteristics

▪ Dimensions	344x136x74 mm
▪ Fuel pump features	Vedi 73-04-02
▪ Fuel filter features	Vedi 73-04-03
▪ Threading of fittings	M12x1.5
▪ Weight FD-m	2,75 Kg

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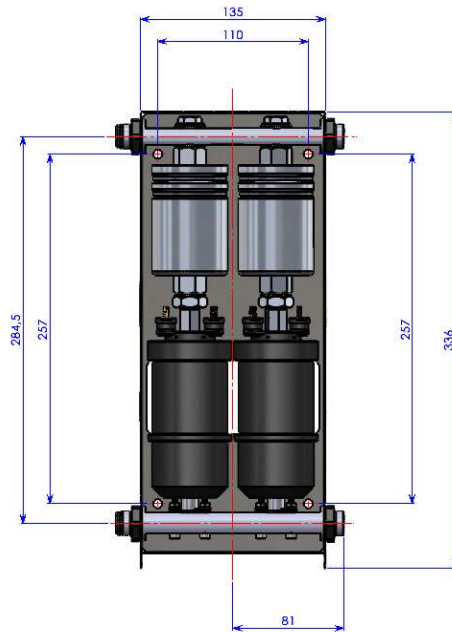
73-13-03 Installation

Necessary Materials

1. Torque wrench
2. 6 mm Allen wrench
3. 12 mm fixed wrench
4. 15 mm fixed wrench
5. 17 mm hex wrench
6. Phillips screwdriver
7. 6mm flat-blade screwdriver
8. Technical Vaseline
9. Other tools depending on the materials chosen during installation

The pump unit is already prewired; all connections inside the cabinet housing pumps and filters are made. To connect the unit to the system, simply proceed as follows.

- a.** Decide on the location of the pump assembly on the firewall, taking care to place it as far as possible from heat sources, as close as possible to the tanks, and in any case not more than 500mm above the lowest point of the fuel system. The pump unit should preferably be installed with the fuel inlet at the bottom or in a horizontal position.
- b.** Open the pump assembly cabinet by unscrewing the two knobs on the top.
- c.** Turn the front of the cabinet outward and release it from the two lower guide slots by pushing downward.
- d.** Based on the intended displacement on the gascolator and pump assembly firewall, decide how to arrange the inlet and outlet fittings on the pump assembly. The assemblies are delivered with both fittings arranged on the right; the connector is also on the right. In case you want to change this arrangement, simply change the position of the inlet or outlet pipe end caps located on the left side of the pump assembly, at the bottom (IN inscription) and top (OUT inscription), respectively. Re-tighten them [1+2] by tightening them to a torque of 35 Nm and holding the duct in place in the cabinet by engaging the appropriate wrench, [3] for upper pipe, [4] for lower pipe; the gasket washers must be replaced.
- e.** Drill [9] on the firewall the 4 fixing holes at the spacing shown in the figure.



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The type of fasteners to be used and the resulting hole diameter of the flame guard are at the discretion of the installer; the holes on the pump assembly are 6.5 mm in diameter; it is not necessary to provide elastic elements for fastening.

- f.** Attach the cabinet to the flame shield by tightening the fasteners to the prescribed torque; if screw fasteners are used, a threadlocker compound should be used on the threads.
- g.** Decide on the optimal position (left or right) for the pump control connector and attach it to the cabinet. Before attaching it, widen outward with a screwdriver [7], the two edges of the connector's attachment territory at the top, to make it easier to insert.
- h.** Connect the aircraft-side wiring loom, which will have been prepared in advance, to the connector; the counterpart connector on the cabinet is supplied with the pump assembly.
- i.** Insert the fuel hose coming from the gascolator into the fitting hose holder, and secure it [6] with a hose clamp; if necessary to facilitate insertion, use denatured alcohol or Vaseline [8].
- j.** Connect the fuel inlet branch at the bottom of the cabinet, coming from the gascolator, by placing a gasket washer above and below the fitting eye. Tighten [1+3] to a torque of 35 Nm. While tightening, rotation of the manifold must be prevented by holding it in place with an appropriate wrench [4].
- k.** Apply the same operations to connect the fuel outlet branch: in this case, to prevent rotation of the manifold, use wrench [3].
- l.** Although all FD-m assemblies are verified at the factory after assembly, it is necessary to reverify there are no leaks by turning on the fuel pumps after finishing the installation.

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- m.** Close the cabinet by inserting the lower part of the cover into the guide slots and screwing the two retaining knobs to the top by hand.



Before starting the engine, check all elements of the pump assembly and fittings for leaks under pressure: if necessary, open the cabinet cover to make sure there are no leaks inside.

73-14-00 Implementation of the Fuel Circuit



The gasoline circuit must comply with any regulations in force in the country where the powerplant is used. The user acknowledges that he/she is responsible for proper installation and perfect compliance with applicable regulations.

73-14-01 Gascolator

The gascolator is not part of the standard equipment: the choice should be made in accordance with the characteristics summarized below.

- | | |
|---|--|
| <ul style="list-style-type: none"> ▪ Type ▪ Casing material ▪ Minimum glass capacity ▪ Operating pressure ▪ Filter element material ▪ Minimum filtering capacity ▪ Number of connections ▪ Tube holder diameter | <ul style="list-style-type: none"> gascolator with wire mesh filter and purge valve, suitable for use with green gasoline metal (avoid glass) 0,15 L -0,1 ÷ 0,2 bar metal 70 µm 1 inlet + 1 outlet 8 mm |
|---|--|



Before each flight, purge the decanter filter of any accumulated water.

73-14-02 Fuel Pump



A safe installation involves mounting two fuel pumps, connected to each other in parallel.



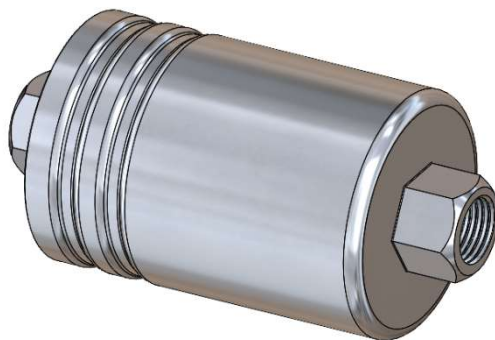
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Fuel pumps are supplied as an accessory. Alternatively, the FD-m accessory, in which two fuel pumps are already installed and connected to the respective filters, can be mounted. In any case, the characteristics of the pumps are as follows.

- | | | |
|--|--------------|---------|
| ▪ Fuel flow | | 100 l/h |
| ▪ Static pressure rating | | 5,5 bar |
| ▪ Max priming height | | 500 mm |
| ▪ Supply voltage | | 12 V |
| ▪ Corrent load | Max | 9 A |
| | at P=3,5 bar | 5,5 A |
| ▪ Inner diameter of suction tube | | 12 mm |
| ▪ Outlet side threading | | M10x1 |
| ▪ Outlet side tightening torque | | 17 Nm |
| ▪ Minimum length of pipe insertion on fittings | | 20 mm |
| ▪ Positive pole eyelet terminal diameter | | 4 mm |
| ▪ Negative pole eyelet terminal diameter | | 5 mm |
| ▪ Weight | | 660 g |

73-14-03 Fuel Filter



73-18-P

- | | |
|------------------------------|----------------------|
| ▪ Fuel flow | 90 l/h |
| ▪ Filter capacity | 10 µm |
| ▪ Filter surface area | 1200 cm ² |
| ▪ Filter material | paper |
| ▪ Maximum operating pressure | 6 bar |
| ▪ Operating temperature | -40÷90 °C |
| ▪ Inlet port | M16x1.5 |
| ▪ Outlet port | M16x1.5 |
| ▪ Weight | 126 g |

The fuel filter should be installed after the two fuel pumps: the presence of the fuel filter is essential to ensure the protection of the injectors from the entry of fine particulate matter, which would damage them.

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Replace the fuel filter at the intervals specified in the routine maintenance schedule: failure to replace may result in poor performance or sudden engine shutdown.

73-14-04 Pipes and Fittings

Material with the minimum characteristics listed below must be used to make the fuel circuit.

- | | |
|--|--------|
| ▪ Inner diameter of fuel delivery tubes | 8 mm |
| ▪ Inner diameter of fuel suction tubes | 8 mm |
| ▪ Minimum continuous operating temperature | 80 °C |
| ▪ Minimum continuous operating pressure | 5 bar |
| ▪ Minimum burst pressure | 10 bar |
| ▪ Minimum radius of curvature | 50 mm |
| ▪ Minimum pipe inlet length on the fitting | 20 mm |

73-14-05 Fuel Valve

Although not essential for engine operation, the adoption of a valve in the fuel system increases its safety and facilitates maintenance operations. In the case of single-tap or compensation nourisse installations, a single-way valve can be installed, which then intercepts the flow of only the fuel inlet branch to the engine. In the case of dual-tank installations, the valve must intercept both the fuel intake branch from the tank and the excess fuel return branch to the tank: this obviously applies to both tanks. Otherwise, since the flow rate of the pump is clearly in excess of the actual consumption of the powerplant, the excess fuel would indiscriminately return to both tanks, causing the tank in use to be emptied in a short time. The characteristics of this component should be as follows.

- | | |
|----------------------|------------------------------|
| ▪ Positions | closed, right, left, both |
| ▪ Rotation angle | 360° without end stop |
| ▪ Number of ways | 2, supply and return to tank |
| ▪ Operating pressure | 3,5 bar |
| ▪ Burst pressure | >>10 bar |

These specifications are to be considered as the minimum to be used.



In the event of an accident and capsizing of the aircraft, it is important that the fuel contained in the tank cannot spill out: for this reason, even on single-tank installations, we still recommend adopting valves that also intercept the return branch to the tank or, alternatively, equipping this branch with a check valve.

73-14-06 Circuit Implementation

Necessary Materials

1. Torque wrench
2. Hexagonal wrench 14 mm

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3. Hexagonal wrench 19 mm
4. Hexagonal wrench 24 mm
5. Weak threadlocker
6. Other tools depending on the materials chosen during installation

- a. Attach a fuel pipe line tube, of the prescribed type, to each wing tank, taking care to secure it elastically to the plates of the aircraft without allowing it to rub against sharp surfaces or edges. For safety reasons, fuel tanks should have a sump for water, which should be purged before each flight. If the aircraft is equipped with a nourisse (cabin tank), the fuel sump tube should be attached to the latter.



Use only metal clamps with rounded edges when tightening pipes to their respective tube holders.

- b. On each line or the intersection of the two lines interpose a fuel valve. The valve can be any of the two-position (on, off), three-position (on right, off, on left), or four-position (on right, off, on left, both) type.



If the three-position valve is used, switching from one tank to the other with the engine running must be done very quickly, to avoid the risk of shutting down the powerplant by switching to the off position.

- c. Attach a water decanter filter (Gascolator) to what will be the lowest point in the entire fuel system. This component protects the fuel pumps and engine from any water in the fuel. The size of the sump determines the maximum running time of the engine with the fuel valve closed: by way of example, remember that a sump volume of 100ml allows the engine to run at full power for about 10 seconds. To facilitate before flight operations, it is recommended that the decanter filter be mounted in a location that can be easily inspected, even once the engine cowling is installed.



The gascolator must necessarily be installed before the pumps, as it cannot work under pressure.

- f. Connect the gascolator to the valve by means of rubber tubing of the prescribed type, taking care to secure it so that it is higher than the bottom of the decanter.
- g. Elastically attach the fuel pumps to the aircraft.
- h. On the pumps, the inlet side has a hose holder for hoses with an internal diameter of 12 mm; on the outlet side, on the opposite face, there is an M10x1 thread. The pumps must be positioned no more than 500 mm above the bottom of the gascolator in order for them to ensure fuel priming: however, it is a good idea to keep them as close to the gascolator as possible and in an upright position, with the fuel inlet port at the bottom and the outlet port at the top. If two pumps are

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used, they should be connected in parallel by installing T-connections on the inlet and outlet.

- i. The pumps are of the non-transparent type, i.e., they do not allow fuel to flow to the engine if they are off; a check valve is also built into them to prevent the system from losing pressure when the pump is off.
- j. Refer to the diagram in this manual for the electrical connections of the pumps.
- f. After the T-connection joining the outlet ports of the two pumps, attach the pressurized filter elastically in an easily accessible area for possible periodic replacement. The inlet port (IN) and outlet port (OUT) fuel and the direction of flow (arrow) are clearly marked on the filter. The location of the filter is irrelevant to the proper operation of the powerplant. The minimum tube insertion length on the filter body is 14 mm.



Use only fuel filters suitable for mounting on pressurized circuits and suitable for use with green gasoline.

- g. Connect the gascolator to the pumps with piping of the prescribed type and the pumps to the pressurized filter, taking care to use new metal clamps of adequate diameter. The tightening torque [1+6] of the outlet line from the fuel pump should be 17 Nm: when tightening, it is advisable to counteract the action of the torque with a wrench [2] engaged on the hexagon on the outlet port of the pump itself, so as not to risk damaging the seals. It is also advisable to use weak threadlocker [5] on the threads to ensure better sealing against vibration.
- h. Connect the pressurized filter to the fuel distributor located at the rear of the engine using prescribed fuel hose. Another pipe should be connected from the distributor to the fuel valve; the fuel valve should in turn be connected to both wing tanks, also regarding the fuel return.



Use only gasoline hoses approved for pressurized circuits, with an inner diameter of 8 mm, of the type resistant to green gasoline. Replace them every two years.

In case the aircraft is equipped with a manifold tank between the two wing tanks (nourisse), the fuel return branch from the engine can also be connected to this tank, possibly interposing a check valve, which will prevent in case of tipping and rupture of the piping the fuel from the tanks in the direction of the engine; this valve should be installed as close as possible to the tank itself.

The pipes must be connected to the distributor through connections with M12x1.5 thread. The tightening torque of the fittings must be 35 Nm and the fittings must engage in the thread for at least 8 mm.

Fasten the hoses to the aircraft in an elastic manner, taking care to ensure that they are not stretched or excessively loose during engine operation. If necessary, protect the external surface of the pipes with a silicone sock, to improve resistance to heat and abrasion.

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The system provides a return line for excess fuel to ensure a constant supply of pressure and to prevent vapour-lock phenomena (formation of hydrocarbon vapor bubbles in the fuel circuit, caused by excessive heating). The pressure in the fuel circuit is usually sufficient to avoid the risk of vapour lock, either in flight or at start-up after a short stop. For the same purpose, the system provides two lines, one to carry fuel to the engine, the second to return excess fuel from the engine to the tanks. If vapour lock occurs, it is advisable to protect the fuel lines with refractory conduits and increase ventilation in the engine cowl.

- i. Screw [4;5] the pressure sensor to the fuel distributor, if any (available as an accessory), tightening [1+4] to a torque of 30 Nm, using an annealed copper washer as a gasket. The predisposed thread is 1/4" gas.



The sensor to be used must be specifically suitable for installation in systems with green gasoline: using unsuitable sensors may result in puncture of the sensing membrane, with fuel leakage and serious fire hazard.

- j. Also screw [3;5] the fuel temperature sensor to the fuel shunt, if any (available as an accessory), tightening [1+3] to a torque of 20 Nm and using an annealed copper washer as a gasket. The threading is M14x1.5.
- k. Bleed the fuel system.



Before starting the thruster, turn on the pump and verify the presence of the rated pressure in the circuit, proper electrical absorption, and the absence of leakage: in particular, verify there are no leaks, even minimal, from the sealing washers and the area where the tubes are inserted in the distributor.



In case of prolonged engine shutdown, it is necessary to check the proper functioning of the fuel pumps and injectors: in fact, they may be damaged or blocked by fuel residue, making starting difficult or impossible.

- l. Connect the positive cable coming from the pump relay to the small terminal of the main pump, after threading the protective cap provided on the cable and terminating it with a D4 mm eyelet terminal.

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- m.** Connect the positive wire coming from the auxiliary pump switch to the small terminal of the auxiliary pump, after threading the protective cap provided on the wire and terminating it with a D4 mm eye terminal.
- n.** Connect two leads to the large terminal of both pumps, after threading the protective caps provided on the leads and terminating them with D5 mm eyelet terminals.
- o.** Connect the other end of the negative cables from the pumps to chassis ground.
- p.** Tighten all the nuts of the positive terminals to a torque of 3 Nm, and the negatives to a torque of 5 Nm, interposing the safety washers provided.
- q.** Stocking the protective caps on the terminals of the pumps: in case of difficulty, sprinkle a layer of Vaseline on the surfaces.



Avoid operating the fuel pumps for a long time without fuel as they may overheat and become irreparably damaged.

73-15-00 Recommended Fuel

The engine is constructed with components suitable for the use of commercial automotive gasoline. The minimum characteristics of the fuel to be used are as follows:

- Green gasoline RON 91 or higher
- Red gasoline 91 octane or higher
- Maximum alcohol content 10%



The use of AVGAS gasoline has not been verified during testing: do not use this type of fuel for any reason, as it could severely damage the injectors and the engine to the point of causing it to shut down.



Using fuel with anti-knock characteristics lower than prescribed can cause damage to the mechanical components of the engine. If such fuels are accidentally used, a thorough inspection of the combustion chamber, pistons, head gasket and crankshaft should be carried out.



The formulation of gasoline varies between summer and winter; therefore, it is important to make sure to use fuels prepared for the climatic condition in which the engine operates.

Avoid storing fuel for a long time and using winter fuel in summer. Summer fuel has less aptitude for evaporation as more volatile components are removed: this decreases the risk of vapour lock in the fuel system.

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73-16-00 Filling the Fuel System

When the pumps are first turned on, or in case work has performed on the fuel system, it is necessary to blow out the air contained in the fuel hoses.

To bleed the system, it is necessary to turn on the auxiliary fuel pump for a few seconds, until a change in the noise emitted by the pump is detected: at this point the correct operating pressure (about 3.6 bar) should be read on the instrument. In case that even after more than 10 seconds after starting the pump, this does not occur, turn off the pump itself to avoid damaging it and proceed as described below. At this stage it is necessary to get help from a second person and operate in an open environment away from heat sources.

Necessary Materials

1. Torque wrench
 2. 12 mm hex wrench
 3. Blotting paper
- a.** Slightly unscrew [2] the fitting of the fuel lines on the #1 bank header, wrapping [3] with paper towels around the space, so as to avoid fuel gushing.
 - b.** Engage the appropriate wrench [1+2] on the fitting connection tightening screw to be ready for re-tightening.
 - c.** Operate the auxiliary fuel pump.
 - d.** As soon as fuel is leaked from the loose connection, retighten it to the prescribed torque (15 Nm).
 - e.** Promptly wipe up any leaked gas with the paper towels [3].
 - f.** Repeat the same operations on the header of bank #2.
 - g.** Operate the pumps again and perform the system pressure check.

73-17-00 Verification and Validation

Proper operation of the powerplant requires that the system can deliver the appropriate amount of fuel under all environmental and flight conditions. Unlike carburetor fuel systems, the electronic fuel injection system ensures smooth and safe operation as the aircraft lay, during maneuvers, and as environmental conditions change.

For these reasons, tuning the fuel system does not present any particular difficulties or critical issues: however, it is important to perform some checks during the first hours of operation, summarized below.

73-17-01 Fuel Houses

After the first few hours of operation, it is essential to completely remove the engine cowlings and check for signs of fuel leakage, usually evidenced even when dried by a green residue of gelatinous appearance. It is also important to check the inner surface of the cowlings, as the flow created by the propeller could disperse any leaks.

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If there are any leaks, even small ones, do not operate the aircraft or start the propeller again until the leak is located and removed. Carefully check all fittings in the fuel circuit, and the tightness of the connections or clamps provided. If in doubt, do not hesitate to replace the clamps or seals.

Another important check is to be made on the hoses: in particular, their outer surface should be checked for bulges (an unmistakable sign of overheating) or abrasions (a sign of contact with engine or aircraft surfaces). If the hose is damaged, it is essential to replace it and modify the passage or attachment on the aircraft. It is also possible to use silicone sheaths to protect the tubes, which protect them from heat and abrasion. The tubes should not be in tension or excessively loose, a sign that they have shifted from their original position: if so, check and, if necessary, modify their attachment.

73-17-02 Fuel Pressure Measurement

Fuel pressure can be measured by installing the pressure sensor in the housing provided on the fuel distributor (1/4" gas thread).

The verification of system pressure should be carried out as follows.

- a.** Install the pressure sensor.
- b.** Purge the fuel system.
- c.** Power up the injection system and verify that the main pump is running for about 2.5 seconds.
- d.** When the main pump is turned off, check that the system is pressurized to at least 3.0 bar. If it is not, turn off the injection system, wait about 10 seconds, and then turn it on again. Check the system pressure: if the minimum expected pressure has not been reached, check for leaks or obstructions in the system.
- e.** Wait about 5 minutes: the pressure in the fuel system should drop no more than 0.5 bar every minute. If it drops more, it is likely that there are leaks or that the check valves inside the pumps are defective.
- f.** Power up the auxiliary pump, if provided, and repeat the checks implemented for the main pump.
- g.** Start the engine and check that the system pressure is between 3.3 and 4.2 bar. If this is not the case, do not fly.
- h.** With the engine running, switch on the auxiliary pump: check that the pressure, increases by no more than 0.4 bar. If the increase is greater, it is necessary to increase the diameter of the return line to the tank.

73-17-03 Fuel Temperature Measurement

The fuel supply system is pressurized and has a return line to the tank: these features make vapour lock phenomena very unlikely. However, it is advisable to verify that the fuel present on the pressurized branch never exceeds 55 °C during use, and 65 °C at start-up.

The verification should be carried out as follows.

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- a.** Perform a test flight in warm weather (above 30 °C), checking in flight that the temperature is within the expected limits: if not, prepare appropriate air intakes to lower the temperature in the engine hood.
- b.** Once on the ground, turn off the engine and wait about 15 minutes.
- c.** Before restarting the engine, measure the temperature reached by the fuel, which must be below 65 °C to avoid vapour lock phenomena that would make restarting difficult
- d.** In case the engine has difficulty restarting, run the auxiliary pump for at least 5 seconds, and try starting the engine again.
- e.** In any case, if the fuel temperature exceeds the prescribed limits on the ground, it is advisable to thermally insulate the fuel lines with fireproof material, move them away from heat sources, and provide an opening at the top of the engine cowling to facilitate the venting of hot air.

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75-00-00 COOLING SYSTEM

75-01-00 Engine Components Cooling

The following mechanical and electrical components of the engine are not cooled by the cooling system, but must be cooled by a flow of fresh air.

- Gearbox
- Exhaust system
- Voltage regulator
- Injection control unit [if located in the engine hood]
- Electrical wiring harness
- Starter relay
- Engine suspension
- Fuel pumps and filters

Normally, the air intake provided for the adduction of fresh air to the intake system and radiators alone is sufficient to meet the temperature limits set for the components. In case the operating limits are not met, it is necessary to make additional air intakes near the most stressed components or, alternatively, to provide ducts that adduct fresh air by taking it from the supply air intakes.

In addition to the shape and position of the air intakes, it is very important to carefully study the extraction vents as well, sizing them with passage sections at least triple the size of the air intakes.

Particular care must be taken in the ventilation of the exhaust system, which is thermally stressed: if the original exhaust system is used, the hottest part is the one near the junction of the manifolds in the muffler.

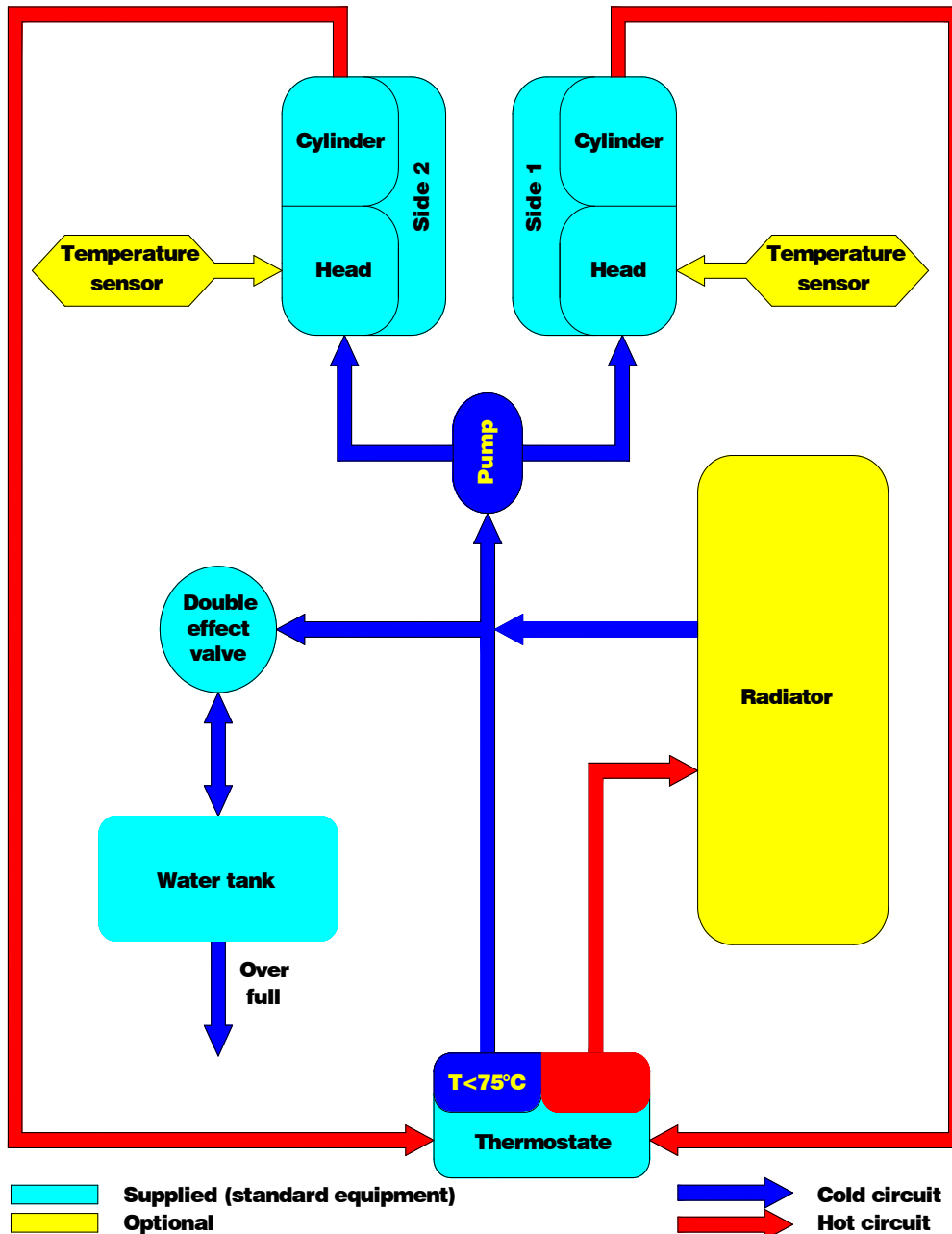
In case the cooling water radiator is mounted in front of the exhaust system, it is sufficient for the air leaving the radiator to pass over the muffler to ensure adequate heat removal. Also check the thermal condition of the exhaust manifolds near the cylinder head, and if necessary, make small air intakes near them.

In case the injection control unit is installed in the engine cowling, it is also necessary to provide one or more air extraction openings in a high position on the cowling itself, to facilitate the evacuation of air even when the aircraft is stationary: in this way it is possible to avoid possible overheating of the injection control unit after engine shutdown, caused by the accumulation of hot air in the cowling.

75-20-00 Liquid Cooling System

SPIRIT and **SPIRIT Turbo** engines are completely liquid-cooled: this choice was made because it improves the reliability and consistency of the engine's performance compared to the simpler air-cooling system but also more critical both in installation and in use. In fact, with liquid cooling, the thermal stability of the engine is improved under all conditions, for example, during long idle runs or during long waits for take off. The adoption of liquid cooling, by improving the cooling of critical points in the engine, also allows higher specific power outputs to be achieved than is possible with air cooling.

75-21-00 System Description



The cooling system is of the pressurized closed-circuit type with integrated relief valve, thermostat and expansion tank. Coolant is sent from the pump keyed on the crankshaft to the cylinder heads through separate stainless-steel ducts: as it exits the cylinders it passes through the thermostat, installed inside the pump cover. When the engine is cold, the thermostat intercepts the flow, short-circuiting the return of the liquid from the cylinder block with the pump inlet manifold, so that the radiator is excluded from the circuit; when the coolant reaches about 75°C, the thermostat

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gradually opens the passage to the radiator: in this way the engine reaches the correct operating temperature more quickly and is less sensitive to variations in load and speed. The bleed valve is at the inlet line of the water pump, which pours excess liquid back into the expansion tank when it is opened; a second valve allows the liquid accumulated in the expansion tank to re-enter the circuit as a result of the vacuum created during the cooling phase of the thruster.

The coolant provides heat removal from both the cylinder heads and the cylinders. Specifically, the coolant enters the cylinder head and exits the cylinders after lapping the outer wall of the liners. The only connections that need to be made in order to use the engine are between the radiator and the inlet and outlet manifolds from the water pump.

The cooling system is set up to connect a heating radiator for the cabin.



The cooling circuit is pressurized: when the engine is hot, avoid removing the red filler cap.

75-22-00 General Characteristics

▪ Maximum coolant temperature in flight		102 °C
▪ Minimum coolant temperature in flight		72 °C
▪ Typical coolant temperature in flight		90 °C
▪ Minimum hangaring temperature (mixture 30% glycol)		-18 °C
▪ Water pump rated flow rate		96 l/min @ 3200 rpm
▪ Maximum heat to be removed	(Spirit 100 R/L)	27,3 kW
	(Spirit 115 R/L)	31,6 kW
	(Spirit 122 R/L)	33,3 kW
	(Spirit 135 R/L)	37,0 kW
	(Spirit 140 R/L)	38,8 kW
	(Spirit 160 R/L)	44,2 kW
▪ Thermostat opening start temperature		75 °C
▪ Thermostat end opening temperature		88 °C
▪ Filling cap valve opening pressure		1±0,05 bar
▪ Depression opening valve filler cap		0,05 bar



Operating the engine with coolant temperatures above the maximum operating limits can facilitate the onset of detonation, a very destructive phenomenon for the engine.

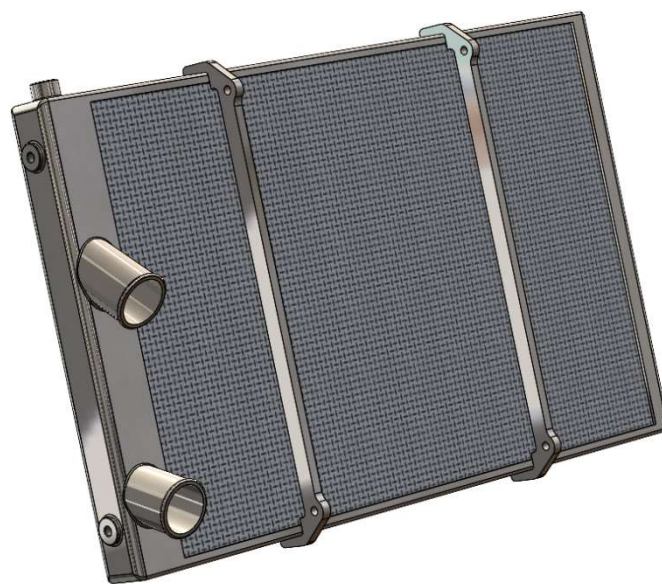
75-22-01 Capacity

▪ Crankcase		2x0,53 l
▪ Heads		2x0,4 l
▪ Water pump		1,05 l
▪ Filling pipe and pump pipes		0,23 l
▪ Expansion tank	max	0,7 l
	standard	0,45 l

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- Distribution pipes 0,51 l
- CR-m STD radiator 0,8 l
- CR-m STD radiator hoses 0,4 l
- Total quantity in the engine 3,7 l
- Total quantity in the engine with CR-m STD 4,9 l

75-23-00 Cooling Radiator Module (CR-m STD)



75-01-P

A cooling radiator and manifold assembly, called CR-m STD (Cooling Radiator module standard), is available as an option. The radiator, made entirely of aluminum, is suitable for most tractor applications, and ensures adequate cooling of the engine, provided that an efficient air intake is made under all operating conditions and that it is able to divert the airflow in a direction orthogonal to the plane of the radiator.

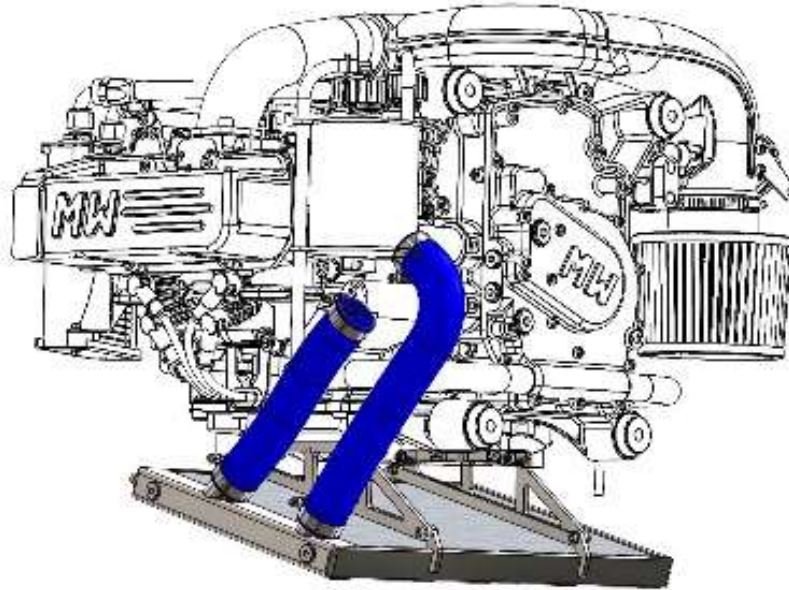
75-23-01 Description

The radiator is supplied with fittings and small parts for connection to the engine: these components are made in integral form (without joints) of silicone rubber; they are able to withstand temperatures close to 250 °C, and thus withstand without any damage the temperatures induced by the proximity of the exhaust manifolds (as long as they are not in contact with them).



In order to ensure the proper safety of the installation, rubber or plastic fittings must be replaced at the scheduled intervals, as they are sensitive to the action of ozone and ultraviolet rays.

The radiator is fixed in the lower part of the engine, at the oil sump, by means of anti-vibration elements, supplied with the radiator itself, and is inclined with respect to the propeller axis: this solution avoids soiling of the radiator and decreases the frontal section of the hood, without penalizing heat exchange too much.



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75-23-02 Component Characteristics

▪ Radiator dimensions	460x270x30 mm
▪ Radiator cooling surface	1100cm ²
▪ Typical cooling flow on the radiator	1,65 m ³ /s
▪ Inner diameter of refrigerant tubes	32 mm
▪ Refrigerant quantity in radiator and tubes	1,2 l
▪ Weight CR-m STD	2,1 Kg

75-23-03 Installation

Necessary Materials

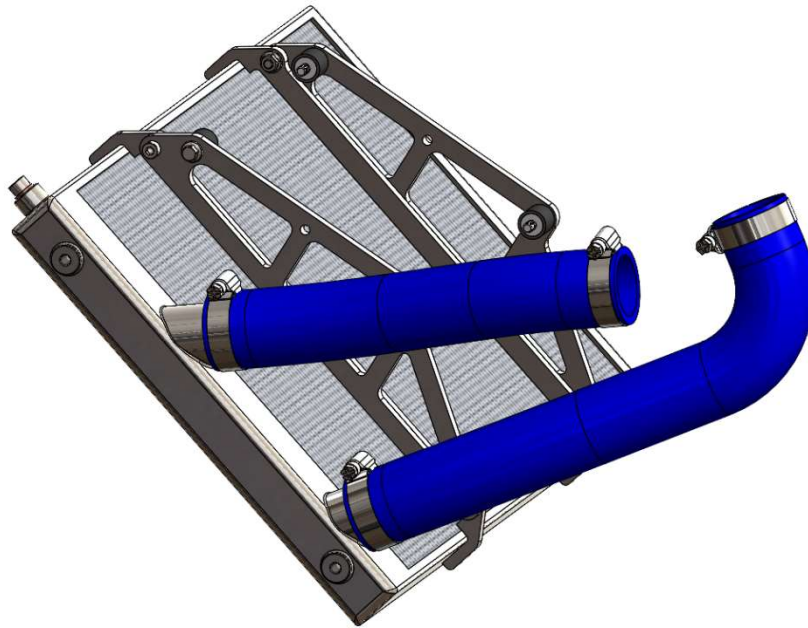
1. Hexagonal socket screwdriver 7 mm
2. Vaseline
3. 3 mm Allen wrench

The installation of the radiator is done as follows.

- a.** Attach the four elastic elements (silent blocks) to the holes on the oil pan, taking care to tighten them until they are flush with the work surface; tightening should be done by hand, applying a moderate load.

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- b.** Slip the two silicone hoses onto the radiator, taking care to position the curved one on the lower manifold, as in the figure; if necessary, use Vaseline [2] to facilitate their introduction.



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- c.** Secure the fittings on the manifolds by tightening [1] the supplied clamps on the hoses to a torque of 5 Nm; tighter tightening unnecessarily stresses the pipes.
- d.** Remove the protective covers present on the pump manifolds.
- e.** Attach the radiator to the underside of the engine, fitting both hoses onto the respective manifolds at the rear of the engine; if it is difficult to introduce, use Vaseline [2].
- f.** Attach [3] the radiator to the four spring elements underneath the oil pan using the screws provided; the screws should engage the vibration-damping elements for the first stretch without strain, after which a fair amount of strain should be felt, determined by the fact that the screw penetrates the rubber thus averting any accidental unscrewing; the screws should be brought to a stop on the radiator support bracket and tightened with a moderate load.
- g.** Secure the fittings on the water pump manifolds by tightening [1] the supplied clamps on the hoses and carry out set-up.

75-24-00 Realization of the Engine Cooling Circuit

75-24-01 Pipes and Fittings

The characteristics of the pipes and fittings of the cooling system should be as follows.

- Minimum continuous operating temperature 125 °C
- Minimum continuous operating pressure 1,5 bar

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- Hoses inner diameter

ideal	32 mm
min	25 mm
- Minimum radius of curvature 50 mm
- Minimum hoses inlet length on the fitting 20 mm
- Use hoses suitable for ethylene glycol and anti-ozone; in any case, change the system hoses at least every 2 years
- Use sealing ties with rounded edges, so as to avoid notching the outer surface of the fittings; after the first heating cycle of the engine carry out re-tightening of the sealing ties.

75-25-02 Radiator

The shape, size and location of the radiator depend mainly on the space available. In special cases, it is also possible to use two radiators instead of one.

- Typical radiator cooling surface ~880 cm²
- Typical cooling flow on the radiator 1,5 m³/s

The radiator should be installed so that the inlet connection is at least 100 mm below the pressurized cap located at the inlet of the expansion tank. If this is not possible, a radiator equipped with a 1-bar vent cap and vacuum valve should be used, and an expansion tank to which the liquid escaping from the cap should be directed. The outlet connection from the radiator should be no more than 1 meter below the pump inlet on the engine.



Position the radiator and fittings in such a way as to avoid any accidental contact with hot parts of the engine, such as the exhaust system, which could alter its integrity.



During operation, cooling circuit components heat up to very high temperatures: avoid touching these components before the engine has cooled down for at least 30 minutes since the last start-up.



Never use the union screws between the crankcase and the gearbox or the cover to fix the radiator or the air intake. Failure to comply with this requirement releases MWfly from any obligation and liability, and causes the automatic revocation of the guarantee.

In case of placing the radiator far away from the motor, using flow and return pipes longer than 4 meters in total and made of expandable material, it may be necessary to replace the preinstalled expansion tank with a larger one. Refer to the maintenance manual to remove the original expansion tank.

75-24-03 Air intake sizing Dimensionamento presa d'aria

It is not possible to provide standard data for sizing the cooling air intake, as the amount of air actually passing through the radiator can vary considerably depending on its position on the engine cowling, the speed, and the aircraft's attitude.

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However, some sizing criteria are valid for most applications and are summarized below.

- The air intake should be positioned as close as possible to the plane of rotation of the propeller.
- The height and width of the air intake should be approximately 80% of that of the radiator.
- The most efficient location for the air intake is usually in the lower side of the cowling.
- If the air intake must be positioned on one side of the cowling, it is best to choose the right side for right-rotation (clockwise) engines, and vice versa.
- Create a duct made of aluminum sheet metal or fiberglass between the radiator and the air intake on the engine hood to ensure a rapid supply of fresh air to the radiator. If necessary, you can use the M8x1.25 threaded holes in the lower part of the oil pan to attach the air intake.
- To improve the efficiency of the radiator, it is advisable to seal any gaps between the air intake, the duct, and the radiator itself.
- The total area of the hood vent must be at least three times greater than the sum of all the hood vents, whether cooling, fuel, or ventilation.
- It's a good idea to shape the vent edge like a spoiler to deflect the air flowing over the hood and create a negative pressure zone.
- Avoid placing the exhaust or parts of it in front of the radiator.

75-24-04 *Expansion Tank Sizing*



If a non-original radiator is used or the cooling circuit is modified, the required capacity of the expansion tank must be recalculated and the original one replaced if necessary.

The original expansion tank, with a total capacity of 0.72 litres, is capable of adequately compensating for a cooling system with a maximum total capacity of 5.8 liters, assuming that a cooling fluid composed of 33% ethylene glycol and 67% water is used and for maximum temperature jumps of 105°C: this value must also include the capacity of the radiator and fittings of the passenger compartment heating system, if the total capacity of the system exceeds this value, an increase of 0.15 litres in the volume of the expansion tank must be considered for each additional liter of cooling fluid.

In any case, it is necessary to perform the coolant system verification.

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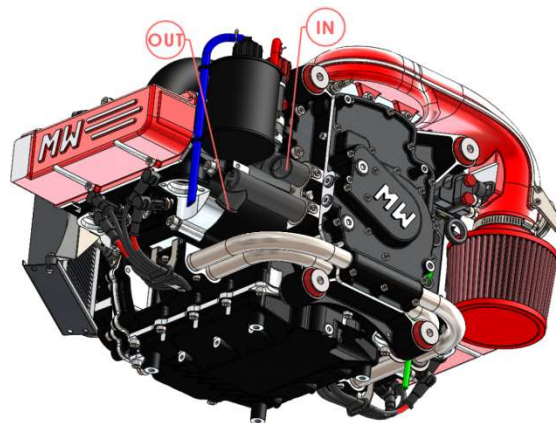
75-24-05 *Circuit Implementation*



Take the utmost care in running the hoses away from heat sources or sharp or abrasive surfaces: if this is not possible, it is necessary to protect the hoses against radiation or contact with suitable material.

The cooling system should connect the inlet manifold and the outlet manifold of the water pump located at the rear of the engine to the radiator.

As evidenced by the labels located on the rear engine cover, the outlet manifold from the pump is the lower one, the inlet manifold to the pump is the upper one; respectively, these manifolds should be connected to the upper radiator port and the lower one. The lower manifold, if necessary, can be rotated: to facilitate rotation, loosen the three clamping screws on the manifold retaining ring; the torque should be reset to 4Nm.



75-04-P

The pipes in the system must be secured, to prevent them from being subjected to mechanical stresses with vibration or from touching sharp or hot surfaces. In the case of circuits with particularly long runs, give preference to rigid pipes (aluminum) with hemming to prevent the fittings from coming loose.

The circuit should be made in such a way that the vent plug on the engine is above each pipe: also, loops, which could accumulate air bubbles, should be avoided. No expansion tank, thermostat, or pressure relief valve need be provided in the system: these components are already present on the engine. The expansion tank on the engine has a cap with an outlet tube for "overflow": this tube runs to the bottom of the engine.

- a.** Check that the pipe is not crushed or clogged
- b.** Ensure that the excess liquid as it exits the hose does not foul areas vital to the safety of the airplane. If necessary, plan to extend it: use only original hoses or hoses resistant to operating temperatures of 120 °C and inert to ethylene glycol

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Do not interchange the two caps on the cooling system fill pipe (red and with 1-bar valve) and the expansion tank (black and without valve) with each other.

All components of the cooling system must ensure safe and stable use of the system. The dimensions and arrangements of the system components must allow operating temperatures of the engine within limits: give preference to tubes of large cross-section, with wide radius bends and without large variations in cross-section; use new radiators with tube bundles of adequate cross-section, preferably with horizontal flow.

75-25-00 Recommended Cooling Fluid

Use only ethylene glycol-based coolants, preferably sold already prepared in solution with water and not in concentrated form. Preferably use liquids with organic additives (called OATs) based on phosphate, boron or silica salts, usually coloured red or orange; glycol with inorganic inhibitors (called IATs), usually coloured blue or green, or glycol with hybrid additives (called HOATs), usually coloured yellow, can also be used.



Avoid mixing glycol with inorganic additives with glycol with organic additives: in such a case, there is a risk of gelatinous intrusion into the cooling circuit, which can significantly alter the flow characteristics of the system.

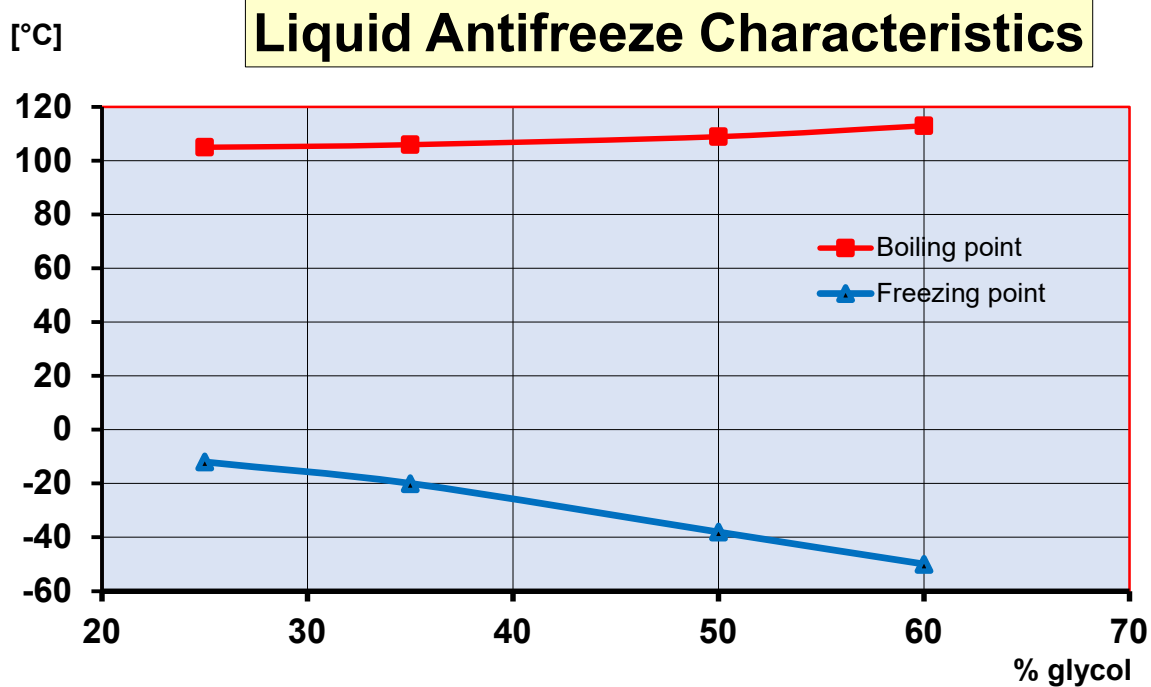


In order to switch from glycol with organic-type additives to glycol with inorganic-type additives and vice versa, it is necessary to flush the cooling system with water several times to completely remove residues of the glycol to be replaced.



Glycol with hybrid additives is compatible with both other types: in case of doubt about the type of glycol used, for any topping up use a glycol with hybrid additives (HOAT).

The typical proportion of coolant to water is one-part glycol to two parts water (33/67). In particularly cold climates, the proportion of glycol may be increased to improve freeze protection in accordance with the following diagram.



75-02-C



The use of antifreeze liquids other than ethylene glycol is not allowed. In particular, the use of propylene glycol, which subjects the thruster to higher than standard operating temperatures by having lower heat capacity, is prohibited.



The use of ethylene glycol undiluted with water is to be avoided, as it is flammable. The use of water, without the addition of antifreeze is allowed in emergencies and for short periods, as it can cause corrosion phenomena to the cooling system components and the powerplant itself.



A coolant consisting of 50% ethylene glycol and 50% water comes to a boil at a temperature of about 116 °C at a pressure of 1 bar. For this reason, the maximum operating temperature is cautiously set at 102 °C.

The data shown refers to a cooling system in full efficiency, with original vent plug and valve in perfect condition. If the installation involves operating temperatures close to the maximum attainable, it is important to frequently check the state of efficiency of the pressurized circuit.

Keeping an eye on the coolant temperature at the inlet of the two banks is important to prevent detonation phenomena in the combustion chamber. However, it is essential to design the cooling circuit in such a way that it can ensure adequate cooling of the

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engine under all flight conditions away from the boiling point of the liquid, so as to avert the onset of overheating.



It is not permissible to operate the powerplant at temperatures higher than the maximum allowed: this causes serious damage to the head gasket and can cause the powerplant to seize.

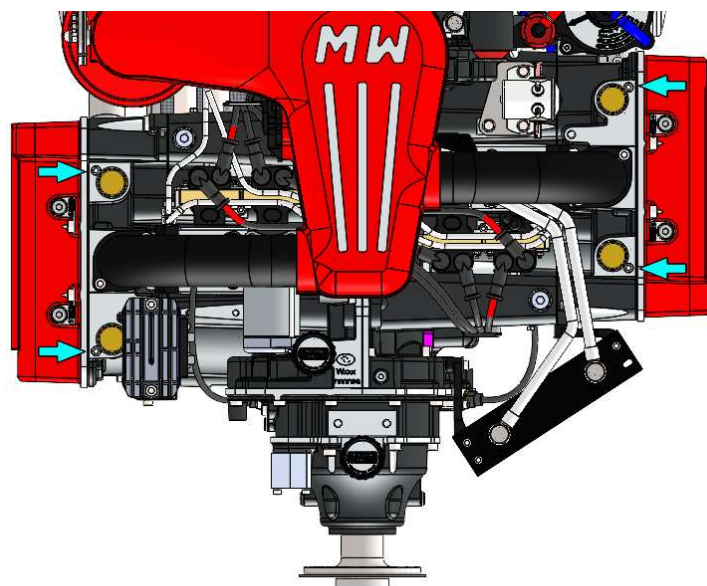
75-26-00 Filling the Coolant Circuit

Necessary Materials

1. Torque wrench
2. 5 mm Allen wrench

75-26-01 Filling

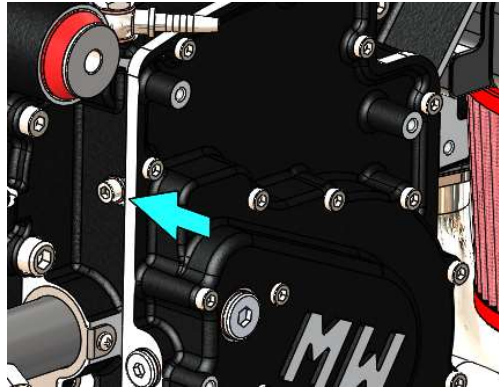
- a.** Slowly introduce liquid through the hole in the filling tube (red cap), until it flows from the four vent caps highlighted in the figure, previously removed [2].



75-05-P

- b.** Reinstall [2] the four circuit vent screws located on the heads, without tightening them.
- c.** Unscrew [2] the liquid pump vent screw located on the left side of the rear cover, partially hidden by the filling tube.

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- d.** Add liquid to the filling tube until the liquid itself comes out of the pump vent screw and the tested vent screws (remained partially unscrewed).
- e.** If the system is equipped with a passenger compartment heating radiator, unscrew any vent hole on the same until the liquid comes out of the vent screw.
- f.** Fill the filler tube (with red cap) to the brim and the expansion tank (with black cap) 2/3 of the way up.
- g.** Tighten [1+2], in order, the pump bleed screw, the bleed screws on the heads and any bleed screw on the heating radiator to the prescribed torque.
- h.** Add coolant to the filler tube up to the brim and hand-tighten both circuit plugs.



If the system consists, even only partially, of rubber material pipes, it is advisable to "pump" the pipes, so as to induce any air bubbles present to exit in the direction of the filling pipe.

75-26-02 Vent

After initial start-up, it is necessary to bleed the cooling system to eliminate any residual air bubbles; operate according to the procedure described below.

- a.** Loosen [2] the vent screws on the heads to eliminate the air accumulated in the cooling circuit; close them again when the liquid gushes out or when the venting is complete.



When carrying out the bleeding operations, be sure to take the utmost caution to avoid burns or burns caused by contact with the coolant.

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- b.** Partially open [2] the water pump vent screw: close it again when the liquid gushes out or when the venting is complete.
- c.** Partially open any vent screw on the passenger compartment heating radiator: close it again when the liquid gushes out or when the venting is complete.
- d.** Partially open the filler cap until you see the liquid coming out of the filler pipe: if you do not see the coolant flowing out, open the filler cap completely; if you see liquid gushing out, tighten it by hand.
- e.** Wait about 15 minutes for the engine and operating fluid to cool down, and then open the filler cap to top up the cooling circuit. If no liquid leaks from the breather screws on the cylinder heads when the engine is hot, unscrew them [2] and then top up from the filler pipe.
- f.** If necessary, also top up the expansion tank.
- g.** Tighten [1+2] to the prescribed torque (6 Nm) the breather screws on the cylinder heads.
- h.** Tighten [1+2] to the prescribed torque (6 Nm) the breather screw on the cooling pump and any screw on the passenger compartment heating radiator.
- i.** Restart the engine and repeat the operations described above after keeping it at about 2500 rpm for about 5 minutes.
- j.** Stop the engine and check for coolant leaks, especially at the radiator and pump connections. If necessary, bleed the system again, repeating the procedure from step **a** to step **i**.
- k.** Use the engine normally. After use, wait for the coolant to cool completely and check the level inside the filler pipe and expansion tank: if necessary, bleed the system again.
- l.** Continue testing after flying until no more filling of the fill tube is required (usually after one or two flights, depending on the system).



Flying before venting the cooling system is extremely dangerous as it can cause the engine to overheat, suddenly and unexpectedly, and cause damage to it and possible seizure.



If the level in the filling pipe is constantly low, it is necessary to bleed the system again, after having carefully checked the absence of leaks from the circuit.



Before each flight, check and if necessary top up the level in the expansion tank: a level that is too low can cause the presence of air bubbles inside the cooling circuit, with consequent overheating.

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75-27-00 Verificaton and Validation



As a passive safety element, the installer should provide warnings and inspection ports that induce checking of the coolant level and the condition of the cooling system piping.



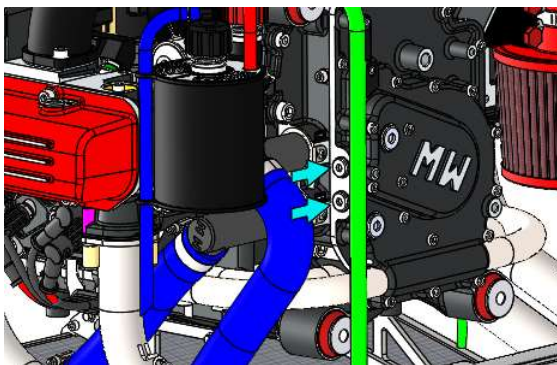
A label with before flight checks to be made and specifications for the cooling fluid is placed on the expansion tank.

Set-up operations of the cooling system should be carried out at first on the ground, so as to avoid an emergency in case there are nonconforming parameters or situations. Only after reaching a certain degree of functional safety of the system should test flights be carried out, for verification of parameters under operating conditions.

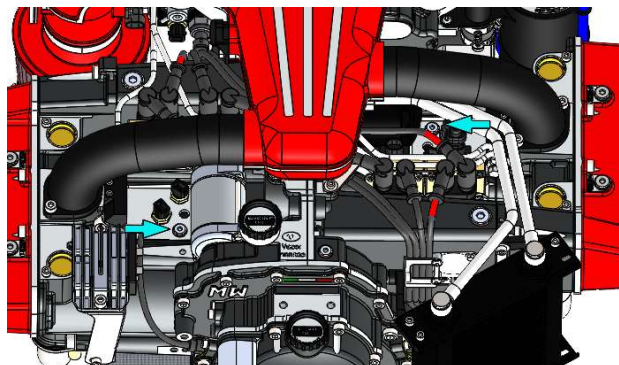
Fine-tuning is mainly concerned with the sizing of the cooling air intake and the subsequent verification, through temperature measurement, of compliance with the operational limits of the system. Another aspect concerns the verification of tightening and the presence of any "hot spots" in the circuit.

75-27-01 Cooling Fluid Temperature Measurement

There are two liquid temperature sensor arrangements on the engine, located at the liquid inlet in each cylinder head, with M12x1.5 threads (75-07-P) and two others with M10x1 threads (75-08-P) at the top of each bank.



75-07-P



75-08-P

During test flights, it is necessary to simultaneously verify the two temperatures, which should not differ by more than 5 °C, and in any case be lower than the maximum allowable temperature under any operating condition. However, the typical operating temperature may vary by a few degrees depending on the installation, i.e., the location and size of the radiator, the cross section of the pipes, the amount of bends

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and fittings in the circuit, and the size and aerodynamic efficiency of the air intake for the radiator.

In case of doubt, dissimilarity of data readings, or particularly complicated circuits, it may be advantageous to use a third and a fourth temperature sensor, placed near the liquid inlet and outlet from the radiator: in this way it is easy to understand what the thermal jump is and thus the effectiveness of the radiator under various flight conditions. In any case, the additional sensors are to be considered for the sole purpose of tuning the system.

In case of the presence of vapor bubbles in the cooling circuit, the reading of the sensors may be distorted, giving incorrect indications of the actual thermal state of the engine, either in excess or in defect of the if real value. To avoid this possibility, before taking the sensor reading and using the engine in flight, it is essential to perform the procedure of purge the circuit of cooling system.

75-27-02 *Relation between Ambient Temperature and Engine Temperature*

It is desirable to perform system tuning under the environmental conditions considered "limit" for aircraft operation. The most severe flight conditions for cooling purposes are obtained by operating as summarized below.

- Maximum ambient operating temperature
- Maximum power applied for maximum allowable time
- Lowest flight speed in relation to applied power

In the case where tests are carried out at ambient temperature below the maximum temperature considered permissible, the refrigerant temperature rise can be calculated from the change in ambient temperature according to the following relation:

$$\Delta T_{h2o} = \Delta T_{amb}$$

This means that each degree increase in ambient temperature produces one degree increase in refrigerant temperature. For example, running the tests at an ambient temperature of 20 °C, and measuring a maximum refrigerant temperature of 90 °C, we can consider that at an ambient temperature of 35 °C, the refrigerant temperature would rise by about 15 °C, reaching 105 °C.

This relation can be applied only from refrigerant temperatures above the maximum thermostat opening temperature. In fact, below that threshold, the efficiency of the radiator is reduced by the thermostat.



However, the maximum temperature achievable under limiting ambient temperature conditions must be verified in reality. The above report is only valid for a rough sizing of the cooling system.

75-27-03 *Verification Test*

To carry out the cooling system tuning, proceed as follows.

- a. Fill and purge the system as described in the maintenance manual

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- b.** Conduct ground tests for about 15 minutes with the engine warm and at various engine speeds: during these operations constantly check the cylinder head temperatures to avoid overheating. If the engine can stay at the correct temperature with a continuous speed of at least 75% of the maximum possible in flight, it is likely that the air intake is well proportioned.
- c.** Turn off the engine and inspect all hot system junction points very carefully, looking for any leaks.
- d.** Tighten any metal clamps holding the fittings until engine is hot.
- e.** With the engine cold, look for any overheating or rubbing points on the pipes; if necessary, make changes to the system.
- f.** When the engine is cold, check the amount of refrigerant fluid inside the expansion tank: if the level is at a minimum (below 20% of total capacity), it is likely that there are leaks in the system or, if the total fluid capacity in the system has changed, that the capacity of the tank itself is inadequate.
- g.** Repeat the above steps until the abnormalities are solved.
- h.** Take the aircraft into the air to check operating conditions, especially during take-off, keeping close to the runway so that emergency landings can be made in case of engine overheating or circuit failure.
- i.** When the engine is cold, recheck the amount of liquid inside the expansion tank to avoid the formation of air bubbles in the cooling circuit.

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76-00-00 ENGINE CONTROLS

76-01-00 Injection and Ignition Module (IJ-m)

Each engine is delivered with the engine harness and the control unit group (hereinafter referred to as IJ-m) wired and tested.



All the branches of the harness are attached to the engine to prevent damage from vibration: if the wiring or any part of it is removed it is necessary to reassemble in exactly the same position so as not to affect safety.

The part of wiring necessary for connection to the instrument panel or to the on-board devices must be made by the installer, following the instructions given in this chapter.

The electrical component installations to be carried out are as follows.

- a.** IJ-m control unit module
- b.** Battery
- c.** Master switch
- d.** Master relay
- e.** Main ECUs switch
- f.** Main injection shutdown switch (kill switch A)
- g.** Auxiliary injection shutdown switch (kill switch B)
- h.** Start button
- i.** Control unit diagnosis warning light A (not necessary when mounting the EM-m instrument)
- j.** Control unit diagnosis warning light B (not necessary when mounting the EM-m instrument)
- k.** Auxiliary pump switch
- l.** FD-m pump unit: alternatively, main fuel pump and auxiliary fuel pump
- m.** Cockpit brakers

An aircraft electrical system built according to a standard scheme guarantees very high safety criteria, as specified below.

- The two ECUs normally operate together and are supervised by the EM-m module which can export the data in the CAN AEROSPACE line and detects any anomalies in the system.
- An auxiliary battery (optional) can be connected to the system from the key switch as an alternative to the main battery, in case of failure of the main battery.
- The capacitor integrated in the IJ-m allows the engine to operate without problems over 1500 rpm and in case of the failure of both batteries since it stabilizes the current produced by the generator.

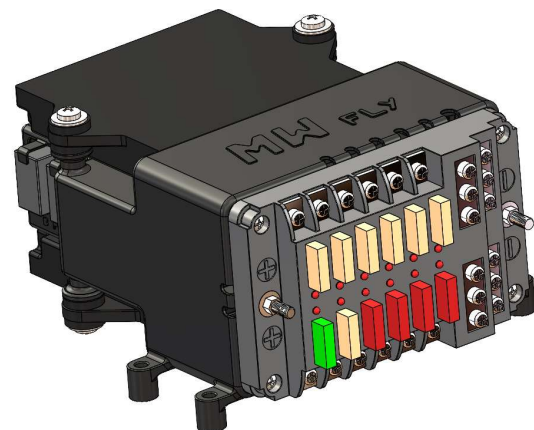
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- The auxiliary fuel pump allows an increase in the safety of the fuel system in critical stages for the flight (take off and landing).
- The fuses pre-installed in the IJ-m, as well as the cabin breakers provided in the diagram, guarantee total protection of the electrical components, allowing the motor to operate with any limitations even in the presence of partial short circuits of the system or its components.

76-01-01 Description

The injection system is kind of semi-phased and uses one injector per cylinder bank; the injection times are calculated on the basis of the power demand (RPM and THROTTLE position) and corrected on the basis on barometric pressure (altitude) and the oil temperature. Furthermore, the injection system also manages the idle and warm up phase conditions of the engine by implementing appropriate injection and ignition control strategies.

The ignition system is inductive discharge and lost spark and controls the advance as a function of rpm and THROTTLE position; this advance value is then corrected as a function of other parameters (intake air temperature and battery voltage), to adapt it to the state of operation of the engine. The engine rpm and the phase are detected by two magnetic captors (one for each ECU), working in parallel, reading the passage of teeth arranged on the fly wheel, fixed directly to the engine crankshaft.



76-01-P

The rpm sensors supply the signal independently, therefore each to a single injection control unit. Each injection control unit is equipped with an output for the diagnostic light, which signals the presence of any system anomalies

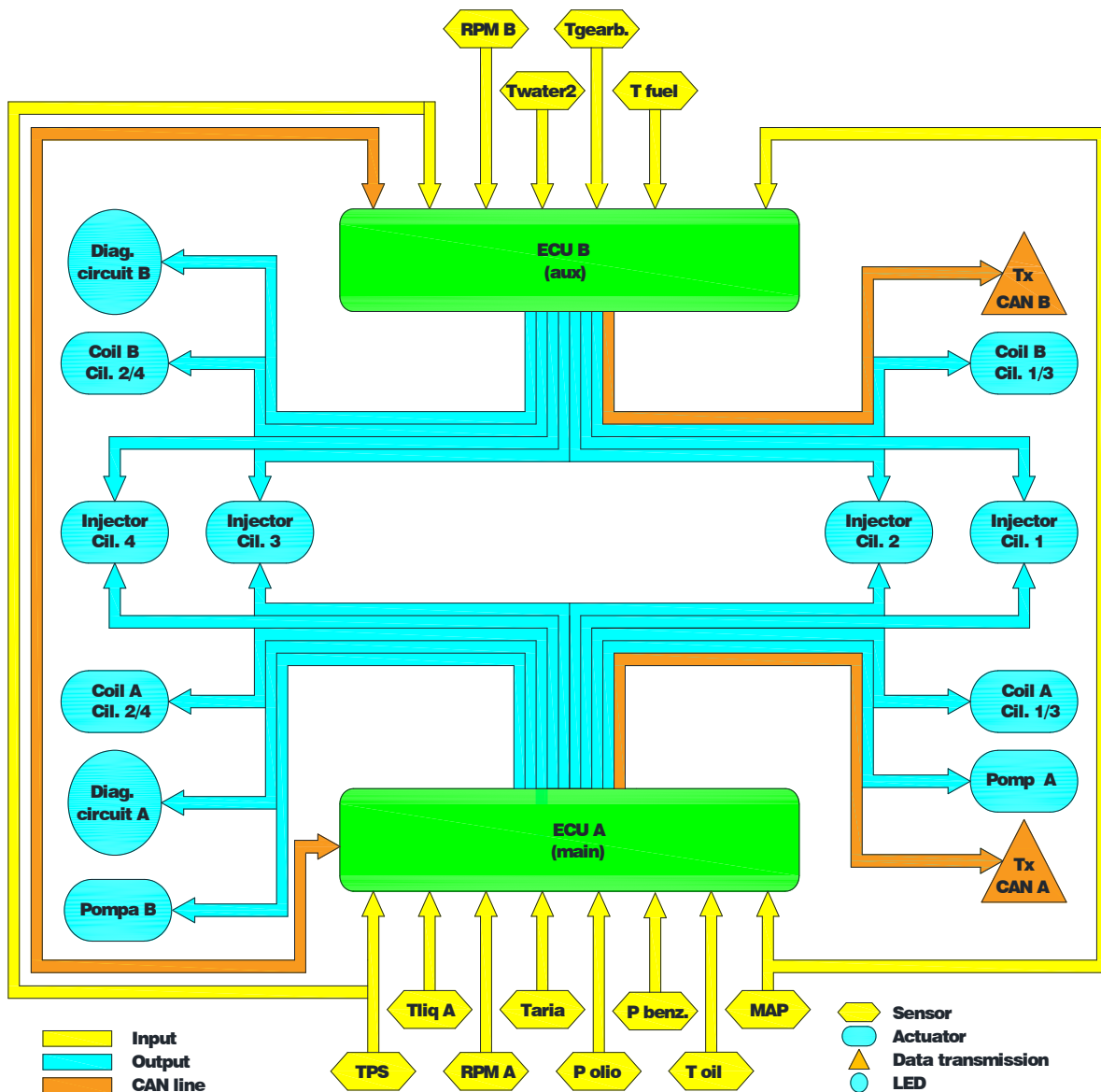


In the event that, during the flight, one of the two diagnostic lights come on, it is essential to land as soon as possible, even if the engine apparently does not show any problems.

The injection and ignition phases are normally controlled by both control units: however, the engine, in the event of a failure of one of the two control units, can also operate without limitations with the remaining control unit, both in the event that the failure concerns the main control unit, both auxiliary control unit. The passage from the standard operating mode with both control units to the emergency mode with a single control unit can take place at any speed and without interruptions in the power supply. With the control unit B, the idle speed is automatically increased by the

injection system to about 1700 rpm, to prevent the involuntary shutdown of the engine in the event of battery disconnection. In this circumstance, the emergency manoeuvre involves switching off the control unit A, to prevent the engine, powered by the generator alone, from accidentally switching off below 1500 rpm.

The following figure shows the functional diagram of the injection system.




76-01-C


Each control unit controls the main fuel pump, which is operated for about 3 seconds when the ignition system is turned on in order to pressurize the fuel system; if the engine does not start the pump turns off, and then it will be switched on as soon as the engine starts; if the engine is shutdown of the engine, even accidentally, the fuel pump is immediately turned off so as to stop sending fuel to the engine. The auxiliary


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fuel pump, in parallel to the main pump, which will be switched on, for safety reasons, in critical conditions of flight (take off and landing)


The injection system is equipped with a data communication CAN line, that can send all the parameters acquired from both control units to a digital instrument (i.e. EFIS, EMS), without adding other sensors.


- 


If it is necessary to carry out welding operations on the aircraft, it is essential to remove the IJ-m from the aircraft, to avoid irreparable damage.
- 

The electrical wiring is made of high-quality material: however, care must be taken in the maintenance, cleaning and washing of the engine.
- 

The advantages offered by injection fuelling, instead of traditional carburettors, are many: there is an improvement in power delivery, consumption, regularity of operation, in the emission of polluting compounds and in weight.
- 

The injection control unit is equipped with a diagnostic function: anomalies or operating conditions that are potentially harmful to the integrity of the engine are recorded in non-labile memory
- 

If the electrical system is built following the diagram provided in this manual, the engine can operate indefinitely at speeds above 1500 rpm even without the battery connected to the electrical system, having previously turned off all other electrical utilities.
- 

The adoption of two rpm sensors is due to redundancy criteria aimed at minimizing the consequences of a possible failure on these components, that are the only truly critical sensors in modern injection systems, together with petrol pumps (which are also double)
- 

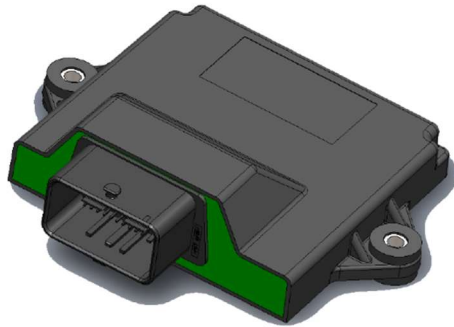
In the event of failure of any sensor other than the rpm sensor (foreseen double), each of the two control units activates the *limp home* mode, which allows the engine to continue to operate without particular limitations. However, in this mode, starting the engine from cold is very difficult. The limp-home mode is indicated by the lighting of the diagnostic lamp.

All the components listed and described below are pre-assembled inside the injection and ignition unit and therefore no action must be performed on them: the description is provided in order to better understand the functions of the system

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76-02-00 Components Features

76-02-01 Injection and Ignition Control Units



76-02-P

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ ECU Dimension ▪ Case protection ▪ Power supply ▪ Maximum absorbed current ▪ Ignition control ▪ Injection control ▪ Type of strategy ▪ Correction on spark advance ▪ Correction on fuel injection time ▪ Additional/optional function ▪ Max temperature without power supply ▪ Max temperature in flight ▪ Minimum temperature in flight ▪ Typical temperature in flight | 144x123.9x35 mm
IP 64
6÷15 V
2 A
mapped, lost spark, and inductive discharge
Mapped semi phased low impedance injector
alfa-n (throttle position-rpm)
air temperature, battery voltage
oil temperature, air temperature, phase, battery voltage
diagnosis, self-mapping, limp-home
85 °C
80 °C
-20 °C
35 °C |
|--|--|

76-02-02 Capacitor

The capacitor regulates the input current to the control unit group, and allows it to work even with the battery disconnected from the electrical system.



76-03-P

- | | |
|--|--------------|
| <ul style="list-style-type: none"> ▪ Type | electrolytic |
|--|--------------|

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▪ Capacitance	22000 µF
▪ Voltage	25 V
▪ Operating temperature	-40÷105 °C
▪ Weight	75 g
▪ Connection	2 for D5 mm ring terminal
▪ Tightening torque	2 Nm

76-02-03 Main Fuel Pump Relay

In the IJ-m group there are two relays, one for each fuel pump. The main fuel pump relay is controlled by the ECUs according to the safety strategy: the pump will be operated for about three seconds to pressurize the fuel system when the ECUs are switched on, and then the fuel pump will be automatically switched off; when the engine starts the pump will be switched on; when the engine stops the pump will stop.

The auxiliary fuel pump is automatically activated by the main control unit only when the fuel pressure drops below 2.5 bar with engine speeds above 1000 RPM.



Automatic control of the auxiliary fuel pump relay is performed by the main control unit alone, which recognizes an emergency condition caused by a significant drop in fuel pressure, and therefore a possible malfunction of the main pump. Following automatic activation of the auxiliary pump, the pilot must activate the procedure indicated in chapter 06.04.07 of the operating manual.

The main fuel pump has the following characteristics.

▪ Type	ON÷OFF
▪ Switching voltage	12 V
▪ Max switching current	20 A
▪ Cycle	>100.000
▪ Operating temperature	-40÷125 °C
▪ Weight	18 g
▪ Coil terminal	2 male faston 4.8 mm
▪ Pole terminal	2 male per faston 4.8 mm

76-02-04 ECUs' relay

The IJ-m group there are two relays, one for each engine control unit. The main ECU relays are controlled by the IGN-SW and provide power to the two ECUs.

Le caratteristiche del componente sono le seguenti.

The main fuel pump has the following characteristics.

▪ Type	ON÷OFF
▪ Switching voltage	12 V
▪ Max switching current	20 A

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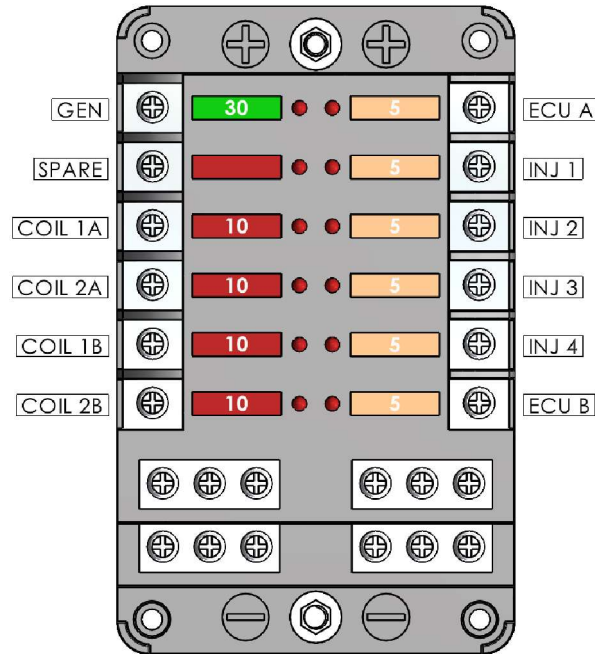
- Cycle >100.000
- Operating temperature -40÷125 °C
- Weight 18 g
- Coil terminal 2 male faston 4.8 mm
- Pole terminal 2 male per faston 4.8 mm

76-02-05 Fuse Box

The fuse box is located outside the control unit group: the box itself is protected by a transparent cover that can be easily removed by acting on the fixing clips on the sides. The fuses housed in the box protect the ignition and injection system, allowing, in the event of an overload of one of the protected components, all the others to continue operating. A led located near each fuse lights up in the event of its interruption, simplifying troubleshooting.

The following figure shows the value of each fuse and the attribution to the component it protects, the meaning of which is as follows.

Funtion	Value [A]
GEN = generatot	30
ECU B = ECU circuit B	5
COIL 1A = coil #1 ignition circuit A	10
COIL 2A = coil #2 ignition circuit A	10
COIL 1B = coil #1 ignition circuit B	10
COIL 2B = coil #2 ignition circuit B	10
WG = Waste Gate turbocharger	5
ECU A = ECU circuit A	5
INJ 1 = injector #1	5
INJ 2 = injector #2	5
INJ 3 = injector #3	5
INJ 4 = injector #4	5



76-04-P

- | | |
|---|--|
| <ul style="list-style-type: none"> ▪ Fuses type ▪ Number of positions ▪ Contact width ▪ Max voltage | <p>Lamellar
12
5,2 mm
32 V</p> |
|---|--|

76-03-00 Components Required for the Electrical System

76-03-01 Battery

- | | | | | | | | | | |
|---|--|-----|-------|---------|-------|-----|-------|-----|-------|
| <ul style="list-style-type: none"> ▪ Capacity ▪ Peack corrent | <table style="border: none;"> <tr> <td style="padding-right: 10px;">min</td> <td>12 Ah</td> </tr> <tr> <td style="padding-right: 10px;">typical</td> <td>16 Ah</td> </tr> <tr> <td style="padding-right: 10px;">min</td> <td>100 A</td> </tr> <tr> <td style="padding-right: 10px;">max</td> <td>300 A</td> </tr> </table> | min | 12 Ah | typical | 16 Ah | min | 100 A | max | 300 A |
| min | 12 Ah | | | | | | | | |
| typical | 16 Ah | | | | | | | | |
| min | 100 A | | | | | | | | |
| max | 300 A | | | | | | | | |

It is recommended to use solid dielectric (gel), maintenance free batteries.



The minimum recommended capacity is that which guarantees an operating autonomy of the engine of at least 10 minutes (with all accessory utilities off), in case of generator failure and with the battery in perfect working order.



The battery must be installed as close as possible to the engine, using cables of adequate section and high-quality crimping: otherwise the performance of the starter and generator could be significantly reduced.

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76-03-02 IGN Switch

The IGN switch it is responsible for giving consent to the two relays for turning on the control units. This switch may be a toggle switch.

The minimum characteristics of the switch must be the following.

- | | |
|-------------------------------|-----------------------|
| ▪ Switch operation | On-Off with retention |
| ▪ Contact voltage DC | 12 V |
| ▪ Contact current | 15 A |
| ▪ Number of cycles | >10.000 |
| ▪ Operating temperature range | -30÷65 °C |



The use of a switch with a safety guard is recommended, as an involuntary actuation of the switch in flight could cause an unwanted shutdown of the engine.

76-03-03 Toggle Switch

For the ECUs and for the auxiliary fuel pump, use a toggle switch with the following characteristics.

- | | |
|--------------------|---------------|
| ▪ Switch operation | ON÷ON, S DPDT |
| ▪ Contact voltage | 12 V |
| ▪ Contact current | 15 A |
| ▪ Switch terminals | Screws D5 mm |
| ▪ Number of cycles | >10.000 |

The connections of the two poles are identical (parallel connection): the adoption of the double pole improves passive safety installation.



The use of a switch with a safety guard is recommended, as an involuntary actuation of the switch in flight could cause an unwanted shutdown of the engine.

76-03-04 Cabin breakers

The breakers that according to the diagrams A-76-01-C and A-76-02-C are to be installed in the cabin, must have the following characteristics.

- | | |
|-------------------------------|-----------|
| ▪ Nominal voltage | 12 V |
| ▪ Contact current | 10 A |
| ▪ Operating temperature range | -20÷60 °C |
| ▪ Number of cycle | >6.000 |

76-04-00 Making the Wiring

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Each powertrain is delivered with the engine harness mounted and secured. The wiring part for connection to the instrument panel or to the on-board equipment must be made by the installer, following the diagram and instructions below. The diagram also indicates the fuses and breakers to be added to the system, in addition to those already included in the IJ-m.



From the following aircraft wiring diagrams, find the one that best suits your engine and electrical system configuration. The following wiring diagrams are for a engines without variable pitch and only with CC-m (76-03-C), for a engines without variable pitch and with EM-m (76-04-C), for a engines with variable pitch with PGM display and CC-m (76-05-C), and finally for a engines with variable pitch and EM-m (76-06-C). For other configurations, contact MWfly or authorized service centers.

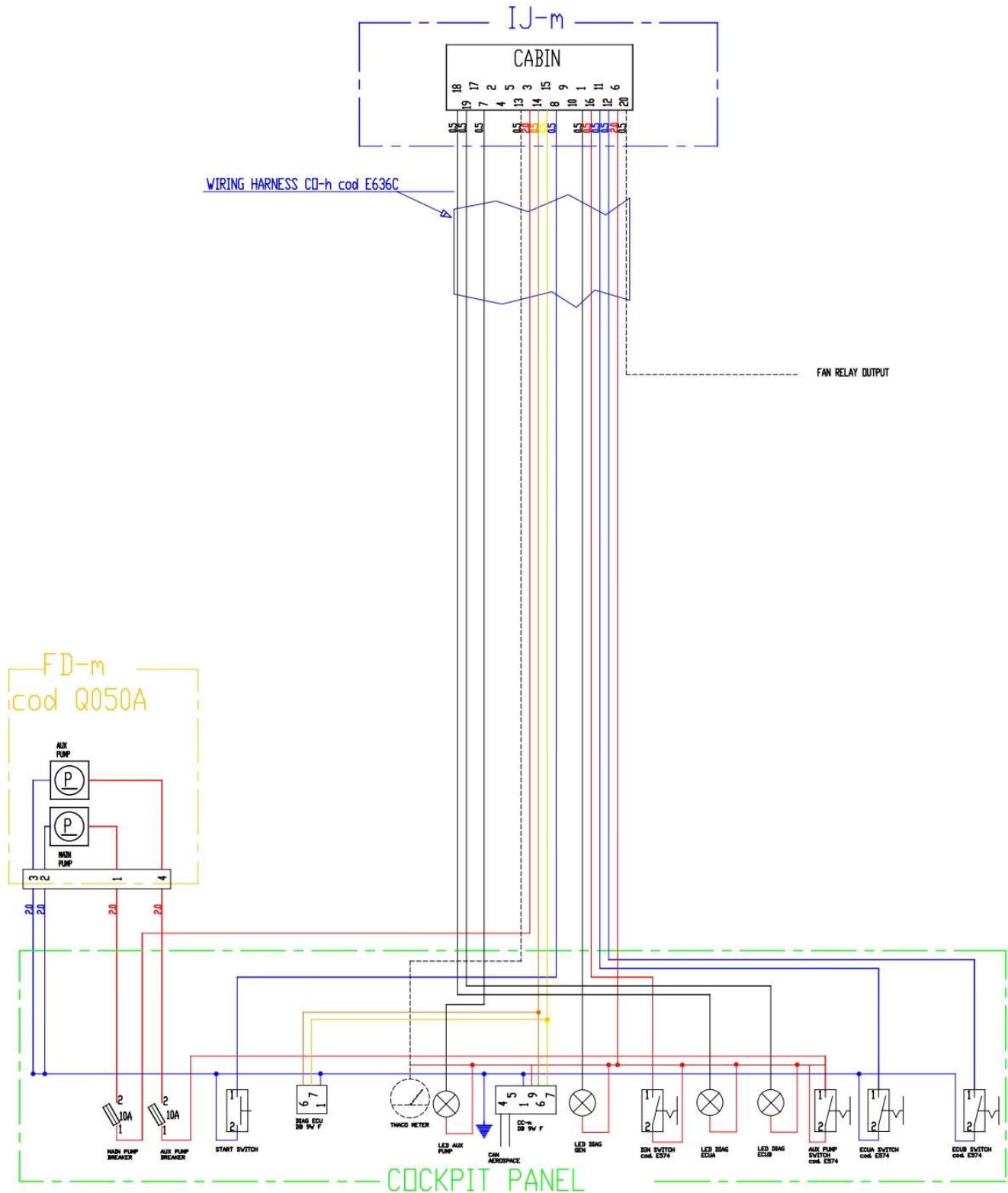


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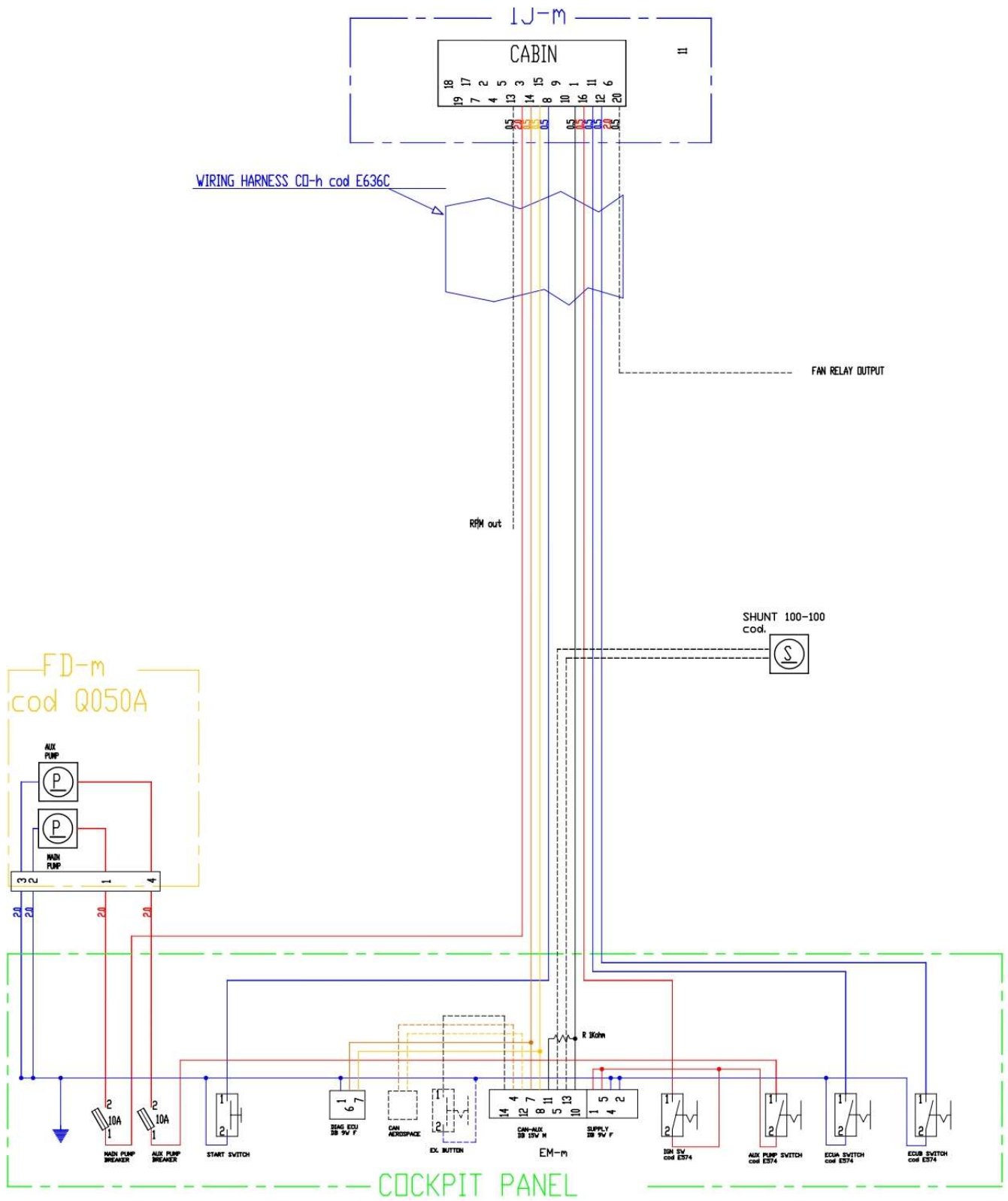
76-03-C cablaggio con C2C V4.2



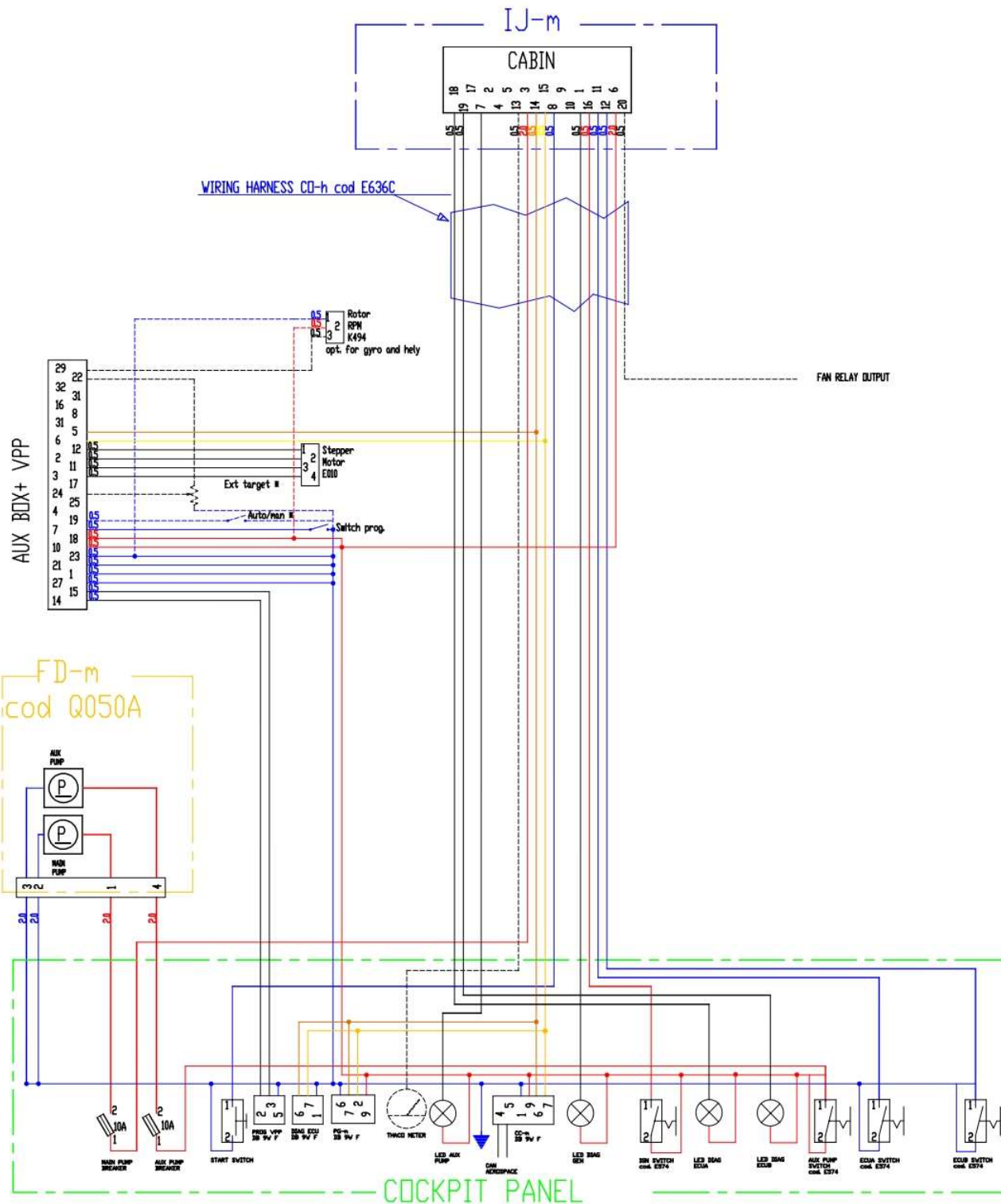
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76-04-C Cablaggio con EM-m V4.1



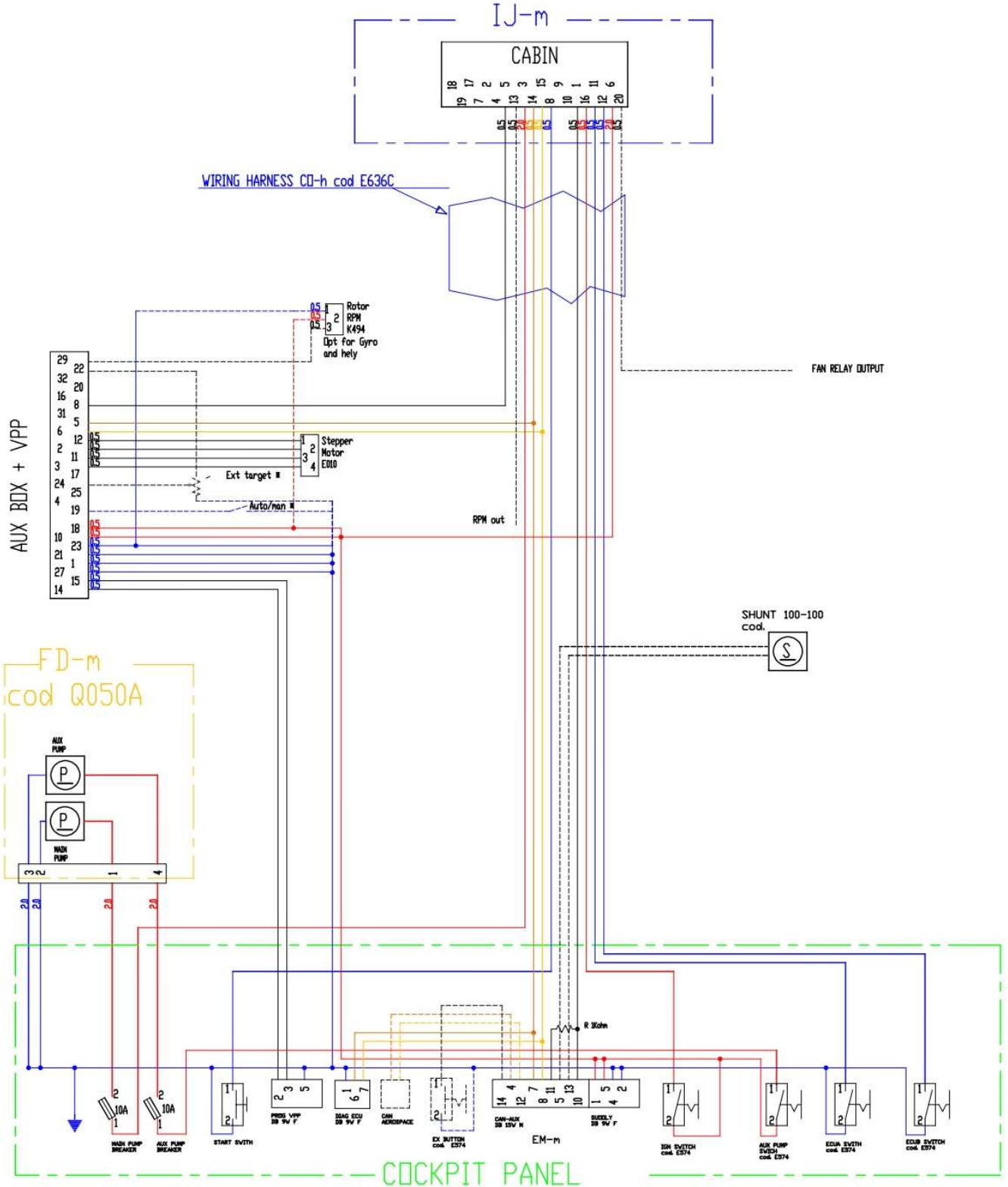
76-05-C Cablaggio con PG-m e C2C V4.1



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76-06-C Cablaggio con EM-m e VPP V4.1

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The installation of the electrical system must be performed by personnel with specific skills and prepared for the purpose: to avoid improvisation.



Failure to comply, even partially, with one of the wiring diagrams shown in figure 76-03-C, 76-04-C, 76-05-C or 76-06-C causes a potential risk of fire, serious damage, or unwanted shutdown of the engine, and causes the revocation of all warranty.

The aircraft wiring must be suitably fixed, in order to prevent excessive mechanical stresses due to vibrations, interference with the controls; avoid, in case of excessive length, to roll up the wiring on itself; also avoid passing near hot spots (exhaust system).



Most of the failures of electronic systems derive from failures in the wiring harness: it is therefore necessary to take the utmost care in installing the wiring.

Referring to diagrams 76-03-C, 76-04-C, 76-05-C and 76-06-C, make the aircraft wiring as per the following tables, each of which shows the assignment of the contacts (pin-out) to the specified connector.

CABIN Connector on IJ-m (E636A Harness) V.4.1			
# pin	Description	Wire dimension [mm ²]	note
1	Spia generatore	0.5	
2	N.C.		
3	Vbatt main pump	1.5	
4	N.C.		
5	N.C.		
6	Vbatt. Aux pump.	1.5	
7	Auxpump control light	0.5	
8	Start relay	0.5	
9	N.C.		
10	N.C.		
11	Kill switch ECU A	0.5	
12	Kill switch ECU B	0.5	
13	RPM out	0.5	4 pulse/RPM
14	CAN +	0.5	
15	CAN -	0.5	

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16	ING-SWITCH	0.5	
17	N.C.		
18	ECUA diag.	0.5	
19	ECUB diag.	0.5	
20	Fun output	0.5	

76-07-C



Connect the battery after completing and checking the entire electrical harness.

76-05-00 Installation and Connection of Components

76-05-01 Preparation of Cockpit Panel

Create the instrument panel by installing the components necessary for the engine electrical system, as shown below.

- a.** Toggle switch for ignition control unit 1 and 2
- b.** Toggle switch ON-OFF to switch off ECU A (Kill switch 1)
- c.** Toggle switch ON-OFF to switch off ECU B (Kill switch 2)
- d.** Toggle switch ON-OFF for auxiliary fuel pump
- e.** Pushbutton for engine start (Start switch)
- f.** LED for diagnosis ECU A (version without EM-m)
- g.** LED for diagnosis ECU A (version without EM-m)
- h.** LED for emergency strategy of AUX PUMP
- i.** Breaker 10 A for main fuel pump
- j.** Breaker 10 A for main fuel pump

76-05-02 IJ-m

Evaluate where to place the control unit group inside the aircraft or, alternatively, on the firewall: in the second case, consider that the control unit group must not be exposed to any splashes of water, nor to the heat from the exhaust system.

It is important to maintain the accessibility necessary to check or eventually replace the fuses and to easily remove the upper connector, called "Cabin".

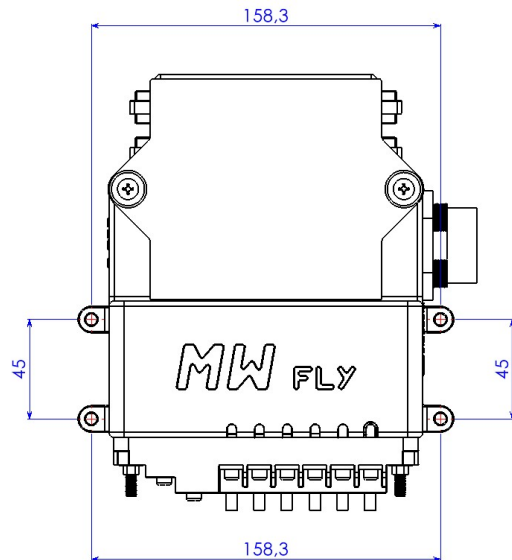
Also consider where to fix the flying connector with flanging and nut, called "Engine", which comes out from the lower side of the IJ-m to the firewall: check that this position does not correspond, in the engine compartment, to particularly hot points (proximity of the muffler), to avoid subjecting the counterpart connector to excessive heat.



Give preference to a horizontal position installation of the IJ-m.

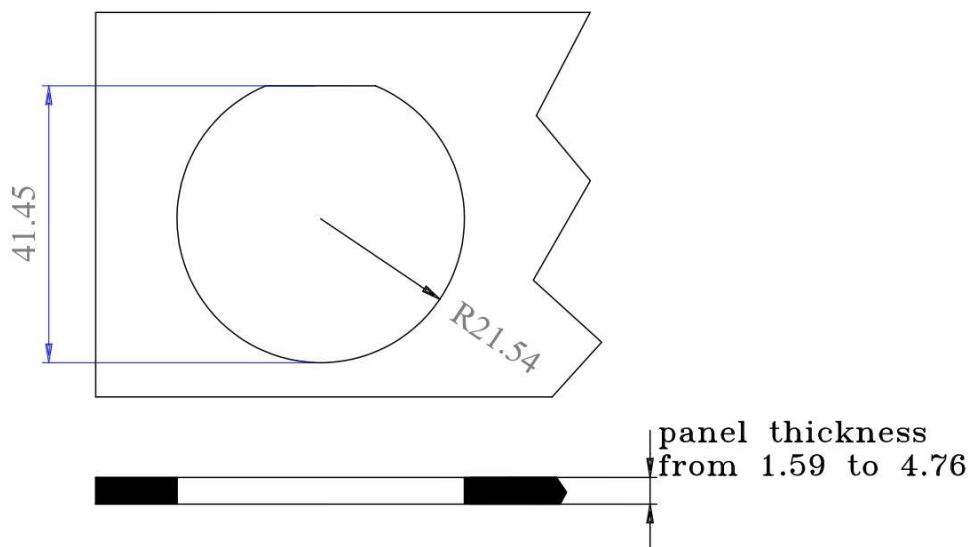
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- a.** Drill four holes on the flame arrester with a 5.5mm bit, respecting the measurements shown in the following figure.



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- b.** Fix the control unit group using 4 screws with their corresponding under-head washers and nuts; in case of difficulty in accessing the rear part of the chosen support surface, it is possible to use threaded inserts for fixing.
- c.** In the case the IJ group is installed inside the cabin drill the firewall as show in the following picture and fix the flying connector "Engine", securing it with the nut supplied.



76-06-P

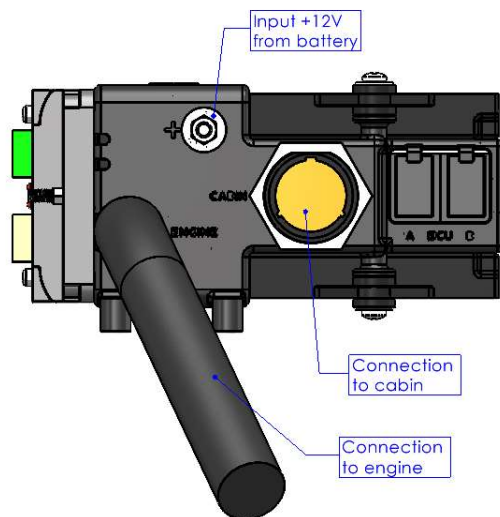
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For all other IJ group installations, create a panel anchored to the aircraft frame and prepared with a hole for the "engine" connector.

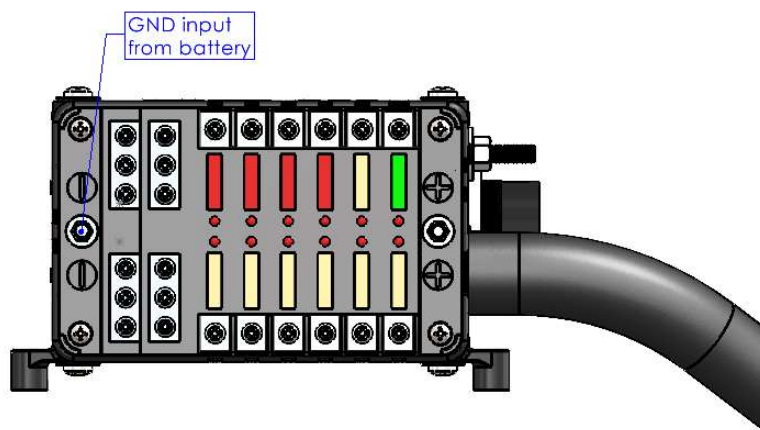


Do not leave the "engine" connector loose as the vibrations could cause the wires to tear from the terminals.

- d. Connect the counterpart connector from the engine wiring from inside the engine compartment, engaging the ring nut until the safety lock is felt.
- e. A circular connector is fixed on the control unit group, which must be connected to the aircraft wiring: this connector is marked with the wording "CABIN".



76-07-P



76-08-P

- f. Connect the positive cable coming from the battery to stud screw M6 marked with the word "Batt": tighten with M6 nut at 8Nm using a safety washer to be placed between the cable lug and the nut.

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- g.** Connect the ground cable to the terminal marked with the symbol "-" on the fuse box: the M5 screw must be tightened to 4Nm and secured with a safety washer.



For safety reasons it is advisable to connect a second ground cable to any of the unused screws located on the right side of the fuse box.

Cable Dimensions Table for IJ-m			
	<i>Connettor/connection</i>	<i>Cable dimension [mm²]</i>	<i>note</i>
1	Cabian connector		See table 24-04-C
4	12 V from battery	4	
6	GND input	4	

76-08-C

76-05-03 Battery

The engine is able to start and run with batteries having a minimum start current of 150 A. However, it is recommended to use batteries with a start current of at least 250 A. This also has higher capabilities to provide better reserve of charges.

The installation of the battery should be done in the following manner.

- a.** Place the battery closet for the engine paying particular attention to the balance of the aircraft.
- b.** Fix the battery in a steady and safe manner and avoid vibrational stress.
- c.** Connect the GND cable and VBATT+ cable using a big section cable at least of 25 mm², or bigger in case the cables are longer than 1 meter.
- d.** Clean the battery clamps and remove any trace of oxidation. Attach the cable to the battery clamps and tighten enough to avoid any loosening. Periodically check if there is sign of oxidation on the battery clamps indicating that the contacts are too loose and that they need to be tightened.
- e.** Spread the battery clamps with anti-acid grease to maintain a good electrical connection.
- f.** In case the engine is used in cold weather conditions, use battery with high cranking current.
- g.** In case of use of the engine in hot weather condition, use power cable with bigger section size.

It is very important to maintain the battery in good condition to enable quick engine starts and steady working conditions of the engine's electronic components.

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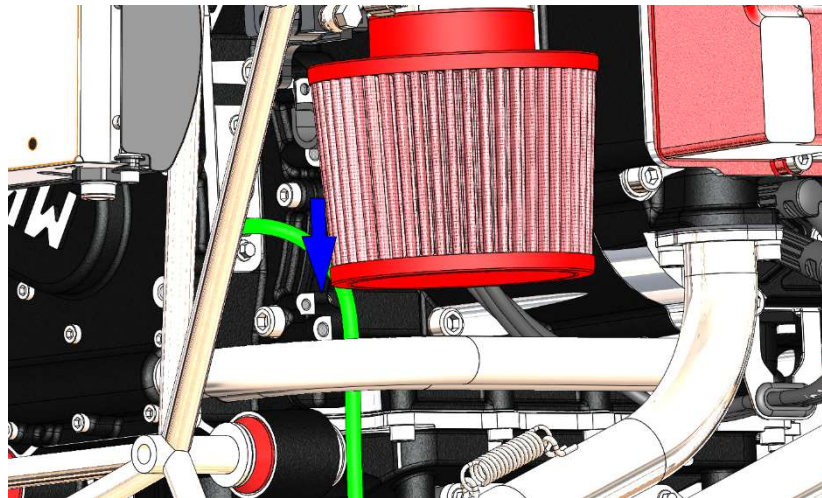
In case of installation of the battery far away from the engine it is necessary to use a cable with bigger section size: an incorrect dimension of the power cable can cause overheating of the cable and fire.



Connections made with cables of inadequate gauge or with screws not tightened properly can cause difficulty in starts and produce electromagnetic interference.

76-05-04 Engine GND

The points provided for the connection of the engine ground are two screws highlighted in the following figure, present in the lower rear part, bank side # 1: you can choose to connect the ground cable with a screw M8x1.25 (eyelet D8), or with one screw M6x1 (eyelet D6). The tightening torque of the screw is respectively 22 Nm or 12 Nm. It is advisable to use a cable as short as possible coming from the frame mass and with a section of not less than 17 mm² (AWG 5).



76-09-P



It is recommended to make two connections to ground the engine, using both positions indicated.



Connect the engine to ground is essential as the anti-vibration engine suspension system completely electrically isolate the engine from the aircraft ground.

76-05-05 Starter System

Refer to paragraph 80-10-04.

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76-06-00 Verification and Validation

The electronic injection and ignition system are optimized to operate in any climatic and operating condition of the engine: this applies if the engine is installed according to the criteria described in this manual and with the original exhaust system. In this case it is only necessary to check the operating temperature of the IJ-m if it is located inside the engine compartment; the placement in the cabin does not normally present problems related to temperature.

If aerodynamic space constraints force installations in which some components of the engine are moved or modified (for example the exhaust system), it is necessary to remap the injection control unit. The tuning is carried out by installing a proportional lambda probe on the silencer: it is therefore necessary to prepare a suitable hole on the silencer, with M18x1.5 thread, positioned near the exhaust pipe (after the confluence of the four manifolds in the muffler).



Using the engine with an improperly calibrated injection system can cause lower performance, irregular operation or shutdown under certain conditions of use.



In the event that the length or arrangement of the intake or exhaust manifolds or the volume of the silencer has been modified, it is mandatory to re-map the control unit.

Any anomalies in the injection system are highlighted by the ECU light coming on the EM-m instrument or by the diagnostic lights.

76-06-01 *Measurement of the Operating Temperature of the Injection Control Unit*



The measurement of the operating temperature of the injection control units must be carried out only if they are located inside the engine compartment.

After installing the engine, check the temperature of the injection control unit by applying an irreversible liquid crystal thermometer as shown in the figure.

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Normally the maximum temperature is reached immediately after the engine is turned off, when the heat accumulated during operation rises upwards.

If the temperature exceeds the limit value, it is necessary to improve ventilation in the engine compartment and heat dissipation, by opening one or more air intakes on the hood, preferably in the upper part.



Using the engine with injection control unit temperatures higher than the maximum allowed can cause it to stop suddenly and cause irreversible damage to the control unit itself.

The control unit temperature measurement must be carried out as follows.

- a.** Carry out the test with air temperature above 25 ° C.
- b.** With the hood fully assembled, start the engine on the ground and, after warming it up, bring it to 3500 rpm for about 5 minutes at a fixed point.
- c.** Switch off the engine and the injection control unit and wait at least 15 minutes.
- d.** Check the temperature marked by the thermometer without turning the control unit back on.
- e.** Replace the thermometer, keeping the removed one for comparison. If the temperature is below the maximum limit, carry out a test flight lasting 10 ÷ 15 minutes and, after landing and having waited at least 15 minutes from switching off the engine, take a new reading.
- f.** If the reading indicates a temperature below the limit, it is possible to fly, keeping the thermometer in position and checking the temperature during flights on particularly hot days.
- g.** In the event that the temperature on the ground or in flight exceeds the limits, do not use the engine without first modifying the canopy in such a way as to decrease the temperature on the injection control unit.



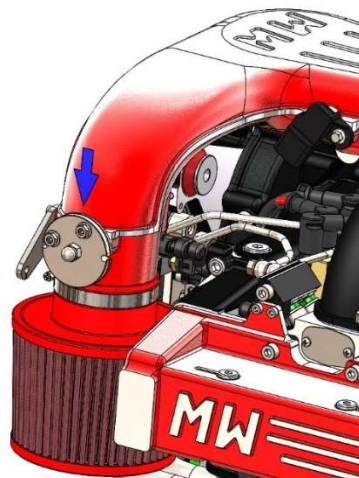
If the limit has been exceeded for values above 15 ° C, the injection control unit must be checked before using it again.

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76-10-00 Throttle Control

On the intake system, above the air filter, there is the throttle valve control cam and the stop bracket for the actuation Bowden cable.

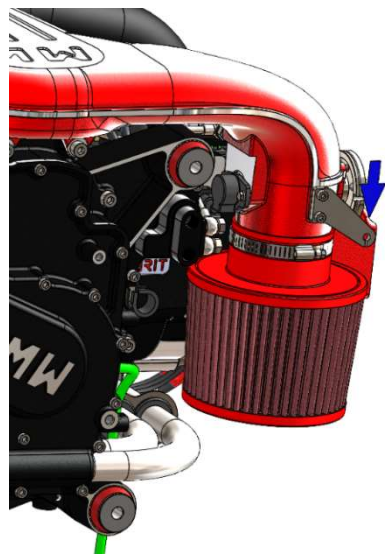
76-10-01 Description



76-11-P

The minimum and maximum position of the cam can be adjusted by means of two dowels placed on the side of the cam itself: these adjusters are set by the factory and therefore, initially, it is not necessary to make any adjustments.

The adjustment of the stroke of the control cable can be performed using a threaded register with double M6 nut for anchoring the cable itself to the striker bracket.



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Two interconnected springs present on the throttle control cams bring the throttle in the open position: take account of this for the realization of the throttle control.

76-10-02 Cable Features

During installation it is only necessary to connect the lever positioned in the cabin to the control cam on the engine via a Bowden cable, considering the characteristics indicated below.

▪ Control cable material	stainless steel
▪ Section of the control cable	D1,2 mm
▪ Minimal tear strength	800 N
▪ Cable clamp seat diameter on throttle cam	5,5 mm
▪ Diameter for screw register on stop bracket	6 mm
▪ Sheath material	polyethylene
▪ Minimum radius of curvature	150 mm
▪ Total stroke of the cable	~35 mm
▪ Total load on the cable	~55 N
▪ Total throttle spring torque	0,37 Nm

76-10-03 Command Implementation

The throttle control is equipped with return springs, which reset the throttle to the fully open position. Take this particularity into account when setting up the control.



This feature allows, in the event of a break in the throttle control cable, to keep the engine running at maximum power in order to manage the emergency in the best possible way.



For particular applications, the accelerator control is available with return springs that close the throttle.

The installation of the throttle control must be done in accordance with what is prescribed below.

Necessary Materials

1. Nylon hose clamps
2. Shears
3. Hard metal file
4. Crimping tool for 6 mm diameter
5. Other tools depending on the materials chosen during installation

- a.** Secure the sheath of the main branch to the engine mount or to the frame using appropriate clamps [1] that do not compress the sheath, to avoid vibration during use.

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- b.** Check that the cable does not contact or pass by hot spots in the engine or engine compartment; also check that the sheath does not come in contact with abrasive or sharp surfaces.
- c.** Mount [5] on the striker bracket on the power unit a screw adjuster, for fine adjustment of the cable travel.
- d.** Take the measurement of the length of the control cable and the sheath: the length of the cable must allow the throttles (throttle cams to be fully closed and opened).
- e.** Pull the sheath off the cable.
- f.** With the shears [2] cut the cable and sheath to length.
- g.** Carefully check that the coil spring present in the sheath has no sharp inward edges that could damage the cable during sliding: if necessary, eliminate these edges with a file [3] or a grinding wheel, having first protected the sheath from the ingress of the dust that will be produced.
- h.** Insert the lug on the cut end of the sheath and crimp it [4] to the sheath.
- i.** Reinsert the sheath onto the cable.
- j.** Fit the cable retainer provided on the cable on the throttle control cam side and tighten [5].
- k.** Insert the cable into the control lever.
- l.** Push the control carefully to the intended end of travel or to the position you wish to have at full power.
- m.** Tighten [5] the control cable to the lever with the intended system (by the installer).
- n.** Move the lever back until the throttles are brought to a closed stop: at this position, the throttle lever end stop must be secured so that the throttle cable is not pulled beyond the end stop.



If you do not set a limit switch on the accelerator control lever, in addition to putting excessive strain on the cable, you can cause the throttle to block, making it impossible for the engine to reach the power necessary for flight.

- o.** Operate the throttle lever repeatedly between the maximum and minimum open positions, and check that there is no snagging or excessive strain in the control. Also check that the closing and opening end-stroke occurs correctly. Any minor stroke corrections are possible by acting [5] on the screw adjuster.
- p.** When the thruster is first turned on, check that in cable is not pulled or otherwise stressed as a result of vibration due to operation.
- q.** Move the lever back until the throttles are fully closed: in correspondence with this position it is necessary to fix the stroke end of the throttle lever, so as not to stress the traction throttle cable over the stroke end.

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Once the check on the throttle cable actuation is complete, it is a good idea to provide for welding the clamping nipples to the cable to prevent unwanted loosening.

It is appropriate for the lever to be equipped with a friction mechanism, possibly adjustable, that can counteract and restrain the action of the return springs mounted on the throttle actuation cams. The springs installed on the thruster return the control to the open position in the absence of pull on the actuating cam.

Make sure that the closing end stop of the throttle lever located in the cabin (idle) coincides with the end stop of the throttle control cam. This precaution is necessary to prevent the cable from being subjected to excessive pull in the open end-of-stroke condition.

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77-00-00 ENGINE INDICATING

77-01-00 Sensors

Standard Sensors

Each engine has a preassembled set of sensors, as detailed below.

- Main control unit motor revolutions
- Auxiliary power unit motor revolutions
- Bank #1 liquid temperature
- Bank #2 liquid temperature
- Engine oil temperature
- Intake air temperature
- Fuel temperature
- Gearbox oil temperature (engine with PSRU)
- Manifold air pressure (MAP)
- Oil pressure sensor
- Fuel pressure sensor
- Throttle position sensor

The characteristics of the sensors provided in the standard equipment are given in the following sections of this chapter.

Additional Sensors

The engine is prepared for the installation of additional sensors than those provided in the standard equipment. Some of the sensors below are also present in the standard equipment (highlighted in bold): in the case it is not possible to use the CAN data export line of the injection system, it is mandatory to use the provisions to install additional sensors, as it is not possible to split the signal of the standard sensors present.

- **Engine oil temperature**
- **Bank #1 liquid temperature**
- **Bank #2 liquid temperature**
- **Intake air temperature**
- **Gearbox oil temperature**
- **Fuel temperature**
- **Manifold air pressure (MAP)**
- **Engine oil pressure (sensor)**
- **Fuel pressure**
- Lambda sensor

The characteristics of the sensors are provided in the following sections of this chapter.



Installation operations should be carried out with the engine cold and switched off.

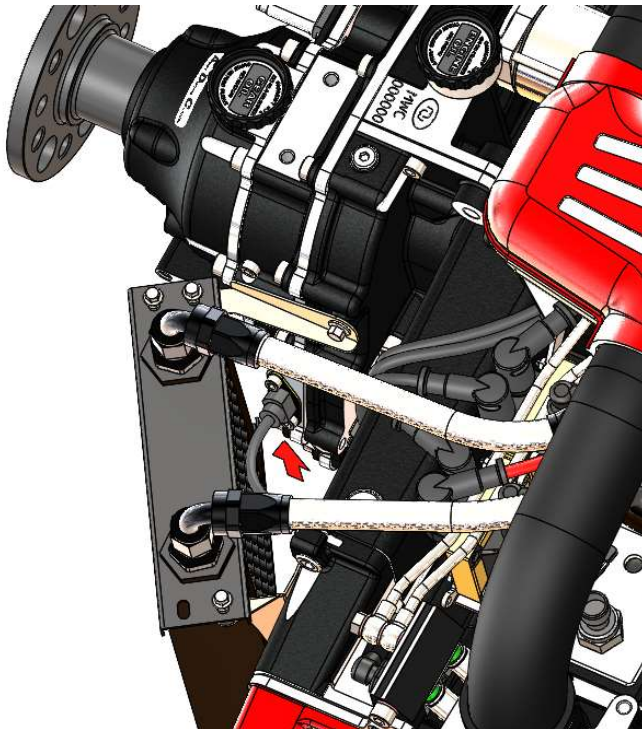


Under no circumstances should the mounting of the instrumentation interfere with the engine wiring: therefore, do not make any connections, shunts, or modifications to the engine wiring, as it will likely affect the reliability and safety of the installation.

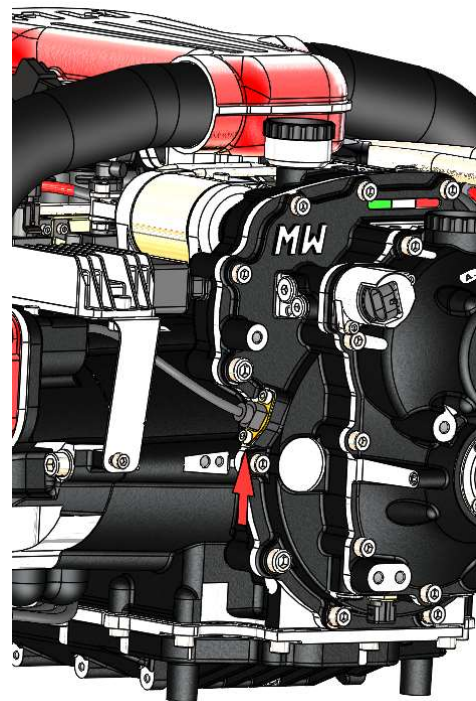
77-01-01 Rev Counter Signal

Standard Sensor Position

Two rpm captors are installed on each engine, each sending the signal to one of the two injection units. Both are installed on the gearbox (or on the front cover for direct engines): the primary captor is installed on the #2 bank side, behind the oil cooler; the secondary captor is installed symmetrically, on the #1 bank side.



77-01-P



77-02-P

The signal provided by these sensors is processed by the injection control units and made available on the CAN line.



The preinstalled engine RPM sensors must not under any circumstances be removed, nor should their signal be intercepted to send it to a measuring instrument, as this would alter the value, causing malfunctions in the engine.

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In case the EM-m instrument or an instrument equipped with CAN Aerospace input is used, the engine revolutions are provided by the preinstalled sensors, and therefore no additional sensor needs to be installed.

Provision for Additional Sensor

For analog type instruments or otherwise not equipped with CAN input, the rev signal can be read directly from the rev signal output of the ECU assembly, referring to the diagram in this manual.

Signal Characteristics

The characteristics of the engine speed signal output from the ECU are as follows:

- Signal output type grounding switch
- Frequency 4 pulses per round



Check with the manufacturer of the engine RPM display instrument for signal compatibility with the instrument itself. For some instruments it may be necessary to insert an appropriate pull-up resistor between the signal and the 12V battery or between signal and a VREF output of the instrument itself.

Installation

To handle this data correctly, proceed as follows.

- a.** Insert into the counterpart of the Cabin connector on IJ-m the contact for the engine RPM signal at connector position 13.
- b.** Crimp the contact to the opposite side of the contact, together with another piece of cable: insert the contact into the connector.
- c.** If necessary, insert pull-up resistor as required by the manufacturer of the instrument in use.
- d.** Make all the remaining connections provided for connecting the chosen instrument to the system.
- e.** Turn on the engine and check the consistency of the value read on the instrument over the entire engine speed range.



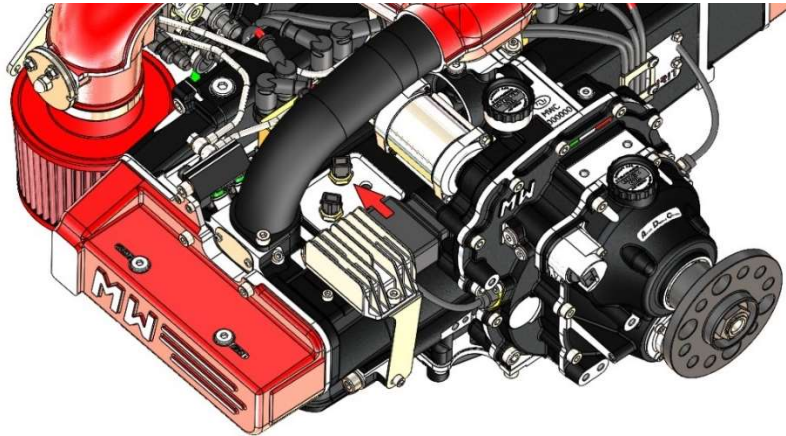
Avoid picking up the engine RPM signal any other way: in addition to getting a dirty signal, you risk interfering with the ignition system and damaging the injection control unit.

77-01-02 *Coolant Temperature Sensor*

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Standard Sensor Position

Two coolant temperature sensors are installed on each engine, one on each bank: at that location the sensors measure the temperature coming out of the engine heads.



77-03-P



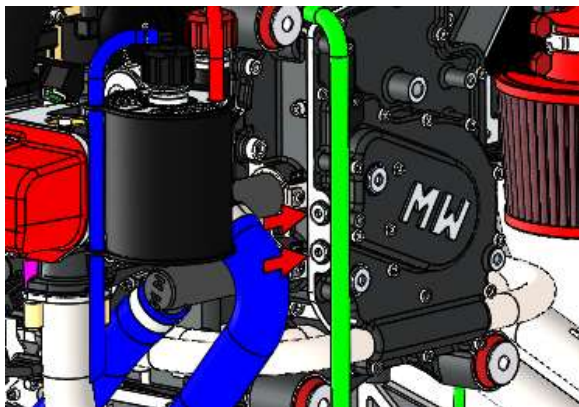
The preinstalled liquid temperature sensors must not under any circumstances be removed, nor should their signal be tapped to send it to a measuring instrument, as this would alter the value, causing malfunctions in the engine.



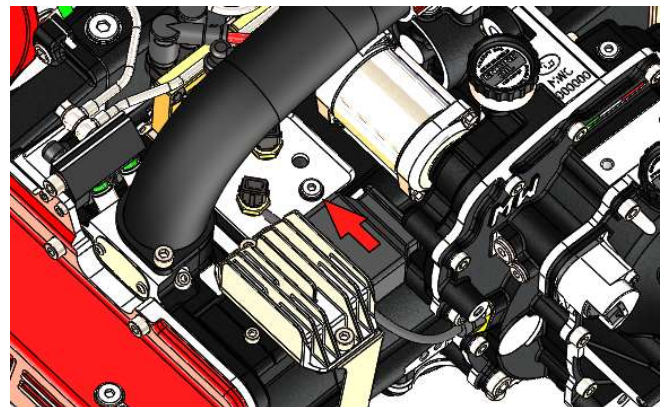
In case the EM-m instrument or an instrument with CAN Aerospace input is used, the coolant temperature is provided by the preinstalled sensors, and therefore no additional sensor needs to be installed.

Provision for Additional Sensor

Provision for mounting an additional sensor is available on rear cover (77-04-P) , or on both banks, near the standard sensor.



77-04-P



77-05-P

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Sensor Characteristics

The characteristics of the standard sensor are as follows.

- Type resistive (NTC) with isolated ground
- Measuring range -30÷150 °C
- Mounting thread M12x1.5
- Resistance to chemicals inert to prolonged contact with ethylene glycol

The minimum characteristics of the additional sensor are as follows.

- Type resistive (NTC) with isolated or separate
- Measuring range 50÷120 °C
- Mounting M12x1,5 on rear cover
M10x1 on crank case
- Resistance to chemicals inert to prolonged contact with ethylene glycol

Installation

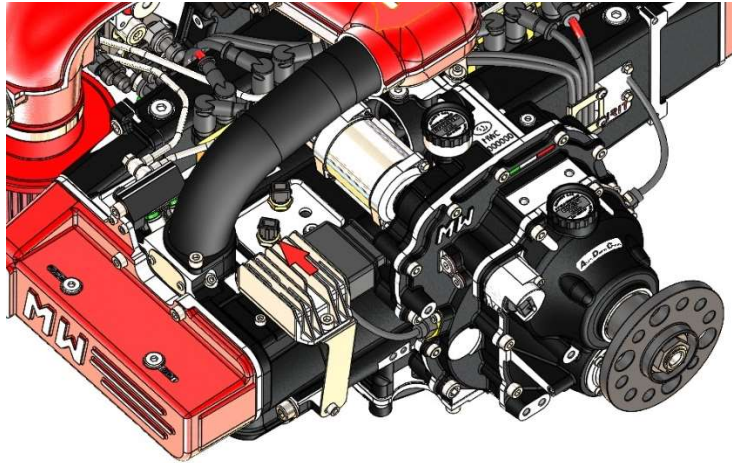
The installation of the sensors should be done as follows.

- a.** Remove the intake system.
- b.** Drain the cooling system.
- c.** Remove the cups on rear cover, or the M10x1 plug from the predisposition holes on both banks; also remove the copper gasket.
- d.** Install the sensor in the pre-drilled hole, interposing the prescribed gasket; weak threadlocker is recommended on the threads.
- e.** Tighten to the torque prescribed by the sensor manufacturer.
- f.** Connect the connector provided to the sensor.
- g.** Refill the cooling system.
- h.** Reinstall the intake system.

77-01-03 Engine Oil Temperature Sensor

Standard Sensor Position

An engine oil temperature sensor is installed on the #1 bank of the engine: in this position, the sensor detects the oil temperature on the sending channel to the cylinder head.



77-06-P

A

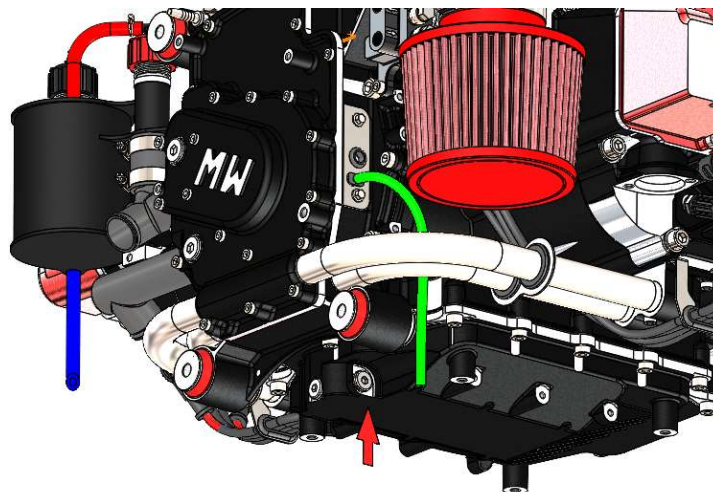
The preinstalled engine oil temperature sensor must not under any circumstances be removed, nor should its signal be tapped to send it to a measuring instrument, as this would alter its value, causing malfunctions in the engine.

i

In case the EM-m instrument or an instrument with CAN Aerospace input is used, the engine oil temperature is provided by the preinstalled sensor, and therefore no additional sensor needs to be installed.

Provision for Additional Sensor

The provision for mounting an additional sensor is on the oil sump at the location shown in the figure.



77-07-P

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Sensor Characteristics

The characteristics of the standard sensor are as follows.

- Type resistive (NTC) with isolated ground
- Measuring range -30÷150 °C
- Mounting M12x1.5
- Resistance to chemicals inert to prolonged contact with synthetic-based lubricants

The minimum characteristics of the additional sensor are as follows.

- Type resistive (NTC) grounded to frame or with isolated ground
- Measuring range 50÷150 °C
- Mounting thread M12x1.5
- Resistance to chemicals inert to prolonged contact with synthetic-based lubricants

Installation

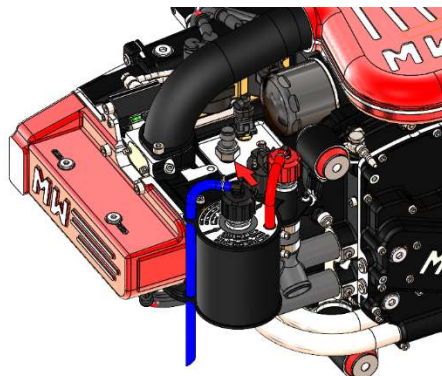
The installation of the sensors should be carried out as follows.

- a.** Remove the engine oil.
- b.** Remove the M12x1.5 plug from the predisposition hole on the sump, bank side #1; also remove the copper gasket.
- c.** Install the sensor in the prepared hole, interposing the provided gasket; weak threadlocker is recommended on the threads.
- d.** Tighten to a torque of 20 Nm.
- e.** Connect the provided connector to the sensor.
- f.** Refill the engine oil.

77-01-04 Oil Pressure Sensors

Standard Pressure Sensor position

The pressure sensor is located on top of cylinder bank #2.

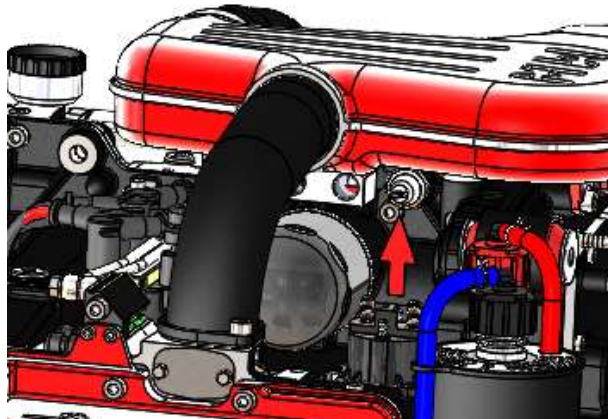


77-08-P

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Provision for Additional Sensor

The provision for mounting an oil pressure sensor is located under the airbox on the side of bank #2.



77-09-P

Sensor Characteristics

The features of the standard sensor are as follows:

- | | |
|--|---|
| <ul style="list-style-type: none"> ▪ Type ▪ Measuring range ▪ Mounting ▪ Resistance to chemicals | <ul style="list-style-type: none"> piezoresistive or variable resistance 0÷5 bar thread 1/4" gas inert to prolonged contact with synthetic-based lubricants |
|--|---|

The most suitable additional pressure sensor is the piezoresistive type: however, variable resistance passive type sensors (rheostats) can also be installed, provided they are equipped with the appropriate reading instrument. The characteristics of the sensor to be used are as follows.

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Type ▪ Measuring range ▪ Mounting ▪ Resistance to chemicals | <ul style="list-style-type: none"> piezoresistive or variable resistance 0÷5 bar thread M10x1 inert to prolonged contact with synthetic-based lubricants |
|--|--|

Installation

The sensor should be installed as follows and without necessarily removing the lubrication oil.

- a.** Remove the intake system.

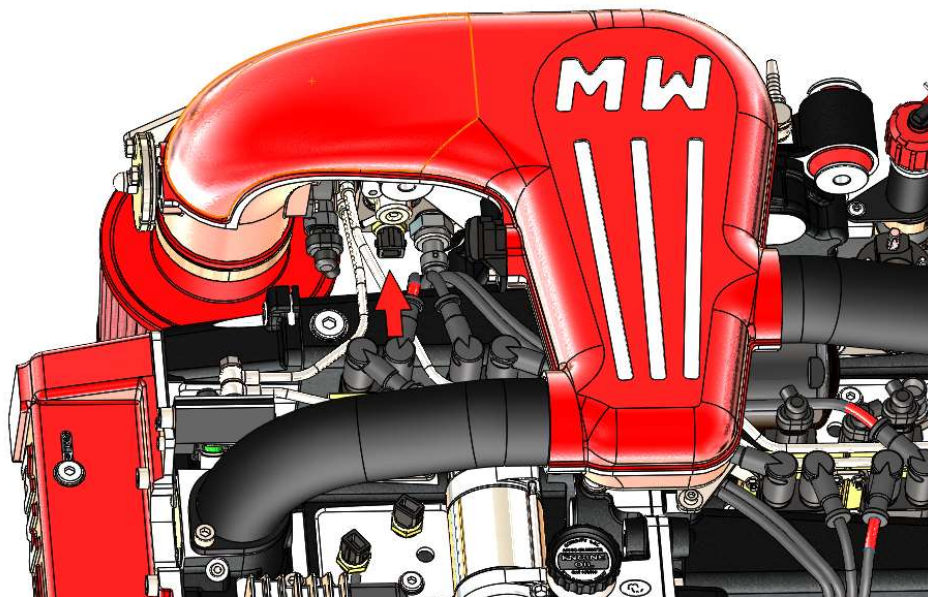
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- b.** Remove the 10x1 cap from the predisposition hole on the #2 bank, under the airbox (77-08-P); also remove the copper gasket.
- c.** Install the sensor in the prepared hole, interposing the provided gasket; weak threadlocker is recommended on the threads.
- d.** Tighten to 15 Nm.
- e.** Connect the connector provided to the sensor.
- f.** Reinstall the intake system.

77-01-05 Fuel Temperature Sensor

Standard Sensor Position

The fuel temperature sensor is located on the fuel distributor, located at the rear of the engine.

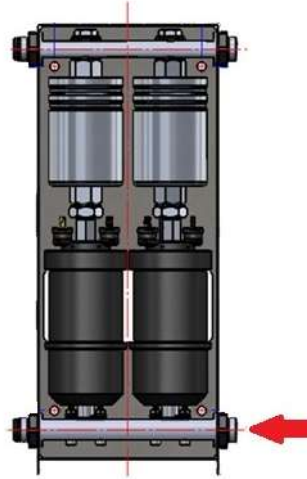


77-10-P

Provision for additional sensor

The provision for mounting a fuel temperature sensor is present on the Fd-m group.

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Sensor Characteristics

The characteristic of the standard sensor are as follows.

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Type ▪ Measuring range ▪ Mounting ▪ Resistance to chemicals | resistive (NTC) grounded to frame or with isolated ground
50÷150 °C
thread M12x1.5
inert to prolonged contact with gasoline and alcohol |
|--|--|

The minimum characteristics of the additional sensor to be used are as follows.

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Type ▪ Measuring range ▪ Mounting ▪ Resistance to chemicals | resistive (NTC) grounded to frame or with isolated ground
50÷150 °C
thread M12x1.5
inert to prolonged contact with gasoline and alcohol |
|--|--|



It is of absolute importance to use only sensors suitable for use with gasoline, as other types of sensors could be damaged causing pressure loss in the system and fires from fuel spillage on hot engine parts.

Installation

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The installation of the sensor should be done as follows.



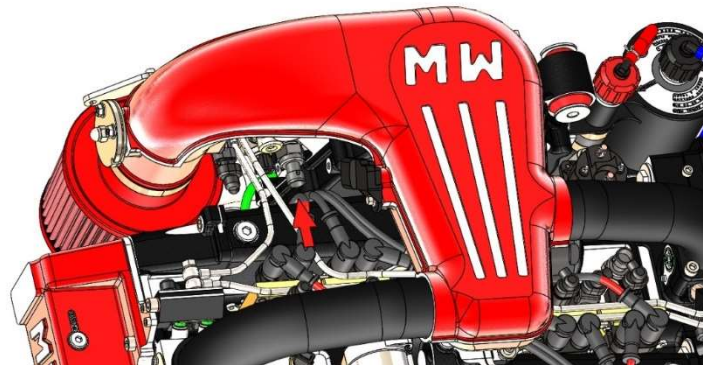
Keep in mind that you are working near highly flammable liquids that are harmful if inhaled and ingested.

- a.** Remove pressure from the fuel system, as described in the maintenance manual.
- b.** Remove the M12x1.5 plug from the inlet fuel rail of the FD-m.
- c.** Install the sensor in place of the plug, interposing the gasket provided; it is recommended to use weak threadlocker on the thread.
- d.** Tighten to 20 Nm.
- e.** Connect the connector provided to the sensor.
- f.** Operate the fuel pumps and bleed them.
- g.** Check for leaks near the installed sensor.
- h.** Reinstall the fuel air filter.

77-01-06 Fuel Pressure Sensor

Standard Sensor Position

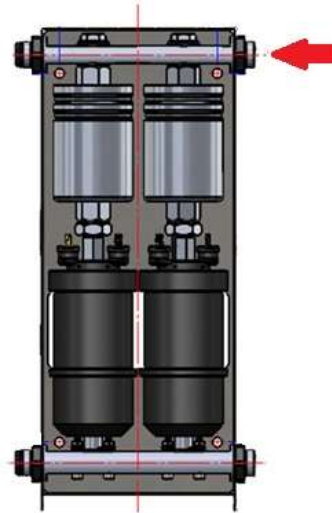
The standard fuel pressure sensor is provide on the fuel distributor, located at the rear of the engine.



77-12-P

Provision for Additional Sensor

The provision for mounting a fuel pressure sensor is present on the Fd-m group.



77-13-P

Sensor Characteristics

The characteristics of the standard sensor are as follows.

- Type piezoresistive or variable resistance
- Measuring range 0÷5 bar
- Mounting thread 1/4" gas
- Resistance to chemicals inert to prolonged contact with gasoline and alcohol

The most suitable additional fuel pressure sensor is the piezoresistive type: however, variable resistance passive type sensors (rheostats) can also be installed, provided they are equipped with the appropriate reading instrument. The minimum characteristics of the sensor to be used are as follows.

- Type piezoresistive or variable resistance
- Measuring range 0÷5 bar
- Mounting thread M12x1.5
- Resistance to chemicals inert to prolonged contact with gasoline and alcohol



It is of absolute importance to use only sensors suitable for use with gasoline, as other types of sensors could be damaged causing pressure loss in the system and fires from fuel spillage on hot engine parts.

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Installation

The installation of the sensor should be done as follows.



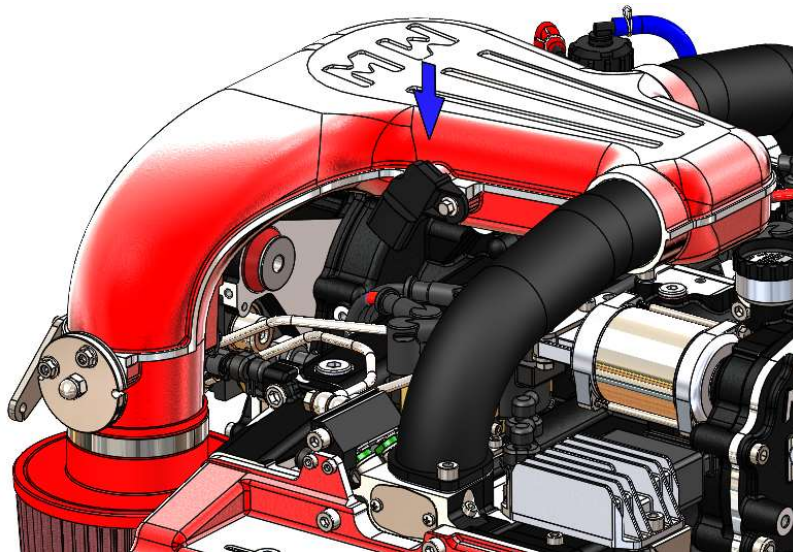
Keep in mind that you are working near highly flammable liquids that are harmful if inhaled and ingested.

- a.** Remove pressure from the fuel system, as described in the maintenance manual.
- b.** Remove the M12x1.5 plug from the outlet fuel rail of the FD-m.
- c.** Install the sensor in place of the plug, interposing the gasket provided; it is recommended to use weak threadlocker on the thread.
- d.** Tighten to 22 Nm.
- e.** Connect the connector provided to the sensor.
- f.** Operate the fuel pumps and bleed them.
- g.** Check for leaks near the installed sensor.
- h.** Reinstall the fuel air filter.

77-01-07 Air Intake Temperature Sensor

Standard Sensor Position

A supply air temperature sensor located on the airbox on the #1 bank side is installed on the engine: the signal is sent to the injection control unit, which processes it to adjust the mixture ratio.



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The pre-installed supply air temperature sensor should not be removed under any circumstances, nor should its signal be tapped to send it to a measuring instrument, as this would alter its value, causing malfunctions in the engine.



In the case of using the EM-m instrument or an instrument equipped with CAN Aerospace input, the supply air temperature is provided by the preinstalled sensor, and therefore no additional sensor needs to be installed.

Provision for Additional Sensor

There is no provision for an additional air temperature sensor.

Sensor Characteristics

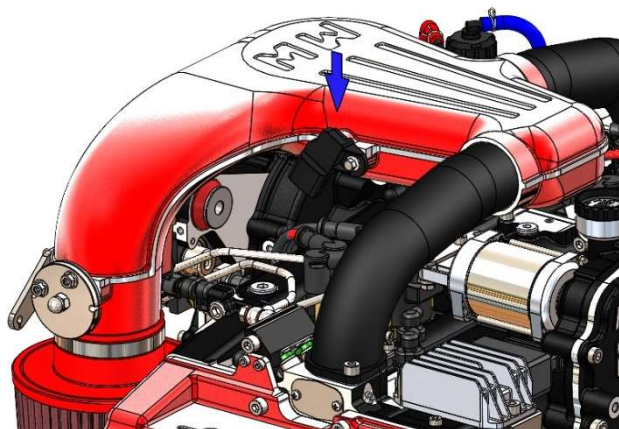
The characteristics of the sensor are as follows.

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Type ▪ Measuring range ▪ Mounting ▪ Resistance to chemicals | resistive (NTC) with isolated ground
-30÷150 °C
plug-in with retaining screw
inert to prolonged contact with green gasoline |
|--|--|

77-01-08 MAP (Manifold Air Pressure) Sensor

Standard Sensor Position

The manifold air pressure (MAP) sensor is on the airbox on the #1 bank side: this sensor, in addition to pressure, also measures the temperature of intake air.



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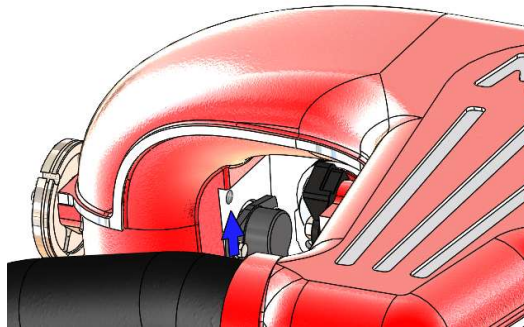
The preinstalled supply air pressure sensor must not under any circumstances be removed, nor should the signal be tapped to send it to a measuring instrument, as this would alter the value, causing malfunctions in the engine.



In the case of using the EM-m instrument or an instrument equipped with the Aerospace CAN input, the MAP value is provided by the preinstalled sensor, and therefore no additional sensor needs to be installed.

Provision for Additional Sensor

The provision for mounting an additional sensor is present on the airbox, near the throttle angle sensor.



77-16-P

A banjo fitting must be screwed into the mounting hole, to which the tube carrying the air to a remote sensor must be connected: the characteristics of an electronic type sensor are described below. However, it is also possible to read the MAP signal with a pneumatic instrument, using the same pressure port.

Sensor Characteristics

The characteristics of the standard sensor are as follows.

- Type piezoresistive
- Measuring range 20÷115 kPa
20÷200kpa turbo engine
- Mounting plug-in with retaining screw
- Resistance to chemicals inert to prolonged contact with gasoline and alcohol

The minimum characteristics of the additional sensor to be used are as follows.

- Type piezoresistive or variable resistance
- Measurement range 20÷115 kPa
20÷200kpa turbo engine

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<ul style="list-style-type: none"> ▪ Pressure tapping thread ▪ Tube inner diameter ▪ Maximum tube length ▪ Tube type 	M8x1mm 4÷6 mm 500 mm suitable for pressure ranges from 0.2 to 1.5 bar (absolute) inert to prolonged contact with green gasoline
<ul style="list-style-type: none"> ▪ Resistance to chemicals 	

Installation

The installation of the sensor should be as follows.

- a.** Remove the airbox mounting plug, including the copper sealing washer.
- b.** Screw a banjo fitting with an M8x1 thread and a hose holder of the appropriate diameter for your sensor into the mounting hole, placing two new copper washers on both sides of the fitting.
- c.** Attach the chosen MAP sensor to the engine or aircraft, in a position not too far from the pressure port and possibly higher, to avoid possible fuel build-up in the pipe.
- d.** Connect the hose at both ends and secure it so that it cannot come loose during use.
- e.** Connect the connector provided to the sensor.

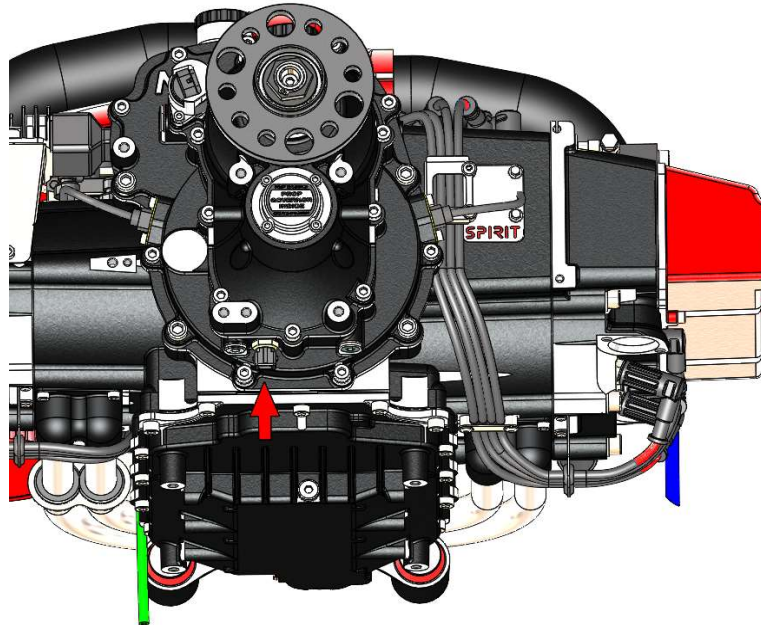


Make sure there is no venting from the connections, which can affect the smoothness of running, especially at low engine speeds and low loads.

77-01-09 Gearbox Oil Temperature Sensor

Standard Sensor Position

The gearbox oil temperature sensor located at the bottom of the gearbox. The signal from that sensor is sent to the electronic propeller pitch control module to adjust the responsiveness of the system to the change in lubricant viscosity as a function of operating temperature.



77-17-P

Provision for Additional Sensor

An additional gearbox oil temperature sensor cannot be installed.

Sensor Characteristics

The characteristics of the sensor are as follows.

- | | |
|---------------------------|--|
| ▪ Type | resistive (NTC) with isolated ground |
| ▪ Measuring range | -30÷150 °C |
| ▪ Mounting | M12x1.5 |
| ▪ Resistance to chemicals | inert to prolonged contact with synthetic-based lubricants |

A

The gearbox lubricant temperature sensor, if preinstalled, should not under any circumstances be removed, nor should its signal be tapped to send it to a measuring instrument, as this would alter its value, causing malfunctions in the governor.

77-01-10 Oxygen Sensor (Optional)

If, during installation, significant changes are made to the intake or exhaust system, it is essential to detect and, if necessary, correct the carburetion. In this case it is necessary to use the lambda sensor.

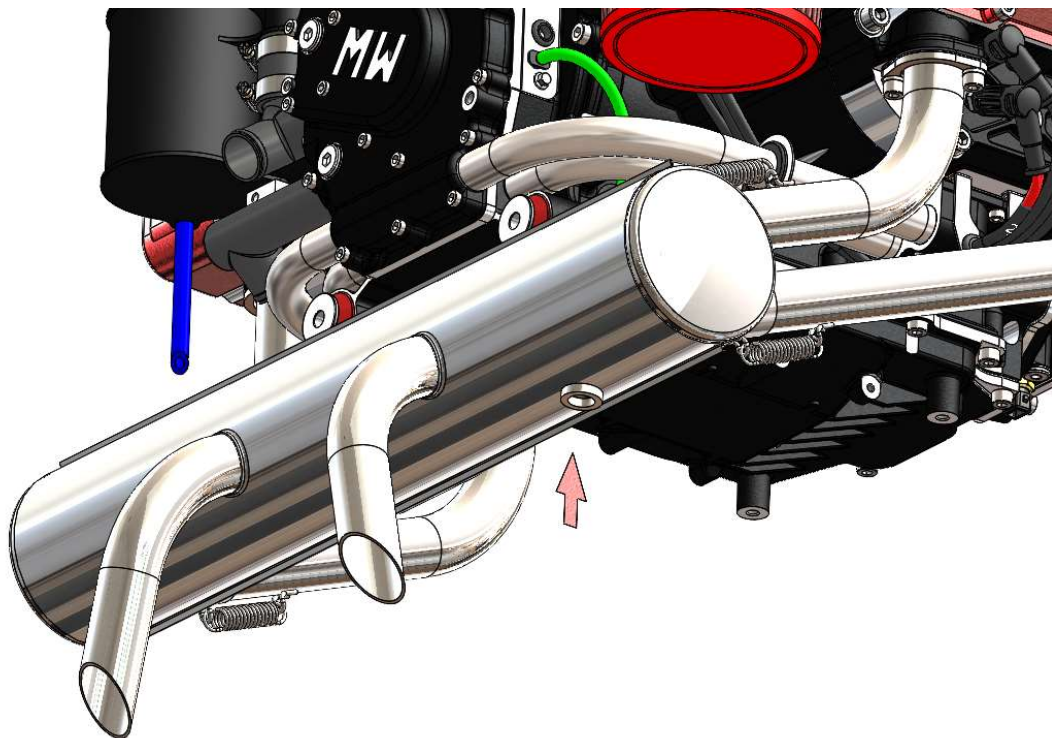
*77-18-P*

Standard Sensor Position

No lambda sensor is included in the standard equipment.

Provision for Additional Sensor

Provision for mounting a lambda sensor is provided on the original muffler supplied as optional.

*77-19-P*

The oxygen sensor detects the amount of oxygen present in the exhaust gas: the value can be displayed by an EFIS or EMS instrument, or it can be sent to the injection control unit, and from there transmitted on a CAN line to the on-board instruments. In the former case, the electrical connection must be made in the manner prescribed by the instrument manufacturer.

Sensor Characteristics

The minimum characteristics of the sensor to be used are as follows.

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- Type proportional with power controller and feedback on temperature
- Measuring range 0,7÷1,3 λ
- Mounting thread M18x1.5
- Resistance to chemicals inert to prolonged contact with gasoline and alcohol

Installation

To install the sensor on the exhaust, operate as follows.



Before working on the exhaust, wait for it to cool completely to avoid dangerous burns.

- a.** Unscrew the plug from the predisposition hole, with M18x1.5 thread, and remove the gasket washer.
- b.** Sprinkle a moderate amount of high-temperature copper grease on the sensor thread.
- c.** Screw the sensor into the housing, tightening to a torque of 45 Nm.
- d.** Mount the connector provided on the sensor.
- e.** Turn on the engine and check that there are no vents between the sensor and muffler.

77-40-00 Cabin Instrument

Any instrument equipped with an Aerospace CAN line for data reception can be used to read the signals from the standard engine management sensors. In this case, a CAN-to-CAN interface is required, as the injection unit uses a proprietary CAN protocol. A dedicated interface for this purpose is available as an accessory (CC-m module).

If using analog instruments or instruments without a CAN line, the appropriate sensors must be connected to them, without interfering in any way with the pre-installed sensors managed by the injection system.

77-40-01 Engine Monitor Module (EM-m)

The EM-m instrument, described below, is equipped with a CAN line, and is therefore capable of reading all the information managed by the ECU group, without the interposition of the CAN to CAN interface.

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The EM-m (Engine Monitor module) instrument is supplied as an option and can be configured for each engine model: the display shows the values of all standard sensors provided (except for the lambda parameter), as well as the hours of operation, battery charging voltage and current, instantaneous consumption and fuel consumed since start-up; the display includes the ignition and ECU failure warning lights, generator failure warning lights (including auxiliary), and the take-off consent light, allowing the instrument panel to be simplified. The EM-m can be equipped with an AHRS e GPS, thus also becoming a valuable tool for navigation.

When using the HG-m governor module, the desired rpm setting is done through the knob on the instrument, which also displays the target rpm value.

Please refer to the instrument manual for the list of functions, the correct way of use, and installation methods.



Do not perform flights or ground tests until you have read and understood the instrument user's manual.



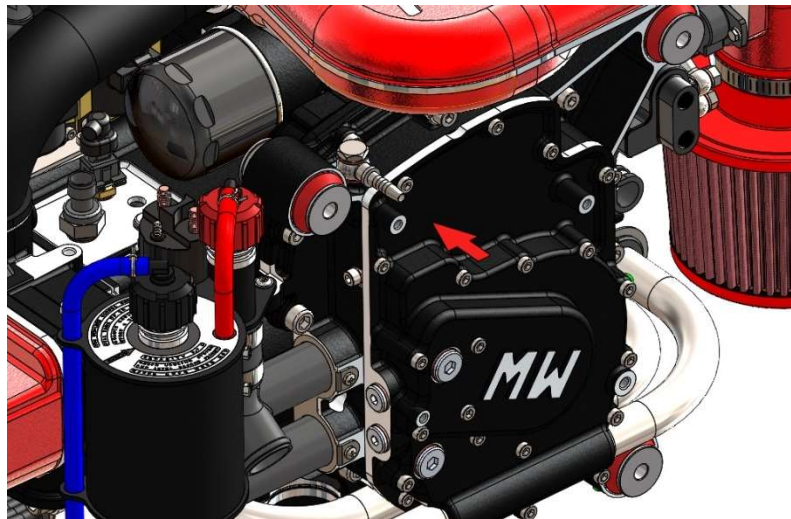
Do not start the engine before electrically connecting the instrument to the wiring harness, as the system will detect the event as a fault.

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78-00-00 EXHAUST

78-01-00 Crankcase Vent

The engine's internal venting system provides for the elimination of blow-by gases and water vapor condensation created in the first moments of operation. Oil vapours are vented through a labyrinth system built into the engine; the blow-by gases are then vented through the hole in the rear cover, to which a hose must be properly connected.



78-01-P

- A Do not exceed the prescribed oil level, as too much oil may cause the excess to escape through the vent system.
- A Any obstruction of the internal ventilation system is potentially dangerous as it can cause the oil seals or even mechanical parts to break due to the increase in internal pressure in the engine.
- A Excessive oil leakage from the breather during normal engine use usually indicates excessively high operating temperatures.

78-01-01 *Making the Crankcase Vent*

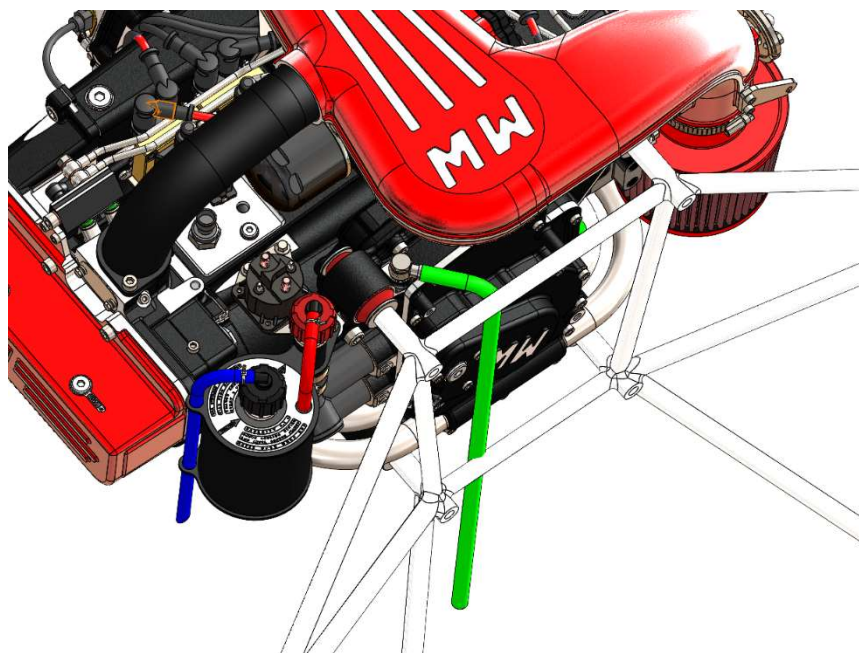
The engines are delivered with a plastic cap to protect the vent hole; the vent hole is located on the rear cover, near the upper left motor mount.

*78-01-P*

A fitting and a pipe with the following characteristics must be connected to the fitting.

- | | |
|---------------------------------|----------------------------------|
| ▪ Thread | M12x1.5 |
| ▪ Type | oil-resistant rubber or silicone |
| ▪ Inner diameter | 8 mm |
| ▪ Maximum operating temperature | 120 °C |

The length of the pipe is decided by the installer: it is best to make sure that the vent pipe comes out of the cowling in the low position.

*78-02-P*

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Necessary Materials

1. Torque wrench
 2. Socket wrench 17 mm
 3. Other tools depending on the materials chosen during installation
- a.** Remove [2] the plastic cap closing the crankcase vent hole.
 - b.** Screw [3] the chosen hose holder fitting into the vent hole and tighten.
 - c.** Slip the hose onto the hose holder screwed onto the rear cover and tighten it in place [3] with a hose clamp.
 - d.** Position the vent pipe in the cowling so that it is away from the exhaust system. Secure it to the engine frame or other parts with hose clamps.
 - e.** Cut the hose to length so that oil vapours can escape from the engine cowling.
 - f.** Check after the first few flights that there is no oil stagnation in the hose, a sign of overpressure at the free end of the hose: if so, the free end of the hose should be placed elsewhere.

78-01-02 Decanter tank

If oil, rather than just oil vapor, leaks from the vent pipe, it may be necessary to install a decanter tank to collect the vent vapors, which must be periodically emptied of accumulated oil. This situation occurs in some tractor applications, where the engine is positioned at a particularly inclined angle on the horizontal plane (aircraft with a two-wheel undercarriage), a situation that renders the engine's internal decantation system partially ineffective. Some applications with turbocharged engines are also critical from this point of view, due to higher operating temperatures and blow-by.



78-03-P

The vent hose coming from the engine must be connected to the inlet of the collection tank. The tank must be positioned as high as possible above the vent hole, avoiding any kinks in the connection hose, which could cause liquid to stagnate. A second hose must be connected to the tank outlet, with the other end exposed to the air. Below the tank is a third connection with a tap, which must be opened periodically to empty the accumulated fluid.

A cyclonic circulation tank is available as an optional extra, as in most cases it is not necessary.

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78-20-00 Exhaust System

The engine has four separate exhaust ports facing the underside of the engine: this allows to design exhaust manifolds with a linear pattern and easy cooling.

Naturally aspirated engines are delivered without an exhaust system: a suitable exhaust system, called EX-m, is available as an option; alternatively, the installer can decide to design and build a specific exhaust system. Turbo engines, however, are delivered with a complete exhaust system.



In turbo engines, avoid modifying the exhaust system to avoid serious operating problems or mechanical failures.

A good exhaust system is essential for good performance and smooth operation from the engine. Also consider that the exhaust system is often a source of failure and overheating of aircraft parts.



When installing the exhaust system, take great care in avoiding overheating of aircraft or engine parts by the manifolds or muffler.



A poorly designed exhaust system is a source of problems to the engine: it is therefore essential to comply with the requirements below when using a non-original exhaust system.

78-21-00 Exhaust Scheme Choice (natural aspirated engine)

To keep the weight and complexity of the exhaust system down, it is preferable to use a single muffler for the four cylinders, placed transversely under the engine and with direct entry of the four exhaust manifolds. An alternative involves merging the four-exhaust manifold from the headers into a single manifold, and then entering the muffler.

If maximum performance is to be favoured, it is advisable to use exhaust manifolds of equal length. On the other hand, to favour progression and torque uniformity at varying rpm, it is preferable to use manifolds of different lengths. It is advisable, however, that the difference in length between the shortest and the longest manifold is not excessive, to avoid running irregularities.

Benefits 4-in-1 Scheme

- Best compromise between silence and performance
- Smoothness of engine running, especially at idle
- Robustness

Disadvantages 4-in-1 Scheme

- Increased weight
- Increased temperature in the engine's cowling

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A variant of such a scheme is the 4-in-2-in-1: again, it is important that the length of the two manifolds before joining be very similar, to avoid problems of exhaust backpressure.

Advantages and disadvantages of such a scheme are about the same as those already described.

Another possible scheme is the 4-in-2, in which the two manifolds of the same bank merge into a common manifold and then into a muffler, or directly into two mufflers, one for each bank. In this case it is essential that the two mufflers be identical to each other, and also the length of the manifolds of the two banks. Normally this is not an advantageous scheme.

Benefits 4-in-2 Scheme

- Less difficulty in inserting into the cowling

Disadvantages 4-in-2 Scheme

- Greater weight
- Greater irregularity at idle

Finally, it is also possible to make exhaust systems that do not include any type of muffler after the exhaust manifolds.

In this case, a manifold must be connected to each exhaust port, with sufficient length to move the exhaust gases away from the engine cowling, to avoid burning. With such an exhaust configuration, the noise level increases considerably, without, however, achieving significant increases in power; this solution, however, allows for the elimination of the weight of the muffler, which can be estimated at about 4 kilograms.

Advantages of Free Discharge Scheme

- Less difficulty in inserting into the cowling
- Less weight
- Lower temperature inside the engine cowling

Disadvantages of Free Discharge Scheme

- Increased noise
- Increased irregularity at idle



However, exhaust noise emissions must be kept within the limits imposed by the laws of the country where the engine is used.

78-22-00 General Features

78-22-01 Location and Size of Discharge Flanges

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Direct Version

Flange position	<i>Cylinder manifold #1</i>	<i>Cylinder manifold #2</i>	<i>Cylinder manifold #3</i>	<i>Cylinder manifold #4</i>
<i>Position in x</i>	174,7	348,7	263,7	437,7
<i>Position in y</i>	272,7	272,7	-272,7	-272,7
<i>Position in z</i>	-29	-29	-29	-29

78-01-C

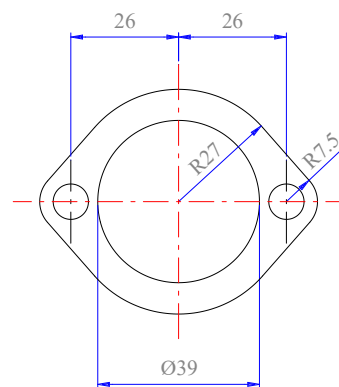
PSRU Version

Flange position	<i>Cylinder manifold #1</i>	<i>Cylinder manifold #2</i>	<i>Cylinder manifold #3</i>	<i>Cylinder manifold #4</i>
<i>Position in x</i>	251,1	425,1	340,1	514,1
<i>Position in y</i>	272,7	272,7	-272,7	-272,7
<i>Position in z</i>	-112,2	-112,2	-112,2	-112,2

78-02-C

The fixing flange of the manifolds and the shape of the manifolds at the point of engagement on the header must be in accordance with the drawing on the side.

Fastening should be done using M8x1.25 class 8.8 screws (stainless steel screws are also allowed), tightening them gradually to a torque of 22 Nm. The length of the mother screw in the head casting is 15 mm. It is convenient to provide an anti-unscrewing washer under each screw head and apply strong threadlocker (green colour) to the threads of the screws.



78-04-P

78-22-02 Operating Temperature

During installation, the temperature on each exhaust manifold should be checked using thermocouples. The temperature should be measured approximately 100 mm from the clamping flange of the manifolds to the engine.

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The temperatures below are to be considered the maximum attainable at full throttle valve opening, regardless of engine speed. It should be borne in mind that exhaust temperatures generally rise as the percentage of throttle valve opening decreases up to about 40 percent open, then fall again for smaller openings.

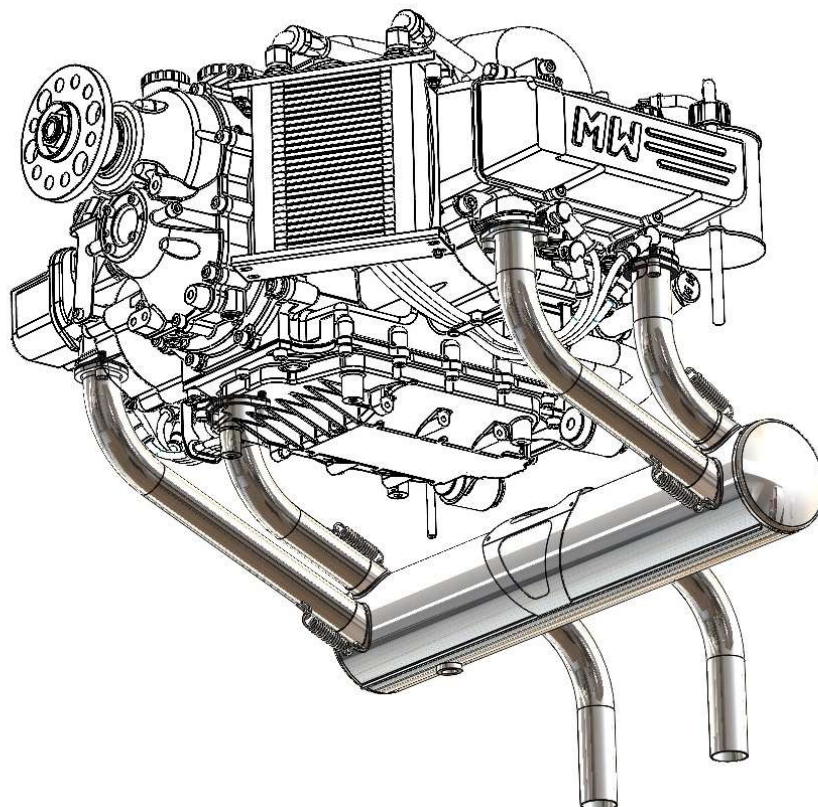
- | | |
|---|--------|
| ▪ Maximum temperature (natural aspired engines) | 750 °C |
| ▪ Maximum temperature (turbo engines) | 900 °C |
| ▪ Maximum temperature for max 1 minute | 920 °C |



Exhaust temperatures above the above limit can cause serious engine damage.

78-23-00 Standard Manifold and Muffler Installation (EX-m)

On request, engines can be equipped with an exhaust system (Exhaust module - EX-m), specially designed to lower noise emissions, without penalizing performance too much.



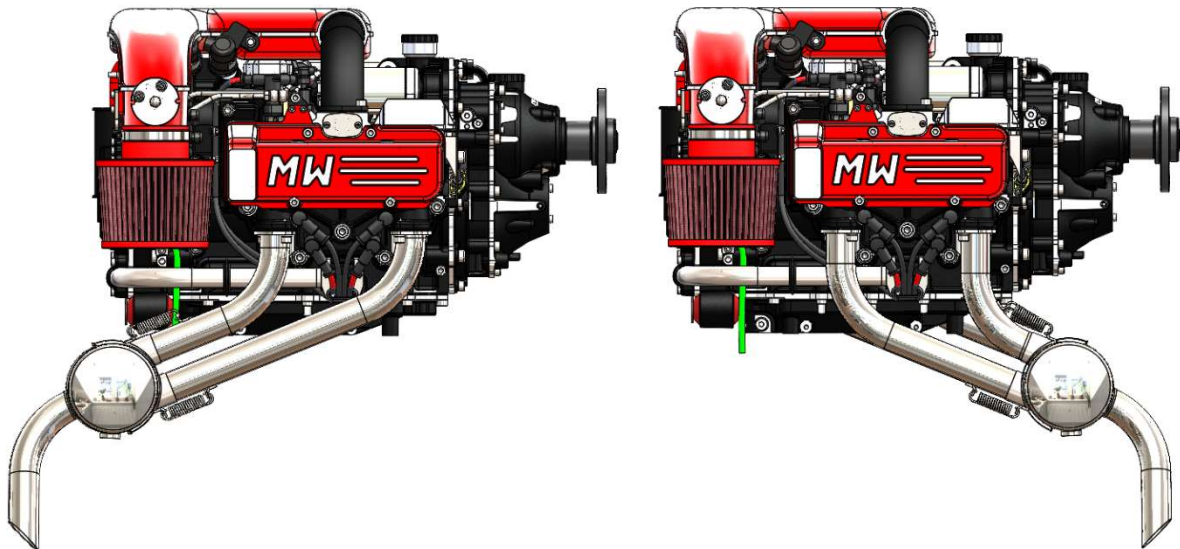
78-05-P

78-23-01 Description

Such a system is suitable for both pulling and pushing applications, being mountable with the muffler facing the rear of the engine or the propeller flange, indifferently: in

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the latter case, to prevent the propeller blades from interfering with the exhaust terminal, it is necessary to mount a spacer between the propeller and the hub of at least 20 mm thickness.



78-06-P

78-07-P

It consists of four exhaust manifolds of different lengths that flow into a cylindrically shaped muffler placed under the powerplant in a recessed, transverse position: the muffler is design to work also as compensation chamber for the pressure waves produced by the succession of phases in the various cylinders and contributes to improving the smooth running of the engine.

The entire exhaust system is made in stainless steel and is mounted in such a way as to avoid distortion of the components as a result of thermal deformation induced by the high operating temperature.

78-23-02 Exhaust Component Features

▪ Manifold weight #1	640 g
▪ Manifold weight #2	430 g
▪ Manifold weight #3	560 g
▪ Manifold weight #4	350 g
▪ Muffler weight	3800 g
▪ Fastener weight	70 g
▪ Total weight	5850 g
▪ Muffler width	656 cm
▪ Sound emission	76 dB

The noise emission value refers to measurements taken at a distance of 5 meters from the engine, at an angle of about 45° to the longitudinal axis of the aircraft, and represents the best value found with the engine at idle speed (1000 rpm).

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78-23-03 Installation

Necessary Materials

1. Torque wrench
2. Pliers
3. 6 mm Allen wrench
4. Hammer with plastic strikers
5. 6 mm flat-blade screwdriver
6. Strong threadlocker

- a.** Number the exhaust manifolds, dividing them according to length, as shown in the figure below.



78-08-P

- b.** Insert the four exhaust manifolds onto the silencer as highlighted in the figure, until they come to a stop at the bottom of their respective housing. To facilitate insertion, use Vaseline if necessary.

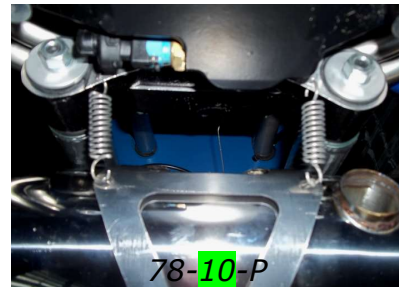


78-09-P

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- c. Use two pliers [2] to twist the two ends of two springs so that one is rotated relative to the other by about 90°.
- d. Insert the two springs supporting the silencer into the appropriate holes on the silencer bracket.

- o If you want to mount the muffler on the rear of the engine, the springs should be hooked to the holes in the rear engine cover so that the exhaust system hangs on the engine.



- o If you want to mount the silencer on the propeller flange side, you must use the support bracket (code T180) to which the springs must be attached. Then the bracket must be fastened to the engine using the two lower gearbox locking screws: fastening in each hole must be done by interposing the annealed copper washers provided between bracket and engine and between bracket and screw head and tightening [1+3] to a torque of 22 Nm.



- e. Place a gasket (supplied with the exhaust system) between each manifold and the seat in the cylinder heads, taking care to centre it correctly with respect to the holes in the mounting screws.
- f. Insert the four manifold flanges onto the studs attached to the headers.
- g. Attach each manifold to the header by screwing on the special nuts provided and interposing the appropriate lock washers: apply a strong threadlocker compound [6] to the threads and screw [3] progressively on the two tightening nuts of each element. Before completing tightening [1+3] to 20 Nm, align the 4 manifolds to the muffler, helping yourself with small hammer blows with plastic knockers [4]. If the assembly is correct, looking at the exhaust system from the propeller side, the silencer should be perfectly horizontal and the outline of the front manifolds should cover that of the rear manifolds: if there are any anomalies, loosen [3] the tightening screws and realign the manifolds.
- h. Using a screwdriver [5], mount the four tension springs on the attachment hooks so that the spring opening is positioned toward the manifold. In case the tension of the springs is insufficient, bend the attachment lugs on the manifold and muffler.

After the first working cycles, it is necessary to check the tightening [1+3] of the collector retaining screws.

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Before working on the exhaust system, it is necessary to wait for it to cool down for at least 15 minutes after the engine is turned off: failure to observe this warning can result in serious burns and scalds.



Any major gas leakage from the exhaust flange area must be eliminated as it can cause the spark plug wires to burn, resulting in engine malfunction or shutdown.



Small vents from the manifold coupling in the header or muffler are possible, but usually disappear after the first few hours of operation.



Reported performance refers to standard atmosphere conditions (ISA), and is obtained with original MWfly exhaust system and intake filters.



After the first few hours of operation, the exhaust system takes on a yellowish and, locally near the manifold connection in the cylinder head, dark purple colour: this is completely normal and can be attributed to the high temperatures that can be reached by the exhaust system during normal use.

78-24-00 Implementation of an Exhaust System

In the case that the EX-m exhaust system is not going to be used, the following notes and recommendations serve as an aid to the aircraft manufacturer or installer, in developing an exhaust system suitable for use.



If the EX-m exhaust system is not used, remapping of the injection control unit is necessary to avoid conditions that could potentially threaten the integrity of the engine.



As a result of using a non-original MWfly exhaust system, the performance of the powertrain may be significantly degraded.

The following recommendations are the result of years of experience: by following them, the results that can be achieved are generally good.

78-24-01 Component Characteristics

▪ Minimum radius of curvature of manifolds	50 mm
▪ Inner diameter of manifolds	35 mm
▪ Minimum muffler volume	5500 cm ³
▪ Minimum gas outflow section from the muffler	1900 mm ²
▪ Maximum load on each manifold	2,5 Kg

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- Maximum bending moment on each manifold 1 Kgm
- Length of exhaust lights in the header 70 mm



The exhaust system must be designed so that the maximum expected load is not exceeded on each point of attachment. If this is not possible, additional supports must be provided to the system.



Exhaust systems that obstruct or restrict the outflow of combustion gases from the engine raise the operating temperature of the engine and can be the cause of detonation, resulting in severe induced damage.

Preferably use AISI 304 or, better, AISI 420 stainless steel when making the exhaust manifolds and silencer.

The recommended thicknesses for making the various components of the exhaust system are as follows.

- Muffler 0,8 mm
- End tube 1 mm
- Manifolds 1 mm
- Fixing flange 4 mm

It is advisable to realize the attachment of the muffler to the exhaust manifolds by means of tension springs. The mounting load of such springs should be at least 50 N. Arrange on the silencer an attachment point for the lambda sensor with M18x1.5 threading. The probe should be placed after the confluence of the four manifolds in a gas flow area: therefore, avoid placing it near the muffler walls or at stagnation points. The lambda is essential for performing exhaust tuning.

78-24-02 Accessories Available

To simplify the construction and installation of non-original exhaust systems, the following accessories are available with their respective order codes.

- Cod. M032 - Traction spring (6 pieces)



78-12-P

- Cod. A117+T245 - Exhaust flange assembly (4 pieces)



78-13-P

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- Cod. G150 – Exhaust Gasket (4 pieces)



78-14-P

- Cod. N329 – Exhaust nut (8pieces)



78-15-P

78-24-03 Implementation



Engine-induced vibrations are the main cause of exhaust system failure; therefore, it is essential to contain these vibrations by making a labile exhaust, i.e., not too stiff.

The configuration and shape of the exhaust system are primarily determined by the space available on the aircraft.

The manifolds must be fixed to the engine header by interposing the provided gasket or a suitable sealing compound.



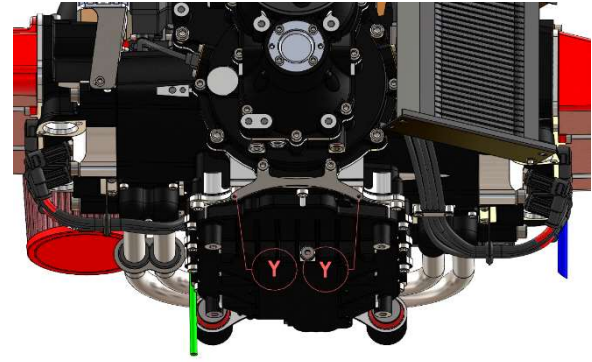
Any gas leaks between the exhaust manifold and the cylinder head are to be avoided, as they could cause the spark plug wires to burn. Frequently check for leaks and the tightness of the retaining screws.

To avoid breakage, the exhaust system must be able to expand upon heating without constraints in opposition: therefore, it is advisable for the muffler to be connected to the exhaust manifolds by springs. The silencer should also be constrained to the engine with an elastic connection: normally, extension springs can be used.

Two holes are provided on the engine for this purpose below the rear attachment points, which can be used to constrain the hook of such springs (points X in fig. 78-16-P). A mounting bracket (item no. T180) is available to tie the muffler to the front of the engine (points Y in fig. 78-17-P). This bracket must be tightened to 22 Nm by means of the two lower screws closing the gearbox to the cylinder block, interposing copper washers, before and after the bracket itself.



78-16-P



78-17-P



It is recommended to fill the spring body with high temperature resistant silicone to increase damping from vibration.



The bonding of the muffler to the engine serves to reduce the bending load on the manifolds and connecting flanges. Failure to provide this restraint is likely to result in rupture of the exhaust manifolds in the area of attachment to the engine.

In cases where the course of the manifolds is not straight, but includes curves in space, the manifolds themselves must incorporate a ball joint: this limits the loads resulting from thermal expansion, and preserves the exhaust from rupture.



The routing of the exhaust manifolds should be such as to avoid any contact or proximity to the spark plug wires: any deterioration of the spark plug wires due to overheating induced by the exhaust system can cause the engine to suddenly shut down.



Take care to provide adequate shielding near the passage of cooling hoses and spark plug wires to prevent excessive heating. In any case, there should be no contact of engine parts with the exhaust manifolds.

78-25-00 Verification and Validation

In case the EX-m system is used, it is only necessary to make sure that the operating temperature of the exhaust system is not excessively high, a circumstance that would affect its durability. For this purpose, there must be adequate ventilation inside the engine cowling: normally the ventilation produced by the air intakes of the radiator and intake system during advancement is sufficient to contain the operating temperature of the exhaust. If this is not the case, a suitable air intake must be provided on the engine cowling to cool the exhaust system, especially near the junction

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of the manifolds in the cylinder heads and in the side area of the muffler (hottest points).

To determine the operating temperature of exhaust system components, use thermochromic paints, that can indicate the temperature reached through colour variation: this will give a detailed indication of where, if necessary, to intervene to limit the operating temperature. Another way to determine whether the exhaust is working at a suitable temperature is to check its coloration: since the exhaust system is made of stainless steel, if with operation the exhaust tends to dull and take on a yellowish coloration it means that the working temperature is correct; on the contrary, areas of iridescent bluish dark coloration are unequivocally the symptom of an excessive working temperature. However, this second mode of assessment is less rigorous, as it provides qualitative rather than quantitative indications.



To keep the exhaust system efficient, avoid subjecting it to thermal shock: when washing the aircraft, it is a good idea to wait for the hot parts of the engine, and the exhaust system, to return to room temperature.



During the warm-up phase and especially when the exhaust system cools down with the engine off, metallic ticking noises are noticeable: this is perfectly normal, and is caused by the mutual sliding of the hot surfaces of the manifolds and muffler.

In the case of using an exhaust system other than EX-m, in addition to detecting the operating temperature, remapping the ECU and detecting the exhaust gas temperature is necessary: in fact, the exhaust system can also significantly change the engine carburetion and the resulting thermal operating conditions.

The lambda value used for engine tuning is variable, depending on load and rpm, and is optimized on each engine after production during deliberation; similarly, exhaust temperatures are also balanced for each engine after production: this optimization is performed with an EX-m exhaust system, and therefore cannot be considered adequately valid for different exhausts.

ECU remapping can only be performed by MWfly or licensed operators.

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79-00-00 LUBRICATION

In the versions that are equipped with a propeller gearbox the lubrication of the gearbox gears is carried out with a specific lubricant, different from that used for the engine oil. For PSRU versions it is necessary to summarize the information in this chapter with that in chapter 61 of this manual.



Unless otherwise agreed, the engine is delivered without engine and gearbox oil: the engine must be refilled with oil before starting the engine.

79-20-00 Lubrication Circuit



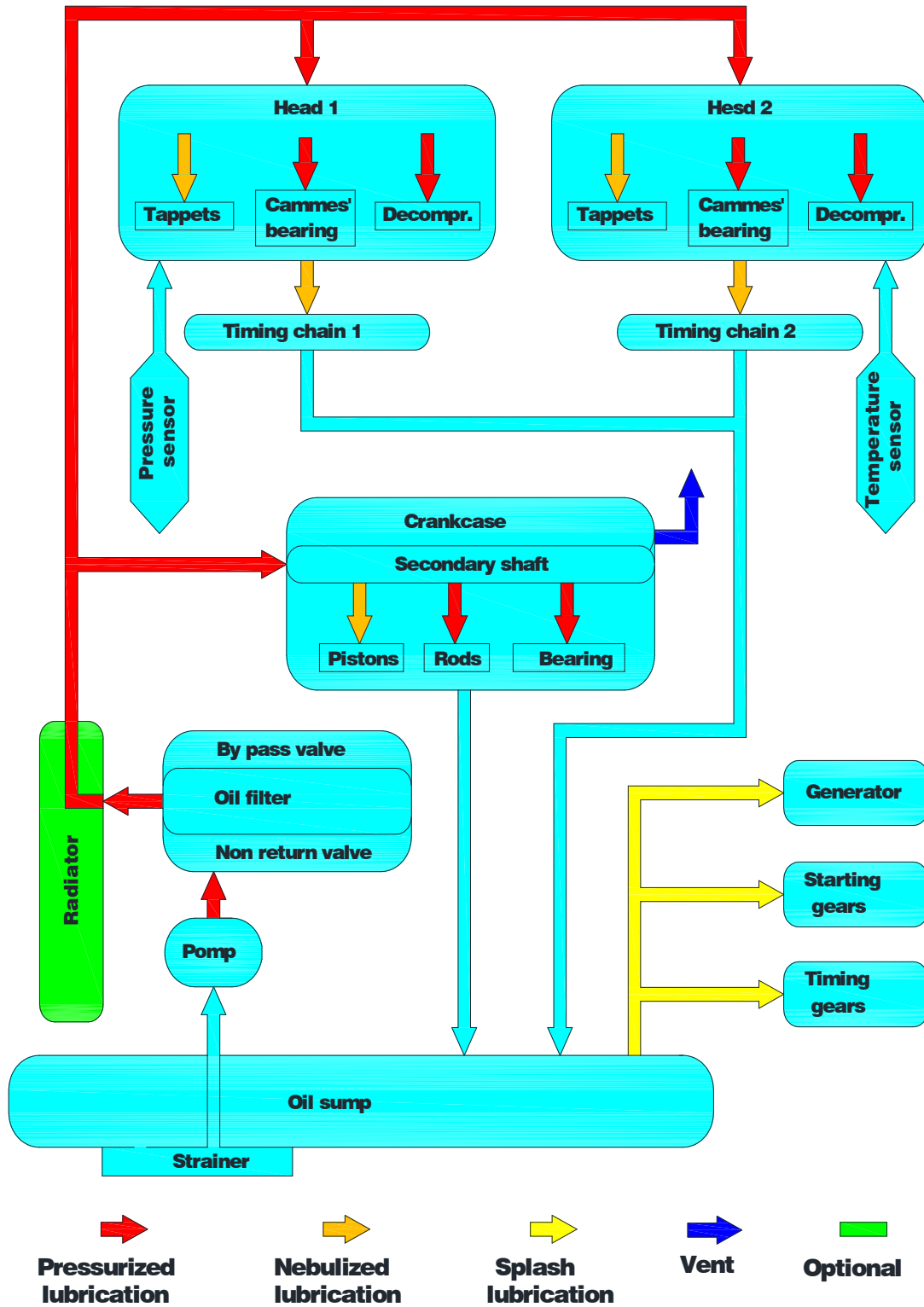
In case of insufficient oil pressure, it is necessary to land as soon as possible, and have the engine overhauled to find the cause of the abnormality and any damage it may have caused.



The lubrication system does not use the pressure pulsations produced by the motion of the pistons to pump oil into the sump, as it is judged to be critical to flight safety.

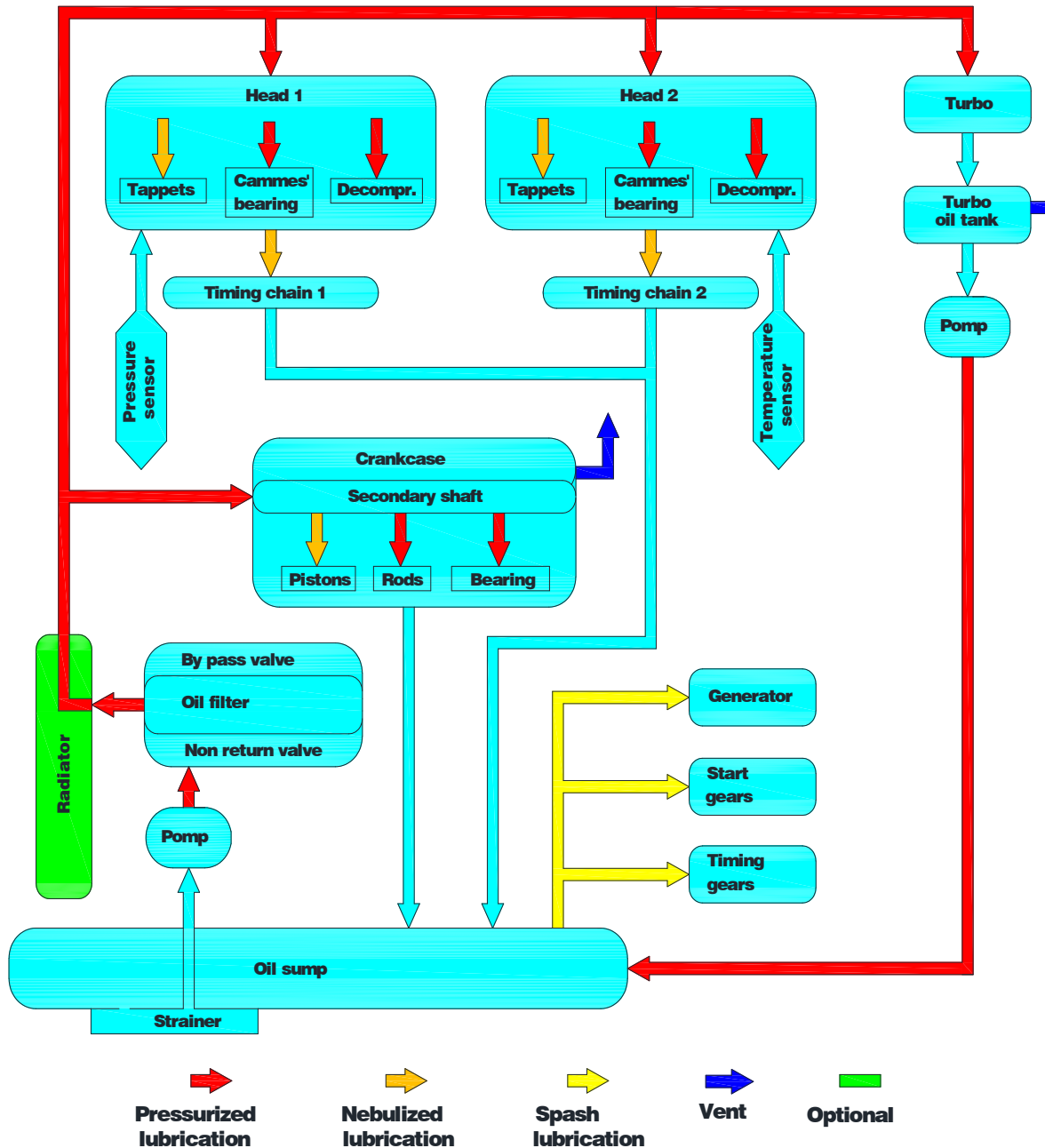
79-21-00 Lubrication Scheme

SPIRIT e **SPIRIT Turbo** engines are equipped with a semi-dry sump lubrication system. The following circuit diagram is shown the lubrication scheme in normal aspired engines.



79-01-C

The lubrication scheme of **SPIRIT Turbo** includes turbocharger lubrication as per the following diagram:

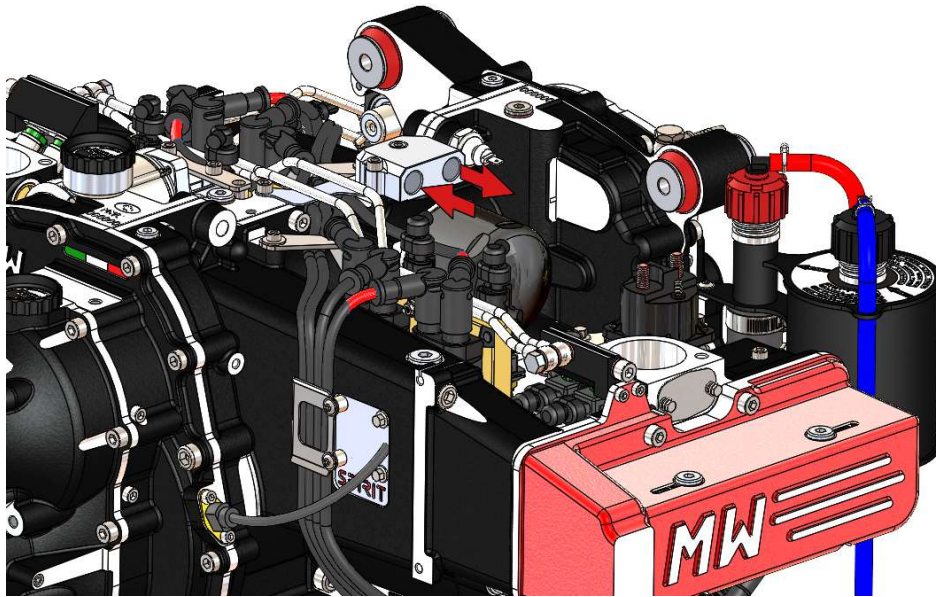


79-02-C

The lubrication pump is of the trochoidal type, and is driven by the secondary shaft, which turns 1.66 times slower than the crankshaft. Oil, drawn from the oil sump

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through a mesh filter, is sent to the cooler through a collector installed at the top of the crankcase, below the intake system.



79-01-P

Returning from the radiator, the oil enters the cartridge filter after intercepting a pressure relief valve. At the outlet of the oil filter, which is equipped with a check valve and by-pass, lubricant is sent to the two cylinder heads through ducts cut in the upper part of the cylinder block; the lubricant enters the camshafts, and drives the hydraulic decompression devices for starting; the residual oil lubricates the camshaft bearings and thrust washers. From the cylinder head, the oil returns to the sump by gravity through the timing chain compartments. Another part of the lubricant, as it exits the oil filter, is sent under pressure to the crankshaft bearings, connecting rod bearings (which it reaches through ducts inside the crankshaft), secondary shaft bearings and starting system. Surplus oil lubricates the pistons and liners. An anti-skid bulkhead is installed between the cylinder block and the oil sump, which allows the oil to be contained within the sump during more pronounced aircraft manoeuvres.

In turbocharged engines, a portion of the oil exiting the lubrication pump is sent to the turbocharger unit through an external pipe. After lubricating the impeller bearings, the excess oil is collected by gravity in a tank located below the turbocharger. The scavenge pump draws the oil from this tank and sends it into the sump. A final pipe connects the oil collection tank to the crankcase to balance the pressures.

The engine oil temperature sensor is mounted at the top of bank #1 X, whose data is sent to the injection control unit: for no reason remove or intercept the signal from this sensor. Engine lubricant pressure is measured by a sensor located at the top of bank #2.

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In order to circulate effectively in the ducts, the lubrication oil must reach a temperature of about 50 °C: avoid subjecting the engine to high working loads before this temperature is reached.



The oil reaches operating pressure a few seconds after starting: this is completely normal and is not a cause of damage to the engine.

79-22-00 General Characteristics

▪ Maximum engine oil pressure in flight	4,5 bar
▪ Minimum engine oil pressure in flight	1,5 bar
▪ Typical engine oil pressure in flight	2,5 bar
▪ Maximum engine oil temperature in flight	130 °C
▪ Minimum engine oil temperature in flight	60 °C
▪ Typical engine oil temperature in flight	100 °C
▪ Minimum engine oil temperature for starting	-10 °C (with recommended oil)
▪ Rated pump lubricant flow rate	26/min @ 3600 rpm
▪ Nominal suction pump flow rate (Turbo engines)	9L/min @ 3600 rpm
▪ Pressure setting oil filter by-pass valve	1 bar
▪ Oil filter weight	280 g

78-22-01 Capacity

▪ Nominal system quantity (with standard OC-m)	Min 3,1 l
▪ Max	3,6 l
▪ Quantities present in cup with dipstick	Min 2,4 l
▪ Max	2,9 l
▪ Quantity between min and max level	0,50 l
▪ Contents in the oil filter	~0,20 l
▪ Contents in OC-m radiator and pipes	~0,50 l
▪ Amount at oil and filter change	3 l

79-23-00 Engine Oil Cooler Installation (OC-m)

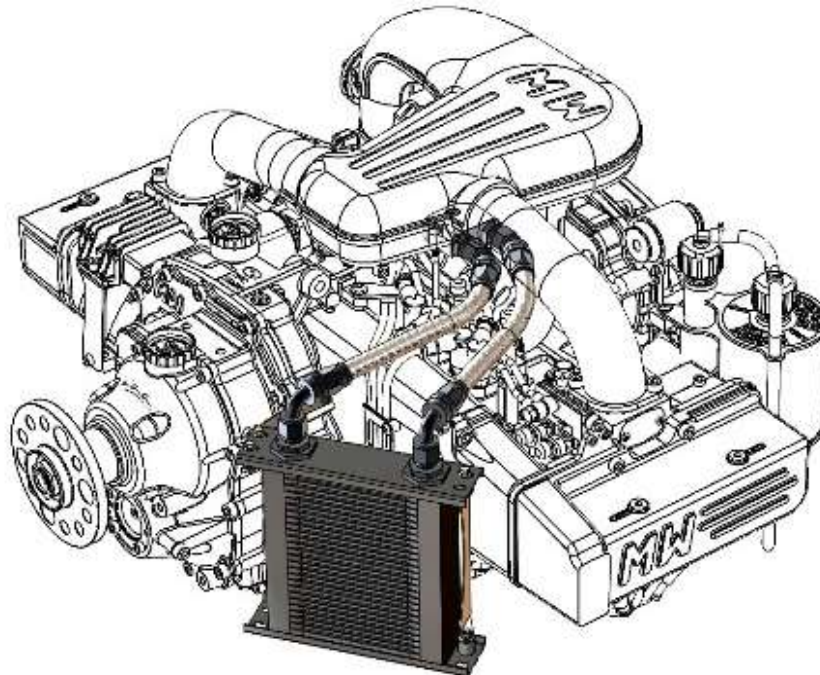
79-23-01 Description

Near the cartridge filter there is provision on the engine for connecting an oil cooler. An oil cooler assembly, called OC-m (Oil Cooler module), is available as an option: the assembly includes the radiator, support bracket, hoses and mounting hardware.



79-02-P

The cooler is located at the front left of the engine, in front of the #2 bank.



79-03-P

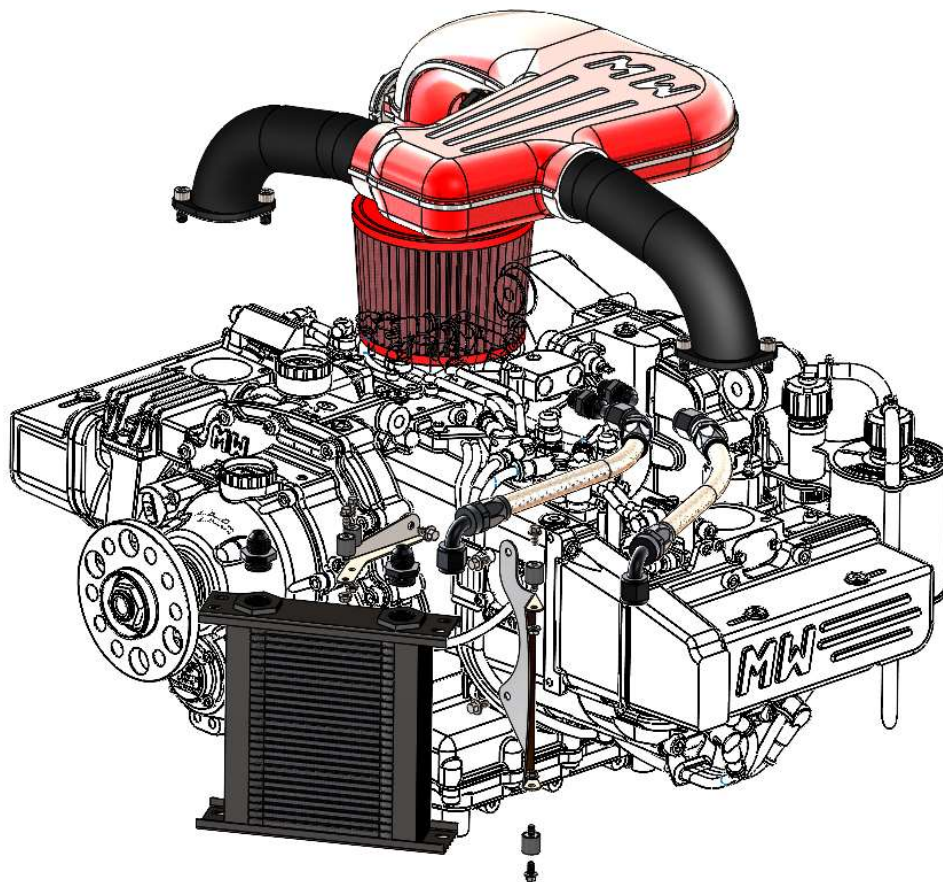
79-23-02 Component Characteristics

- | | |
|--|-----------------------|
| ▪ Cooler dimensions | 210x200x50 mm |
| ▪ Cooler cooling surface | 175 cm ² |
| ▪ Typical cooling flow on the radiator | 0,3 m ³ /s |
| ▪ Lubricant tube inner diameter | 10 mm |

- Oil quantity in cooler and pipes ~0,43 l
- OC-m weight 1,45 Kg

The lubricant is intercepted before entering the cartridge oil filter, sent to the cooler, and then reintroduced into the engine through the appropriately prepared holes.

The connection holes between the engine and oil cooler pipes are in the upper part of the engine, below the airbox: to connect them, the airbox must be removed.



79-04-P

79-23-03 Installation

Necessary Materials

1. Torque wrench 50 Nm
2. 7/8" socket wrench
3. 8 mm socket
4. 10 mm socket
5. 21 mm socket
6. 27 mm socket
7. Vaseline

Carry out the installation in accordance with the following requirements.

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- a. Remove the intake assembly.
- b. Screw [5] the adapters to the oil collector, interposing the copper washers provided: tighten [1+5] to 30 Nm.
- c. Screw [6] the adapters to the cooler, taking care to keep the O-rings provided in place: tighten [1+6] to 30 Nm.
- d. Attach [3] the supplied silent blocks to the cooler mounting brackets using the appropriate nuts: tighten [1+3] to 5Nm.
- e. Attach [4] the main cooler support bracket using the supplied screws, and tighten to [1+4] 10Nm.
- f. Fasten [4] the secondary bracket using the supplied screw: do not tighten to torque.
- g. Attach [3] the cooler to the brackets using the supplied screws: tighten [1+3] to 5Nm.
- h. Tighten [1+4] the secondary bracket to 10Nm.
- i. Attach [2] the cooler hoses to the oil collector (the 90° bend must remain available for connection to the oil radiator): the shortest must be placed in the forward position (toward the propeller flange); do not tighten.
- j. Attach [2] the cooler hoses to the cooler itself: do not tighten.
- k. Arrange the cooler hoses so that they remain flattened below the airbox; then tighten [2] the connecting nipples.
- l. Reassemble the intake assembly.
- m. Check on the ground for lubricant leakage: increase tightening if necessary.

A

During operation, the components of the lubrication circuit heat up to very high temperatures: avoid touching these components before the engine has cooled down for at least 30 minutes since the last start-up.

79-24-04 Implementation of the Oil Cooling Circuit

79-24-01 Pipes and Fittings

The characteristics of the pipes and fittings of the oil cooler circuit shall be as follows.

- Minimum continuous operating temperature 170 °C
- Minimum continuous operating pressure 10 bar
- Minimum tube inner diameter 7 mm
- Minimum radius of curvature 50 mm
- Minimum pipe inlet length on the fitting 20 mm
- Use hoses suitable for engine oil and anti-ozone, possibly with external metal braid; in any case, change system hoses at least every 2 years.

79-24-02 Cooler

The shape, size, and location of the cooler depend mainly on the available space.

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- Typical cooler cooling surface ~150 cm²
- Typical cooling flow on the cooler 0,3 m³/s

Favour positions that minimize the length of the hoses, to reduce pressure drops. The cooler should have a drain plug at the bottom, to be opened when changing engine oil.



If the cooler is very far from the engine and the hoses are not of adequate diameter, this results in a high pressure drop in the system, which can affect the proper operation of the engine.



Position the radiator and fittings in such a way as to avoid any accidental contact with hot parts of the engine, such as the exhaust system, which could alter its integrity.



During operation, the components of the lubrication circuit heat up to very high temperatures: avoid touching these components before the engine has cooled down for at least 30 minutes since the last start-up.



Under no circumstances use the screws between the crankcase to the gearbox, or air intake to fasten the cooler or an air intake. Failure to do so releases MWfly from all obligations and responsibilities to the user, and will result in automatic revocation of the warranty.

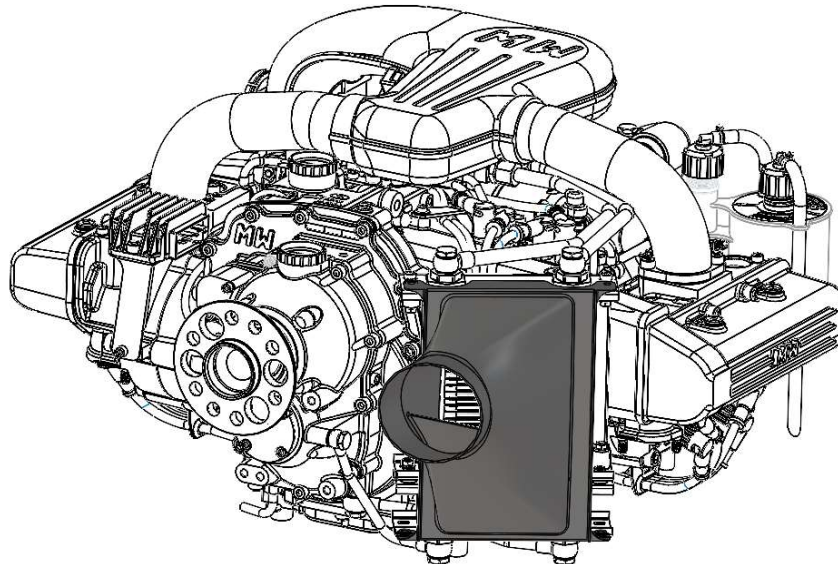
79-24-03 *Air intake sizing*

It is not possible to provide standard data for sizing the oil radiator cooling air intake, as the amount of air actually passing through the radiator can vary considerably depending on its position on the engine cowling, the speed, and the aircraft's attitude.

However, some sizing criteria are valid for most applications, and are summarized below

- The air intake should be positioned to the right of the propeller (for an observer viewing the aircraft through the propeller) and as close as possible to the propeller's plane of rotation.
- The height and width of the air intake should ideally be approximately 80% of that of the radiator. If using the gearbox oil cooling radiator, consider creating a single air intake for both radiators.
- Create a duct made of aluminum sheet metal or fiberglass between the radiator and the air intake on the engine cowling to ensure a rapid supply of fresh air to the radiator. In case both the engine oil radiator (OC-m) and the gearbox oil radiator (GC-m) are mounted, a conveyor with a 95mm diameter inlet is available as an

accessory, to be fixed to the engine oil and gearbox oil radiators, which provides ventilation for them.



79-05-P

- To improve radiator efficiency, it is advisable to seal any gaps between the air intake, the duct, and the radiator itself.
- The total area of the cowling's air extraction window must be at least three times greater than the sum of all the cowling's air intakes, whether cooling, fuel, or ventilation.
- It is advisable to shape the edge of the extraction window like a spoiler, to divert the air that touches the bonnet and create a depression area.

79-24-04 *Setting Up*



Take the utmost care in running the hoses away from heat sources or sharp or abrasive surfaces: if this is not possible, it is necessary to protect the tubes against radiation or contact with suitable material.

The cooler must be connected to the engine through the collector provided at the top of the crankcase, below the airbox unit (79-01-P).

As evidenced by the arrows, the supply branch to the radiator is the rear branch (furthest from the propeller flange); the return branch is the front branch.

The threads prepared for connection are M16x1.5. It is advisable to secure the cooler with anti-vibration mounts (silent blocks).

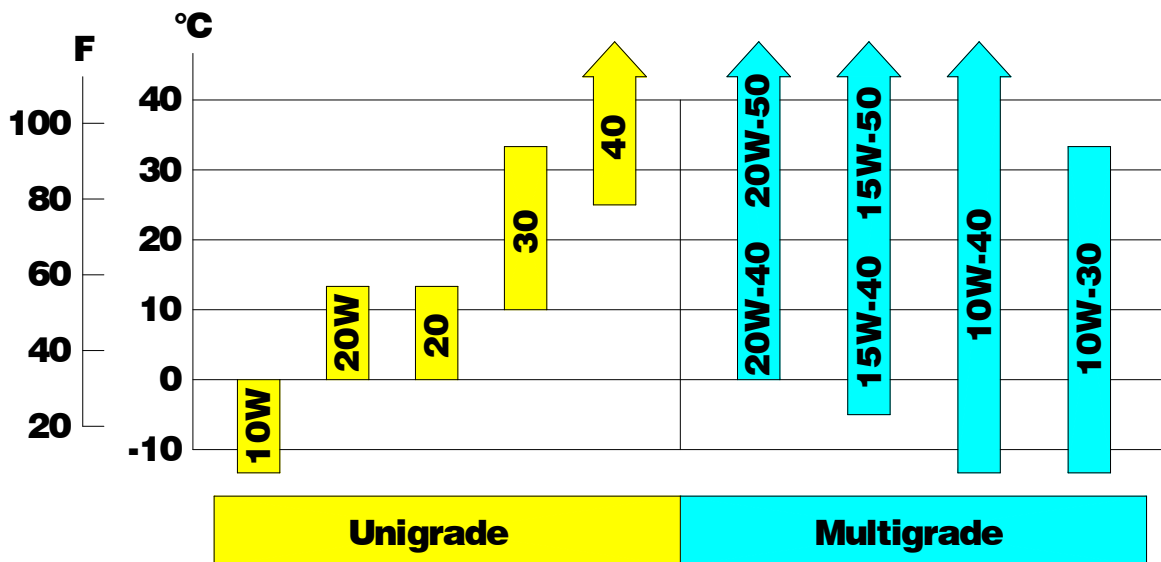


After making the connections between the engine and cooler, check on the ground that there are no lubricant leaks and that the operating pressure is within the prescribed limits.

79-25-00 Recommended Engine Lubricant

The recommended engine oil for use in temperate climates is SAE 10W40, API specification SH or higher.

When using the engine in particularly cold or hot climates, the optimal viscosity of the oil to be used should be selected based on the average atmospheric temperature of the area of use according to the following table.



79-02-C

The decision to use an oil of a different thermal grade than the prescribed one should be based on the measurement of operating temperatures: in the case of too high lubricant temperatures, oils of a higher thermal grade should be used; in the case of difficulty in reaching the prescribed minimum operating temperature, use oils of a lower thermal grade.

In case of use of the OC-m system, the amount of lubricant contained in the engine is 3.6 litres. In case of using a different oil cooler, from this quantity, the quantity of oil contained in the OC-m system (79-22-01) must be subtracted and the capacity of the radiator and the hydraulic connection fittings added.



Insufficient level of engine oil in the sump can cause engine damage.



After the first 10 hours of operation, it is necessary to replace oil and engine oil filter: failure to do so may result in performance degradation and engine damage.

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To preserve the integrity of the mechanical components of the engine, it is advisable that the lubricant should not be altered as a result of thermal cycling or oxidation: therefore, engine oil should be replaced at the prescribed intervals even if the engine is not in use or, in the case of particularly severe use (e.g., dusty areas, high operating temperatures, high atmospheric humidity), at shorter periods.



The quality of engine oil has a great influence on the durability and reliability of the engine: replacement at the indicated intervals of filter and oil is therefore an important prerequisite for the integrity of engine operation.

79-26-00 Lubricant Filling



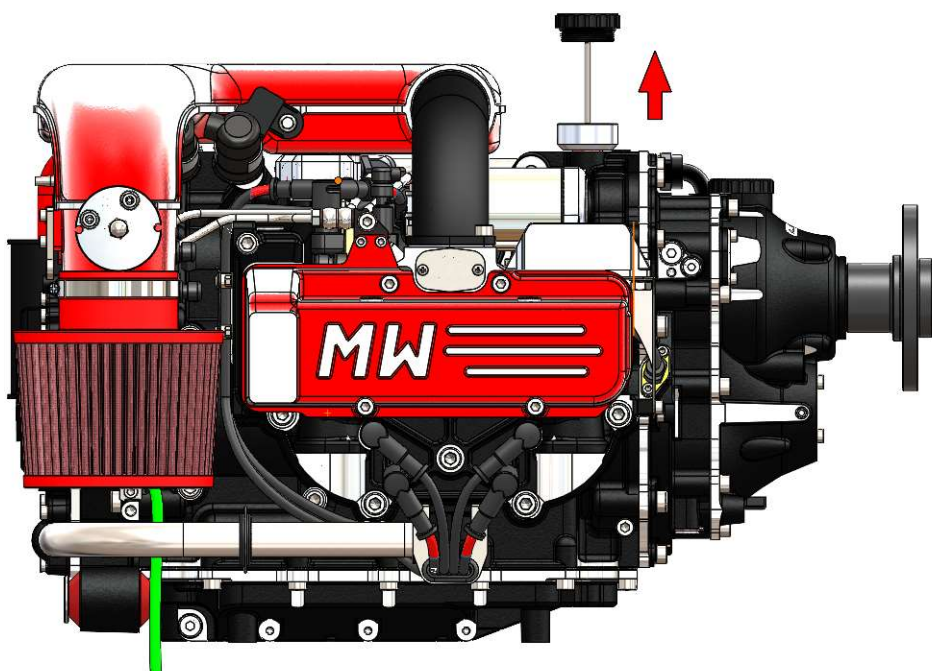
The engine is delivered without engine oil or gearbox oil. Before starting or conducting any kind of test that puts the engine into rotation, it is necessary to refill with the recommended lubricants

Necessary Materials

1. Oil filler cap tightening lever (X283)
2. Paper towels



Engine oil must be introduced by unscrewing [1] the filler cap located on the upper front of the crankcase.



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The amount of oil present in oil sump can be checked by means of the dipstick built into the filler cap, on which there is a notch to identify the maximum level; the minimum corresponds to the bottom of the dipstick.



79-06-P

The difference in oil quantity between the minimum and maximum level is 0.55 litres.

The measurement of the oil level should be made when the engine is cold and waiting at least 5 minutes from any top-up, to allow the oil to flow downward, thus avoiding erroneous readings; the reading should be made taking care to position the aircraft so as to obtain a horizontal lay of the engine.

Level measurement is performed as follows:

- a.** Unscrew [1] the cap by turning counter clockwise.
- b.** Wipe the dipstick of oil using a paper towel [2].
- c.** Reinsert the dipstick into the housing until the cap rests against its seat, without screwing it in.
- d.** Slide the cap with the dipstick back out of the housing.
- e.** Check that the level is between the bottom of the dipstick and the notch; if in doubt about the actual level, use paper towel [2] to check to what level the dipstick is wet with oil.
- f.** Top up if necessary, using oil of the same type. After waiting at least 5 minutes, check the level again.
- g.** Screw the cap back on by hand or with the specific lever [1] (tighten slightly), taking care to check that it has reached the stop.

Periodically also check the seal of the annular gasket (O-ring) located above the cap thread: if there is leakage, replace the gasket with a new one, available for replacement.



Check the oil level in the sump before each flight and top up with lubricant of the same type if necessary.

79-27-00 Verification and Validation

Fine-tuning of the lubrication system is done by measuring oil temperature and pressure under the most severe conditions of use. This condition can be identified in the take off and subsequent climb to flight altitude. The condition becomes even more severe in hot weather and, in any case, in the summer season.

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Operating the powertrain with engine oil temperatures below the rated operating temperature can cause vapor condensation to form, causing the lubricating properties of the oil to expire.



Using the engine with a non-original engine oil filter can cause serious mechanical damage due to incorrect operating pressure of the lubrication system.

The measurement of these parameters is very easy in case the EM-m instrument is used: in fact, in that case the data appears directly on the instrument, and can also be stored for a more careful and safe evaluation after the flight.

In case the oil temperature or pressure is not within the operating limits, the thermal grade should be changed, in accordance with the given table. In case the temperature remains high even with an appropriate oil thermal grade, the air flow to the oil cooler should be increased, or a larger cooler should be installed.

In addition to measuring the parameters in the condition described above, it should be verified that along the entire flight envelope, adequate oil pressure is ensured to the engine: if not, try increasing the amount of oil inside the sump, without exceeding one additional liter; if the problem remains, the flight envelope should be limited to ensure stable lubrication conditions. Also make sure that the engine lay is within the reported limits.



The lubrication system is not suitable for aerobatic flight.

It is a good practice to check for oil emulsion build up by unscrewing the lubrication system filler cap. The engine is equipped with an efficient internal ventilation system, which through a labyrinth-like path allows oil vapours to escape from the engine without an excessive amount of oil in suspension. This, in most applications, prevents condensation from forming inside the engine. Where oil emulsions are evident on the plug or on the internal parts of the engine, it is necessary to reduce the flow of fresh air to the oil cooler in a manner that raises the operating temperature of the lubricant while still meeting other operating constraints.

79-27-01 Measurement of Engine Oil pressure

In case the EM-m instrument is not used, a specific sensor must be installed to measure the engine oil pressure. Instructions for installing the additional oil pressure sensor are described in paragraph 77-01-04.

79-27-02 Measurement of Engine Oil Temperature

Similarly, in the case of the absence of the EM-m instrument, an engine oil temperature sensor must be installed: the provision is on the right side of the oil sump and has an M12x1.5 thread (see paragraph 77-01-03)

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The oil temperature sensor preinstalled on the engine supplies the data to the injection system: do not derive the signal for the instrument from this sensor so as not to alter the measured value

79-27-03 Ambient Temperature - Engine oil Temperature Relation

It is advisable to perform the verification of the system under the environmental conditions considered "limit" for aircraft operation. The most severe flight conditions for lubrication purposes are obtained by operating as summarized below.

- Maximum ambient operating temperature
- Maximum power applied for maximum allowable time
- Lowest flight speed in relation to applied power

In case the tests are carried out at ambient temperature below the maximum temperature considered permissible, the temperature rise of the lubricant can be calculated from the change in ambient temperature according to the following relation:

$$\Delta T_{oil} = 0,3 * \Delta T_{amb}$$

This means that each degree increase in ambient temperature produces an increase in lubricant temperature of 0.3 °C. For example, running the tests at an ambient temperature of 15 °C, and measuring a maximum lubricant temperature of 93 °C, we can consider that at an ambient temperature of 35 °C, the coolant temperature would rise by about 6 °C to 99 °C.



The maximum attainable temperature under limiting ambient temperature conditions must still be verified in reality. The above report is only valid for a rough verification of the lubrication system.

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80-10-00 STARTING

80-10-00 Starting System

The starting system consists of an electric starter that acts on a reduction gear, which in turn is engaged on the secondary shaft through a further reduction.

The intermediate gear is equipped with an over-torque clutch, to avoid damage to the gears in case of difficult starting.

The release between the starter and the secondary shaft after starting the engine is ensured by a free wheel, installed inside the last reduction stage.

The starter is controlled by a contactor, which diverts the adequate current required for starting directly from the battery.

80-11-00 Component Characteristics

80-11-01 Starter

The starter is attached to the top of the engine at bank #1. The starter results in engine ground. The positive pole of the starter is connected to the start relay contactor by means of a 17 mm² (AWG 5) cross-sectional area cable: therefore, no assembly work on the starter is required during installation. The characteristics of this component are as follows.

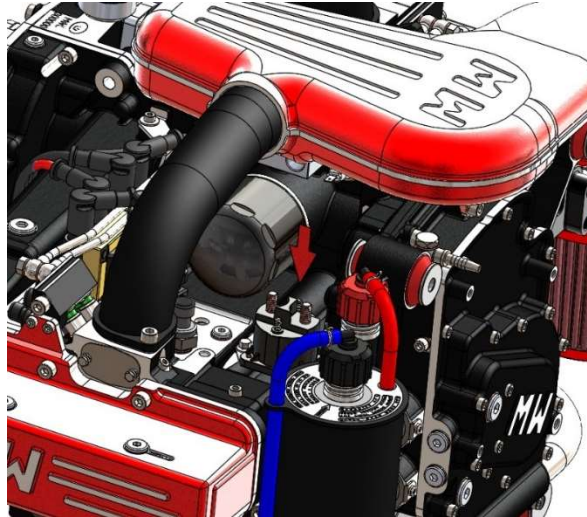
- | | |
|------------------------------------|------------------------|
| ▪ Type | with permanent magnets |
| ▪ Power rating | 0.65 kW |
| ▪ Rated voltage | 12 V |
| ▪ Inrush current consumption | 150 A |
| ▪ Maximum temperature for starting | 80 °C |
| ▪ Reduction ratio | 1÷29.7 |
| ▪ Engine revs on starting | 150÷180 rpm |



Starting is possible even at starter temperatures higher than that indicated, albeit with lower efficiency and higher absorption characteristics.

80-11-02 Start Relay

The start relay is attached to the top of the engine, bank 2 side, and is already connected to the engine wiring.

*80-01-P*

- Rated voltage 12 V
- Current on the exchange
 - max 800 A
 - continuous 100 A
- Operating temperature -40÷85 °C
- Weight 200 g
- Exchange terminals 2 for D8 mm eyelet terminal
- Terminal tightening torque 15 Nm

Carry out short start-ups to avoid a overheat the start relay.



The start relay must remain in the upright position, with the terminals facing upward: if the installation requires the start relay to be moved from its original position, comply with this essential requirement.

80-11-03 Starting Button

The starting button is responsible for giving consent to the start relay in order to start the engine.

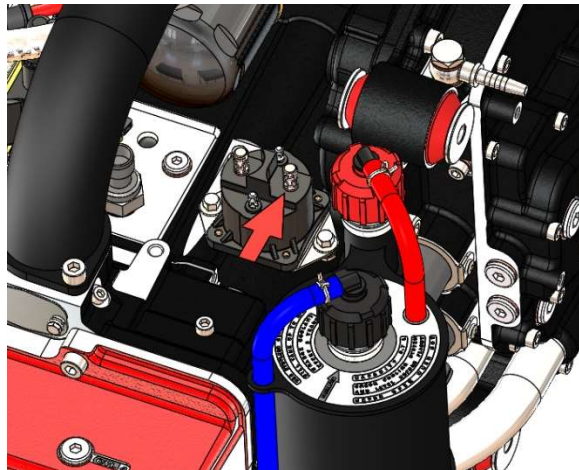
The minimum characteristics of this component should be as follows.

- Switching voltage 12 V
- Switching current 4 A
- Type of arousal momentary
- Number of cycles >50.000
- Operating temperature -30÷70 °C

80-12-00 Electrical Connections

The engine is delivered with the starter power cable already fitted, and connected to the starter contactor. The cable coming from the terminal named "Start" on the IJ-m should be connected to the second terminal of the start relay, as short as possible and with a cross-section of not less than 17 mm² (AWG5). The inrush current for

starting can be up to 300 A. The tightening torque of the M8 nut on the contactor should be 15 Nm. Take care to reinstall the safety washer present, which secures against accidental unscrewing. Use D8mm eyelet terminals.



80-02-P



The starting system if used for prolonged periods is prone to overheating. Make starting attempts lasting no more than 10 seconds. Wait at least 30 seconds between starts. If the engine does not start on the third/fourth attempt, it is useless to insist.



In case it is necessary to move the start relay from its original location, it is necessary to reinstall it with the same lie relative to the horizontal to ensure proper operation.

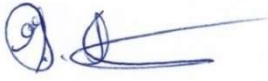



The maximum operating temperature of the starter is 80 °C: avoid exceeding it, so as not to damage the windings and the insulation inside the starter.

After the engine is installed and the engine cowling ventilation vents are made, check the maximum operating temperature of the starter and start relay.

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SIGNATURES AND LIST OF REVISIONS TO THE DOCUMENT

Filled out and checked on 25/11/2022 *from* Guido FANTINI *Signature* 

Approved on 25/11/2022 *from* Stefano MARELLA *Signature* 

Review	Applicability	Chapter	Page	Modification date
A.3	From #028220	01-00-00: Introduction	All	01/08/25
A.3	From #028220	10-00-00: Engine installation	All	01/08/25
A.3	From #028220	21-00-00: Air conditioning	All	01/08/25
A.3	From #028220	24-00-00: Electrical power	All	01/08/25
A.3	From #028220	61-00-00: Transmission	All	01/08/25
A.3	From #028220	72-00-00: Engine	All	01/08/25
A.3	From #028220	73-00-00: Fuel and control	All	01/08/25
A.3	From #028220	75-00-00: Cooling system	All	01/08/25
A.3	From #028220	76-00-00: Engine controls	All	01/08/25
A.3	From #028220	77-00-00: Engine indicating	All	01/08/25
A.3	From #028220	78-00-00: Exhaust	All	01/08/25
A.3	From #028220	79-00-00: Lubrication	All	01/08/25
A.3	From #028220	80-10-00: Starting	All	01/08/25