ROTAX®
AIRCRAFT ENGINES

BRP

INSTALLATION MANUAL

FOR ROTAX® ENGINE TYPE 914 SERIES

ref. no.: IM-914 | part no.: 897818

picture: ROTAX® 914 UL with options

⚠ WARNING

Before starting with engine installation, please read the Installation Manual completely as it contains important safety relevant information.

This Installation Manual for the ROTAX® aircraft engines should only be used as a general installation guide for the installation of ROTAX® engines into airframes. It should not be used as instruction for the installation of a ROTAX® aircraft engine in a specific type of airframe or airplane. BRP-Rotax GmbH & Co KG does not assume any warranty or liability in this context.

In no event shall the Installation Manual be used without following the specific instructions and/or requirements of the manufacture of an airframe or airplane ("Manufacturer"). For verification and/or for release of the engine installation, the respective Manufacturer must be contacted. Any modifications or adaptations to the airframe or airplane shall be carried out and/or be verified and released by the Manufacturer only.

Improper use of the Installation Manual and/or non compliance with the installation requirements of the Manufacturers can cause personal injury or property damage. BRP-Rotax GmbH & Co. KG disclaims any liability for any and all damage and/or injuries (including death) resulting from the improper use of Installation Manual and non compliance with the installation requirements of the Manufacturer.

Translation into other languages might be performed in the course of language localization but does not lie within ROTAX® scope of responsibility.
In any case the original text in English language and the metric units are authoritative.

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Chapter: INTRO
GENERAL NOTE

Foreword

Before carrying out engine installation related work on the engine, read this Installation Manual carefully. The manual will provide you with basic information on correct engine installation for safe engine operation.
If any passages of the manual are not clearly understood or if you have any questions, please contact a ROTAX® authorized distributor or their independent Service Center for ROTAX® aircraft engines.
BRP-Rotax GmbH & Co KG (hereinafter “BRP-Rotax“) wishes you much pleasure and satisfaction flying your aircraft powered by this ROTAX® aircraft engine.

The structure of the manual follows, whenever possible, the structure of the ATA (Air Transport Association) standards. The aim is the compatibility with the aircraft manufacturers documentation, which means they still must adapt or incorporate the documentation to their standard.

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Chapter: LEP
LIST OF EFFECTIVE PAGES

Each new revision to the Installation Manual will have a new List of Effective Pages.

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TABLE OF AMENDMENTS

Approval*
The technical content of this document is approved under the authority of DOA ref. EASA.21.J.048.
This document is part of the ICA for product [1996].

Edition 3/Rev. 0 August 01 2019

Rev. no.	Chapter	Page	Date of change	Remark for approval	Date of approval from authorities	Date of inclusion	Signature
0	INTRO	all	Aug. 01 2019	DOA*			
0	LEP	all	Aug. 01 2019	DOA*			
0	TOA	all	Aug. 01 2019	DOA*			
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0	10-10-00	all	Aug. 01 2019	DOA*			
0	24-00-00	all	Aug. 01 2019	DOA*			
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0	78-00-00	all	Aug. 01 2019	DOA*			
0	79-00-00	all	Aug. 01 2019	DOA*			
0	80-00-00	all	Aug. 01 2019	DOA*			

Summary of amendments

Summary of the relevant amendments in this context, but without any claim to completeness.

Rev. no.	Chapter	Page	Date of change	Comment
0	all 00–00–00 24–00–00	all 10 5	Aug. 01 2019 Aug. 01 2019 Aug. 01 2019	Standardization, New Layout Wiring color codes Battery specification

Chapter: 00–00–00
GENERAL NOTE

TOPICS IN THIS CHAPTER

GENERAL

In this Manual all ROTAX® 914 Series engines are described.

NOTE

ROTAX® 914 Series includes 914 F and 914 UL.

Purpose

The purpose of this manual is to provide aircraft manufacturers with technical requirements (e.g. interface descriptions and limitations) that must be adhered to when installing this type of engine into an aircraft or certifying aircraft powered by this engine type. Furthermore it should allow independent ROTAX® Maintenance Technicians (iRMT) to install this engine into an airframe in compliance with the relevant installation and safety instructions provided by the engine manufacturer.

For detailed information related to aircraft and aircraft/engine installation, maintenance, safety or flight operation, consult the documentation provided by the aircraft manufacturer and/or its dealer.

For additional information on engines, their maintenance or parts, you can also contact your nearest ROTAX® authorized Aircraft Engine Distributor or their independent Service Center.

ROTAX Distributors

For ROTAX® Authorized Distributors for aircraft engines see latest Operators Manual or the official website www.FLYROTAX.com.

Engine serial number

When making inquiries or ordering parts, always indicate the engine serial number. Due to continuous product improvement, engines of the same engine type might require different support and spare parts. The engine serial number is on top of the crankcase, magneto side.

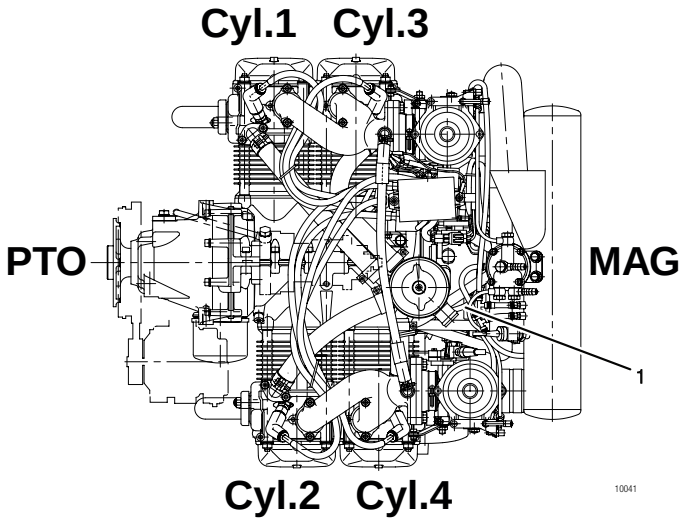

Figure 1.1: 914 Engine serial number

1 Engine serial number

TYPE DESCRIPTION (914 SERIES)

The type description consists of the following parts:

Designation

Designation		Description
Type	**914**	4–cyl. horizontally opposed, turbocharged engine
Certification	**F**	Certified to FAR 33 (TC No. E00058EN), JAR-E (TC No. EASA.E.122)
	UL	Approved to according ASTM F2339
Configuration	**2**	Prop shaft with flange for fixed pitch propeller
	3	Prop shaft with flange for constant speed propeller and drive for hydraulic governor for constant speed propeller
Suffix	**- XX**	Explanation of the type designation Suffix, see SB-914-049.

Options

Available options (optional equipment) for the engine type mentioned above:

	external alternator	vacuum pump	drive for rev counter/ hour meter	governor
for configuration 2	yes	yes	yes	no
for configuration 3	yes	no	yes	yes

NOTE

Conversion of the configuration 2 to configuration 3 and vice versa may be accomplished by BRP-Rotax Authorized Distributors or their independent Service Centers.

SCOPE OF SUPPLY

Basic

- 4-stroke, 4 cylinder horizontally opposed, spark ignition engine with turbocharger, single central camshaft hydraulic tappets – push rods – OHV
- Liquid cooled cylinder heads
- Ram air cooled cylinders
- Dry sump forced lubrication
- Dual ignition of breakerless capacitor discharge design
- 2 constant depression carburetors and airbox
- 2 electric fuel pumps (12 V DC)
- Electric starter (standard or starter with extended power output)
- Stainless steel exhaust system
- Expansion tank (coolant)
- Engine suspension frame
- Integrated AC generator with external rectifier-regulator (12 V 20 A DC)
- Propeller drive thru integrated gearbox with shock absorber and overload clutch (optional on configuration UL2)
- Oil tank
- External start relay
- Drive of hydraulic governor (on configuration 3 only)

AUXILIARY EQUIPMENT (OPTIONAL)

Any equipment not included as part of the standard engine version and thus not a fixed component of the engine is not in the volume of supply.
Components especially developed and tested for this engine are readily available at BRP-Rotax.

Auxiliary equipment certified

The following auxiliary equipment has been developed and tested for this engine.

- external alternator
- vacuum pump (feasible on configuration 2 only)
- drive for tachometer/hour-meter
- oil radiator with connections
- coolant radiator
- coolant overflow bottle

⚠ WARNING

Non-compliance can result in serious injuries or death!
The user assumes all risks possibly arising by utilizing auxiliary equipment.The furnishing of proof in accordance to the latest FAR or EASA has to be conducted by the aircraft manufacturer.

Auxiliary equipment not certified

The following auxiliary equipment has not been developed and tested for this engine.

- intake filter
- Flydat
- shock mount
- mechanical tachometer
- electric tachometer
- oil hose

ABBREVIATIONS AND TERMS

Abbreviations	Description
*	Reference to another section
⊕	center of gravity
	The drop symbol indicates use of sealing agents, adhesives or lubricants (only in the Illustrated Parts Catalog).
°C	Degrees Celsius (Centigrade)
°F	Degrees Fahrenheit
rpm	Revolutions per minute
A	Ampere
AAPTS	Ambient Air Pressure Temperature Sensor
AC	alternating current
Ah	Ampere hour
A/C	Aircraft
AR	as required
assy.	assembly
ASB	Alert Service Bulletin
ACG	Austro Control GmbH
ACL	Anti Collision Light
API	American Petrol Institute
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
AWG	American Wire Gauge
CAN	Controller Area Network
Coil 1–4	Ignition coils 1–4
CPS 1+2	Crankshaft Position Sensor 1+2
CSA	Constant Speed Actuator
CTS	Cooling Temperature Sensor
CW	clockwise
CCW	counter-clockwise
CGSB	Canadian General Standards Board
DCDI	Dual Capacitor Discharge Ignition

DC	direct current
DOA	Design Organisation Approval
DOT	Department of Transport
EASA	European Aviation Safety Agency
IM	Installation Manual
ECU	Engine Control Unit
EGT	Exhaust Gas Temperature
INTRO	Introduction
EMS	Engine Management System
EMS GND	Engine system internal ground reference which is intended to be disconnected from aircraft common ground during flight
EMC	Electromagnetic compatibility
EN	European Standard
ETFE	Ethylene Tetrafluoroethylene
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FOD	Foreign object damage
Fuse box	Power conditioning and distribution for the Engine Management System
hr.	hours
HIC A	Harness Interface Connector A
HIC B	Harness Interface Connector B
IAT	Indicated Air Temperature
ICA	Instructions for Continued Airworthiness
IFR	Instrument Flight Rules
IFSD	In-flight -shutdown
INJ 1–8	Injector 1–8
IPC	Illustrated Parts Catalog
ips	inch per second
iRMT	independent ROTAX Maintenance Training
ISA	International Standard Atmosphere
kg	Kilograms

KNOCK	Knock sensor
Lane A	System A of Engine Management System
Lane B	System B of Engine Management System
MAPS 1 & 2	Manifold Air Pressure Sensor 1 & 2
MATS 1 &2	Manifold Air Temperature Sensor 1 & 2
MON	Motor Octane Number
MAG	Magneto Side
N	Newton
n.a.	not available
NDT	Non Destructive Testing
Nm	Newtonmeter
NVFR	Night Visual Flight Rules
OAT	Organic Acid (Additive) Technology
OHM	Overhaul Manual
OHV	Over Head Valve
OM	Operators Manual
OPS	Oil Pressure Sensor
OTS	Oil Temperature Sensor
PCD	Pitch Circle Diameters
PCV	Pressure Control Valve
POA	Production Organisation Approval
PS	Power supply
PTFE	Polytetrafluoroethylene (Teflon)
PTO	Power Take Off
Rev.	Revision
ROTAX®	is a trademark of BRP-Rotax GmbH & Co KG
RON	Research Octane Number
RON 424	ROTAX® Standard 424
s.v.	still valid (only Illustrated Parts Catalog)
S/N	Serial Number
SAE	Society of Automotive Engineers
SB	Service Bulletin
SI	Service Instruction

SI-PAC	Service Instruction Parts and Accessories
SPST	Single pole single throw
STP	Shield twisted pair
SL	Service Letter
SMD	Surface Mounted Devices
TBO	Time Between Overhaul
TC	Type certificate
part no.	Part number
TOA	Table Of Amendment
TOC	Table of content
TSN	Time Since New
TSNP	Time Since New Part
TSO	Time Since Overhaul
V	Volt
VFR	Visual Flight Rules
LEP	List of Effective Pages
MM	Maintenance Manual
MEP	Multi Engine Piston
X3	Connector on Engine Management System wiring harness which serves as an interface for power supply.
XXXX	shows the serial component number

WIRING COLOR CODES

Figure 1.2

CONVERSION TABLE

Units of length:	**Units of power:**
1 mm = 0.03937 in 1 in = 25.4 mm 1 ft = 12 in = 0.3048 m	1 kW = 1.341 hp 1 hp = 0.7457 kW 1 kW = 1.3596 PS 1 PS = 0.7355 kW
Units of area:	**Units of temperature:**
1 cm² = 0.155 sq. in (in²) 1 sq. in (in²) = 6.4516 cm²	K = °C – 273,15 °C = (°F – 32) / 1,8 °F = (°C x 1.8) +32
Units of volume:	**Units of velocity:**
1 cm³ = 0.06102 cu in (in³) 1 cu in (in³) = 16.3871 cm³ 1 dm³ = 1 l 1 dm³ = 0.21997 gal (UK) 1 gal (UK) = 4.5461 dm³ 1 dm³ = 0.26417 gal (US) 1 gal (US) = 3.7854 dm³	1 m/s = 3.6 km/h 1 ft/min = 0.3048 m/min = 0.00508 m/sec 1 m/s = 196.85 ft/min 1 kt = 1.852 km/h 1 km/h = 0.53996 kn
Units of mass:	**spec. fuel consumption:**
1 kg = 2.2046 lbs. 1 lb. = 0.45359 kg	1 g/kWh = 0.001644 lb/hph 1 lb/hph = 608.277 g/kWh
Density:	**Units of torque:**
1 g/cm³ = 0.016018 lb/ft³ 1 lb/ft³ = 62.43 g/cm³	1 Nm = 0.737 ft lb = 8.848 in lb 1 ft lb = 1.356 Nm 1 in lb = 0.113 Nm
Units of force:	**Cable cross-section: Conversion table-Wire Gauge: AWG-mm²**
1 N = 0.224809 lbf 1 lbf = 4.4482 N	AWG —> mm² 4 —> 21 6 —> 13 8 —> 8.4 10 —> 5.3 12 —> 3.3 14 —> 2.1 16 —> 1.3 18 —>0.8 20—> 0.52
Units of pressure:	
1 Pa = 1 N/m² 1 bar = 100 000 Pa / 1000 hPa / 100 kPa 1 bar = 14.503 lbf/in² (psi) 1 in Hg = 33.8638 hPa	

SAFETY NOTICE

Although reading such information does not eliminate any hazards, it promotes understanding, and applying of the information will promote correct use of the engine. Always apply common workshop safety rules.

The information and descriptions of components and systems contained in this Manual are correct at the time of publication. BRP-Rotax maintains a policy of continuous improvement of its products without imposing upon itself any obligation to retrofit products previously manufactured.

Revisions

BRP-Rotax reserves the right to remove, replace or discontinue any design, specification, feature or other at any time, and without incurring obligation.

Measurement

Specifications are given in the SI metric system with the imperial- and US customary measurement system equivalents in parenthesis.

Symbols used

This Manual uses the following symbols to emphasize particular information. This information is important and must be observed.

⚠ WARNING
Identifies an instruction which, if not followed, may cause serious injury or even fatal injury.

⚠ CAUTION
Identifies an instruction which, if not followed, may cause minor or moderate injury.

ATTENTION
Identifies an instruction which, if not followed, may severely damage the engine or could void any warranty.

NOTE

Indicates supplementary information which may be needed to fully complete or understand an instruction.

ENVIRONMENTAL NOTE
Environmental notes give you tips on environmental protection.

A revision bar outside the page margin indicates a change to text or graphic.

SAFETY INFORMATION

Use for intended purpose

⚠ WARNING

Non-compliance can result in serious injuries or death!
The user has to assume all risks possibly arising from utilizing auxiliary equipment.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Never fly the aircraft equipped with this engine at locations, air speeds, altitudes or in other situations which do not allow a successful no-power landing after sudden engine stoppage.

- This engine is not suitable for aerobatics (inverted flight, etc.). Flight attitudes outside the permissible limits are not allowed
- This engine has exclusively been developed and tested for fixed wing, gyrocopter, pusher and tractor applications. In case of any other usage, the OEM is responsible for testing and the correct function of the engine
- It should be clearly understood that the choice, selection and use of this particular engine on any aircraft is at the sole discretion and responsibility of the aircraft manufacturer, assembler or owner/user
- Due to the varying designs, equipment and types of aircraft, BRP-Rotax grants no warranty on the suitability of its engines use on any particular aircraft. Further, BRP-Rotax grants no warranty on this engines suitability with any other part, component or system which may be selected by the aircraft manufacturer, assembler or user for aircraft application
- Unless correctly equipped to provide enough electrical power for night VFR (according to latest requirement as ASTM), the ROTAX® 914 UL is restricted to DAY VFR only

⚠ WARNING

Non-compliance can result in serious injuries or death!
For each use of DAY VFR, NIGHT VFR or IFR in an aircraft the applicable legal requirements and other existing regulations must be adhered to.

- In addition to observing the instructions in our Manual, general safety and accident precautions, legal regulations and regulations of any aeronautical authority must be observed
- Where differences exist between this Manual and regulations provided by any authority, the more stringent regulation shall be applied
- For continued airworthiness see Maintenance Manual Line

- Unauthorized modifications of engine or aircraft will automatically exclude any liability of the engine manufacturer for consequential damage
- This engine may be equipped with a vacuum pump other than the GENUINE ROTAX® vacuum pump. The safety warning accompanying the air pump must be given to the owner/operator of the aircraft into which the air pump has been installed

Engine operation

- The engine must always be operated according to the content of the latest Operators Manual
- To eliminate the risk of injury or damage, ensure any loose equipment or tools are properly secured before starting the engine
- The use of propellers and their fastenings which exceed the specified values of moment of inertia and imbalance is not allowed and releases the engine manufacturer from any liability
- Improper engine installation, use of unsuitable piping for fuel, cooling and lubrication system and use of unsuitable wiring for electric and engine management system releases the engine manufacturer from any liability

INSTRUCTION

Engines require instructions regarding their installation, application, use, operation, maintenance and repair.
Technical documentation and regulations are useful and necessary complementary elements for trainings, but can by no means substitute for theoretical and practical instructions.
These instructions should cover explanation of the technical context, advice for operation, maintenance, installation, use and operational safety of the engine.

Safety notice

In this technical Manual passages concerning safety are especially marked. Pass on safety warnings to other users!

Accessories

This engine must only be operated with accessories supplied, recommended and released by BRP-Rotax. Modifications are only allowed after consent of the engine manufacturer.

Spare parts

See Illustrated Parts Catalog, latest issue for the respective engine type.

ATTENTION

Only use GENUINE ROTAX® spare parts. Spare parts must meet the requirements defined by the engine manufacturer. This can only be guaranteed when using GENUINE ROTAX® spare parts and/or accessories. Spare parts are available at ROTAX® Authorized Distributors and their independent Service Centers. Any warranty by BRP-Rotax will become void if spare parts and/ or accessories other than GENUINE ROTAX® spare parts and/or accessories are used (see latest Warranty Conditions).
See relevant Service Letter on www.FLYROTAX.com

Standard tools / Special tools

ATTENTION

Only use tools and appliances which are suitable for the relevant task according to the latest Manuals.

State of delivery

⚠ WARNING

Engine and gearbox are delivered in “dry“ conditions (without fuel, oil and coolant).
Before putting the engine into operation it must be filled with oil and cooling liquid. Use only oil and coolant as specified.

See latest Operators Manual and Service Instruction SI-914-019 “Selection of suitable operating fluids“, current issue.

TECHNICAL DOCUMENTATION

These documents form the instructions ensuring continued airworthiness of ROTAX® aircraft engines.
The information contained herein is based on data and experience that are considered applicable for authorized mechanics (iRMT, see Maintenance Manual Line) under normal conditions for engine removal and installation. Concerning design of engine installation in depth knowledge of aircraft design is required.
Due to the fast technical progress and fulfillment of particular specifications of the customers it may occur that existing laws, safety prescriptions, constructional and operational regulations may not be sufficient or cannot be transferred completely to the object bought, in particular for special constructions.

Documentation

- Installation Manual
- Operators Manual
- Maintenance Manual (Line and Heavy Maintenance)
- Overhaul Manual
- Illustrated Parts Catalog
- Alert Service Bulletin
- Service Bulletin
- Service Instruction / Service Instruction-Parts and Accessories
- Service Letter

Status

The status of the Manuals can be determined by checking the table of amendments. The first column of this table indicates the revision status, which should be compared with the revision provided on the ROTAX®-Website: www.FLYROTAX.com
Amendments and current versions can be downloaded free of charge.

Replacement pages

Furthermore the Manual is constructed in such a way that single pages can be replaced instead of the complete document. The list of affected pages is given in the chapter LEP. The particular edition and revision number is given on the footer of each page.

Reference

This Manual is only part of the technical documentation and will be supplemented by the respective Operators Manual, Maintenance Manuals and Illustrated Parts Catalog.

ATTENTION
Pay attention to references to other documentation, found in various parts of this Manual.

If not stated otherwise, any reference to a document refers to the latest edition issued by BRP-Rotax.

This symbol informs you of additional references (data sheets, Manuals, etc.) associated with the given subject.

Illustrations

The illustrations in this Manual are merely sketches and show typical arrangements. They may not represent full detail or the exact shape of the parts but should outline the same or similar function. Therefore deriving dimensions or other details from illustrations is not permitted.
TYPICAL indicates a general view which may not represent exact details.

NOTE

The Illustrations in this Manual are stored in a graphic database system and are provided with a consecutive, irrelevant, number.
This number (e.g. AE 5iS001) is of no significance for the content.

Some measurements are given in the drawings, these are manufacturing dimensions and are subject to corresponding tolerances.

Installation drawings

Installation drawings and a DMU-model for (virtual) installation analysis are available from the ROTAX® Authorized Distributors or their independent Service Centers on special request and relevant non disclosure and copyright regulations.

The illustrations in this Manual show a possible installation variant including non certified parts.

APPROVAL OF ELECTRIC AND ELECTRONIC COMPONENTS (EQUIPMENT QUALIFICATION ACCORDING TO RTCA/DO-160)

Electromagnetic compatibility (EMC)

The engine complies with the electromagnetic interference and lightning strike requirements of RTCA/DO-160C, section 18, 20-22 and IEC 801-2.

The following EMC tests have been carried out:

- Radio frequency (RF) sensitivity (conducted)
- Radio frequency (RF) sensitivity (radiated)
- Audio frequency sensitivity
- Lightning strike sensitivity
- Conducted radio frequency (RF) interference
- Radiated radio frequency (RF) interference

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Chapter: 10–10–00
STORAGE AND INSTALLATION

TOPICS IN THIS CHAPTER

GENERAL

ATTENTION
Risk of consequential damage to engine and aircraft as a result of corrosion and damage. Under no circumstances is a corroded or damaged engine to be installed in an aircraft!

ENGINE STORAGE

The engine is preserved at BRP-Rotax thus guaranteeing proper protection against corrosion damage for at least 12 months after the date of delivery from BRP-Rotax.

This warranty is subject to the following conditions:

- The engine must be stored in the GENUINE ROTAX® packing as supplied by BRP-Rotax.
- The covers on various openings must not be removed
- The engine must be stored in a suitable place (at min. -40 °C/-40 °F and max. +80 °C/ 176 °F)
- The bag (blue) surrounding the engine must not be damaged or removed, as it protects the engine from corrosion and oxidation

If the engine is stored for a period longer than 12 months (or it is not stored in the GENUINE ROTAX® packing) then maintenance tasks must be carried out every 3 months as per the currently valid Maintenance Manual Line.

UNPACKING THE ENGINE

ATTENTION
The attachment screws are only for transport and must not be used in the aircraft.

ATTENTION
During engine installation take into account the total engine weight and ensure careful handling.

Unpacking the engine

When the engine is delivered, check for damage of the packaging. If the package is damaged, contact the authorized Distributor- or their independent Service Center for ROTAX® aircraft engines.
To unpack a new engine and for checking the state of delivery, proceed as follows:

Step	Procedure
1	Remove the wooden cover.
2	Remove the bag and protective wrapping around the engine.

Step	Procedure
3	Check that the serial number and engine type on the type plate are identical to those shown on the delivery note. If the serial number or the engine type is deviating from the delivery contact a ROTAX® Authorized Distributor- or their independent Service Center for ROTAX® aircraft engines.
4	Check the engine for damage or corrosion. If the engine is damaged or corroded, contact a ROTAX® Authorized Distributor- or their independent Service Center for ROTAX® aircraft engines.
5	Unscrew the transport bracket screws from wooden bottom of the box.
6	Remove transport brackets from engine.

Transport

The engine to be lifted by two hooks or straps around the middle of the intake manifolds. See section engine views, numbering of cylinders and definition of main axes.

Protective coverings

ATTENTION

Protective coverings are only for use during transport and engine installation. They must be removed completely (including sealing materials) before the engine is operated.

All openings are protected against ingress of contamination and dampness. It is recommended to leave the protective plugs in place until installation of the specific feed line.

The protective coverings can be found at following locations:

Pos.	Installation location	Amount
1	Exhaust sockets	1x cone plug
2	Air intake socket on turbo	1x cover
3	Connection for manifold pressure	1x scew
4	Fuel pressure control (in- and outlet)	1x cap on each opening
5	Oil supply and oil discharge	1x cap on each opening
6	Oil return (turbo)	1x cap
7	Supply and discharge of coolant	1x cap on each opening
8	Propeller shaft on configuration 3	1x disk plug or cap
9	Airbox	2x cap
10	Governor flange	1x cover

ENGINE SUSPENSION AND INSTALLATION POSITION

ATTENTION

During engine installation take into account the total engine weight and ensure careful handling.

Engine suspension

The engine suspension is essentially determined by the aircraft design. Eight attachment points are provided (4 on the engine and 4 on the engine suspension frame).

Engine suspension frame

If the engine suspension frame is not used or if modified:

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

The engine is supplied with a tested and certified suspension frame for the fireproof bulkhead. The exhaust system and the turbocharger are supported on this frame too.Installation in the aircraft is carried out using captive rubber mounts which also isolate vibration and noise from the aircraft frame.

Turbocharger

Furthermore a suitable suspension for turbocharger and exhaust system has to be developed. **Since these components weigh approx. 6 kg (13 lbs), this suspension has to be carefully designed and tested.**

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

DEFINITION OF ATTACHMENT POINTS

ATTENTION

A minimum of 4 attachment points must be used. These must be distributed symmetrically between the left (L) and right (R) sides.

Therefore it is recommended to use the ROTAX® engine suspension frame and the 4 stated attachment points R2, L2, R3 and L3.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The aircraft or fuselage manufacturer must design the engine suspension so that it can safely carry the maximum occurring operational loads without exceeding the max. allowable forces and bending moments on the engine housing and attachment points.
Tighten all engine suspension screws as specified by the aircraft manufacturer.

ATTENTION

The attachment screws are only for transport and must not be used in the aircraft.

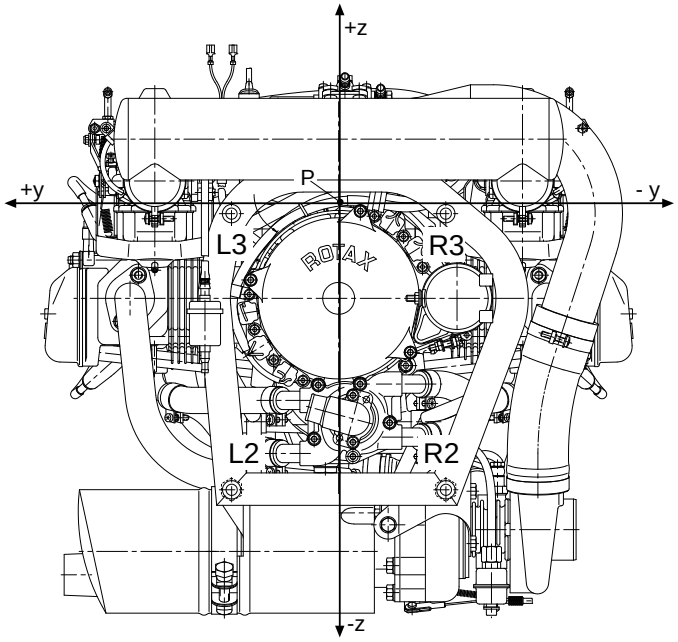

Figure 2.1: Attachment points rear view

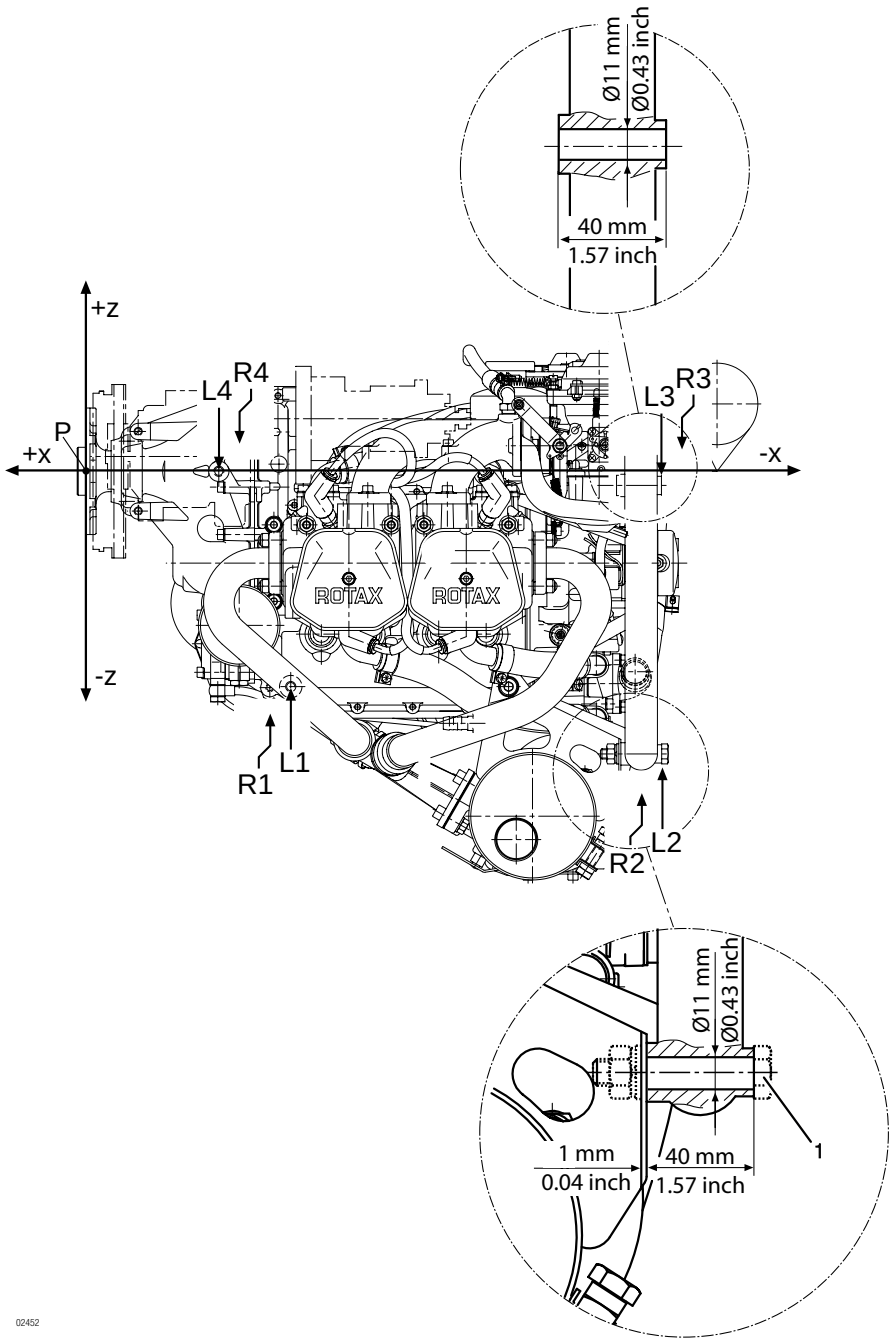

Figure 2.2: Attachment points side view

Attachment point	**L1**	**R1**	**L2**	**R2**	**L3**	**R3**	**L4**	**R4**
x-Axis (mm)	-200,8		-564				-128,3	
y-Axis (mm)	-71	71	105	-105	105	-105	87	-87
z-Axis (mm)	-211		-277		-7		0	
max. allowable forces (limit load) in x Axis (N)	5000		5000				1900	
max. allowable forces (limit load) in y Axis (N)	5000		2000				1900	
max. allowable forces (limit load) in z Axis (N)	5000		3000				1900	
max. allowable bending moment (limit load) in x,y,z Axis (Nm)	77		100				39	
Thread	M10						M10	
max. usable thread length (mm)[1]	25						19	
max. usable thread length (mm)[2]	25						16	

1. up to gearbox S/N 28986
2. starting from gearbox S/N 28987

PERMISSIBLE INSTALLATION POSITIONS

ATTENTION

Upside-down/inverted installation of the engine.
The oil system, fuel system and the cooling system are unsuitable for upside-down/inverted installation of the engine!

NOTE

All distances are given in relation to the reference coordinate system (P).

Installation positions

The following installation position details refer to the aircraft in parked position (aircraft on ground, ready for take off).

- Engine suitable for propeller in tractor or pusher arrangement
- Installation only with propeller shaft above cylinders

Propeller axis

The centres of attachment points L1 and R1 must be on a y2 axis parallel to the y-axis.
Permissible deviation from parallel: ±5°

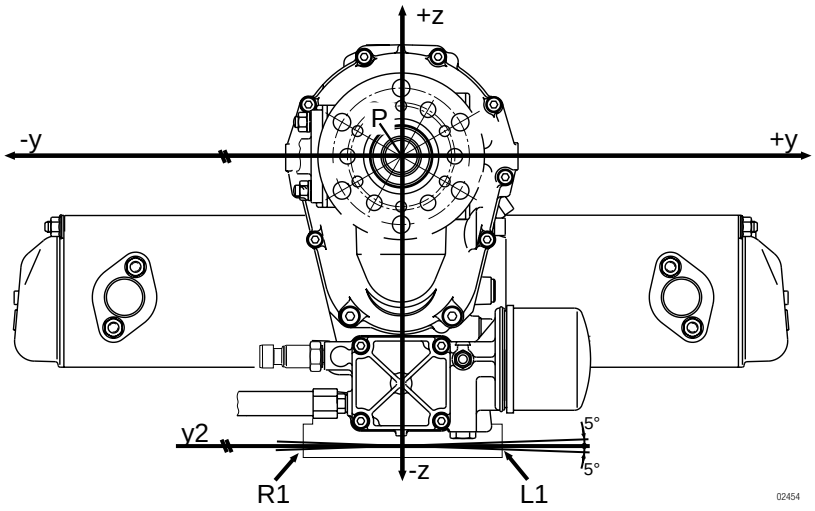

Figure 2.3: Deviation Propeller axis

Longitudinal axis: The centre of the attachment points L1 and L(T)2 must be on axis x2 parallel to the x axis.
Allowable pitch deviation of parallelism of axis:

- on ground
  max. 6° counter-clockwise
- in operation
  max. 10° counter-clockwise,
- max. 30° clockwise

⚠ WARNING

Non-compliance can result in serious injuries or death!
On installations with fuel tank located above carburetor level combined with badly closing carb float valve, fuel could pass into cylinders at more than 6° decline of propeller shaft axis after longer periods of downtime. See FAR, § 33.17. To avoid a possible gasoline explosion (cylinder full with fuel) at start up, take care of well-closing float needles. In case of doubt, the fuel valve must be closed or the aircraft parked with increasing propeller shaft axis.

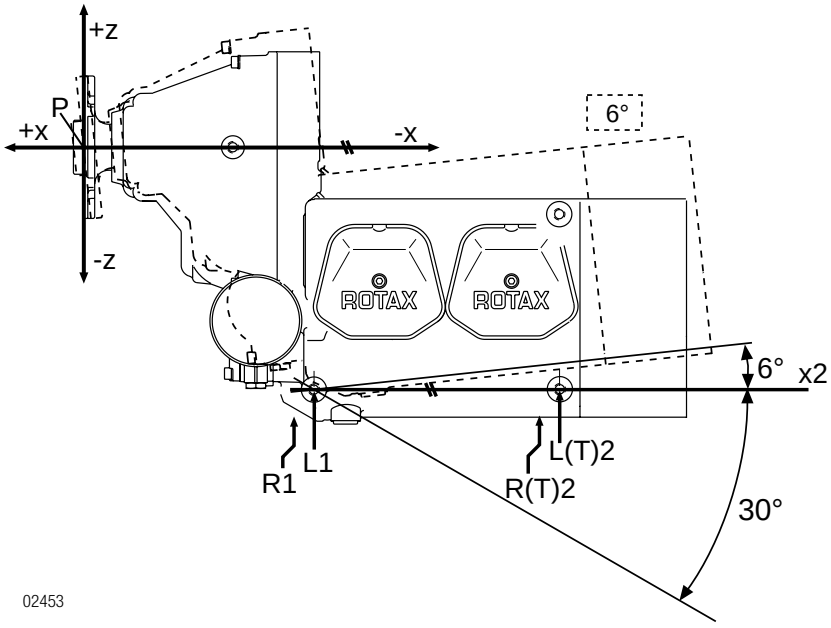

Figure 2.4: Deviation longitudinal axis

Vertical axis

The y-axis must be perpendicular to the longitudinal axis of the aircraft.
Permissible deviation from perpendicular: ±10°

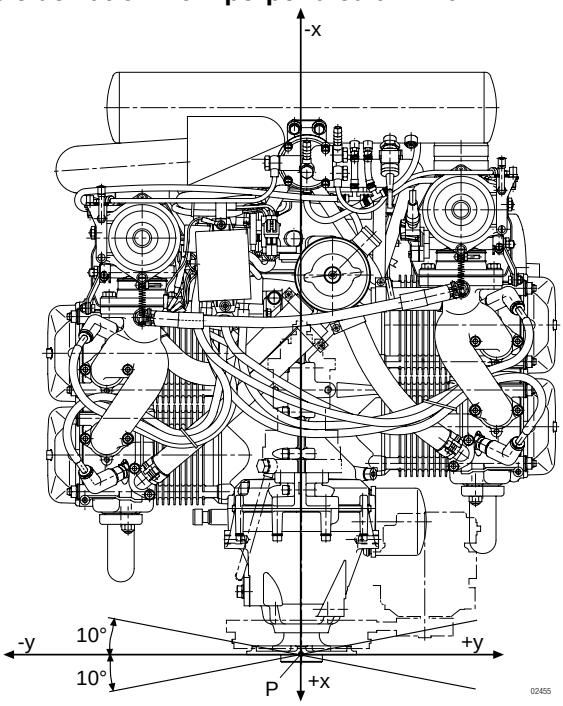

Figure 2.5: Deviation Vertical axis

ENGINE SUSPENSION

The rubber mounts for neutralizing vibrations and all engine suspension components not in the scope of delivery must be ground run tested at the specified loads and tested for vibration behavior.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Noise emission and vibration

ATTENTION

The engine suspension must be designed to prevent excessive engine movement and to minimize noise emission and vibration on the airframe.

ATTENTION

If the GENUINE ROTAX® engine suspension frame is not being used, a vibration test must be carried out.

See Service Letter SL-912–010 “Vibration test”, latest issue.

NOTE

With suspension on the 4 top lugs L3, R3, L4 and R4 only, the tilting moment due to the pull of the propeller will be avoided while, if attached on the bottom lugs only, the moment of tilting is taken care of accordingly.

Damping elements

ATTENTION

All elements for neutralizing vibrations must be captive.

Standard aircraft industry damping elements (e.g. Lord) are suitable. The illustration shows Lord J 3608-1 or J 3608-2 rubber mounts.

NOTE

Consult the parts manufacturer for the dimensions of the rubber mounts.

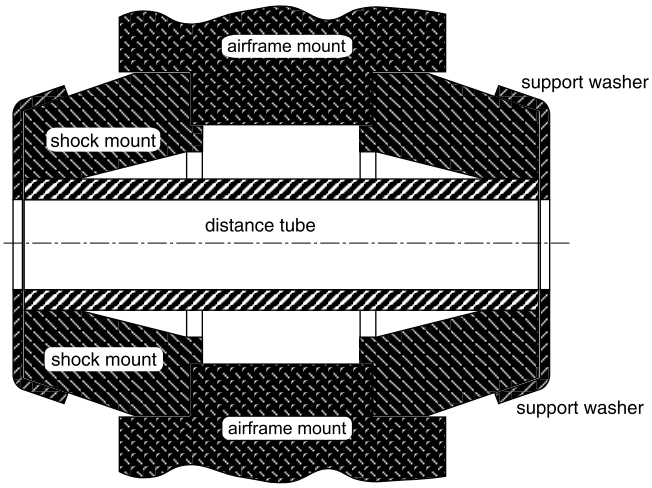

Figure 2.6: Damping element engine suspension

Vibration neutralization

The vibration and acoustic insulation factor is dependent on the aircraft manufacturer. Perform the determination as described in SL-912-010.

PREPARATIONS FOR TRIAL RUN OF ENGINE

⚠ WARNING

Non-compliance can result in serious injuries or death!
Engine start and operation must be observed as described in the Operators Manual.

CHECKS BEFORE TRIAL RUN

⚠ WARNING

Non-compliance can result in serious injuries or death!
Always observe the engine from a safe place while it is running. Check that the cockpit is occupied by a competent operator.

NOTE

This checklist is not exhaustive. Consult all Instructions for Continued Airworthiness.

See latest Operators Manual of the respective engine type.

Review relevant Service Instruction SI-914-019 for "Selection of suitable operating fluids" current issue.

- Check engine oil, coolant and fuel level
- Check throttle and choke controls hit both stops and operates in correct range of motion
- Make sure that no tools remain in the engine compartment
- Check for other foreign or loose objects
- Check for tight fit of propeller and pitch setting
- Check that propeller control hits stops and operates on correct range of motion (if equipped)
- Fasten the aircraft to the ground in an appropriate way and use chocks for the wheels. Secure the area surrounding the propeller to exclude hazards to other persons
- Visual inspection of engine and accessories
- Check for leaks
- Check suspension of engine
- Check for a tight fit of oil filter
- Check oil hose connections are correct
- Check for correct oil system purging

- Check if other systems and instruments are installed appropriately
- Check gauges for accuracy
- Check wires routed properly and secured
- Check exhaust system for security and free of blockage
- Preheat engine in cold weather

CONDUCT TEST RUN

See latest Operators Manual of the respective engine type.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The general safety information must be observed for all work on the aircraft engine and its surrounding components.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Proper clothing, ear protection etc. should be used during any engine test run.

VERIFICATION OF THE THROTTLE LEVER DETENT FOR MAX. CONTINUOUS POWER

Performance check in accordance with Operators Manual.
If nominal performance won't be reached or is in excess of, examination of the installation and engine will be necessary.

ATTENTION

Don‘t conduct any test flights before fault has been traced and found.

NOTE

Make an entry of the details and test results into the engine log book.

Chapter: 24–00–00
ELECTRICAL POWER

TOPICS IN THIS CHAPTER

INSTALLATION OVERVIEW

Scope of supply

The certification of items/components which are not included in the standard volume of supply of engine has to be conducted by the aircraft manufacturer.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Position	Scope of supply
1-20	are included in the standard volume of supply of the engine
52-57	are included in the standard volume of supply of the engine
21-25	are available as accessory
30-51, 58	can't be supplied by BRP-Rotax

Components

The engine is supplied with the wiring completed and ready to operate. Only the following connections to the aircraft have to be established.:

- Integrated generator
- External rectifier-regulator
- Electronic modules
- Electric starter
- Start relay
- 2 electric fuel pumps
- TCU
- Isolating switch for servo motor
- 2 lamps (boost- and caution lamp)
- Items conditional for operation like circuit breakers, ON-OFF switches, control lamps, relays, instrumentation and capacitors

Optional components

- External alternator
  (as option if the output of the integrated generator is inadequate)
- Electric tachometer (accessory)
- Appliance (Battery,...)
  not supplied by BRP-Rotax

Wiring diagram

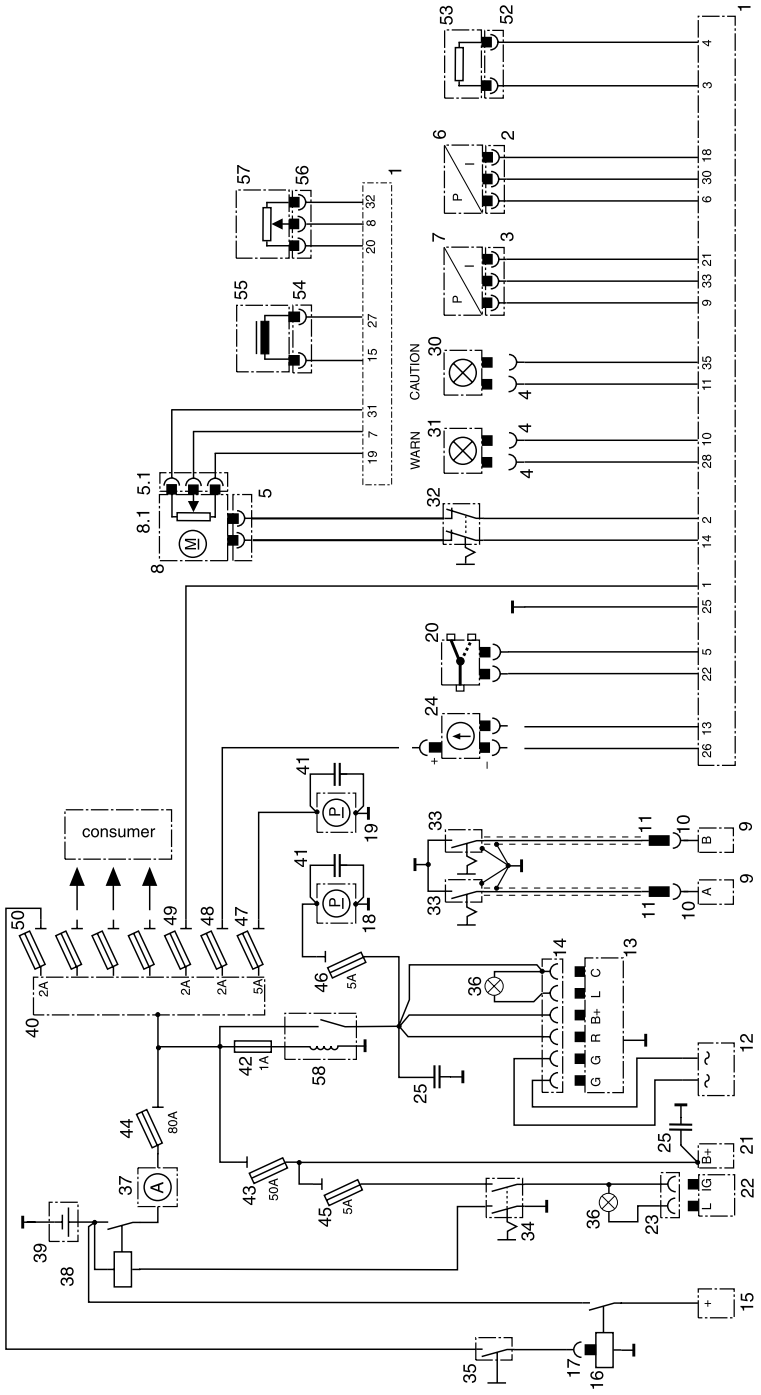

Figure 3.1: Wiring diagram

1	*36-pole plug receptacle for TCU*	*2, 3*	*Plug connection for servo motor*
4	*Plug connection for lamps*	*5*	*Plug connection for servo motor* ***+5.1*** *for potentiometer*

6	*Pressure sensor (ambient)*	*7*	*Pressure sensor (airbox – already wired in advance)*
8	*Servo motor* ***+8.1*** *potentiometer*	*9*	*2 electronic modules (A and B)*
10, 11	*Plug connection for ignition switch*	*12*	*Integrated generator*
13, 14	*External regulator-rectifier with plug connections*	*15*	*Electric starter*
16, 17	*Starter relay with plug connection*	*18*	*Electric fuel pump (main pump)*
19	*Electric fuel pump (aux pump)*	*20*	*3-way solenoid valve (float valve pressure - already wired in advance)*
21, 22, 23	*External alternator with connections*	*24*	*Electric rev.-counter*
25	*Capacitor*	*30, 31*	*Lamps*
32	*Isolating switch for servo motor*	*33*	*2 Ignition switches*
34	*Master Switch*	*35*	*Starter switch*
36	*Control lamp*	*37*	*Amperemeter*
38	*Battery relay*	*39*	*Battery*
40	*Bus-Bar*	*41*	*Capacitor*
42-51	*Circuit breaker*	*52*	*Plug connection for airbox temperature sensor*
53	*Airbox temperature sensor (already wired in advance)*	*54*	*Plug connection for trigger coil assy.*
55	*Trigger coil assy. (speed)*	*56*	*Plug connection for throttle positioning sensor*
57	*Throttle positioning sensor (already wired in advance)*	*58*	*Relay*

GUIDELINES FOR THE CIRCUIT WIRING

General

BRP-Rotax cannot prescribe the exact wiring installation design due to the existence of many different types of aircraft, where our engines are installed. Accordingly, it is the responsibility of the airframe manufacturer to define the specific routing of the external wiring .

NOTE

Good practices for the installation of aircraft related wiring is given within following standards and Advisory Circulars (search on the internet):

- *Aviation Maintenance Technician Handbook FAA-H-8083-30*
- *AC 21-99: Aircraft Wiring and Bonding*
- *AC 43.13: Acceptable Methods, Techniques and Practices - Aircraft Inspection and Repair*

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

ATTENTION

The routing and connections have to be completed by the aircraft manufacturer in accordance to ASTM F2639 and effective certification FAR or EASA.

ATTENTION

The power supply to the various consumers (e.g. battery) must have adequate circuit protection (fuses, fusible links or circuit breakers). Using incorrectly rated fuses may result in destruction of the equipment. Do not route consumer cables (e.g. battery) alongside the secondary ignition cable. There is a risk of electromagnetic interference or damage.

ATTENTION

Do not bend, kink, pinch or otherwise improperly stress the wiring harness. Use proper routing, clamping and strain relief on wiring harnesses.

NOTE

Follow the relevant regulations (licensing conditions)
of the maintenance staff, during manufacturing of the wiring harness and repairs or modifications of the aircraft

The representation of components (such as switches, protection devices etc.) that are not included in the scope of engine delivery is purely symbolic. It does not constitute a specification of the version and shall therefore only be seen functionally.
The actual interpretation/selection of the corresponding regulations and specified characteristics is the task of the aircraft manufacturer.

BATTERY

ATTENTION

The aircraft manufacturer must ensure that the permissible limits of the battery (e.g. max. charging voltage) never be exceeded. Compliance with the operating limits of the battery must also be ensured in case of malfunction of the charging system. This can be ensured for example by using a suitable battery management system.

ATTENTION

Observe the specifications of the battery.
The size of the battery needs to be adequate for essential flight equipment and has to meet the airworthiness requirements of its place of operation.

ATTENTION

The use of rechargeable batteries with lithium–ion technology should only be used in combination with a suitable battery management system. If such an battery is used, the responsibility is up to the aircraft manufacturer. The approval of the relevant aeronautical authority may be necessary. For installation of lithium-ion batteries refer e.g. to FAA AC No: 20-184

The specification of the battery must ensure that during each operating state and also during the transition between two operation states a sufficient supply of the avionics is guaranteed (e.g. during engine start). Depending on the applicable regulations avionics need to be supplied for at least 30 minutes with energy after a failure of the primary power supply in case they are required for safe operation of the aircraft.
If the aircraft is regularly started at temperatures below - 5 °C (23 °F) (ambient- and oil/coolant temperature are below this temperature) it is recommended to provide a connection for an external power supply and a possibility for adequate engine pre-heating.

To warrant reliable engine start use a battery of at least 16 Ah capacity (depending on the type and specification we recommend 18 Ah).

INTERNAL GENERATOR

NOTE

Approx. 250 W AC output at 5800 rpm. For DC output in connection with rectifier-regulator.

See Chapter 24-00-00 section Rectifier regulator

Feeding wires

NOTE

If the internal generator is not connected, then the yellow wires must be insulated so that a ground fault is not possible. The internal generator must not be operated in a short-circuit.

Feeding wires from the generator to rectifier-regulator on left side of ignition housing.

- 2 flexible cables, 1.5 mm^2 yellow (in shielding metal braid)
- length approx. 660 mm (26 in.) starting from ignition housing
- with on each plug socket 6.3 x 0.8 to DIN 46247

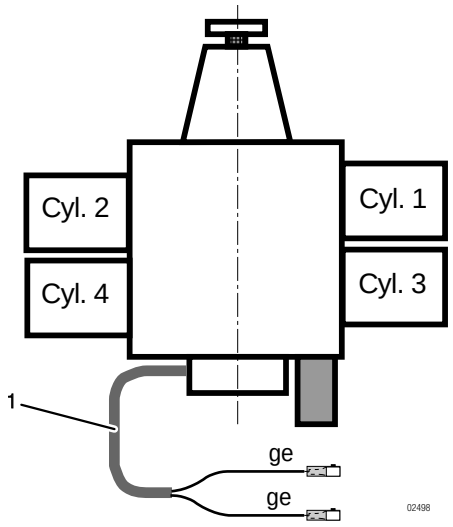

Figure 3.2: Feeding wires internal generator

1 Feeding wires (yellow)

RECTIFIER REGULATOR

Type	Electronic full-wave rectifier regulator
Output voltage	14.2 V ± 0.3 (from 1000 ± 250 rpm)
Current limit	max. 22 A
Permissible component temperature	max. 80 °C (176 °F)

NOTE

The performance specifications are given for optimal cooled components. If necessary, use a separate heat sink for the rectifier regulator.

Weight See Chapter 72-00-00 section Weight

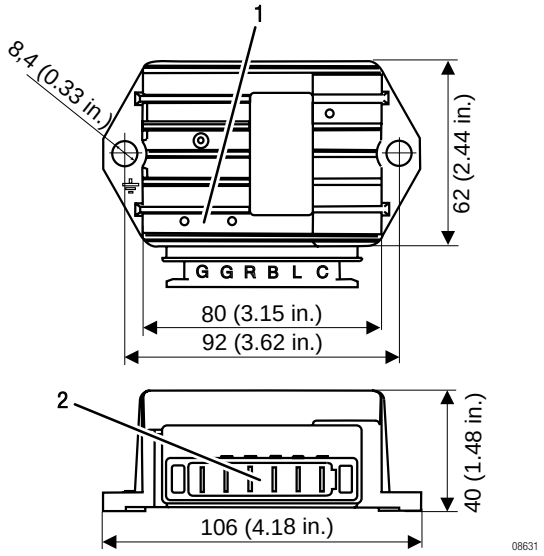

Figure 3.3: Rectifier regulator area component temperature and description of connections

1 Area component temperature

2 Description of connections:
G = yellow – from generator
R = red – to battery positive terminal
B = Battery positive terminal
L = Warning lamp circuit
C = Control or field circuit

REQUIREMENTS FOR FLAWLESS OPERATION OF THE RECTIFIER REGULATOR

ATTENTION

The voltage difference between battery and terminal C of regulator should be less than 0.2 V. Use cables in this area as short as possible and with adequate cross section.

ATTENTION

Never sever connection between terminal C and B of regulator (e.g. by removal of a fuse) while the engine is running. Overvoltage and regulator damage can occur! During engine stop break circuit between battery and terminal C to avoid discharge of battery!

NOTE

A charge-indicating lamp 3 W/12 V may be fitted on the instrument panel.
See Wiring diagram

Body of regulator Body of regulator must be grounded with no resistance allowed.

Fuse The rectifier regulator has to be protected by suitable slow blowing fuse or circuit breaker.

Wire size Wire size of the main circuit of at least 2.5 mm² (14 AWG).

Capacitor A capacitor of at least 22000 µF/25 V is necessary to protect the correct function of regulator and to flatten voltage. The regulator is not designed to store any electrical charge. If for any reason the battery or bus system is disconnected from the regulator while the engine is running (i.e. the master switch is shut off) the capacitor will safely absorb and dissipate the electrical charge produced by the generator. Otherwise the regulator would be damaged.

Amperage

ATTENTION

The current over engine speed graph was determined and is only effective under the following conditions.

Ambient temperature:	20 °C (68 °F)
Voltage:	permanent 13.5 V/DC
Tolerance:	max. ± 5 %

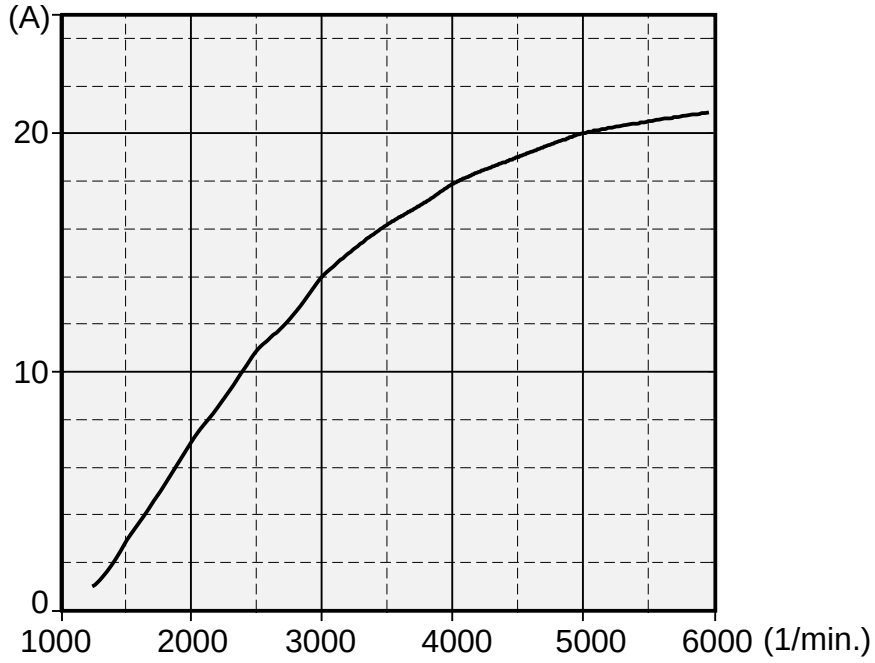

Figure 3.4: Current over engine speed graph

IGNITION SWITCHES (MAG SWITCH)

Type Two separate, suitable on-off switches

Switching voltage min. 250 V

Switching current min. 0.5 A

Wires Wires from the ignition switches connect to the electronic module.

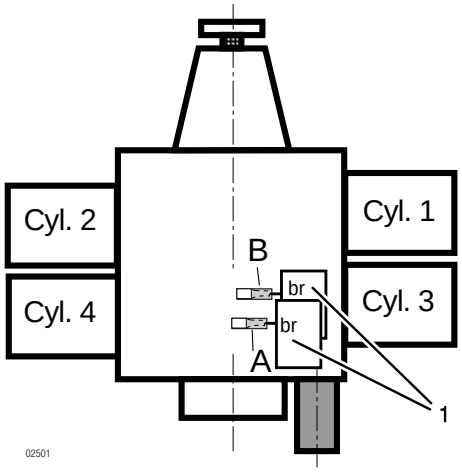

Figure 3.5: Electronic module

1 Electronic module

Wire

ATTENTION
Observe the minimum indications to the configuration! Unshielded or insufficiently-shielded cables can cause engine shut-off due to electro-magnetic and radio interference.The metal base of each ignition switch must be grounded to aircraft frame to prevent EMI.

The electromagnetic compatibility (EMC) and electromagnetic interference (EMI) depends essentially on the wire used.
Shielded flexible cable,
Shielding braid on both ends grounded to prevent EMI (e.g. specification MIL-27500/18).
Min. section area: 2x 0.75 mm² (18 AWG)

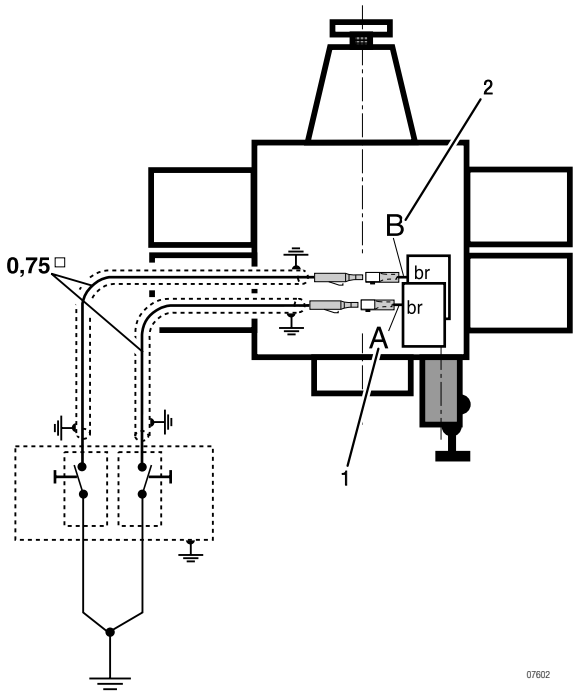

Figure 3.6: Wire

1 Wire for ignition circuit A *2 Wire for ignition circuit B*

Wire A Wire of top electronic module (marked “A”) for ignition circuit A.

Wire B Wire of bottom electronic module (marked “B”) for ignition circuit B.

Ignition circuit A Ignition circuit A controls top spark plugs of cylinder 1, 2; lower spark plugs of cylinder 3 and 4.

Ignition circuit B Ignition circuit B controls top spark plugs of cylinder 3, 4; lower spark plugs of cylinder 1 and 2.

Flexible wire One each flexible wire 0.75 mm² (18 AWG) brown
Length approx. 35 mm (1 3/8“) beginning at electronic module with one each plug socket and insulating sleeve 3.96 mm. At the new version the cable grommet and fasten connector are integrated in the 6-pole connector housing.
See SI-914-016 latest issue

ASSEMBLY OF THE FLAT PIN TERMINAL

NOTE

One each cable grommet and flat pin terminal are supplied loosely packed.

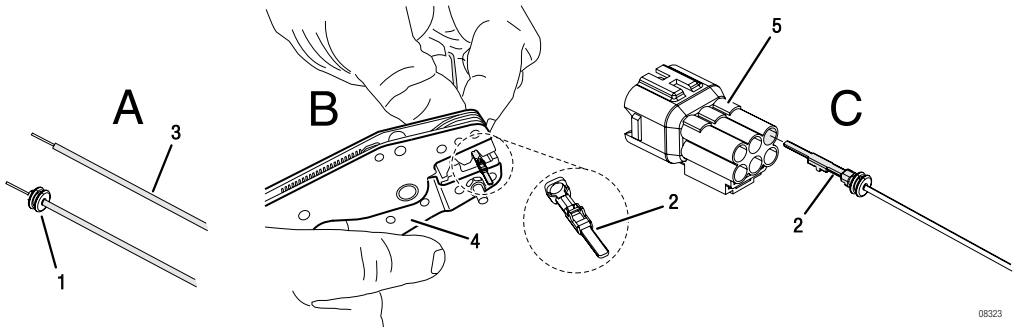

Figure 3.7: Assembly of the flat pin terminal

1 *Cable grommet*
2 *Flat pin terminal*
3 *Wiring (airframe)*
4 *Crimping pliers*
5 *Position in the connector housing*

Special tools

The following special tools and equipment are necessary for fitting the Faston connector.

Part no.	Description
n.a.	MOLEX Crimping pliers 64016-0035
n.a.	MOLEX Disassembly total 63813-1500

Procedure

Step	Procedure
1	Strip cable as required.
2	Install the cable grommet in correct position and direction (A).
3	Use suitable crimping pliers to fit the fasten connector (B).
4	The cable grommet is held by the secondary crimp.
5	Push the Faston connector in the corresponding slot of the connector receptacle until it is locked in place (C).
6	Check for tight fit.
7	Press the pin holder (white) downwards using the long nose pliers.

NOTE

Faston connector and insulation sheath of the old version are available as spare part.

See SI-914-016 latest issue

NOTE

The pin holder must not be pressed with excessive force.

ELECTRICAL FUEL PUMP

⚠ WARNING

Non-compliance can result in serious injuries or death!
An essential point is according to regulations, that the fuel pumps are connected on two completely independent power supplies.

ATTENTION

The routing and connections have to be completed by the aircraft manufacturer in accordance to ASTM F2639 and effective certification FAR or EASA.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Capacitor

ATTENTION

To warrant reliable operation of the electrical fuel pump the use of capacitor of at least 1 µF/25 V is necessary.

Voltage 12 V/DC

Current input per fuel pumps by one fuel pump: ~ 1.7 A

by two fuel pumps (Series): ~1.5 A

The diagram shows the current input over pressure.
The diagram outlines minimum capacity at nominal voltage on pump.
Pressure- and suction head are “ZERO”.
Graph is effective on a seasoned pump only, running-in period approx. 30 min.

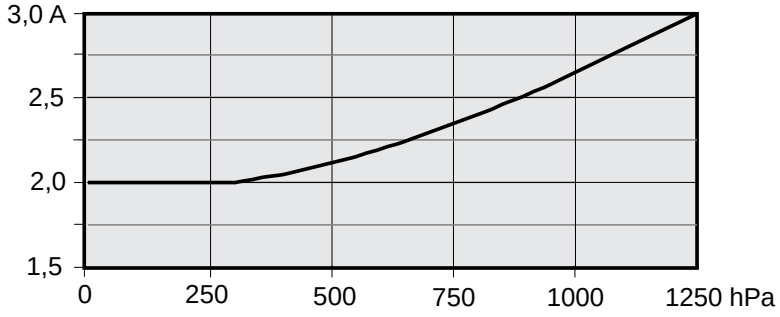

Figure 3.8: Diagram current input

Installation See Chapter 73-00-00

Connection Plus terminal: M4 screw connection[3]
Minus terminal M5 screw connection[3]

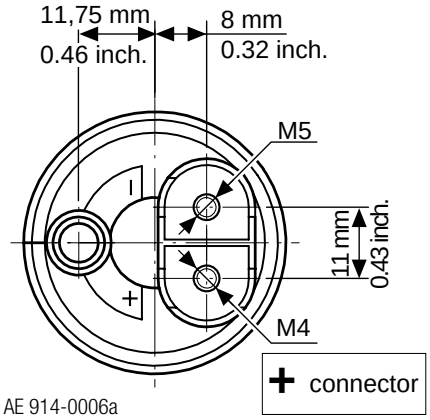

Figure 3.9: Fuel pump-connection

Radio interference For radio interference suppression a capacitor (Fig. Wiring diagram Pos. (41)) of 1µF / 100 V has to fitted as near as possible to the terminals.

Fuse Each of the two fuel pumps has to be protected by slow blowing 5A fuse in accordance with Wiring diagram

3. suitable for ring terminals to DIN 46225

ELECTRONIC TURBO CONTROL UNIT (TCU)

ATTENTION

The TCU comprises electronic components and is therefore completely sealed. The TCU is allowed to be opened only by persons authorized by BRP-Rotax.

NOTE

At wrong polarity of the supply voltage both lamps will light up.

Nominal voltage (12V/DC)	min. 6 V / max. 18 V
Operating temperature range	min. -25 °C (-13 °F) / max. +70 °C (+160 °F)
Storage temperature range	min. -40 °C (-40 °F) / max. +70 °C (+160 °F)
Electrical load	See Chapter 24-00-00 section Internal consumer
Weight	See Chapter 72-00-00 section Weight

Installation

⚠ WARNING

Non-compliance can result in serious injuries or death!
Installation in the engine compartment is not permitted since the components are not of a fire resistant construction.

ATTENTION

Choose place of installation such, that operation is within the specified temperature limits.

A recommendable location is in the cockpit, below the instrument panel.
The TCU has to be in an area were it is protected against moisture.
Place of installation is limited by the length of the wiring harness.

Support of the TCU on the 4 rubber shock mounts which ensures an attachment free of vibrations.
If the standard attachment should not be utilized or changed, certification to the latest requirements has to be conducted by the aircraft manufacturer.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

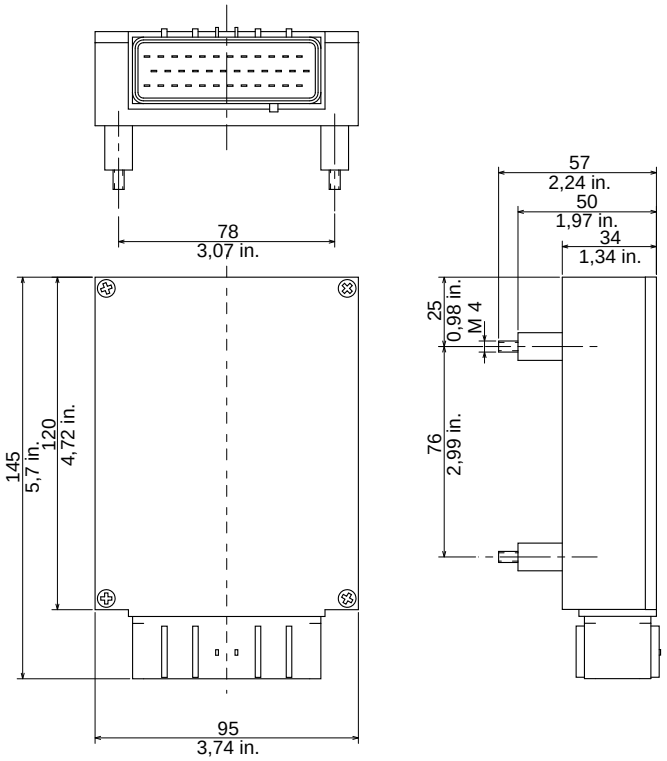

Figure 3.10: TCU Dimensions and attachment points

Connection with flexible cable
+ terminal: 0.75 mm² (18 AWG) white No. 1[4]
– terminal: 0.75 mm² (18 AWG) white No. 25[4]

Fuse The TCU has to be protected by a slow blowing 2A fuse or circuit breaker in accordance with the wiring diagram.

4. from the 36 pole plug receptacle of the TCU with ring terminal 4.2 mm dia. to DIN 46225

ISOLATING SWITCH FOR SERVO MOTOR

The isolating switch serves to break the circuit of the servo motor for a short time in case of surging of the TCU.
After a short hunting stable operation should follow.

ATTENTION

The isolating switch has to be designed such that it is guarded against being turned "off" by mistake or unintentionally. The fixed and secured position is "ON".

Design 2-pole ON –OFF (DPST) switch

Switching voltage min. 100 V

Switching current min. 2 A

Installation

ATTENTION

The servo motor is connected to DC supply. The polarity (wire 2 and 14) of the cables must not be changed, otherwise the sense of rotation would be reversed and control would be rendered ineffective.

- On the instrument panel in the pilot's field of view, anytime and easy to reach.
- The isolating switch has to be installed directly into the lines from 36 pole plug receptacle to servo motor.
- To avoid any mix-up of the polarity cut first one wire and connect on switch as per wiring diagram
- After first wire is connected sever second wire and connect also to switch.

WARNING LAMPS

CAUTION LAMP

See Figure 3.1: Wiring diagram.

Lamp color **ORANGE** or color as per effective regulations

Current voltage 12 V/DC
depending on input voltage of the TCU
Activation performed via the minus pole, Positive pole is always active.

Current maximal 0.5 A

Flexible cable Negative terminal 0.75 mm² (18 AWG) white No. 11[5]
Positive terminal 0.75 mm² (18 AWG) white No. 35[5]
length approx. 600 mm (24 in.) from TCU

ATTENTION
Do not connect – (neg.) terminal to ground or the + (pos.) terminal to bus (12 Volt), each wire must be connected directly to the lamp. Use a two wire lamp; do not use a lamp that grounds through the base as this will defeat the warning system.

Function:

1) The caution lamp illuminates briefly during a power cycle (Master Switch ON).

2) Blinking when malfunction of TCU electrical system (TCU, sensors, servo motor etc).

BOOST LAMP

Lamp color **RED** or colour as per effective regulations.

Voltage 12 V/DC
depending on input voltage of TCU
Activation performed via the minus pole, Positive pole is always active.

Current maximal 0.5 A

Flexible cable Negative terminal 0.75 mm² (18 AWG) white No. 10[5]
Positive terminal 0.75 mm² white No. 28[5]
length approx. 600 mm (24 in.) from TCU.

5. from the 36 pole plug receptacle of the TCU, plug 6.3 x 0.8 to DIN 46247

ATTENTION
Do not connect – (neg.) terminal to ground or the + (pos.) terminal to bus (12 Volt), each wire must be connected directly to the lamp. Use a two wire lamp; do not use a lamp that grounds through the base as this will defeat the warning system.

Function:

1) The boost lamp illuminates briefly during the power cycle.

2) Continually illuminated when manifold pressure limit is exceeded.

3) Blinking when 5 min full throttle limit is exceeded.

See latest Operators Manual of the respective engine type.

EXTERNAL ALTERNATOR (OPTIONAL EXTRA)

NOTE

The voltage regulator is integrated in the alternator.

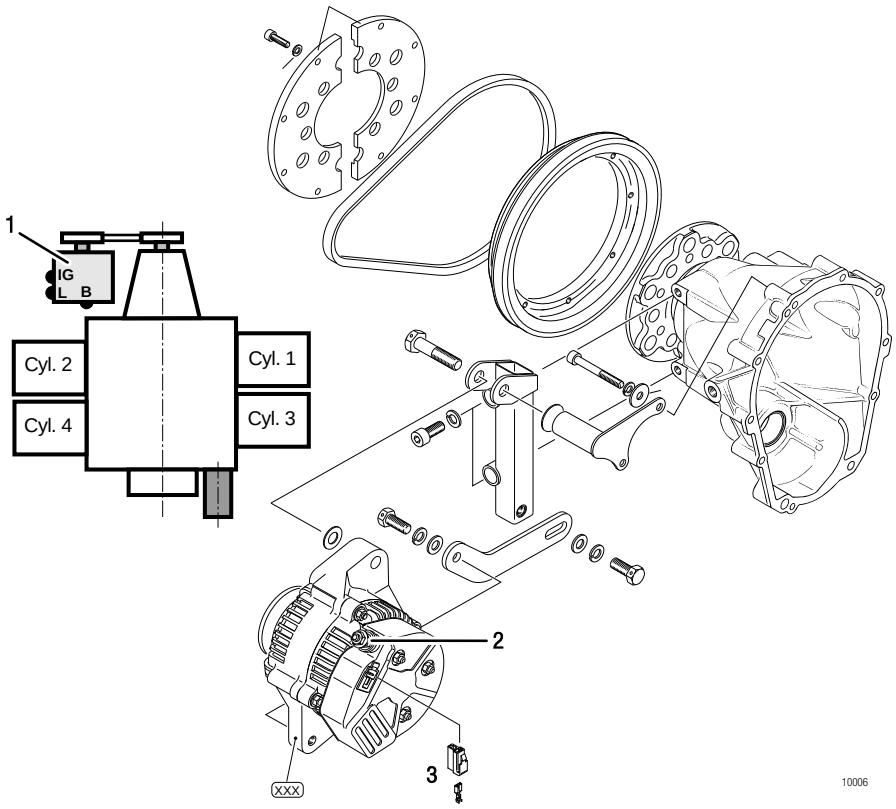

Figure 3.11: External alternator

1 External alternator
2 Positive terminal
3 Control wiring

Technical Data

Output	max. 600 W/DC at 6000 rpm
Output voltage	14.2 V - 14.8 V
Ambient temperature	Min. -30 °C (-22 °F) / Max. +90 °C (194 °F)
Weight	See Chapter 72–00–00 section Weight

Connections

Power supply wires	Power supply wires to external alternator located on the outside of propeller gear.
Positive terminal	M6 screw connection (tightening torque 4 Nm / 35 in. lb) suitable for cable terminal according to DIN 46225
Grounding	Via engine block
Control wiring	Via supplied standard plug (Sumitomo 6111-2568) and 6.3 x 0.8 Faston connectors (female).

REQUIREMENTS FOR CORRECT OPERATION OF THE INTEGRATED RECTIFIER REGULATOR

Fuse The rectifier regulator must be protected by a slow blowing 50 A fuse or circuit breaker. Fuse or circuit breaker rating must be determined by load, wire size and length.

Cross section of the main circuit at least 4 mm² (10 AWG)

Capacitor a capacitor of at least 22 000 µF / 25 V is necessary.

Amperage

ATTENTION

The current over engine speed graph was determined and is only effective under the following conditions.

Ambient temperature:	20 °C (68 °F)
Voltage:	permanent 13.5 V
Tolerance:	max ± 5 %

NOTE

The speed of the external alternator is 1.24 times the crankshaft speed or 3 times the propeller speed.

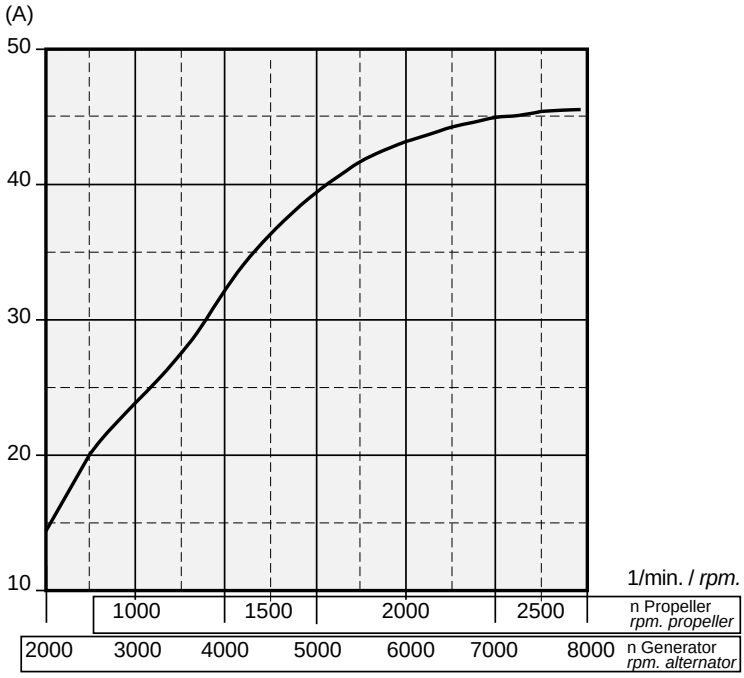

Figure 3.12: Current over engine speed graph

CONNECTION OF THE ELECTRIC REV COUNTER (TACHOMETER)

Output signal

ATTENTION

The graphs depicting output signals have been determined and are effective only at the following conditions.

Ambient temperature:	20 °C (68 °F)
Tolerance:	max. ± 5 %

NOTE

The pick-up for the rev counter generates one pulse per revolution. Pulse shape and pulse voltage as per recordings (oscillogram).

BRP-Rotax developed especially for this application a non-certified electric rev counter.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

See SI-13-1996 latest issue

Feeding wiring Feeding wiring to electric rev counter from the 36-pole receptacle of TCU.
Length approx. 1000 mm (39.4 in.) from TCU.

Connections Flexible cables 0.75 mm² (18 AWG), white no. 26[6]
Flexible cables 0.75 mm² (18 AWG), white no. 13[6]

6. from the 36-plug receptacle of TCU. Wires supplied without plug connection.

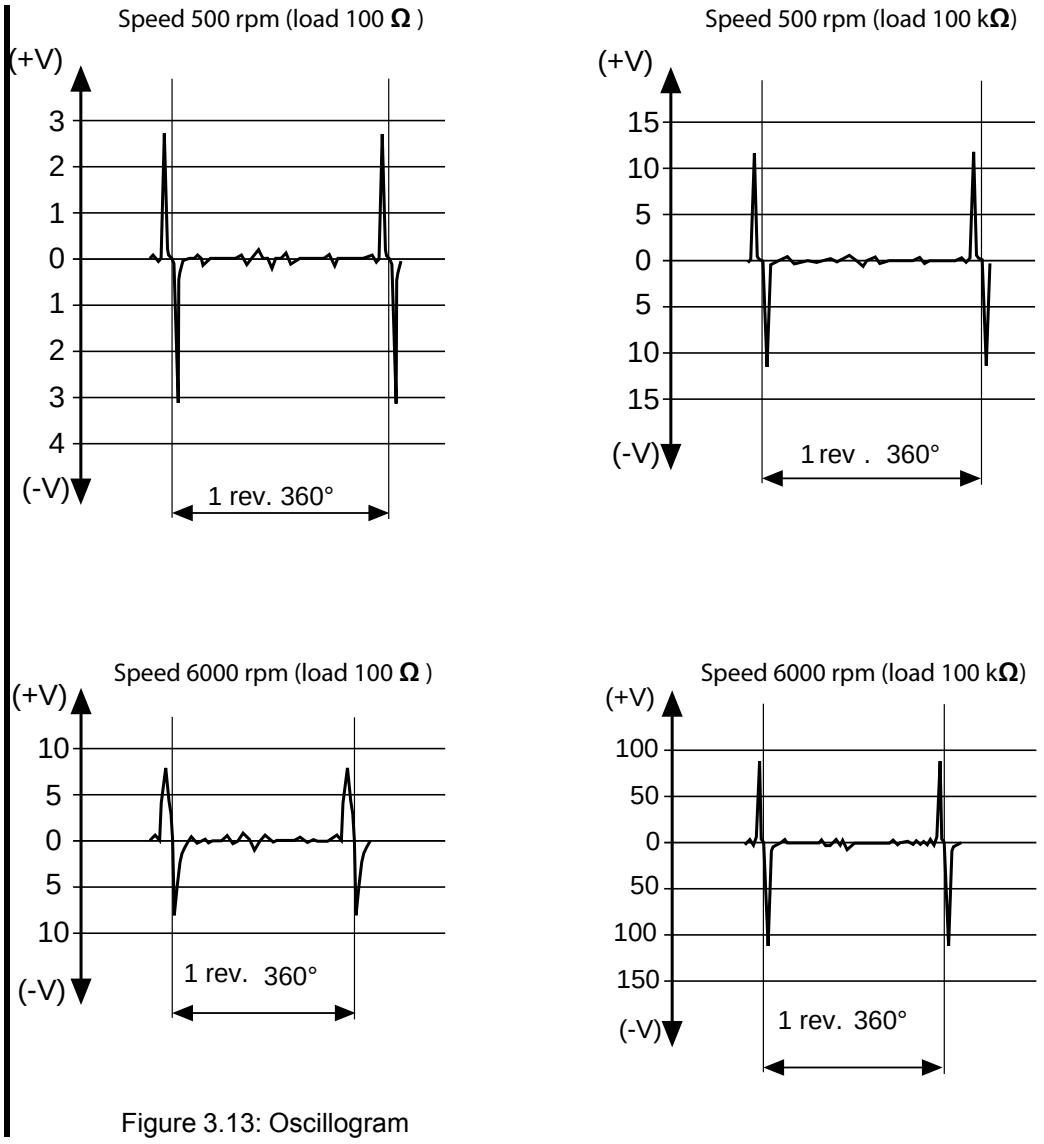

Figure 3.13: Oscillogram

INTERNAL CONSUMER OF ELECTRIC POWER

⚠ WARNING

Non-compliance can result in serious injuries or death!
The power consumption of extra loads has to be limited to the extent that the internal need of power is always covered.

Refer to graph (current output over speed) of the integrated generator and the external alternator.

Current consumption components

Components	Current consumption
Fuel pump (main)	max. 3 A
Fuel pump (stand by)	max. 3 A
TCU[7]	max. 0.3 A
Servomotor	max. 1 A
Boost lamp[8]	approx. 0.25 A
Warn lamp	approx. 0.25 A
Summary[9]	~ 8 A

NOTE

A complete electrical load analysis covering all installed loads must be calculated by the aircraft manufacturer.

7. internal power consumption, without servo motor and lamps
8. standard value, actual value up to aircraft manufacturer
9. without electric starter and start relays

Chapter: 61–00–00
PROPELLER DRIVE

TOPICS IN THIS CHAPTER

SYSTEM LIMITATIONS

Operating limits

Refer to latest issue of the Operators Manual.

Moment of inertia

System Limit	Min.	Max.
Moment of inertia on propeller	–	6000 kg cm^2 (14.238 lb ft^2)

Max. permitted static out-of-balance on a prop

max. 0.5 gm (.043 lb.in.)

Propeller shaft

System Limit	Min.	Max.
Extension of the propeller shaft	–	maximal 120 mm (4.72 in.)

Torque

ROTAX® 914 at i= 2.4286: 340 Nm (250 ft.lb) (on propeller)

PROPELLER DRIVE

Propeller shaft flange

The propeller in tractor or pusher arrangement must be fitted on the propeller flange in accordance with applicable regulations. As required utilize one of three possible pitch circle diameters (P.C.D.) on the flange.
Certification of the propeller sizing and arrangement to the latest requirement such as FAR or EASA has to be conducted by the aircraft manufacturer.

⚠ WARNING

Never operate the engine without propeller as this results in serious engine damage from overspeeding. Never fit the propeller directly on the crankshaft.

ATTENTION

Modification of the propeller shaft is not permitted.

Vibration analysis

Vibration analysis of the whole system (engine, suspension, propeller etc.) should be carried out as part of the certification process.
If no limits are available in the technical literature, a max. of 0.5 IPS (inches per second) at 5000 rpm. can be assumed.

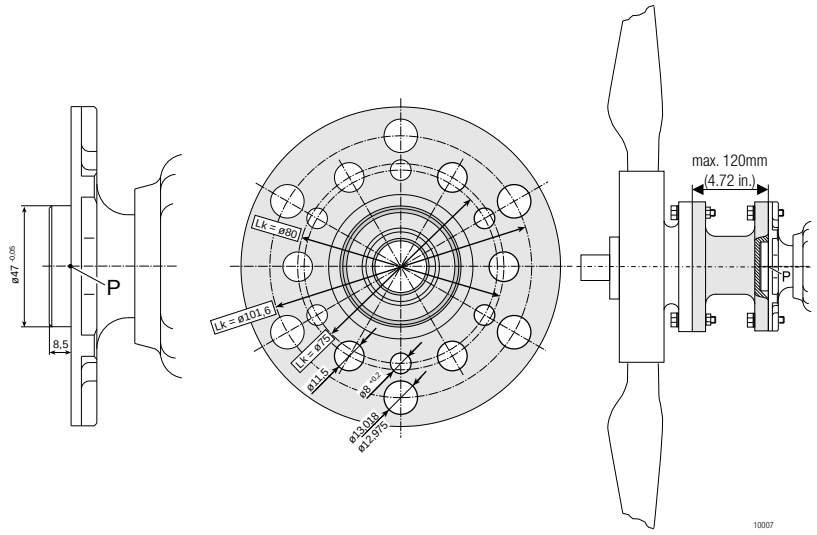

Figure 4.1: Propeller shaft flange

Pitch circle diameter 75 mm (2.95 in.)	6x through holes 8 mm (0.31 in.)
Pitch circle diameter 80 mm (3.15 in.)	6x through holes 11.5 mm (0.45 in.)
Pitch circle diameter 101.6 mm (4“)	6x through holes 13 mm (0.51 in.)

Hub diameter	47 mm (1.85 in.)
Gear transmission	i= 2.4286 (51 Teeth/21 T)

left, counter clockwise, looking towards face of flange

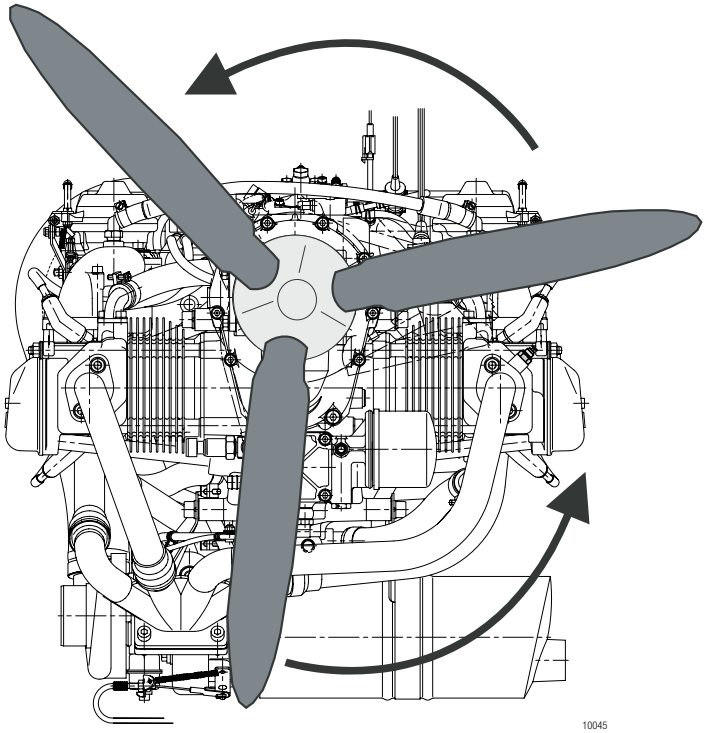

Figure 4.2: Direction of rotation

VACUUM PUMP

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Drive Drive via propeller gear.

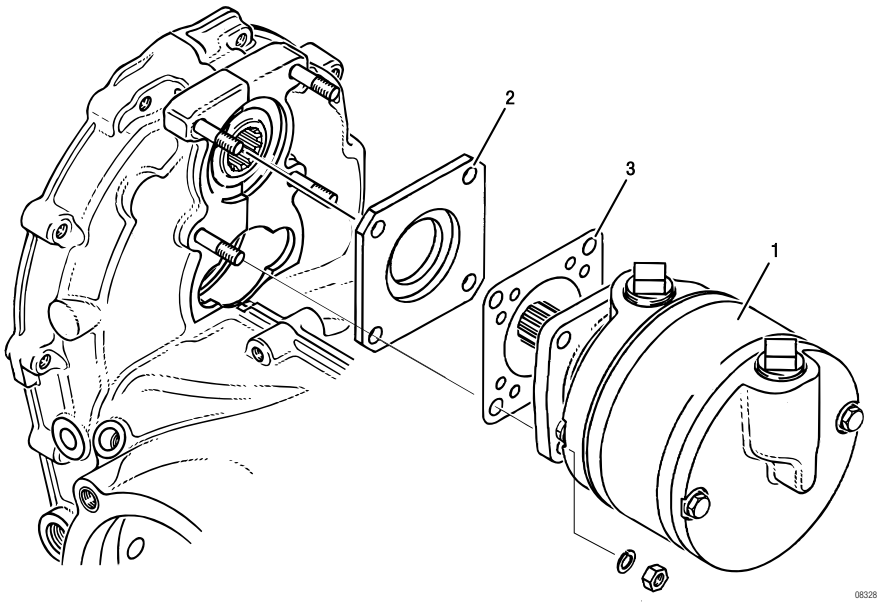

Figure 4.3: Vacuum pump

1 Vacuum pump
2 Attachment flange
3 Gasket

Connection vacuum pump

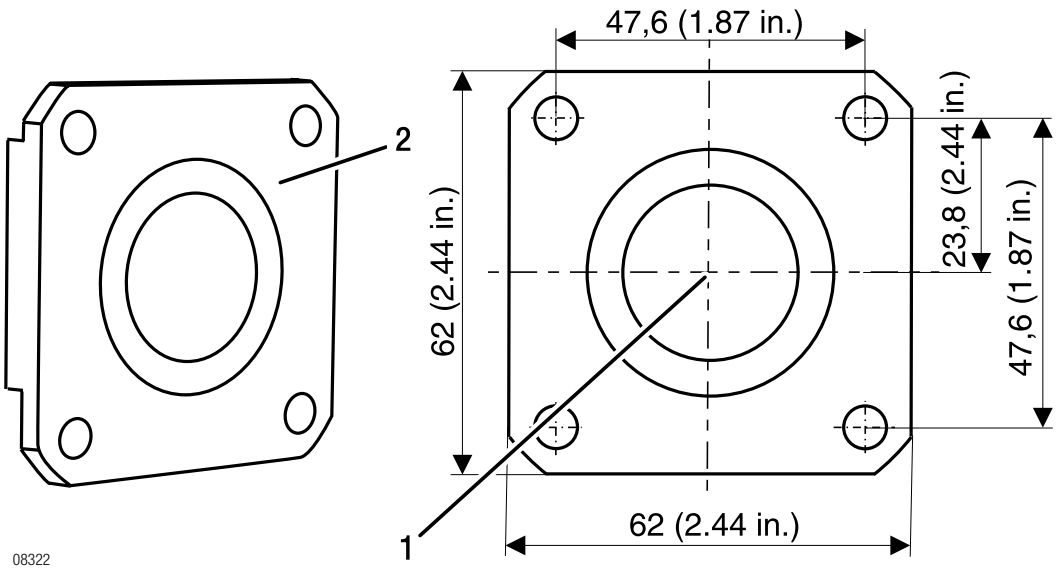

Figure 4.4: Attachment flange vacuum pump

1 Connection vacuum pump *2 Attachment flange*

	x-axismm [in]	**y-axis**mm [in]	**z-axis**mm [in]
Connection	-206.3 [8.12]	0	51.5 [2.03]

Speed reduction

Speed reduction from crankshaft to hydraulic governor is 1.842, i.e. the vacuum pump runs with 0.54 of engine speed.

Connection

ATTENTION
Obey the manufacturers instructions!

Thread size	M6
Effective thread length	max. 17 mm (9/16")
Governor drive	Internal spline 20/40 SMS 1834 NA 14x1,27x30x12
Power input	max. 600 W

HYDRAULIC GOVERNOR FOR CONSTANT SPEED PROPELLER

See SB-914–035, Installation/use of governors for ROTAX® Engine type 914, latest issue.

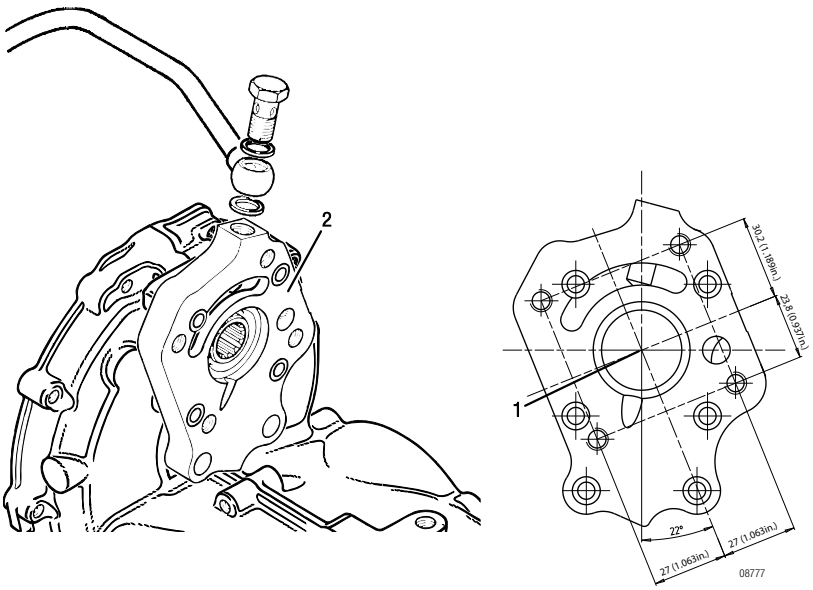

Figure 4.5: Crankcase flange

1 Connection for propeller governor

2 Governor flange

Drive

Drive via propeller gearbox.
Position of the propeller connection on the governor flange:

x-axis [mm/in]	**y-axis** [mm/in]	**z-axis** [mm/in]
-206.3 (8.12)	0	51.5 (2.03)

Connection

ATTENTION

Obey the manufacturers instructions!

Technical Data

Gear ratio from crankshaft to hydraulic governor is 1.842, i.e. the propeller governor runs at 0.54 times engine speed.

Mounting pad	AND20010
Thread size	M8
Thread length	max. 14 mm (0.55 in)

Toothing	Internal spline 20/40 SMS 1834 NA 14x1,27x30x12
Power input	max. 600 W
Operating pressure	max. 30 bar (435 psi)
Direction of rotation of the propeller governor	counter clockwise, looking towards of flange on crankcase

Chapter: 72–00–00
ENGINE

TOPICS IN THIS CHAPTER

SYSTEM DESCRIPTION

For a detail System description refer to the latest issue of the Operators Manual.

NOTE

Allow ± 1 mm on all stated dimensions as manufacturing tolerance.

A	points of attachment (for engine transport) - centre of gravity		
P	zero reference point for all dimensions		
x, y, z	axes for system of coordinates		
PTO	power take off side	**MAG**	magneto side
Cyl. 1	Cylinder 1	**Cyl. 3**	Cylinder 3
Cyl. 2	Cylinder 2	**Cyl. 4**	Cylinder 4

Side view

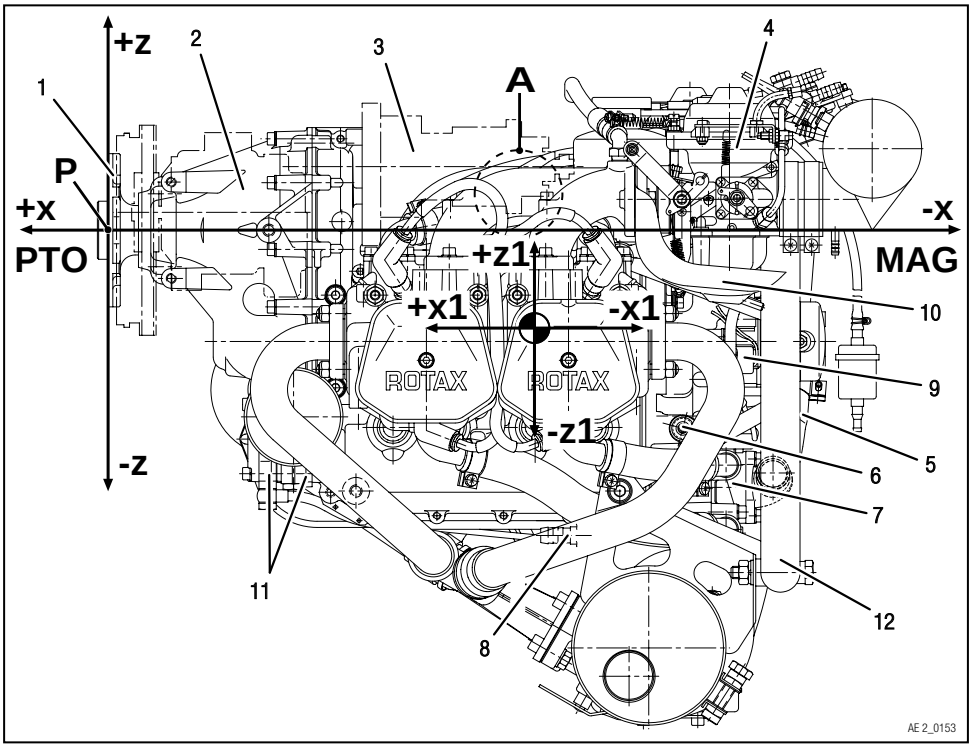

Figure 5.1: Side view engine

1	*Propeller flange*	*2*	*Propeller gear*
3	*Vacuum pump or hydraulic governor for constant speed propeller*	*4*	*Constant depression cab*

5	*Ignition cover*	6	*Connection for mechanical tachometer (optional)*
7	*Coolant pump*	8	*Connection for oil return line (engine)*
9	*Ignition housing*	10	*Drip tray*
11	*2 separate oil pumps (pressure & turbo scavenge)*	12	*Engine mount*

Front view

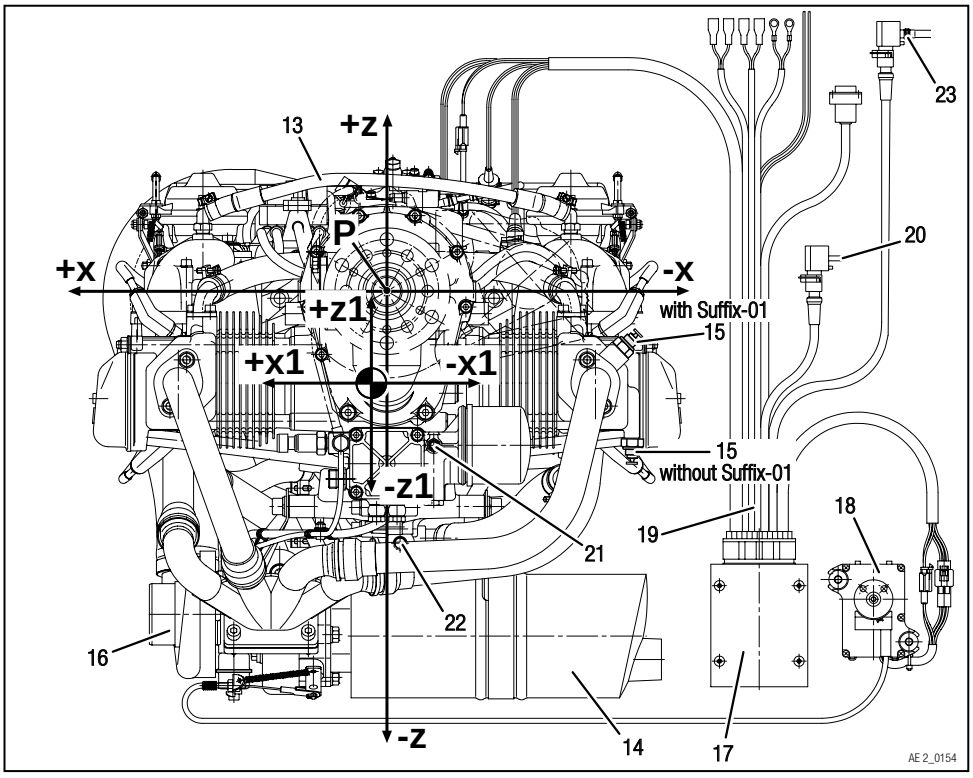

Figure 5.2: Front view engine

13	*Compensation tube*	14	*Stainless steel exhaust system*
15	*Sensor for cylinder head temperature (without Suffix-01)/ coolant temperature (with Suffix-01)*	16	*Turbocharger*
17	*Turbo control unit (TCU)*	18	*Servo motor*
19	*Cable assembly*	20	*Pressure sensor airbox*
21	*Oil temperature sensor*	22	*Connection for oil return line (turbo)*
23	*Connection for ambient pressure*		

Top view

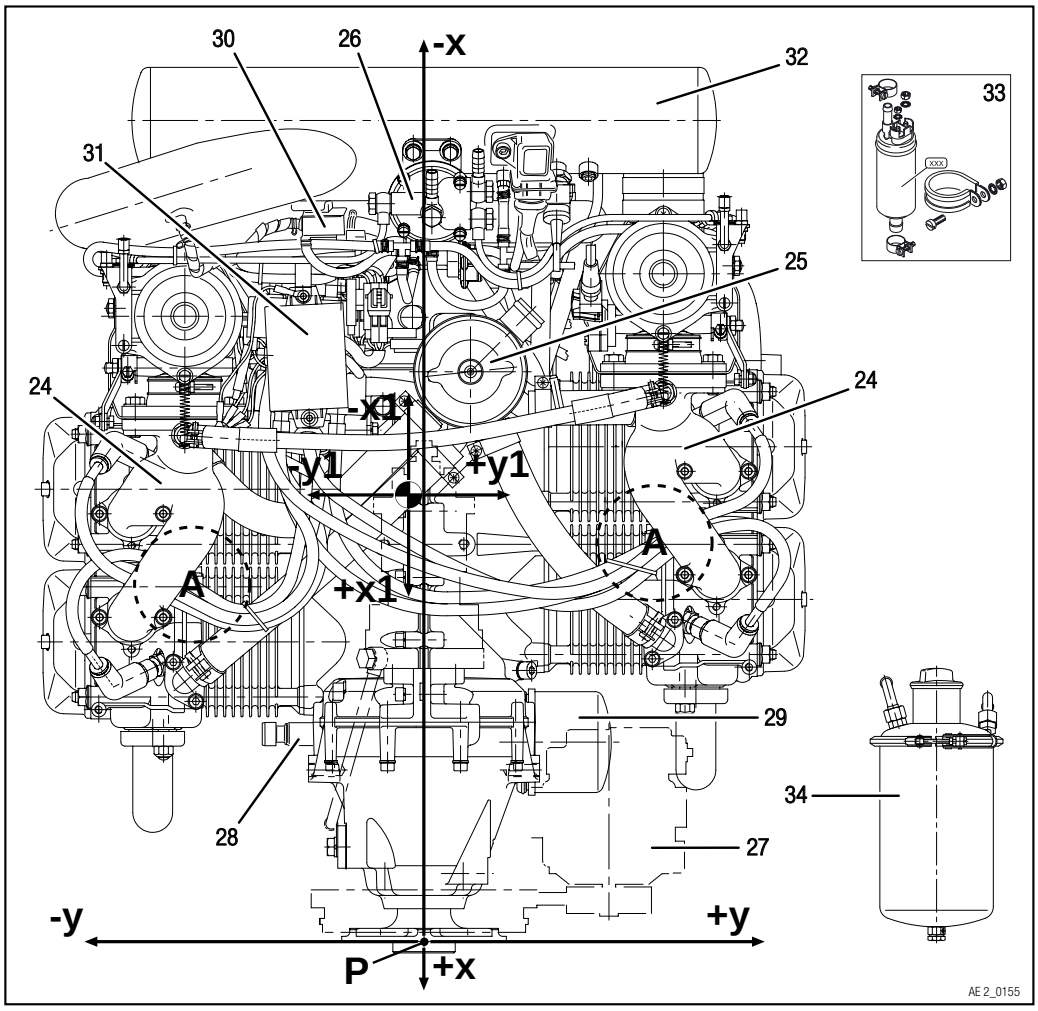

Figure 5.3: Top view engine

24	*Intake manifold*	*25*	*Expansion tank*
26	*Fuel pressure regulator*	*27*	*External Alternator*
28	*Oil pressure sensor*	*29*	*Oil filter*
30	*Three way solenoid valve*	*31*	*Electronic modules*
32	*Airbox assy.*	*33*	*Fuel pump*
34	*Oil tank*		

TECHNICAL DATA

To maintain clarity, only data relevant for engine installation and operation will be stated in the Manual.

NOTE

Connecting sizes, capacities, gear and reduction ratios, electric power, permissible temperatures, etc. can be found in the respective section of engine installation or other relevant engine type documentation.

WEIGHT

The engine weight is defined by the following conditions:

- **Engine dry** from serial production with internal alternator, with overload clutch (see chapter Description of design).

Configuration

Configuration	Weight
2	71.7 kg (158.07 lb)
3	74.4 kg (164.02 lb)

Accessories

Accessories	**Weight** [kg (lb)]	**Spare part**	**Optional**[10]
Airbox	1.3 (2.8)	X	X
Exhaust system	approx. 4 (approx. 8.8)	X	X
External alternator assy.	3 (6.61)		X
HD-starter	0.43 (1)	X	X
Hydraulic governor assy. incl. drive (depending on type)	approx. 2.2 to 2.7 (approx. 4.8 to 6)		
Fuel pump assy.	—		X
Radiator	1 (2.2)		X
Cooling air buffle/ Air guide hood	0.6 (0.79)	X	X
Air filter	0.5 (0.33)		X
Engine mount	2 (4.4)	X	X
Oil radiator	0.5 (1.21)		X

10. Can be installed original to the engine at the factory (also available as a spare part).

Rectifier regulator	0. (0.66)		X
Starter relay	0.45 (0.32)		X
Overload clutch	1.7 (3.7)	X	X[11]
Vacuum pump assy.	0.8 (1.76)		X

INSTALLATION DIMENSIONS STANDARD CONFIGURATION

NOTE

All distances are given in relation to the reference coordinate system (P).

	Pos. (+)	Neg. (-)	Total
Max. dimension in x-Axis [mm (in)]	8.5 (0.33)	-656.6 (-25.85)	665.1 (26.18)
Max. dimension in y-Axis [mm (in)]	288 (11.34)	-288 (-11.34)	576 (22.68)
Max. dimension in z-Axis [mm (in)]	220 (8.66)	-311 (-12.24)	531 (20.90)

CENTER OF GRAVITY OF ENGINE AND STANDARD ACCESSORIES

NOTE

All distances are given in relation to the reference coordinate system (P).

	Standard configuration 3	External alternator	Hydraulic governor	Vacuum pump
Center of gravity on x-Axis [mm (in)]	-327 (-12.87)	-100 (-3.94)	-276 (-10.87)	-255 (-10.04)
Center of gravity on y-Axis [mm (in)]	-9 (-0.35)	139 (5.47)	0 (0)	0 (0)
Center of gravity on z-Axis [mm (in)]	-102 (-4.02)	6 (0.24)	56 (2.20)	56 (2.20)

MOMENTS OF INERTIA

	Configuration 2	Configuration 3
Axis x1-x1 (kg cm²)	20 470	21 210
Axis y1-y1 (kg cm²)	24 560	25 450
Axis z1-z1 (kg cm²)	26 520	27 480

11. 914 UL optional

OPERATING LIMITS

	Manual
Engine speed	See OM 914 Series Chapter 2.1
Manifold pressure	See OM 914 Series Chapter 2.1
Acceleration	See OM 914 Series Chapter 2.1
Critical flight level	See OM 914 Series Chapter 2.1
Oil pressure	See OM 914 Series Chapter 2.1
Oil temperature	See OM 914 Series Chapter 2.1
Cyl. head temperature (without Suffix –01)	See OM 914 Series Chapter 2.1
Coolant temperature sensor (Suffix –01)	See OM 914 Series Chapter 2.1
Exhaust gas temperature	See Chapter 78-00-00 section Operating limits
Airbox temperature	See OM 914 Series Chapter 2.1
Ambient temperature for electronic module	See Chapter 24-00-00 section Electronic module
Fuel pressure	See OM 914 Series Chapter 2.1

BANK ANGLE

Banking of plane deviation from the effective vertical:
See Operators Manual 914 Series.

The engine design is for a conventional, non-aerobatic, fixed wing tractor or pusher type configuration with the oil return port in the optimum position (see Chapter 79–00–00 section Connecting dimensions and location of connections). With this consideration the engine is properly lubricated in all flight profiles.
The resulting bank angle ß (depending on acceleration/deceleration) may never exceed the max. bank angle.

NOTE

Pitch or role angle α is not equal with ß, except stabilized condition (Without acceleration).

System Limit	Min.	Max.
Static roll angle ß		40°

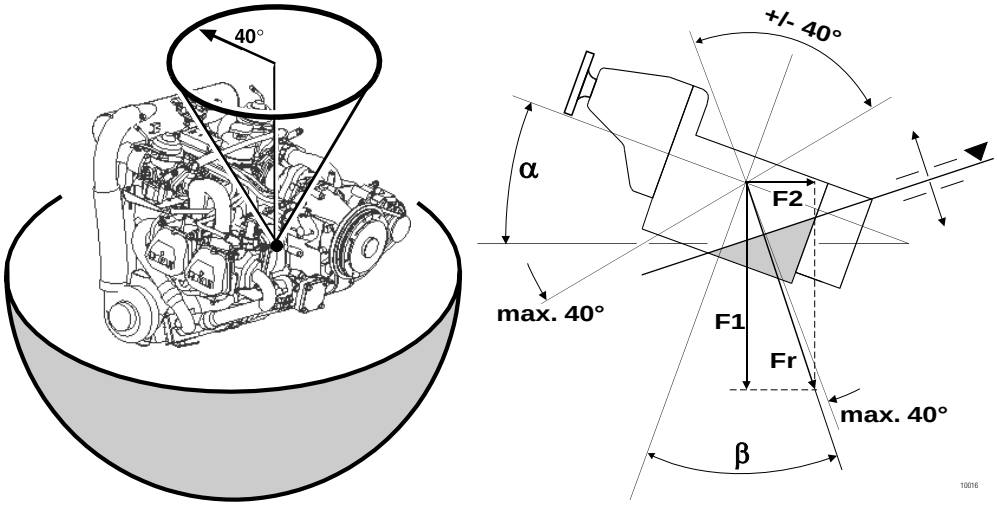

Figure 5.4: Bank angle

Angle/force	Description
α	Pitch or roll
F1	Gravity
β	Bank angle
F2	Acceleration
Fr	Result of F1 and F2

Chapter: 72–60–00
AIR INTAKE SYSTEM

TOPICS IN THIS CHAPTER

REQUIREMENTS ON THE AIR INTAKE SYSTEM

⚠ WARNING

Non-compliance can result in serious injuries or death!®
Carb icing is a common reason for engine trouble. No implements are included in the supply volume for preheating of the intake air. Because of the generated heat by turbo-charging preheating of the intake air is possibly not necessary. But an alternate air door or flap that draws air from the engine compartment is recommended as the air filter could possibly close by formation of ice. Door or flap must be in front of turbocharger (suction side)! Preheating of the intake air will result in performance loss because of the lower air density!

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

ATTENTION

All items of the air intake have to be secured against loss.

TECHNICAL DATA

Operating limits **CO-Measurement:**

CO-Emission	min. 1.5 % CO at 5500 1/min. (Load 100 – 104 %)
CO-Emission	min. 3.0 % CO at 5800 1/min (Load 110 – 115 %

Measured on each single cylinder. Measuring point is analog to EGT- measurement. See chapter “Exhaust system”.

ATTENTION

Any changes on the air intake system (e.g. modification on the airbox, usage of an intercooler etc. can affect the flow rate in the air intake system and the fuel mixture ratio. In the course of certification the fuel mixture process must be proofed by a CO-measurement.

ATTENTION

Prevent leakage!
Utilize the full slip-on length for all connections. Secure hoses with suitable clamps or crimp connection.

Connections

	Outside diameter	Slip-on length
Drainage line	6 mm (0.24 in)	max. 17 mm (0.67 in)
Air intake socket on turbocharger	60 mm (2.36 in)	max. 25 mm (0.98 in)

Location of connecting nipple P2

	x axis [mm (in)]	**y axis** [mm (in)]	**z axis** [mm (in)]
Cylinder side 1/3	-568 (-22.36)	-180 (-7.09)	-20 (-0.79)
Cylinder side 2/4	-590 (-23.23)	180 (7.09)	-20 (-0.79)

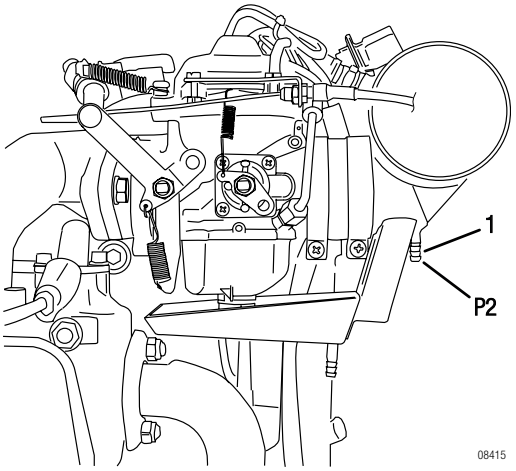

Figure 6.1: Location connecting nipple P2

1 *Connecting nipple for drainage lines*

P2 *Connecting nipple P2*

INTAKE AIR DUCTING

High engine performance needs air temperature as low as possible at air intake. Therefore the air filter should be located in a recess of the engine cowling or separated from warm air by baffles such that fresh air can be aspirated.

Technical data

Max. length of ducting	500 mm (20 in)
Inside diameter	Min. outside dia. of the intake socket on turbocharger
Min. mean bending radius	100 mm (4″)

NOTE

Compression process in the turbocharger will heat up air considerably, depending on pressure ratio. Usual temperature rise of 40 °C (104 °F) at take-off performance.

ATTENTION

Air temperature above the limit will automatically reduce boost pressure with consequent performance loss. The automatic back off on boost pressure will protect the engine against damage from overstressing.

Notes regarding too high air temperatures in the air box

If in case of high intake air temperature the max. air temperature in the airbox is frequently or permanently above the limit, the arrangement of air intake has to be improved or an intercooler has to be installed.

NOTE

Intercooler is not in the scope of the supply volume.

INTERCOOLER

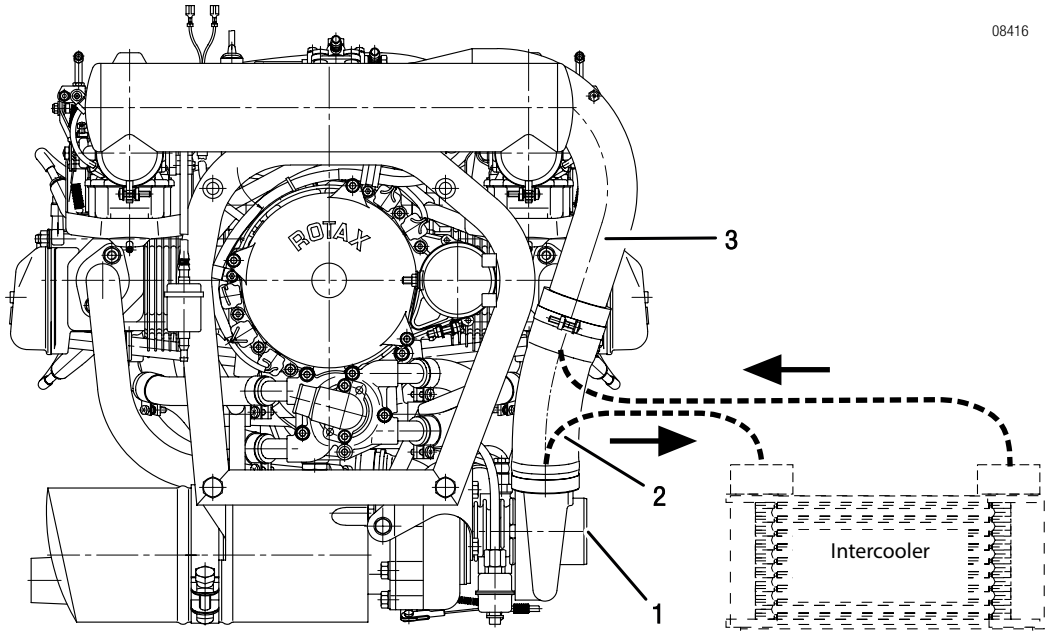

Figure 6.2: Intercooler

1 Connecting turbocharger
2 Compressor
3 Inlet into airbox

Intercooler has to be installed between pressure side of turbo and inlet into airbox.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

- A minimum flow rate of 300 m3/h (220 cfm) has to be warranted for all conditions.
- The pressure loss must not exceed 5 hPa.

ATTENTION

No additional forces or moments are allowed on turbocharger or airbox, therefore the intercooler must be supported independent and free of vibrations.

ENVIRONMENTAL NOTE

Observe the CO-emissions!
Check the CO-emission when installing an intercooler and adjust the jetting if necessary.

AIR FILTER

BRP-Rotax offers an air filter as described below.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Use only filter elements which will not tend to restrict the flow when in contact with water. Incorrect filter can result in freeze. This can lead to damage engine.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

ATTENTION

A minimum flow rate has to be warranted for all conditions. The pressure loss must not exceed.

Minimum flow rate 300 m³/h (390 yd³/h)

Pressure loss 5 hPa

Choice of a suitable filter The following points should assist the aircraft manufacturer at the choice of a suitable filter:

- 4 fold cotton fabric
- Surface covered with metal screen
- Total filter area at least 1400 cm² (217 in²)

AIRBOX

The airbox is furnished with 2 drain holes at the lowest position possible.
The holes are necessary to drain fuel from flooding float chambers caused by leakage past float valve.

NOTE

This drain bores are very small (1.5 mm dia. (1/16")) Compensation of process conditions is taken care of by the TCU.

Drainage lines

⚠ WARNING

RISK OF FIRE! Non-compliance can result in serious injuries or death!
Connect drainage lines well, otherwise emerging fuel from a possible leakage could drip onto the exhaust system.

Requirements

Observe the following requirements!

- The lines have to be routed such that in case of damage the surplus fuel is drained away suitably.
- Route the lines without kinks and avoid tight bends.
- Route the lines with a continuous decline.
- The lines have to be protected against any kind of blockage e.g. by formation of ice.

ATTENTION

RISK OF FIRE!
With closed or blocked drainage bores fuel could flow into combustion chamber, possibly ruining the engine by hydraulic lock or emerging fuel could drip onto the exhaust system.

DATA FOR OPTIONAL COMPONENTS OF AIR INTAKE SYSTEM

Air filter

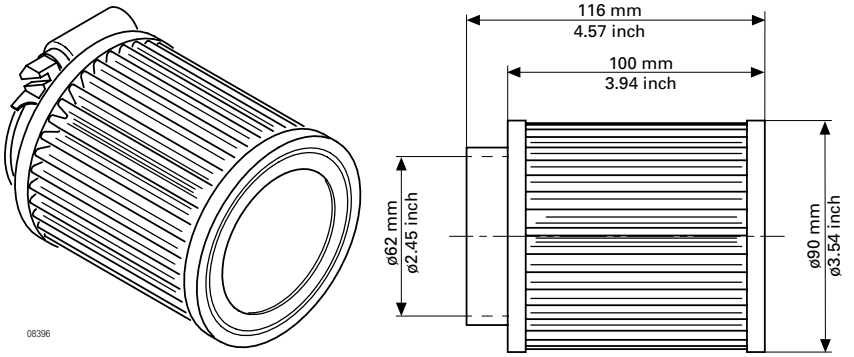

Figure 6.3: Dimension air filter

Chapter: 73–00–00
ENGINE – FUEL AND CONTROL

TOPICS IN THIS CHAPTER

INTRODUCTION

ATTENTION

The design of the fuel system is the responsibility of the aircraft manufacturer. The fuel system must be designed to ensure that the engine is supplied with sufficient fuel at the correct pressure in every operational situation. Operating limits must be adhered to!

Fuel

The fuel flows from the tank via a coarse filter/water trap to the two electric fuel pumps with 2 check valves connected in series. From the pumps fuel passes on via the fuel pressure control to the two carburetors.

Connection lines

On the standard version of the engine the fuel lines from fuel pressure control to the carburetors are already installed.
The fuel system from tank to the fuel pressure control has to be installed by the aircraft manufacturer.
Only the following connections per Figure Fuel System have to be established:

- Feeding lines to suction side of the electric fuel pumps.
- Lines from pressure side of the electric fuel pump to inlet of fuel pressure control.
- Return line from fuel pressure control to fuel tank.

Return line

Via the return line surplus fuel flows back to the fuel tank and suction side of fuel system.

NOTE

The fuel pressure control ensures that the fuel pressure is always maintained approx. 0.25 bar (3.6 psi) above the variable boost pressure in the "airbox" and thus ensures proper operation of the carburetors.

The fuel system includes the following items:

- Fuel tank
- Coarse filter
- Fine filter/watertrap
- Fuel shut off valve
- 2 electric fuel pumps
- as well as the required fuel lines and connections

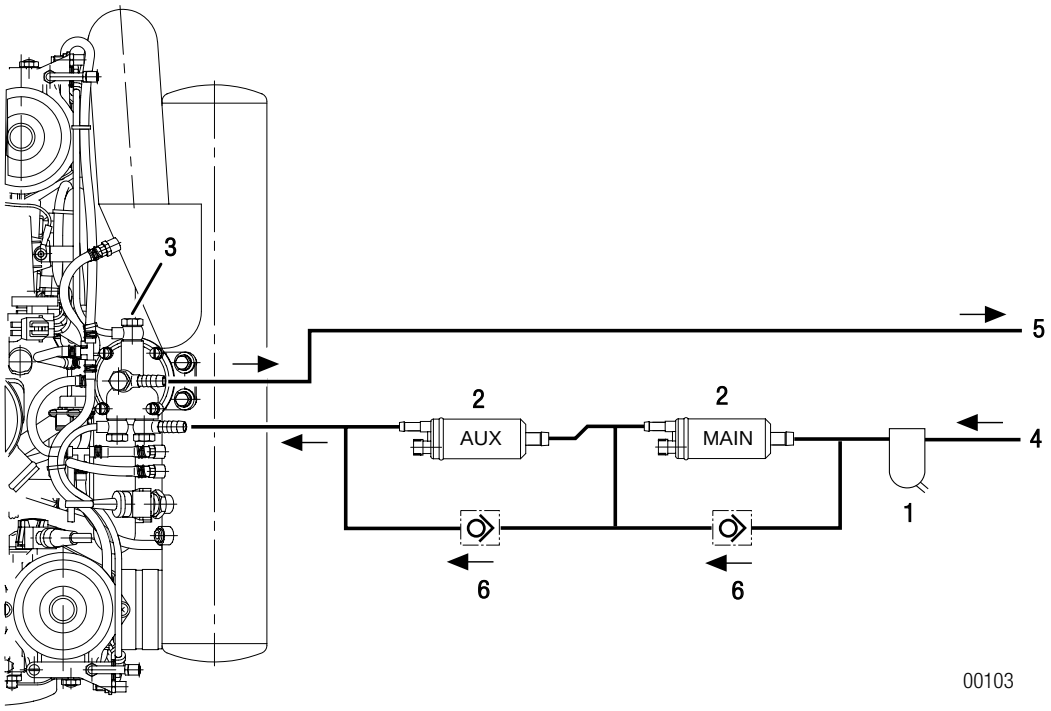

Figure 7.1: Fuel System

1 Filter/water trap (gascolator)	*2 Electric fuel pump*
3 Fuel pressure control	*4 Feeding line from tank*
5 Return line to tank	*6 Check valve*

REQUIREMENTS OF THE FUEL SYSTEM

Operating limits

See Operating Manual 914 Series Chapter 2 section Operating limits.

ATTENTION

The design and layout of the entire fuel system must ensure engine operation within the specified operating limits.

In case of deviations in fuel pressure:

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Fuel pressure in excess of stated limit can lead to an override of the float valve with subsequent engine stop.

FUEL TEMPERATURE

To avoid vapour locks keep the temperature of the fuel lines, float chamber and related deviced below 45 °C (113 °F).
In case of temperatures over 45 °C (113 °F) in the vicinity of fuel lines watch for vapour lock.
If you should encounter problems in this respect during the test period, then the affected components such as the supply line to the fuel pumps have to be cooled.

FUEL PRESSURE INDICATION

NOTE

There is no standard connection provided to measure the full pressure.

Notes on checking of fuel pressure

For general observation and at engine troubles fuel pressure readings would be helpful. A feasible connection would be an additional hose nipple 4/6 (1) joined to the fuel line.

Step	Procedure
1	Remove banjo bolt M10x1x19.
2	Fit additional hose nipple (with integrated orifice) and 2 sealing rings by use of a longer banjo bolt M10x1x30. Tightening torque of the banjo bolt: 15 Nm (133 in.lb).

ATTENTION

At tightening of the fuel lines support the specific line, to prevent any internal stresses.

NOTE

The Figure shows the additional ring hose nipple connected to fuel line of carburetor 1/3. This ring hose nipple may be also fitted on the fuel line 2/4, but not on the outlet and inlet.

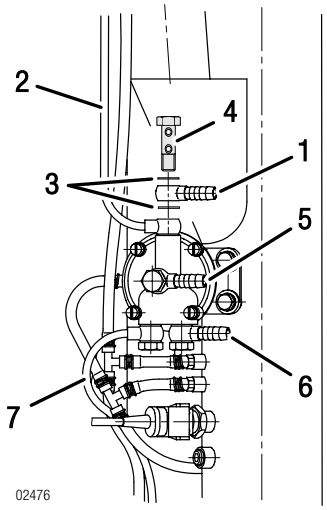

Figure 7.2: Measure the full pressure

1	*Hose nipple with integrated orifice*	*2*	*Fuel line 1/3*
3	*Sealing ring*	*4*	*Banjo bolt M10x1x30*
5	*Fuel line*	*6*	*Inlet fuel line*
7	*Fuel line 2/4*		

FUEL LINES

Safety

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

ATTENTION

For prevention of vapor locks:
All the fuel lines on the suction side of the fuel pump have to be insulated against heat in the engine compartment and routed at distance from hot engine components, without kinks and protected appropriately. At very critical conditions (e.g. problems with vapor formation) the fuel lines could be routed in a hose with cold air flow.

Fuel return line

ATTENTION

The fuel return must be a line of low flow resistance. Max. tolerated pressure loss is 0.1 bar (1.5 p.s.i.) between fuel pressure control and tank inlet with both electric fuel pumps in action. Otherwise the carburetors could flood.

Screw clamp

ATTENTION

Prevent leakage!
Utilize the full slip-on length for all connections. Secure hoses with suitable clamps or crimp connection.

COARSE FILTER

On fuel tank as per valid certification.

WATER SEPARATOR / GASCOLATOR

The installation of a water separator/gascolator must be carried out by the aircraft or fuselage manufacturer and verified according to the latest regulations, such as FAR or EASA.

FINE FILTER

In the feed line from tank to the fuel pumps an additional fine filter with mesh size 0.1 mm (70–100µ) has to be provided. The filter has to be accessible for service.
A combination of filter/watertrap (gascolator) is recommended.

GENUINE ROTAX® FUEL PUMP ASSY.

Electrical fuel pump

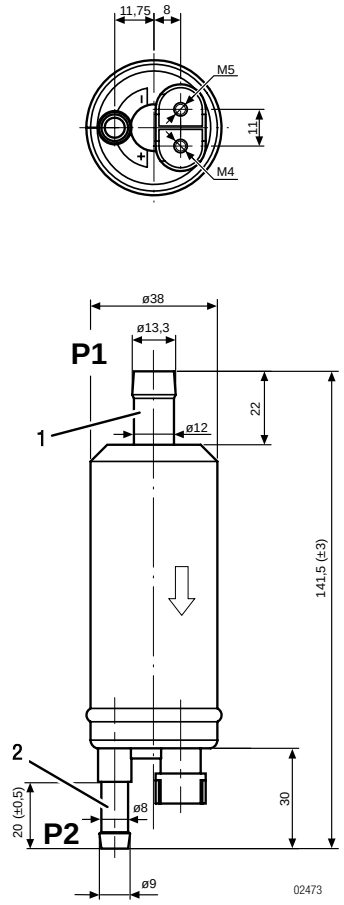

Figure 7.3: Electrical fuel pump

1 Inlet (suction side) *2 Outlet (pressure side)*

Design	self priming vane pump
Volume of supply	electrical fuel pump with attachment kit, 2 hose clamps and various attachment elements
Weight	0.35 kg (.8 lb) inclusive attachment items
Fitting position	horizontal or vertical
Engine start, operating temperature	-25 °C (-13 °F) up to 50 °C (120 °F)
Connections	Inlet (1) (suction side) Outlet (2) (pressure side)

ATTENTION
Prevent leakage! Utilize the full slip-on length for all connections. Secure hoses with suitable clamps or crimp connection.

Delivery rate/ pressure

The diagram shows the delivery rate of the electrical fuel pump over pressure.

Take note of the following:

- Diagram outlines min. capacity at nominal voltage on pump
- Pressure and suction head are "ZERO"
- Graph is effective on the seasoned pump only, running-in period approx. 30 min.

NOTE

A capacity increase of approx. 20% is feasible by run-in process.

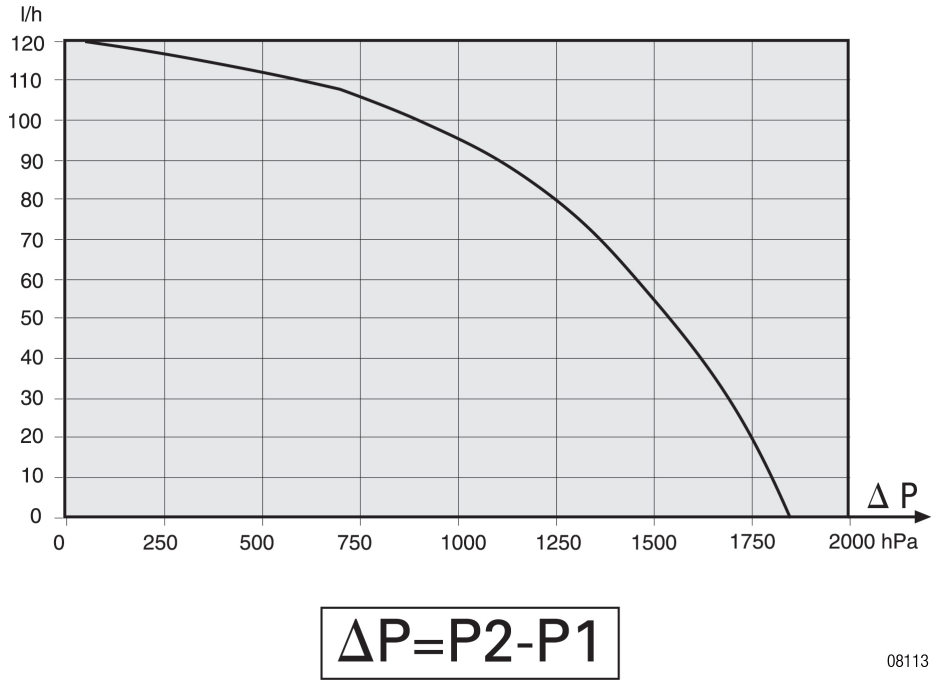

Figure 7.4: Delivery rate fuel pump

Place of installation

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Installation of the fuel pumps principally near the fuel tank to gain advantage of a cool location, especially important at tendency of vapor locks.
Install the pump in low position, if possible below fuel tank, free of vibrations. Therefore, fuel pump attached directly on the engine is not permitted. Max. suction height 250 mm (10 in).

Because of the risk of steam vapor formation on the suction side of the pumps and other safety reasons is the pump installation not permitted in the engine compartment.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Installation in the engine compartment is not permitted since the components are not of a fire resistant construction.

If possible the fuel pump should be installed in such a way that it is easily accessible for maintenance (so that the fuel filter (1) can be checked according to the maintenance schedule)

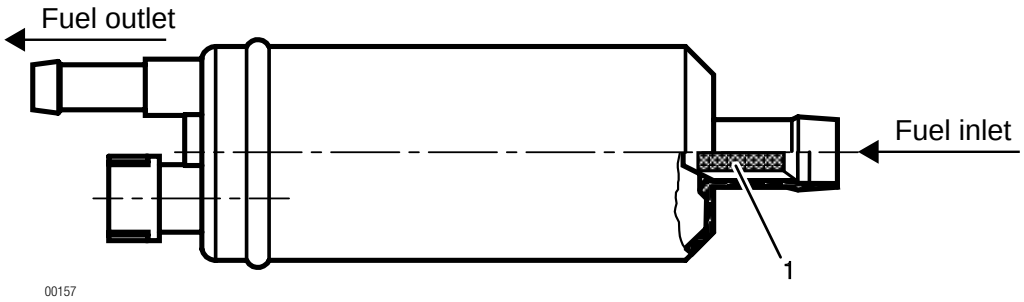

Figure 7.5: Fuel pump fine filter

1 Fuel filter

FUEL PRESSURE REGULATOR

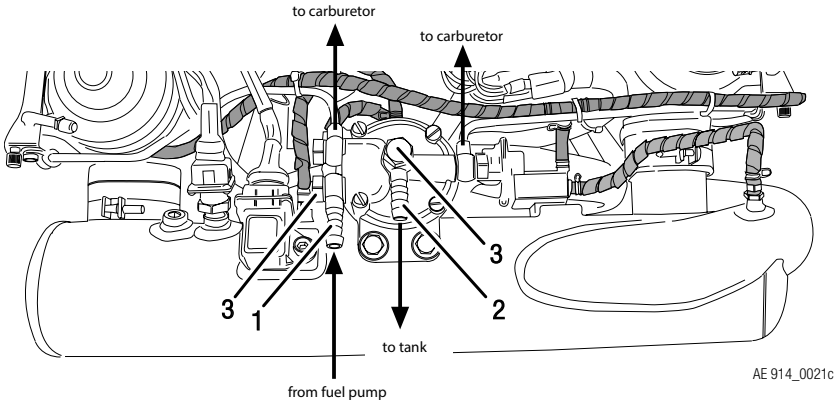

Figure 7.6: Fuel pressure regulator

1 Inlet
2 Outlet
3 Banjo bolt M10x1x19

Connections	Inlet: from fuel pumps Outlet: return to tank
Hose nipple	4/6 DIN 7642
Outside dia. ø	8 mm (5/16”)
Slip-on length	max. 20 mm (3/4”)
Tightening torque of the banjo bolts	15 Nm (133 in.lb)

ATTENTION

Prevent leakage!
Utilize the full slip-on length for all connections. Secure hoses with suitable clamps or crimp connection.

NOTE

The control of the fuel pressure is achieved by a valve activated from a diaphragm. Reference pressure is the boost pressure in the airbox.
Any arrows shown on top of the fuel pressure control are of no significance for this application.

CHECK VALVE

Technical Data

Opening pressure	0,1 - 0,15 bar (1.5 - 2.2 psi)
Permitted pressure in reserve-biasing	2 bar (29 psi)
Burst pressure	5 bar (72.5 psi)

CARBURETOR

⚠ WARNING

Non-compliance can result in serious injuries or death!
The carburetor flange assembly has to carry the weight of the carburetor and intake system. Ensure that the screw of the clamp is positioned on the underside as supplied and the gap between the clamp plates is 8 mm (.31 in.).

The carburetors on the standard engine are already attached by a flexible flange (and connecting hoses on the airbox). Only connections of the Bowden cable for preheating, choke and throttle have to be established.
It is recommended, to make the adjustment of the Bowden cable after engine installation has been completed, to ensure exact final adjustment.

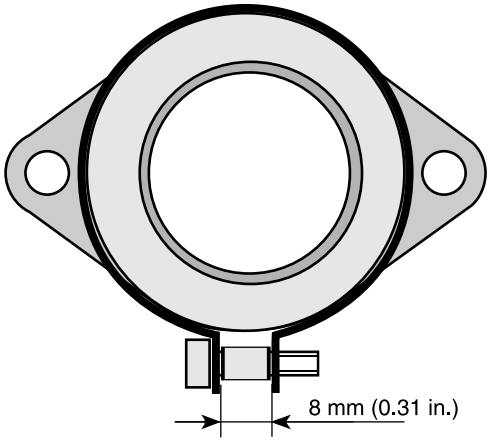

Figure 7.7: Carburetor socket

REQUIREMENTS ON THE CARBURETOR

⚠ WARNING

Non-compliance can result in serious injuries or death!
In the area of the float chamber the temperature limit of the fuel must not be exceeded. If necessary install additional insulation or heat shields.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

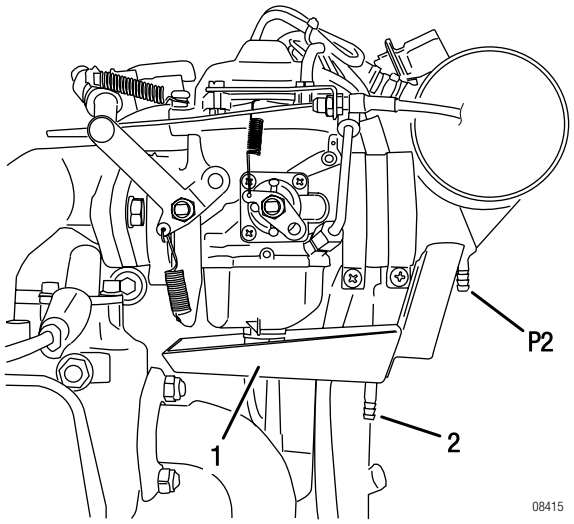

Figure 7.8: Drip tray

1 Drip tray
2 Draining connection
P2 Connection for drain line

Drip tray

The carburetors are positioned above the exhaust sockets. Below the carburetors one each drip tray with a draining connection is fitted which serves as a heat shield as well.

Connecting nipple for leakage line

Outside diameter:	6 mm (1/4”)
Slip-on length:	max. 17 mm (11/16”)

DRAINAGE LINES ON AIRBOX AND DRIP TRAYS

⚠ WARNING

RISK OF FIRE! Non-compliance can result in serious injuries or death!
Connect drainage lines well, otherwise emerging fuel from a possible leakage could drip onto the exhaust system.

Requirements

- The lines have to be routed such that in case of damage the surplus fuel is drained off suitably.
- Route the lines without kinks and avoid tight bends.
- Route the lines with a continuous decline.
- The lines have to be protected against any kind of blockage e.g. by formation of ice.

CONNECTIONS FOR THROTTLE BOWDEN CABLE ACTUATION AND PERMISSIBLE LOAD

ATTENTION
The specified permissible loads must never be exceeded!

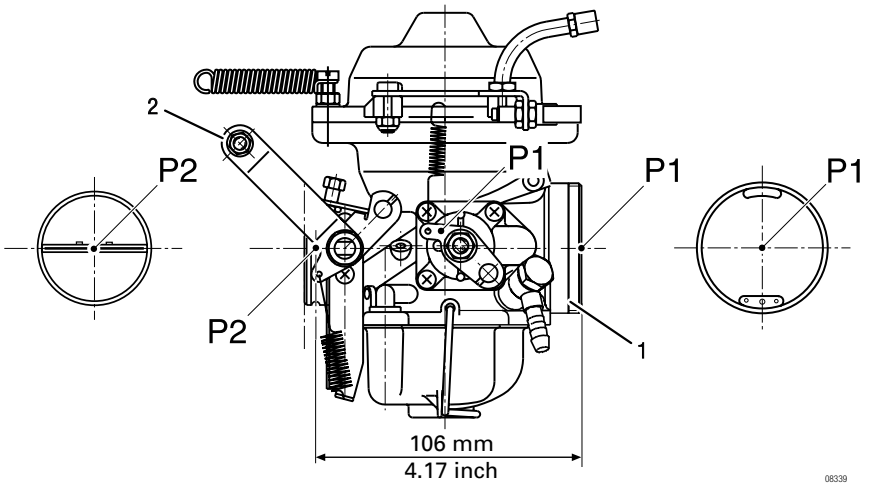

Figure 7.9: Connections Cable actuation

1 Connection for airbox
2 Connection for throttle actuation
P1 Centre position of carburetor socket
P2 Point of reference

TECHNICAL DATA

See Figure 7.9: Connections for Bowden cable actuation

Position P1

Carburetor for	x-axis	y-axis	z-axis
Cylinder 1/3	-521 mm (20.52 in)	-180 mm (-7.1 in)	25 mm (0.988 in)
Cylinder 2/4	-553 mm (-21.77 in)	180 mm (7.1 in)	25 mm (0.988 in)

Load P2

	Reference point P2
max. permissible forces (limit load) in x, y and z-axis [N (lbf)]	60 (13.49)
max. permissible bending moments (limit load) in x, y and z-axis [Nm (lbf ft)]	4 (2.95)

Airbox or air filter

Outside diameter:	50 mm (2 in)
Slip-on length:	12 mm (0.47 in)

Throttle actuation

Set screw	M5x12
Tightening torque	4 Nm (2.95 lbf ft) (suitable for 1.5 mm (0.06 in) steel wire or flexible wire)
Action travel	65 mm (2.56 in)
Actuating force	min. 1.5 N (0.33 lbf) max. 8 N (1.79 lbf)
Limit load per carburetor	20 N (4.49 lbf)

NOTE

Throttle opens by spring.

Choke actuation

NOTE

The choke shaft is marked. This mark has to point towards cable engagement.

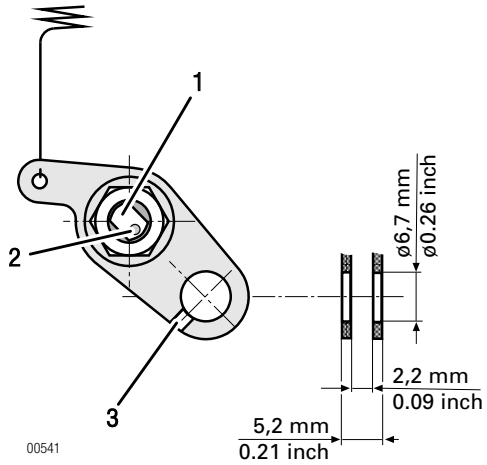

Figure 7.10: Choke actuation

1 Choke shaft
2 Marking
3 Cable engagement

Clamping nipple:	6 (suitable for 1.5 mm (0.06 in) flexible wire or steel wire)
Action travel:	23 mm (0.91 in)
Actuating force:	min. 10 N (2.24 lbf) max. 45 N (10.11 lbf)
Limit load:	100 N (22.48 lbf)

REQUIREMENTS ON BOWDEN CABLE ACTUATION

⚠ WARNING

Non-compliance can result in serious injuries or death!
With throttle lever not connected the throttle valve will remain fully open. The starting position of the throttle valve is therefore full throttle! Therefore never start the engine without connecting the throttle lever first.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The cable actuations being used must not be affected at all by vibrations emanating from the engine or the airframe.

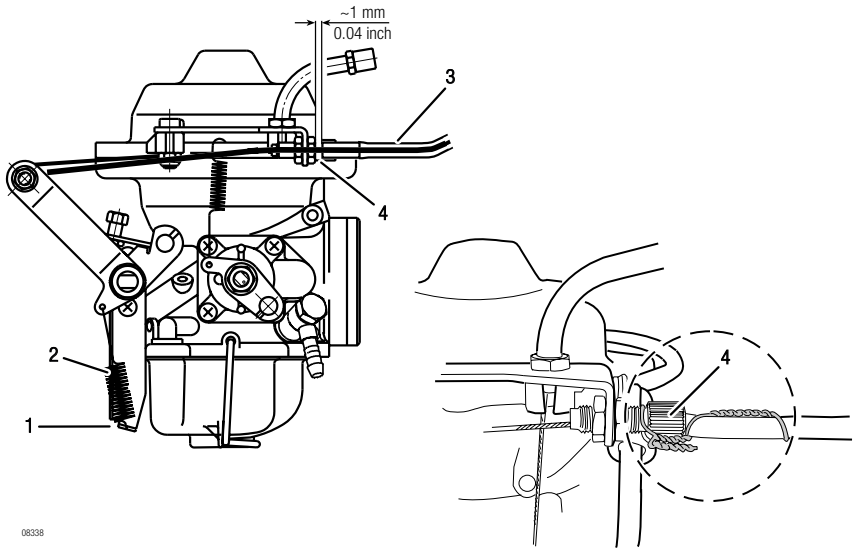

Figure 7.11: Bowden cable actuation

1 Lever flap
2 Return spring
3 Cable sleeves
4 Adjustment screws

Bowden cable

The two throttles have to be controlled by two separate Bowden cables working synchronously.
Adjust the cables to a free travel of 0.04 in.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Use Bowden cable with minimized friction so that the spring on the throttle can open the throttle completely. Otherwise fit a stronger return spring or a cable with pull-push action would have to be used. Secure the Bowden cable sleeves in the adjustment screws (e.g. safety wire).

REQUIREMENTS ON THE THROTTLE LEVER

From throttle position 108 to 110 % the boost pressure rises rapidly and the throttle becomes very sensitive in this range.
Therefore try to prevent operation in this small range or if setting for take-off performance pass this range quickly.
For this reason it is recommended to assist the pilot with an visual/manual arrangement at setting for max. cruise performance.
A detent on your throttle lever at max. continuous power would be most suitable. Provide this at throttle position 104% corresponding to 8-9 mm (5/16” –11/32”) travel before full throttle stop.
The sketch depicts a feasible arrangement.
The throttle lever is pressed onto throttle gate and comes to a stop at max. continuous power. Against the spring force the throttle lever will be released from the detent and can be moved further to take-off performance.

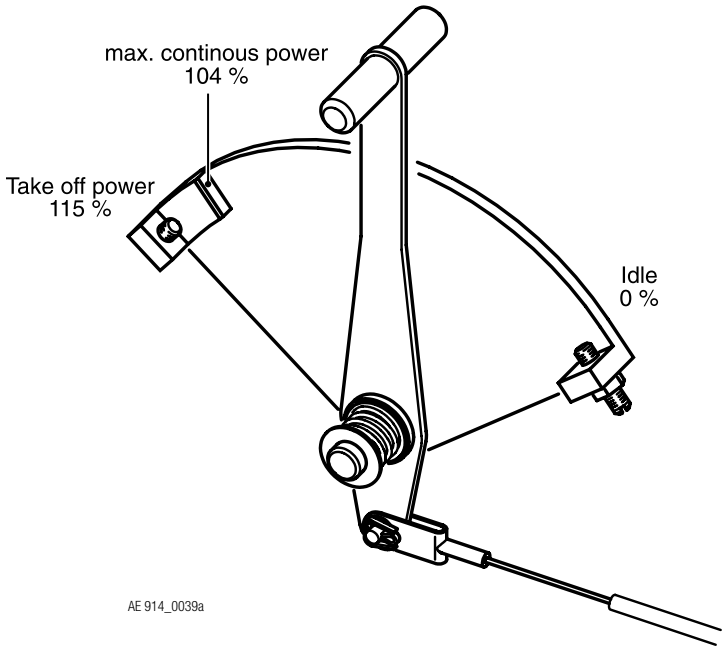

Figure 7.12: Depicts a feasible arrangement

Mechanical stops Adjustable positive stops for idle- and full throttle position are of course required.
This stops have to be designed such to render adjustability and to prevent overload of the idle stop on the carburetor.

LOCATION AND DETERMINATION OF THE THROTTLE POSITION FOR MAX. CONTINUOUS POWER

It is a necessity for trouble free engine operation that the pilot can locate the exact throttle position for max. continuous performance.

ATTENTION
A manual determination (e.g. by a graduated disk) is not precise enough and therefore not permitted.

The exact determination is achieved electronically by a PC program especially developed for this engine.
For further details refer to the corresponding Maintenance Manual, section "Control system of the turbo charger".

Chapter: 75–00–00
COOLING SYSTEM

TOPICS IN THIS CHAPTER

SYSTEM DESCRIPTION

For a detailed System description refer to the latest issue of the Operators Manual.

SYSTEM LIMITATIONS

Operating limits

Refer to latest issue of the Operators Manual .

⚠ WARNING

Non-compliance can result in serious injuries or death!
The cooling system must be designed so that the operating limits are not exceeded. To minimize flow resistance, use radiators that have both a parallel flow and have a low flow resistance. A prime example would be the GENUINE ROTAX® radiators. Be sure to use short hoses and pipelines.

Cooling

The engine cooling system is designed for liquid cooling of the cylinder heads and ram air cooling of the cylinders.
The cooling system of the cylinder heads is a closed circuit with an expansion tank and overflow bottle.

Coolant

The coolant flow is forced by a water pump, driven from the camshaft, from the radiator to the individual cylinder heads. The coolant flows from the top of the cylinder heads to the expansion tank. Since the standard location of the radiator is below engine level, the expansion tank located on top of the engine allows for coolant expansion.

Expansion tank

The expansion tank is closed with a pressure cap (with pressure relief valve and return valve). As the coolant heats up and expands, the pressure relief valve opens and the coolant flows via hose at atmospheric pressure to the transparent overflow bottle. As it cools down, the coolant is sucked back into the cooling circuit.

Shape, size and position

The shape, size and position of the radiator(s) depends mainly on the space available in the aircraft.

Measuring the coolant temp.

Readings are taken on measuring point of the hottest cylinder head, depending on engine installation.

The temperature sensors are located in cylinder head 2 and 3.

Radiator

If a GENUINE ROTAX® radiator is being used, then an oil-water heat exchanger must not be present. The radiator is dimensioned to cater for the heat of the coolant and cannot cope with the additional heat generated by the oil system.

INTERFACE DESCRIPTION

INTERFACE OVERVIEW

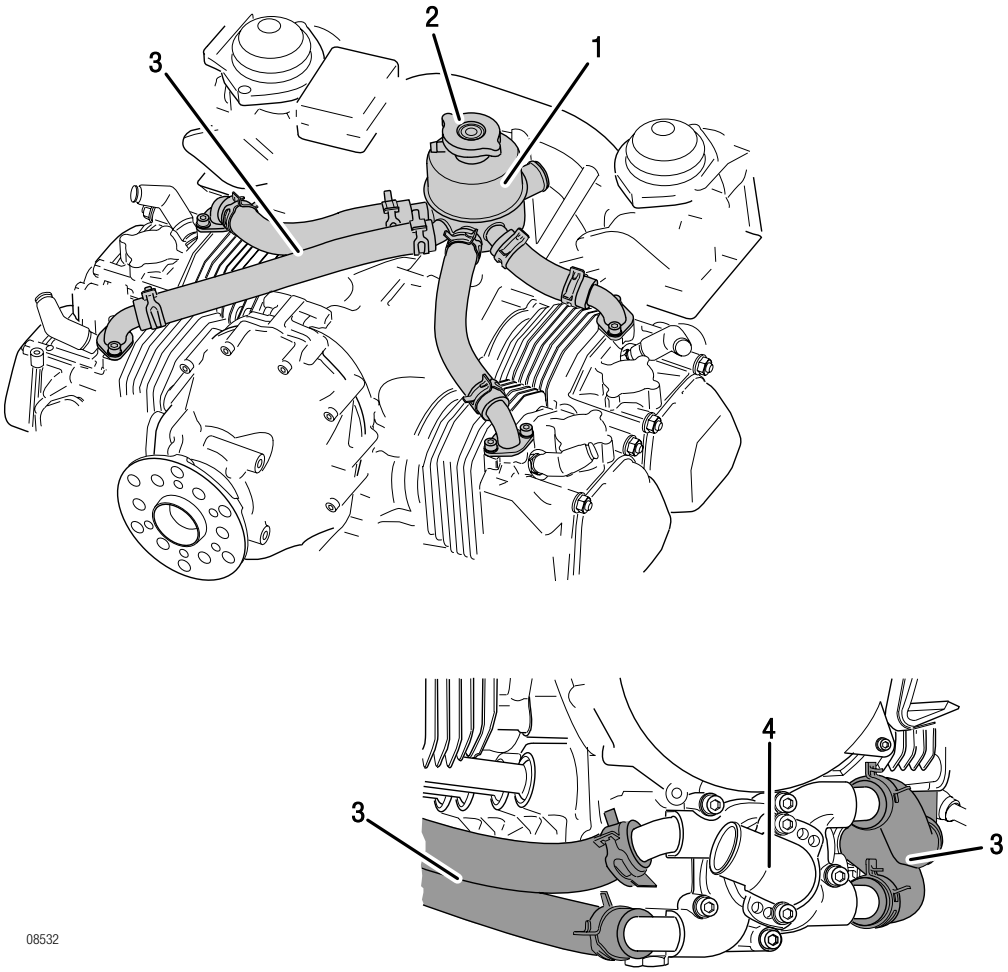

Figure 8.1: Cooling system

1 Expansion tank	*2 Radiator cap*
3 Coolant hose	*4 Water pump*

HYDRAULIC INTERFACES

Water inlet elbow

Interface Parameter	Min.	Max.
Cooling system pressure (relative)	1.6 bar (23.2 psi)	-
Cooling water temperature	- 20 °C (- 4 °F)	125 °C (257 °F)
Cooling water flow (at 5800 rpm)	60 l/h (15.85 US gal/ min.)	-
Slip on length	19 mm (0.75 in)	

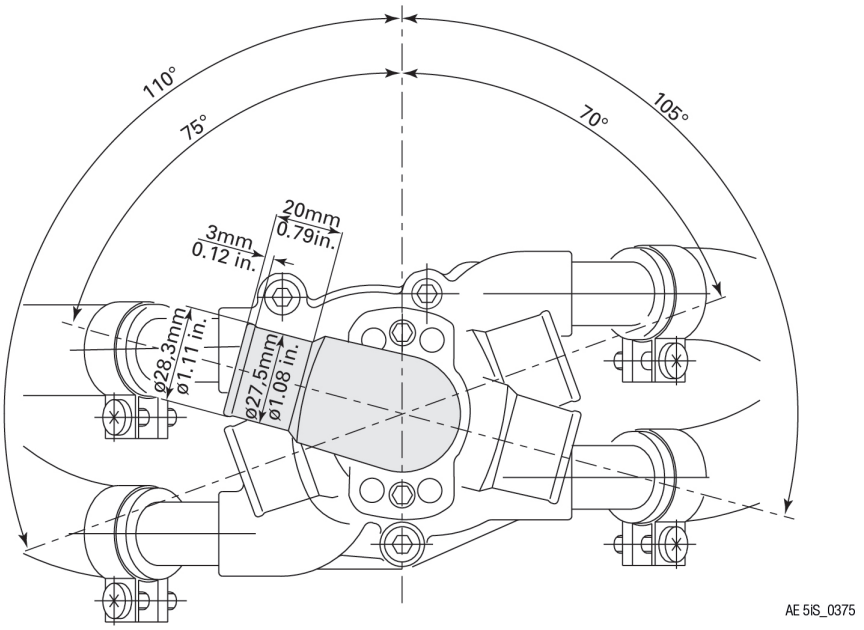

Figure 8.2: Water inlet elbow

Connection: Outer diameter 27 mm (1.07 in).

Water outlet

Interface Parameter	Min.	Max.
Cooling system pressure (relative)	1.6 bar (23.2 psi)	-
Cooling water temperature	- 20 °C (- 4 °F)	130 °C (266 °F)
Cooling water flow (at 5800 rpm)	70 l/h	-

Connection: Inner diameter 25 mm (0.98 in).

Expansion tank connection

Interface Parameter	Min.	Max.
Slip on length	18 mm	

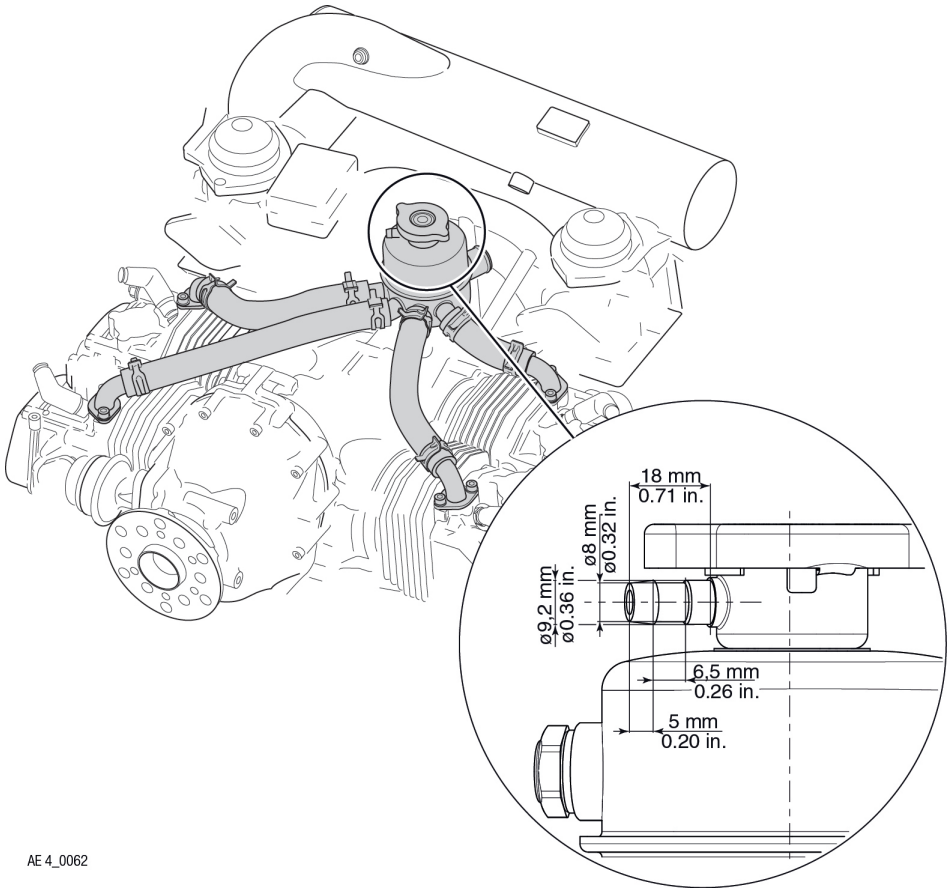

Figure 8.3: Expansion tank connection

AIR COOLING INTERFACES

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

For front installation in a closed cowling, ducting of cooling air to the cylinders is recommended. In this case a costly horizontal partitioning can be avoided.

NOTE

The engine remains in this case completely on the warm side of the engine compartment and is very well accessible. In special cases a separate cold air supply to the air intake filters has to be provided.

BRP-Rotax has developed especially for this application a non-certified cooling air ducting to be conducted by the aircraft manufacturer.

Position	x-axis	y-axis	z-axis
P1	- 300 mm (- 11.81 in.)	- 30 mm (- 1.18 in.)	- 14 mm (- 0.55 in.)

Cooling air duct

NOTE

In some special cases (entirly closed cowl) a separate cold air supply to the induction air filter should be provided.

Following recommendations should assist the aircraft or fuselage manufacturer in selecting suitable cooling air ducts:

Specification	Description
Cooling capacity	The cooling air duct must be designed so, that it transfers thermal energy of approx. 6 kW (5.7 BTU/s) at take-off performance.
Cross section of air duct	Cross section of the air duct min. 100 cm² (15.50 in²).
Material	Glass fibre reinforced plastic or heat and fire resistant material.
Attachment options	Friction–fit on engine block and mounting above the cylinder and the crankcase.

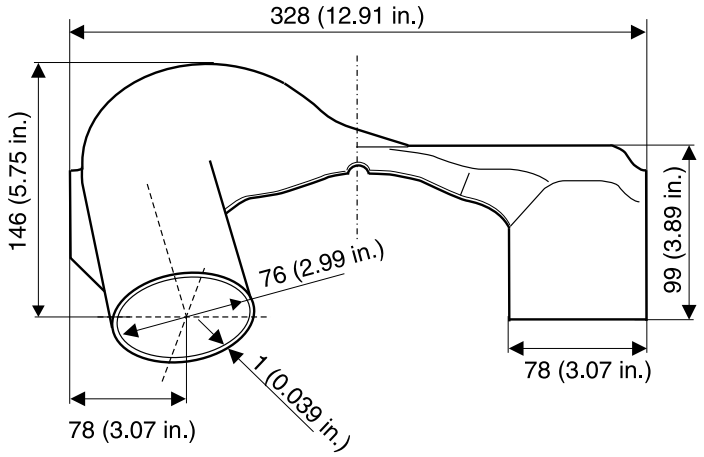

Figure 8.4: Cooling air duct for tractor

INSTALLATION NOTES

General

The representation of components in this chapter which are not within scope of the delivery is only symbolic. The design shown in this chapter does not represent a specified execution but should support the understanding of the system.
The final design, the selection and specification of parts according to the respective applicable regulations, the consideration of the system limitations and interface description as well as the comprehension of the operating limits in every operational state is in the responsibility of the aircraft manufacturer.
The aircraft manufacturer has to make sure that the operating limits given in the Operators Manual can be supervised by the pilot. The execution of the installation must allow the operation of the engine according to the Operators Manual.

INSTALLATION OVERVIEW

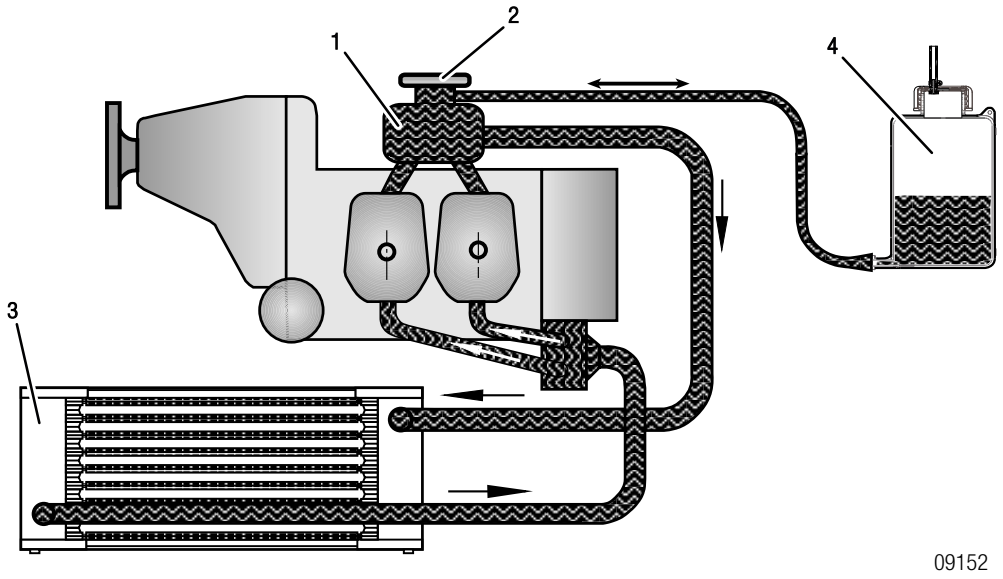

Figure 8.5: Cooling system

1 Expansion tank	*2 Pressure cap*
3 Radiator	*4 Overflow bottle*

COOLANT HOSES

ATTENTION

Hoses exposed to direct heat radiation from the exhaust system, must be suitably protected with heat-resistant protection covers, for example.

Aluminium tubes with an inner diameter of 25 mm (0.98 in) can be used instead of longer hoses. These must have a bulge in order to prevent coolant hoses working loose.

NOTE

Note, the addition of an aluminium tube will double the number of hose clamps required!

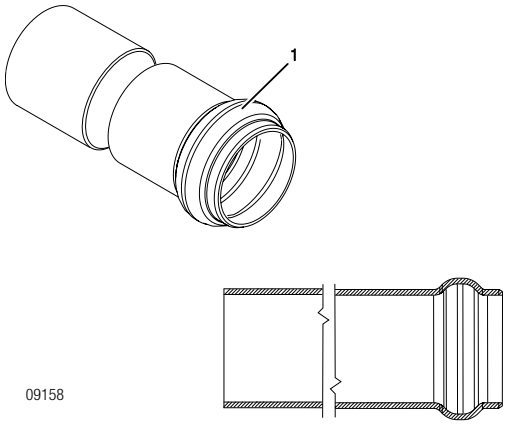

Figure 8.6: Aluminium tube

1 Bulge

Temperature resistance	min. 125 °C (257 °F)
Pressure durability	min. 5 bar (72 psi)
Inner diameter	25 mm (1″)
Bending radius	min. 175 mm (6.89 in.) (except moulded hoses)
Material	100 % resistant to glycol, antifreeze, ozone

Hose from expansion tank

⚠ WARNING

Non-compliance can result in serious injuries or death!
A soft walled hose is not suitable as it can collapse and cause cooling system failure.

- The hose from the expansion tank to the overflow bottle must be rated for vacuum/suction for min. 125 °C (257 °F), e.g. it must be strong enough to withstand high temperatures and vacuum/suction during the cooling down period.
- The aircraft manufacturer must give the possibility to the pilots to check the coolant level in the expansion tank. Also it is necessary to inform the pilots about the daily inspection of the coolant level in the aircraft manufacturers operators (pilots) manual or an adequate link to the Operators Manual
- It is recommended that adequate measures are taken for carrying out these inspections, e.g. a flap or panel on the cowling or a warning instrument in the cockpit for low coolant level.

COOLANT TYPES

Without Suffix -01 **Permissible coolant types:**

- Conventional coolant based on ethylene glycol
- Waterless coolant based on propylene glycol

See SI-914-019.

Conventional coolant Conventional coolant is recommended as it commonly available and has a greater thermal heat transfer capability. Its limitation is its lower boiling point.

Waterless coolant Waterless coolant is recommended if the design of the aircraft can not maintain the coolant temperature limit 120 °C (248 °F).

Mixing ratio

ATTENTION
Obey the manufacturers instructions!

	Mixture ratio	
Description	**Concentration**	**Water**
Conventional coolant	50 %	50 %
Some conventional coolants are available pre-mixed by the manufacturer. In this case do not mix with water, instead follow the manufacturers instructions.		
Waterless coolant	100 %	0

Boiling point

- **Conventional coolant**
  Conventional coolant with a rate of 50 % water cannot boil at a temperature below 120 ° C (248 °F) at a pressure of 1.2 bar (18 psi). The max. coolant temperature limit is therefore 120°C (248 °F).

NOTE

Permanent monitoring of coolant temperature and cylinder head temperature is necessary.

- **Waterless coolant**
  Waterless coolant has a very high boiling point that prevents coolant loss due to “boiling over“ (vapor loss), but not to prevent detonation, which can occur with cylinder head temperatures higher than 135 °C (275 °F) . It does not require pressure to maintain its boiling point. Due to a lower thermal conductivity the engine temperature will typically run about 5-10 °C (41- 50 °F) higher with waterless coolant.

NOTE

Permanent monitoring of cylinder head temperature is necessary.
Additional monitoring of the actual coolant temperature is possible but not necessary for waterless coolant.

NOTE

When using EVANS NPGR, NPG+ or added pure ethylene glycol as a coolant, note that these fluids have a flammability rating 1 (classification LOW at a scale from 0 to 4). The mentioned coolants are complying according to their material safety data sheet with a flammability classification, which has only low danger and a low risk of flammability. To date, no cases in engine operation or flight operation, laboratory conditions or from the field were reported, which show unsafe conditions of ROTAX® aircraft engines in combination with the relevant coolants.

Marking

ATTENTION
The coolant to be used and its concentration (percentage water rate) must be correctly communicated to the owner.Waterless coolant must not mix with water, as otherwise it will lose the advantages of a high boiling point.

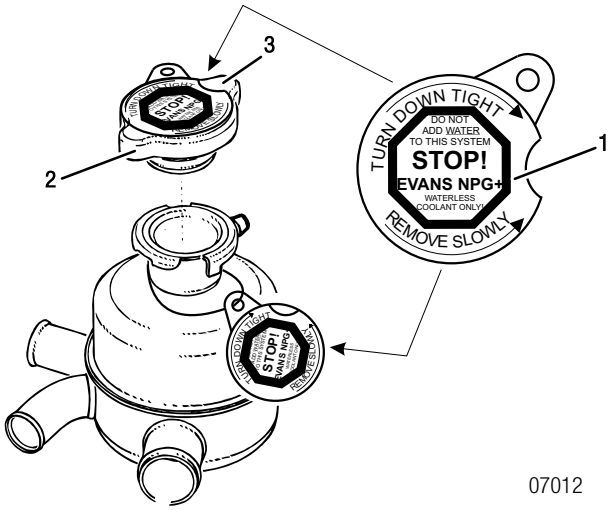

Figure 8.7: :Marking of the coolant

1	*Warning sticker*	*2*	*Radiator cap*
3	*Opening pressure information of radiator cap*		

Suffix -01

Permissible coolant types:

- Conventional coolant based on ethylene glycol

ATTENTION

Obey the latest edition of Service Instruction SI-914-019, for the selection of the correct operating media.

Conventional coolant is recommended as it commonly available and has a greater thermal heat transfer capability. Its limitation is its lower boiling point.

NOTE

Permanent monitoring of coolant temperature is necessary.

ATTENTION

Obey the manufacturers instructions!

	Mixing ratio	
Description	**Concentrate**	**Water**
Conventional coolant	50 %	50 %
Some conventional coolant is available pre-mixed by the manufacturer. In this case do not mix with water, instead follow the manufacturers instructions.		

Boiling point

Conventional coolant:

Conventional coolant with the rate of 50 % water cannot boil at a temperature below 120 ° C (248 °F) at a pressure of 1.2 bar (18 psi). The max. coolant temperature limit is therefore 120 °C (248 °F).

NOTE

Permanent monitoring of coolant temperature is necessary.

REQUIREMENTS, PERMISSIBLE LOCATION AND INSTALLATION POSITION

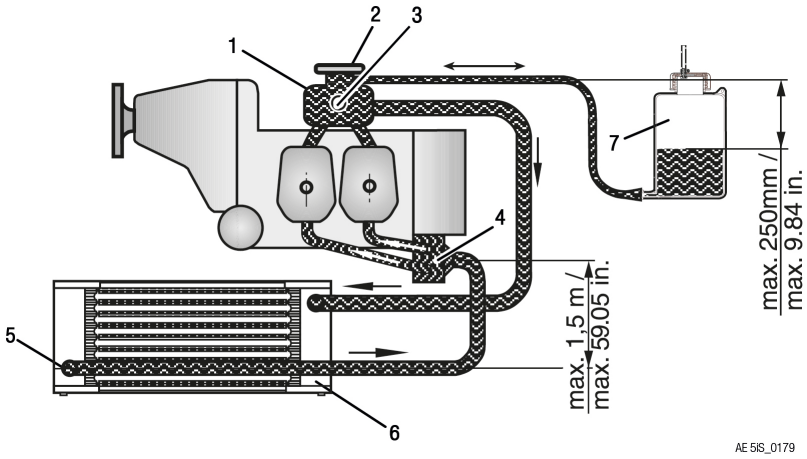

Figure 8.8: Permissible location

1	*Expansion tank*	*2*	*Pressure cap*
3	*Fluid level glass*	*4*	*Water pump*
5	*Radiator outlet*	*6*	*Radiator*
7	*Overflow bottle*		

Radiator

⚠ WARNING

Non-compliance can result in serious injuries or death!
The components must be designed and installed such that the permissible operating temperatures are maintained and the max. values are not exceeded. This must also apply to “Hot day conditions“! If need be, take appropriate measures.

ATTENTION

If required, the radiator outlet may be located max. 1.5 m (4.92 ft.) underneath the inlet elbow of the water pump and no higher than the expansion tank.

Expansion tank location

To ensure proper operation of the cooling system, the expansion tank with pressure cap in the main operating systems must be installed on the highest point of the cooling circuit.

NOTE

The expansion tank is fitted on top of the engine in standard configuration.

Overflow bottle

The system also needs an overflow bottle in which surplus coolant is collected and returned to the coolant circuit during the cooling down period.

ATTENTION

Ensure proper operation of the cooling system.
The suction height between overflow bottle and expansion tank must not exceed 250 mm (10 in.).

NOTE

For proper operation ensure that the hose to the overflow bottle is as short as possible.

Overflow bottle requirements

See SB-914-025“Modification of the overflow bottle“, latest issue.

- Transparent material
- Temperature resistant from -40 °C to +130 °C (-40 °F to 266 °F)
- 100 % resistant to glycol and suitable for all other antifreeze agents
- Volume approx. 0.5 l (0.13 US gal)
- With vent diameter at least 2.5 mm (0.1 in)
- Label about indicating function and content

Capacity overflow bottle

⚠ WARNING

Non-compliance can result in serious injuries or death!
The overflow bottle must never be empty, otherwise air will be sucked into the cooling circuit; this can have a negative effect on the safe operation of the engine.

Installation overflow bottle

ATTENTION

Emerging coolant can be flammable under certain conditions.
The overflow bottle and its supply and discharge must not be installed close to the exhaust system.

CONNECTING SIZE AND POSITION OF CONNECTIONS

The hoses must be fixed with appropriate clips to prevent loss, e.g. with spring type hose clamps, such as those used for the coolant hoses between the water pump and cylinder. Clamps of this type have performed well in the field.

To radiator	Outside diameter	25 mm (1″)
	Slip-on length	max. 22 mm (7/8″)
To overflow bottle	Outside diameter	8 mm (3/8″)
	Slip-on length	max. 15 mm (9/16″)
Water inlet elbow	Outside diameter	27 mm (1 1/16″)
	Slip-on length	max. 19 mm (3/4″)

Connecting dimension

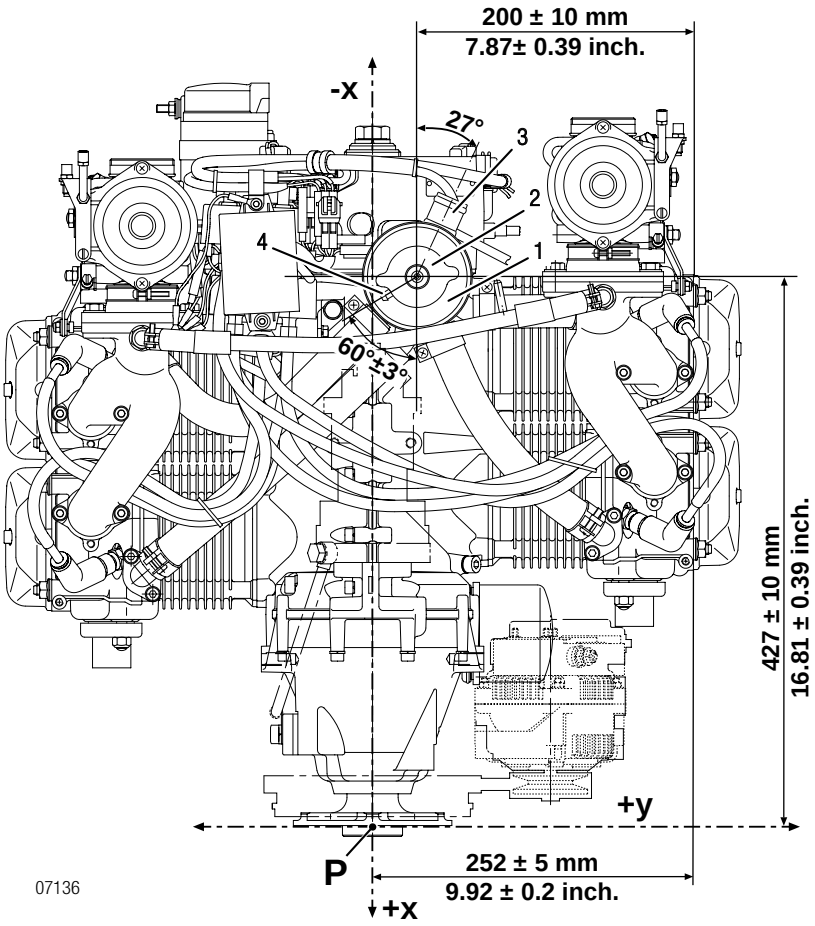

Figure 8.9: Connecting dimension

1 *Expansion tank*
2 *Radiator cap*
3 *Connection to the radiator*
4 *Connection to the overflow bottle*

Water inlet elbow

ATTENTION

Prevent leakage!
Utilize the full slip-on length for all connections. Secure hoses with suitable clamps or crimp connection.

Choose between six possible installation positions of water inlet elbow appropriate to specific installation (see Fig. Connecting dimension).
Use two M6x20 Allen screws and lock washers to attach the water inlet elbow. Tighten screws to 10 Nm (90 in lb).

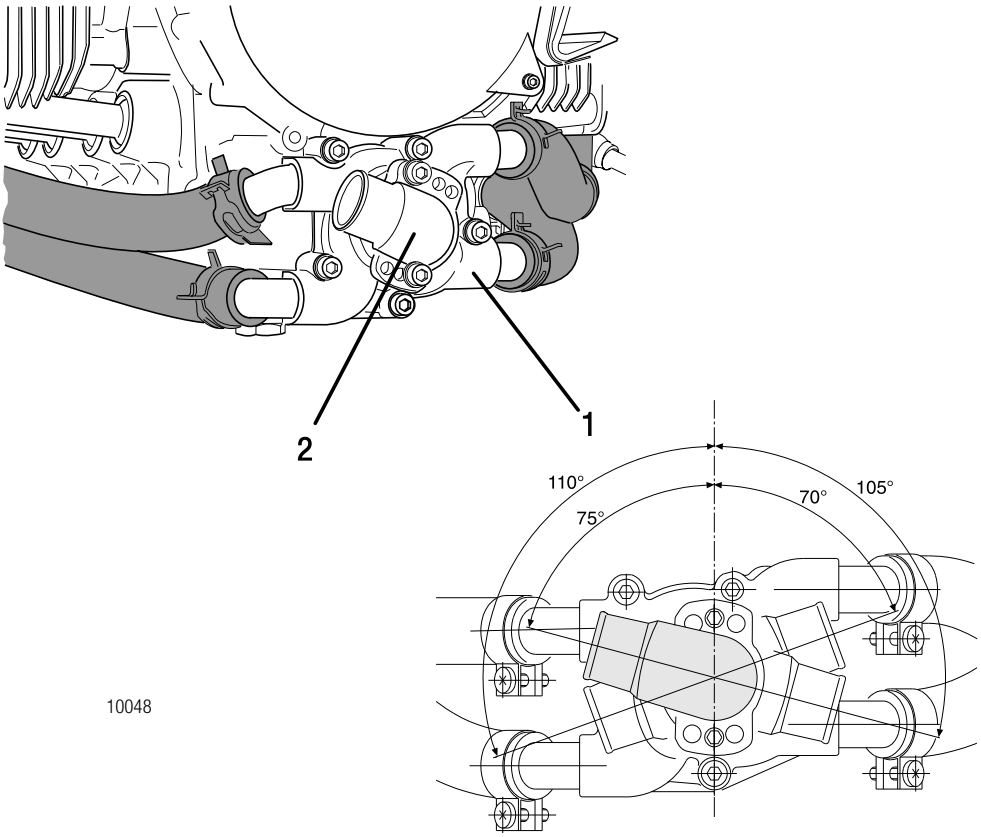

Figure 8.10: Water inlet elbow

1 Water pump housing

2 Water inlet elbow

VALIDATION OF INSTALLATION

The maximum coolant temperature must be determined in order to check the efficiency of the cooling system.

Suffix -01

Measurement of coolant temperature

There are two temperature sensor on the cylinder 2 and 3 for measuring the coolant temperature. During flight test the place with the highest coolant temperature must be found, this can vary with different engine installation (cowling or free installation, tractor or pusher, fight speed etc.)

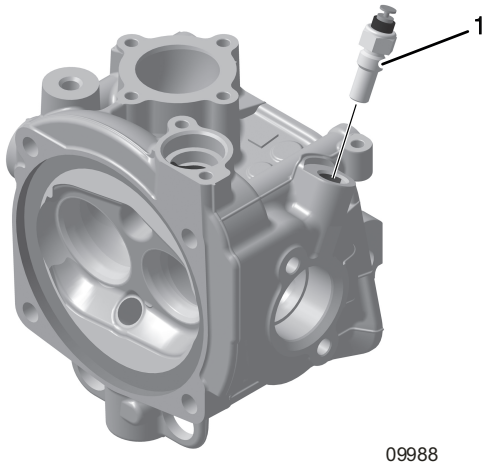

Figure 8.11: Coolant temperature sensor

1 Coolant temperature sensor

NOTE

At engines with cylinder heads of the new configuration, the cooling system must be designed so that the operating limits are not exceeded. A determination of the dependency on coolant temperature and cylinder head temperature is not necessary any more.

without Suffix -01

Cylinder head temperature

There are two temperature sensors, one each on cylinder 2 and 3. During flight test the place with the highest coolant temperature must be found, this can vary with different engine installation (cowling or free installation, tractor or pusher, fight speed etc.)

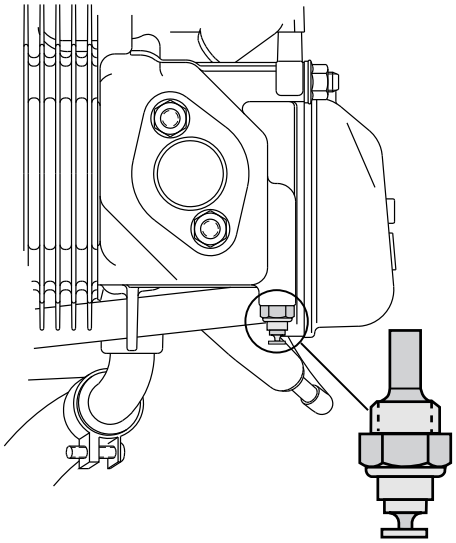

Figure 8.12: Temperature sensors (without Suffix -01)

Coolant outlet temperature

⚠ WARNING

Non-compliance can result in serious injuries or death!
Do not restrict the coolant flow with the sensor.

ATTENTION

It is possible to record a false measurement when measuring fluid temperatures.
If fluid volume is lost and the sensor is not fully submerged in the liquid, the indicating instrument could incorrectly display a lower temperature, by measuring the air temperature instead of the coolant temperature.

The measuring of the coolant exit temperature is performed using a separate sensor, which has to be installed in the line between expansion tank and radiator inlet.

Cylinder wall temperature

Max. permitted cylinder wall temperature on hottest cylinder is 200 °C (392 °F). See the following figure.

NOTE

If this temperature is exceeded, appropriate measures (e.g. cooling air ducts, modifications to cowling, etc.) must be taken to bring it within limits again.

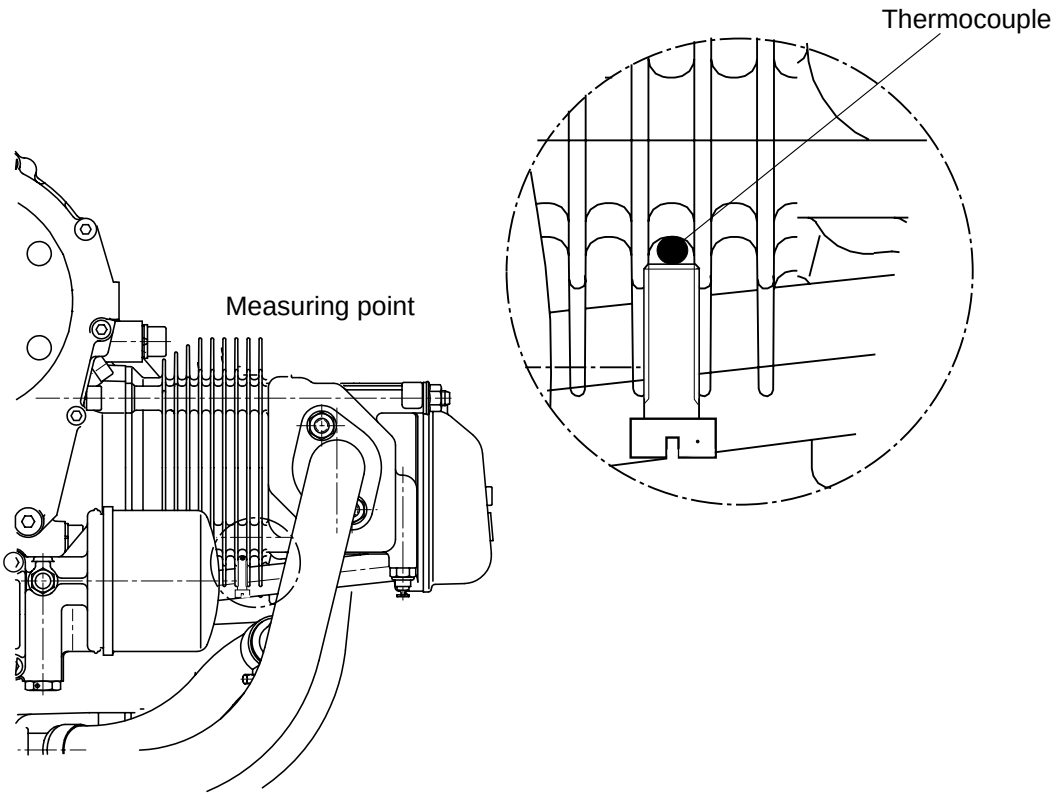

Figure 8.13: Measuring point

Pressure test

To ensure the System has no leakage, remove the pressure cap from the expansion tank. Then attach the pressure tester and pump the system until the pressure manometer shows 1.2 bar (18 psi). After min. 1 minute, there should be still 1.2 bar (18 psi) pressure in the system.

- Check the efficiency of the coolant radiator and its proper sealing between cowling and radiator.
- Check the proper flow between expansion tank and overflow bottle.
- Ensure that no ram air is induced onto the overflow bottle vent line.
- Check efficiency of air duct (if installed) and proper air flow through the duct and around cylinders.
- Consider cold (winter) and hot (summer) conditions in ground and flight testing.
- Check proper dampening of the water radiator and stressless installation and proper sealing.

DETERMINATION OF OPERATING LIMITS, COOLANT AND NECESSARY MODIFICATION ON RADIATOR INSTALLATION FOR ENGINE

Maximum values **With Suffix -01: Not relevant.**

Maximum values **Without Suffix -01.**

Depending on the achieved maximum values of the cylinder head temperature and the coolant temperature following action are necessary:

Conventional coolant		
Coolant temperature	Cylinder head temperature	Action
less than 120 °C (248 °F)	less than 135 °C (275 °F)	Both values are below operating limit. It is necessary to monitoring constantly cylinder head temperature and coolant exit temperature.
more than 120 °C (248 °F)	less than 135 °C (275 °F)	Cooling capacity too low. Check of the installation necessary.
less than 120 °C (248 °F)	more than 135 °C (275 °F)	
more than 120 °C (248 °F)	more than 135 °C (275 °F)	

Waterless coolant		
Coolant temperature	Cylinder head temperature	Action
less than 120 °C (248 °F)	less than 135 °C(275 °F)	Maximum cylinder head temperature is below operating limits. Operating with waterless coolant, is permissible without modification to the installation.
more than 120 °C (248 °F)	less than 135 °C (275 °F)	
less than 120 °C (248 °F)	more than 135 °C (275 °F)	Cooling capacity too low. Check of the installation necessary.
more than 120 °C (248 °F)	more than 135 °C (275 °F)	

NOTE

For detection of possible indication error an additional monitoring of the cylinder head temperature is necessary which shows an exceeding in case of coolant loss.

Flight test

The aircraft manufacturer has the option of converting the coolant temperature and the cylinder head temperature to an aircraft specific cylinder head temperature. This is possible by calculating the difference between the head material and the coolant temperature. Refer to the flight test example that follows.
Once the calculation is made and the indicating instrument re-labelled it is acceptable to use the cylinder head temperature as the primary cockpit display instead of installing a sensor in the coolant flow.
The measurement is based on the maximum coolant temperature and cylinder head temperature according to the current requirement.

ATTENTION

In no case a cylinder head temperature higher than the limit (see table of maximum values) can be defined because detonation could not be sufficiently prevented.

Flight test example

Calculated values
(Maximum values found for coolant temperature and cylinder head temperature. Refer to the current specification of the FAA and/or EASA)

	Coolant temperature	102 °C (216 °F)
	Cylinder head temperature	110 °C (230 °F)
=	Difference cylinder head and coolant temperature	8 °C (46 °F)

The cylinder head temperature is 8 °C (46 °F) higher than the coolant temperature.

thus

	Coolant temperature limit	120 °C (248 °F)
+	Difference cylinder head and coolant temperature	8 °C (46 °F)
=	Total	128 °C (262 °F)

The highest cylinder head temperature permitted is 128 °C (262 °F), so that the max. coolant temperature is kept.

With this special application, safe operation of the engine that prevents boiling of the coolant is possible up to a cylinder head temperature of 128 °C (262 °F).

ATTENTION

This cylinder head temperature with the limit found for this type must be displayed constantly in the cockpit. The indicating instrument and the Manuals must be changed to cylinder head temperature.

ATTENTION

The design of the radiator installation must be changed (example: cowl modifications), if the operating temperature exceeds the specified limits.

OPERATING LIMITS

⚠ WARNING

Non-compliance can result in serious injuries or death!
The cooling system must be designed so that operating temperatures will not exceed the maximum values.

"Boiling point of the coolant"

Monitoring the cooling system is important for controlling engine cooling and prevent knocking combustion within the operating limits. It is important that the coolant circuit is designed so that the coolant does not reach boiling point under any conditions. If the temperature exceeds the boiling point, the engine can quickly overheat due to loss of coolant. The boiling point of the coolant is mainly influenced by:

- Coolant types (not for Suffix -01)
- Mixture ratio (percentage of water)
- System pressure (opening pressure of radiator cap)

Coolant temperature

with Suffix -01

Coolant outlet temperature maximum 120 °C (248 °F)

NOTE

Permanent monitoring of coolant temperature is necessary.

Coolant temperature

without Suffix -01

Coolant outlet temperature maximum 120 °C (248 °F).

Cylinder head temperature

	Conventional coolant	Waterless coolant
914 F/UL	maximum 135 °C (275 °F)	maximum 135 °C (275 °F)
	NOTE *Permanent monitoring of coolant temperature and cylinder head temperature is necessary.*	**NOTE** *Permanent monitoring of cylinder head temperature is necessary. Additional monitoring of the actual coolant temperature is possible but not necessary for waterless coolant.*

Correlation between coolant temperature and cylinder head temperature

There is in principle a regular relationship between coolant temperature and cylinder head temperature. The coolant transfers some of the combustion heat to the radiator. Thus, the coolant temperature is usually lower than the cylinder head temperature. But the temperature difference between coolant and cylinder head is not constant and can vary with different engine installation (cowling or free installation, tractor or pusher, flight speed, etc.).

NOTE

The basic requirement for safe operation is that boiling of conventional coolant must be prevented. The boiling point of conventional coolant is 120 °C (248 °F) with a 50/50 mixture proportion and a system pressure of 1.2 bar (18 psi).

GENERAL NOTES ON THE COOLING SYSTEM

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Essential parts of the cooling system, such as radiator, etc., are available for this engine from BRP-Rotax.

ATTENTION

Risk of chafing, wear , loss of coolant.
Ensure that no contact with hoses or hose clamps of the engine is given (risk of chafing, wear, loss of coolant) at the installation of external components (governor, vacuum pump).

Radiator

ATTENTION

The size and type of radiator should be adequate to transfer thermal energy of approx. 30 kW (28.45 BTU/s) at take-off power.

In an installation as depicted with the radiator in a higher position than the standard supplied expansion tank, a water accumulator has to be fitted instead of the expansion tank. Additionally a suitable expansion tank has to be installed at the highest point of the cooling circuit.

NOTE

Experience has shown that with good airflow, a radiator with an area of 500 cm² (77.5 in²) is required for trouble free operation.

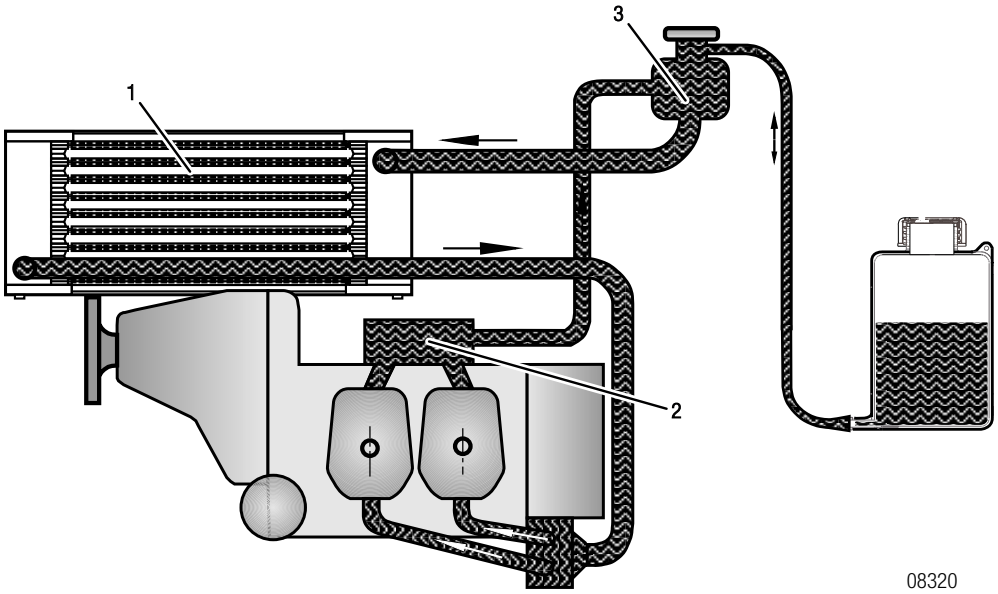

Figure 8.14: Radiator

1 Radiator
2 Water accumulator
3 Expansion tank

Flow rate

The flow rate in the coolant circuit is approx. 60 l/min (15.85 US gal/min.) at 5800 rpm. At full throttle, an approximate value of around 0.75 m^3/s (28.59 cu.ft/sec) can be assumed for the required cooling air flow.

Flow resistance

The flow resistance of the coolant in the optional ROTAX® radiator is correctly adjusted for the cooling system. If using other radiators, check the flow rate and cooling capacity.

Installation of the radiator

No provision has been made for attachment of the radiator(s) on the engine (rubber mounts are recommended).

ATTENTION

If a GENUINE ROTAX® radiator is not being installed, ensure sufficient cooling capacity.
The radiator must be installed without distortion or stress and be free of vibrations.

To achieve the best possible cooling effect via the airflow passing through the cooler, it is recommended to install a tight fitting, flexible seal or duct between the cowling and radiator.

COOLANT CAPACITY

4 cylinder heads	560 cm³ (0.020 cu.ft) (without Suffix -01)
	400 cm³ (0.016 cu.ft) (with Suffix -01)
Coolant pump	100 cm³ (0.004 cu.ft)
Expansion tank	250 cm³ (0.009 cu.ft)
Overflow bottle	approx. 0.5 l (0.13 US gal)
2 m coolant hose (InnerØ 18 mm)	500 cm³ (0.018 cu.ft)
Total coolant quantity for engine	approx. 1.5 l (0.4 US gal)

Chapter: 76–00–00
ENGINE CONTROLS

TOPICS IN THIS CHAPTER

CONNECTION FOR INSTRUMENTS

ATTENTION

Obey the manufacturers instructions!

These connections to be established in accordance to certification and/or national specifications.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

For notes regarding the electric rev counter consult the chapter 24-00-00 section Connection of the electric rev counter.

SENSOR FOR CYLINDER HEAD TEMPERATURE

Depending on the cylinder head design (old or new version), there are different methods of measurement with either cylinder head temperature sensor (without Suffix -01) or coolant temperature sensor (Suffix -01).

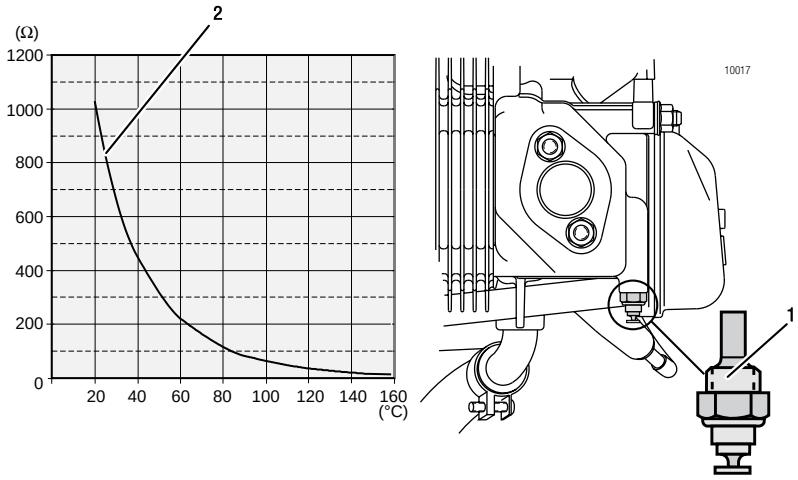

Figure 9.1: Cylinder head temperature (without Suffix -01)

1 Sensor for cylinder head temperature *2 Graph resistance over temperature*

Technical Data

The temperature sensor is directly fitted into cylinder head i.e. a direct temperature reading of the cylinder head material is taken.

Location	In the cylinder head of the cylinder 2 and 3
Connection	Spade terminal 6.3 x 0.8 DIN 46247
Grounding	Via engine block

Position

Cylinder head down

	x-axis [mm (in)]	**y-axis** [mm (in)]	**z-axis** [mm (in)]
2	-200 (-7.88)	241 (9.49)	-157 (-6.18)
3	-387 (-15.24)	-241 (-9.49)	-157 (-6.18)

Graph of sensor resistance over temperature

ATTENTION

The graph resistance over temperature has been determined and is effective at the following conditions only:

Ambient temperature: 20 °C (68 °F)

Tolerance: max. ± 10%

SENSOR FOR COOLANT TEMPERATURE (SUFFIX -01)

Depending on the cylinder head design (old or new version), there are different methods of measurement with either cylinder head temperature sensor (without Suffix -01) or coolant temperature sensor (Suffix -01).

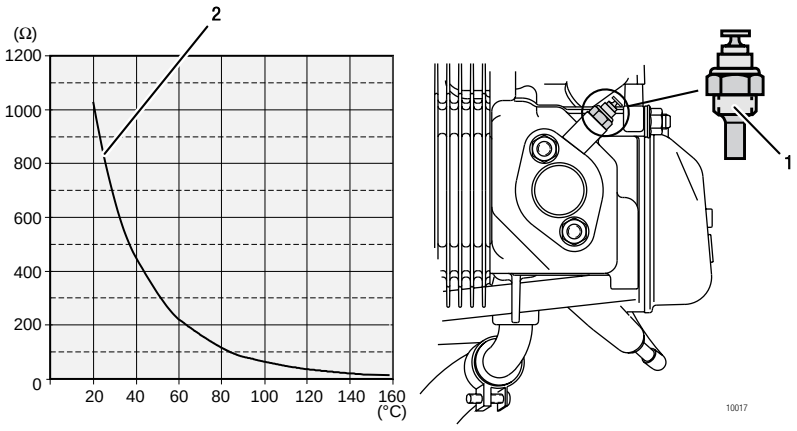

Figure 9.2: Coolant temperature sensor (Suffix -01)

1 Coolant temperature sensor

2 Graph resistance temperature

Technical data

The temperature sensor is directly fitted into cylinder head i.e. a direct temperature reading of the cylinder head material is taken.

Location	In the cylinder head of the cylinder 2 and 3
Connection	Spade terminal 6.3 x 0.8 DIN 46247
Grounding	Via engine block

Position

Cylinder head top

	x-axis [mm (in)]	**y-axis** [mm (in)]	**z-axis** [mm (in)]
2	26.0 (1.02)	225.9 (8.90)	44.4 (1.74)
3	-173.0 (-6.81)	-225.9 (-8.90)	44.4 (1.74)

Graph of sensor resistance over temperature

ATTENTION

The graph resistance over temperature has been determined and is effective at the following conditions only:

Ambient temperature: 20 °C (68 °F)

Tolerance: max. ± 10%

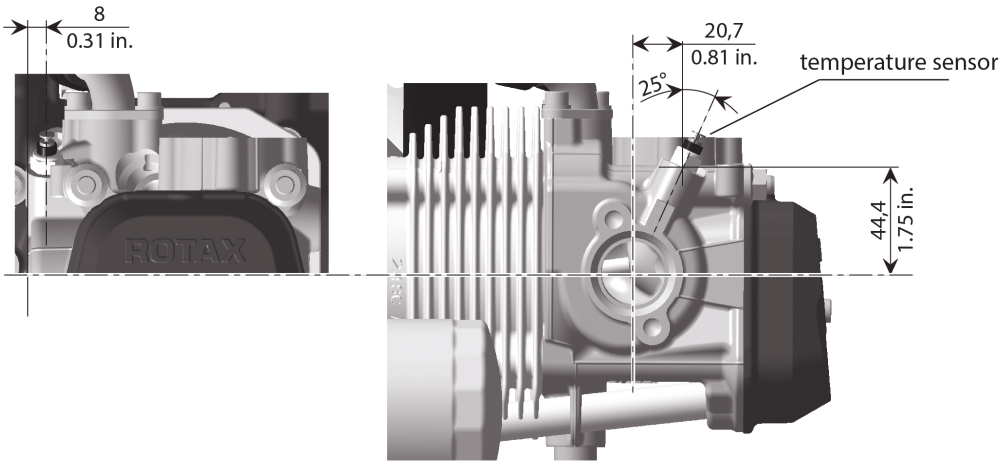

Figure 9.3: Position Temperature sensor

SENSOR FOR OIL TEMPERATURE

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

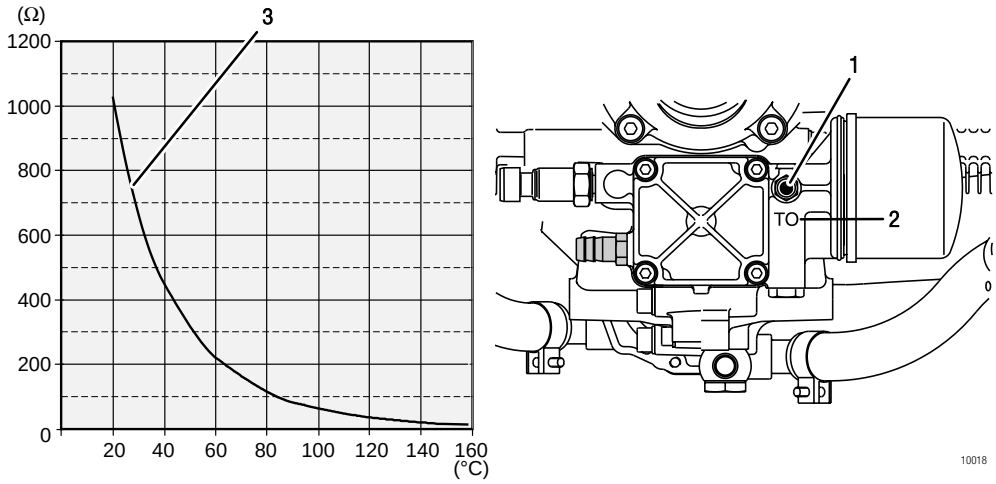

Figure 9.4: Sensor for oil temperature

1 Sensor for oil temperature
2 TO marking (Temperature Oil)
3 Graph resistance over temperature

NOTE

BRP-Rotax offers a non-certified temperature indicating instrument.
Refer to Illustrated Parts Catalog, latest issue.

Marking

Marked with “TO“ (Temperature Oil) on oil pump flange.

ATTENTION

To avoid any mix-up with indication wiring, mark this particular cable also with “TO“.

Position

	x-axis [mm (in)]	**y-axis** [mm (in)]	**z-axis** [mm (in)]
Point of support	-115 (-4.53)	46 (1.81)	-150 (-5.92)

Technical Data

Location	Oil pump housing
Connection for sensor wiring	Spade terminal 6.3x0.8 DIN 46247
Grounding	Via engine block

Graph of sensor resistance over temperature:

ATTENTION
The graph resistance over temperature has been determined and is effective at the following conditions only:

Ambient temperature:	20 °C (68 °F)
Tolerance:	max. ± 10%

OIL PRESSURE SENSOR

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

NOTE

Due to a configuration of the electric oil pressure sensor (absolute type) are already displayed on the ground approx. 0.2 bar (3 psi) depending on the elevation and ambient pressure).

See also SI-914-031 “Oil pressure sensors for ROTAX® Engine Type 914 (Series), current issue.

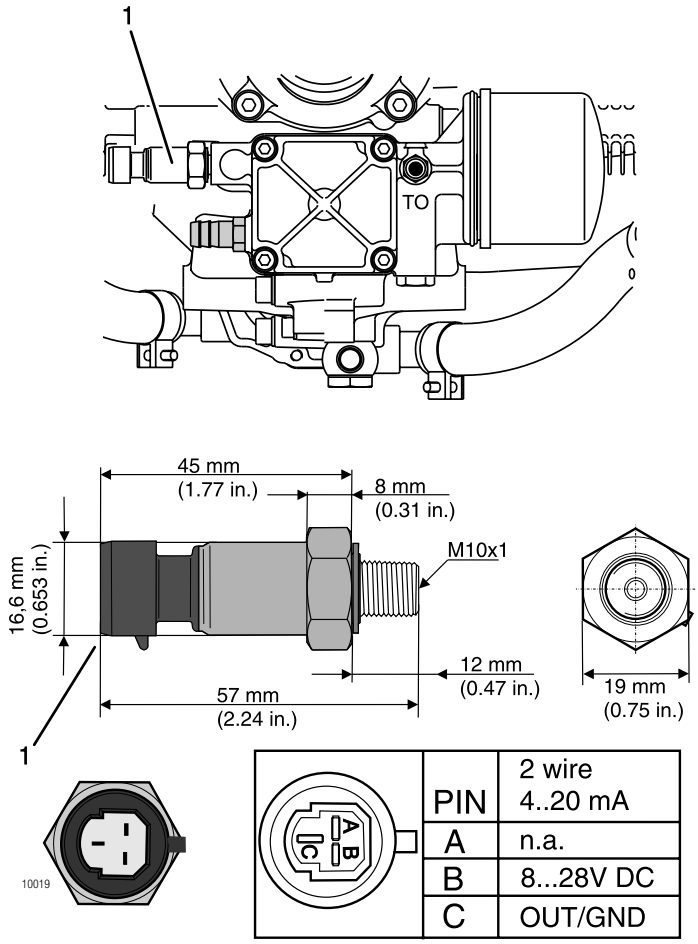

Figure 9.5: Oil pressure sensor

1 Oil pressure sensor

As the instruments need a separate power supply and a different design for the electrical oil pressure sensor, the resistance type instrument (type VDO), which was supplied by BRP-Rotax up to now, is not suitable anymore. Suitable instruments are offered by various instrument manufacturers (e.g. ROAD or Aviasport).

Technical Data

Location	Oil pump housing
Wire gauge	Standard wire 0.5 mm² (AWG 20)
Cable length	3 m (118 in.)
Operating temperature range	min. -40 °C (-40 °F) max. +125 °C (+257 °F)
Grounding	Via engine block/airframe ground
Tightening torque	15 Nm (68 in lb) and LOCTITE 243

Output signal

In contrary to the oil pressure sensor offered up to now, which was providing the signal on the basis of a sensor resistance variation, the new oil pressure sensor operates on basis of a current variation. This has to be taken into account for the selection of the appropriate cockpit instrument.

Wiring connections

for instrument

The oil pressure sensor is equipped with a connector. As output signal the 2-wire version (4 to 20 mA) is available.

- **Oil pressure sensor PIN A** (connector housing PIN 1)
  is not connected and has no function.
- **Oil pressure sensor PIN B** (connector housing PIN 2)
  has to be connected to the positive bus via a fuse or circuit breaker (the Red lead from the current oil pressure sensor).
- **Oil pressure sensor PIN C** (connector housing PIN 3)
  has to be connected directly to the indicating instrument.

For connection to the indicating instrument a connector set part no. 881302 or oil pressure sensor wire assy. part no. 864250 is available. The connection cable and connector is attached to the engine .

NOTE

The sensor cable can be modified in its length according to the installation situation, e.g. shortened or extended. For extension an appropriate cable (Ölflex®Heat 260 MC 2x 0.5 mm² (AWG 20) or equivalent) can be used. A resistance cable or similar is not necessary.

Graph current over pressure

ATTENTION

The graph current over pressure has been determined and is effective at the following conditions only:

Ambient temperature: 20 °C (68 °F)

Tolerance: max. ± 4 %

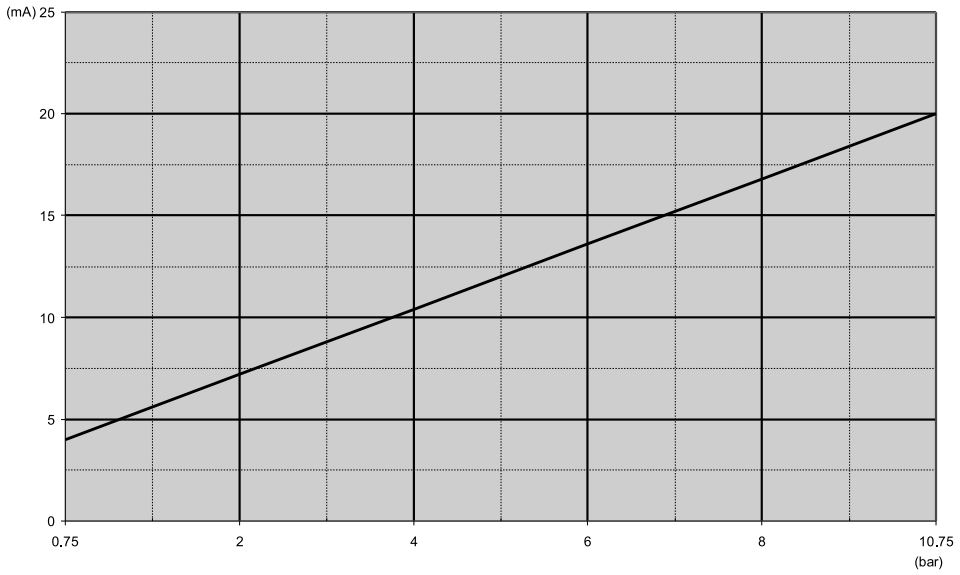

Figure 9.6: Graph current over pressure sensor

MECHANICAL REV COUNTER (TACH DRIVER) (OPTIONAL)

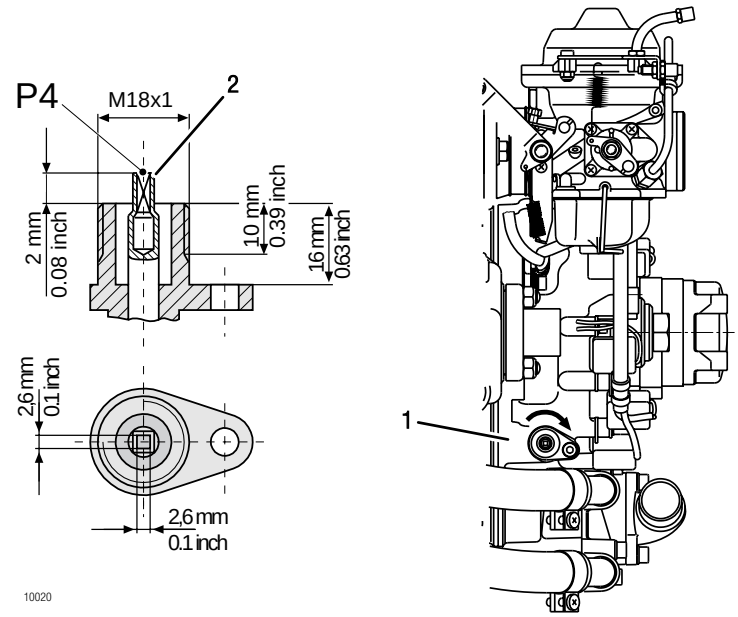

Figure 9.7: Mechanical rev counter

1 Ignition housing

2 Rev counter shaft

Technical Data

Location	Ignition housing
Direction of rotation of the rev counter shaft	Right (Clockwise)
Reduction ratio	i= 4 i.e. 1/4 of engine speed
Installation dimensions	See Figure 9.7: Mechanical rev counter

Position

	x-axis [mm (in)]	**y-axis** [mm (in)]	**z-axis** [mm (in)]
Point of engagement P4	-465 (-18.31)	87 (3.43)	-160 (-6.3)

PRESSURE SENSORS

2 pressure sensors are included in the supply volume of the engine and connected by plugs with the wiring harness.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Since a failure of pressure interconnections of airbox, float chambers, fuel control and pressure sensor would possibly result in an engine stop all these interconnections have to made very carefully.

Pressure interconnections

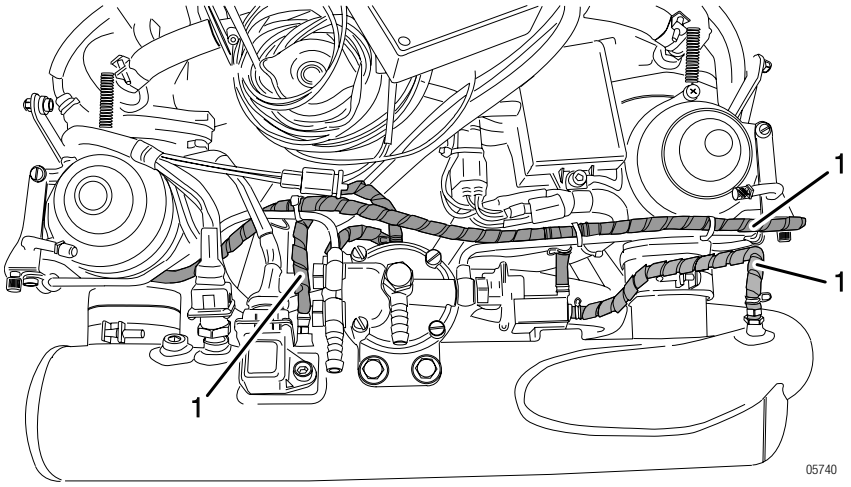

Figure 9.8: Pressure interconnections

1 Pressure interconnections

Plug connection

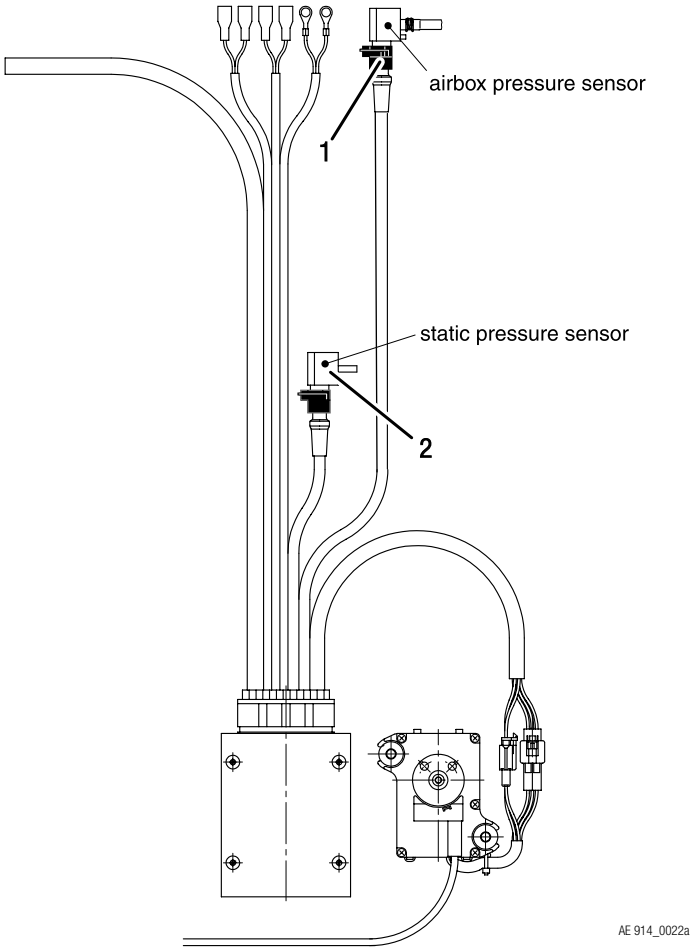

Figure 9.9: Plug connection

1 Airbox pressure sensor *2 Ambient pressure sensor*

AMBIENT PRESSURE SENSOR

Effective range 100 up to 1200 hPa
max. deviation: ± 60 hPa

Operating temperature min. -40 °C (-40 °F)/ max. +125 °C (257 °F)

Dimensions and attachment

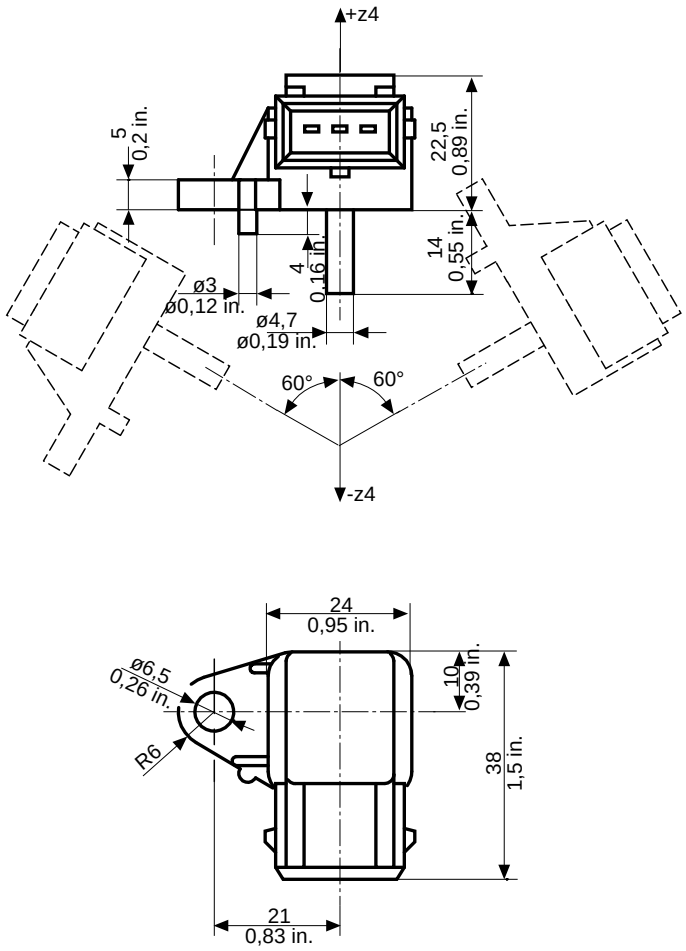

Figure 9.10: Dimensions and attachment ambient pressure sensor

Fitting position The pressure connection points downwards to prevent possible condensate from entering the sensor, i.e. the longitudinal axis z4 has to be parallel to z-axis in system of coordinates. Tolerated deviation of parallelism: ± 60°.

Location of installation Vibration neutralized installation in a stable zone, e.g. in cockpit. In the area of the pressure pick-up approx. the same atmospheric pressure (static air pressure) has to prevail as at inlet of turbocharger. Location of installation is limited by the length of the wiring harness.
Length of cable assy.: approx . 250 mm (10 in.) from TCU.

ATTENTION
Remove protective cap before operating the sensor.

ATTENTION
Prevent any foreign objects entering through hole.

MEASURE MANIFOLD PRESSURE

ATTENTION
Prevent leakage! Utilize the full slip-on length for all connections. Secure hoses with suitable clamps or crimp connection.

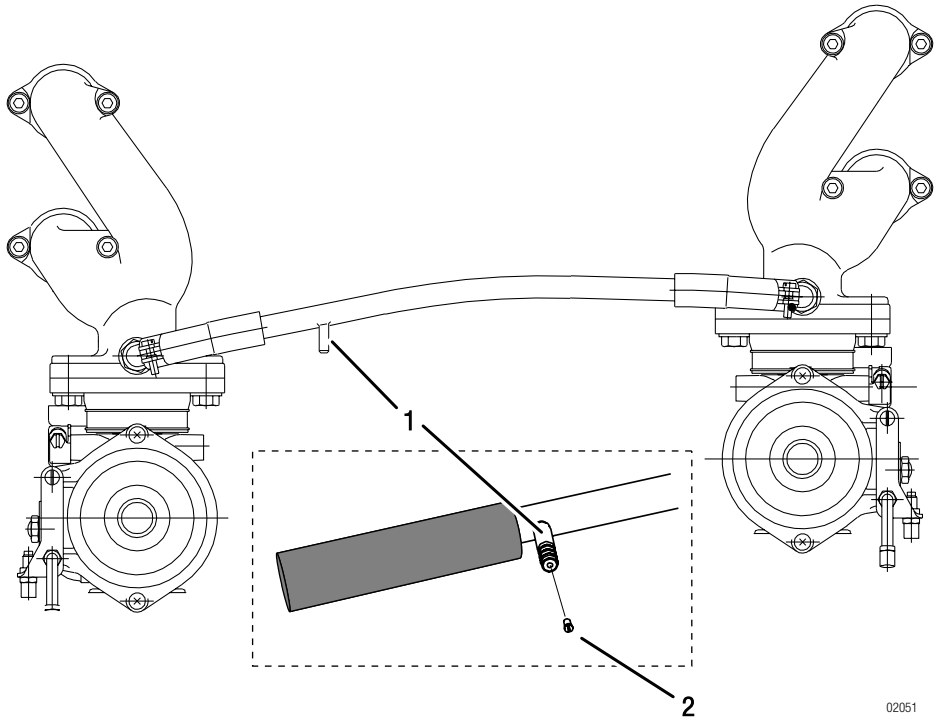

Figure 9.11: Measure manifold pressure

1 Connection nipple

2 Screw M3.5x6

Connection nipple

Outside diameter:	6 mm (1/4″)
Slip-on length:	max. 17 mm (11/16″)

ATTENTION

Protective coverings are only for use during transport and engine installation.

If connection for pressure reading is not employed it has to suitably plugged. New style compensating tubes have plugged this connection by a screw M3.5x6.

ATTENTION

Flawless operation of the indicating instrument needs the installations of a water trap between engine and instrument for the fuel condensate.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

AIR TEMPERATURE IN THE AIRBOX (OPTIONAL)

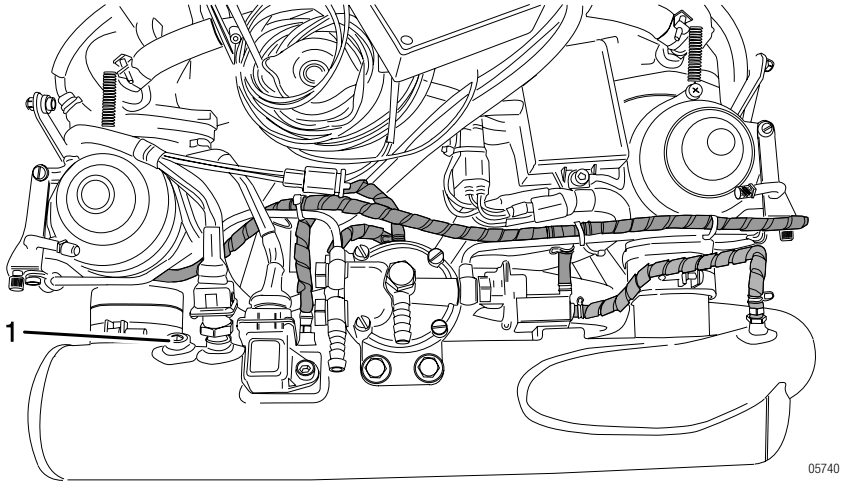

Figure 9.12: Airbox plug screw

1 Plug screw

Plug screw

To take air temperature readings in the airbox a connection is provided. This connection is closed on the standard engine by a plug screw.

Thread:	1/8-27 NPT
Thread length:	ca. 9 mm (3/8″)

Chapter: 78–00–00
EXHAUST SYSTEM AND TURBOCHARGER

TOPICS IN THIS CHAPTER

The complete exhaust system is in the volume of supply and is certified together with the engine.

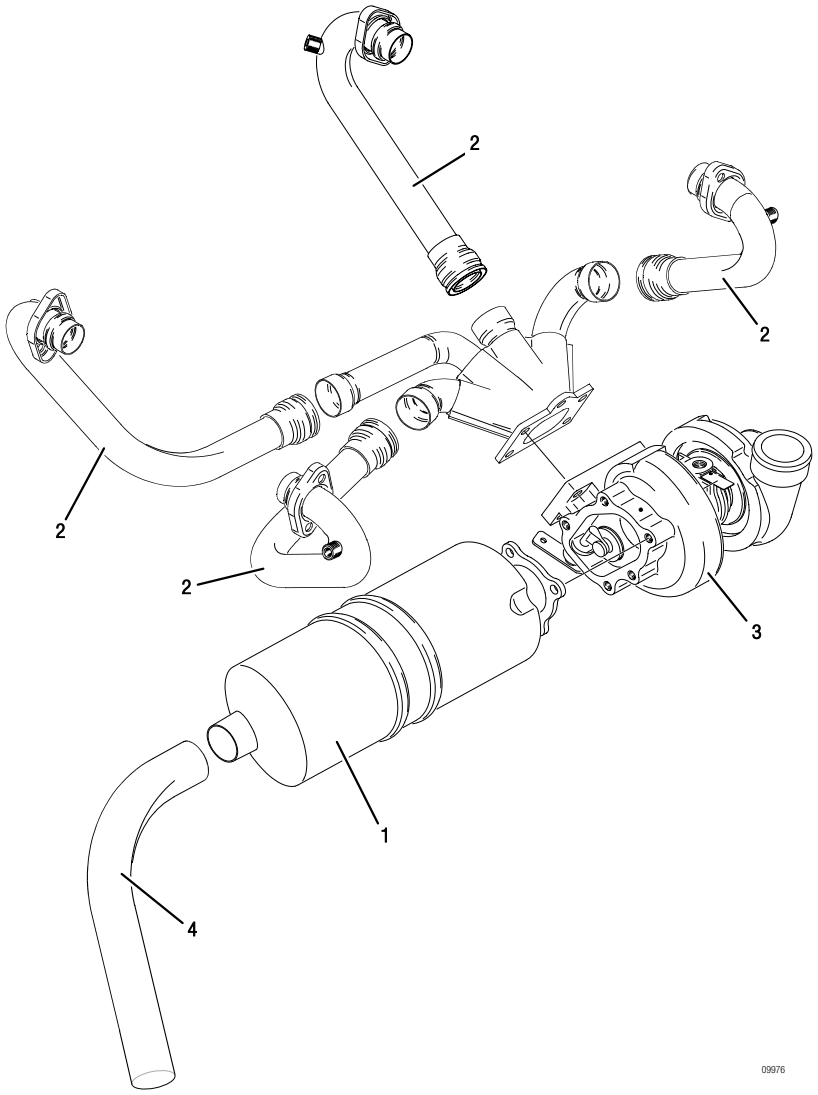

Figure 10.1: Exhaust system

1 Muffler assy.	*2 Exhaust bend*
3 Turbocharger assy.	*4 Exhaust below*

GENERAL NOTES ON THE EXHAUST SYSTEM

An exhaust system especially designed for universal application has been developed by BRP-Rotax.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

ATTENTION

Damage of the exhaust system possible.
Vibrations due to improper installation and maintenance is the most common reason for damage of the exhaust system.

Ball slip joints The ball slip joints should be greased with heat resistant lubricant (ie.: LOCTITE ANTISE-IZE) to avoid jams and locks of the ball slip joint.

EXHAUST TAIL PIPE

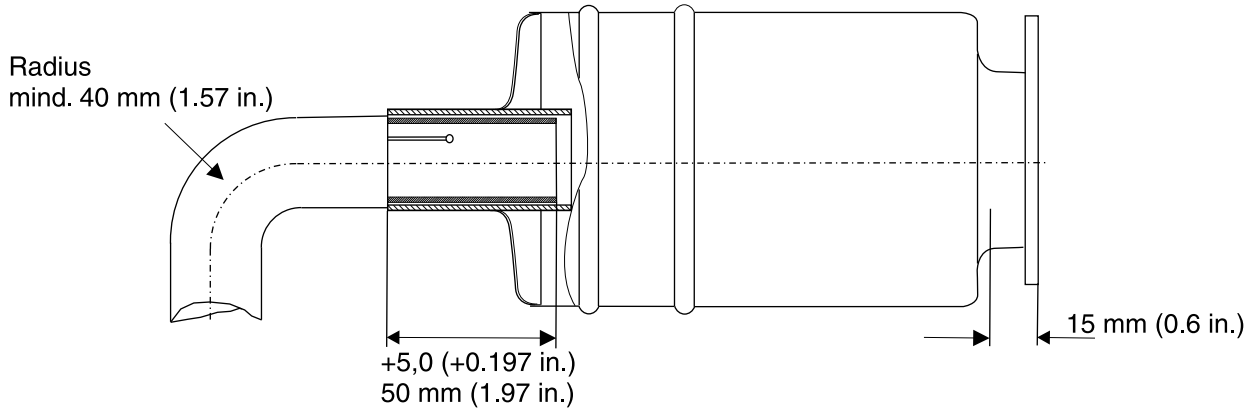

Figure 10.2: Dimension Exhaust tail pipe

Mean bending radius of an tail pipe min. 40 mm (1.57 in.)

Exhaust bend, inside diameter min. 38 mm (1.50 in.)

Medium tube length max. 250 mm (10 in.)

At a medium tube length of 250 mm (10 in.) and more, the tail pipe must have additional support.

Insertion depth The insertion depth of the tail pipe into the muffler must be ensured.

Material X15CrNiSi 20 (DIN 1.4828)

Position (P1)

	x axis[mm (in.)]	**y axis**[mm (in.)]	**z axis**[mm (in.)]
Tube end P1	-438 (-17.24)	211 (8.31)	-338 (13.31)

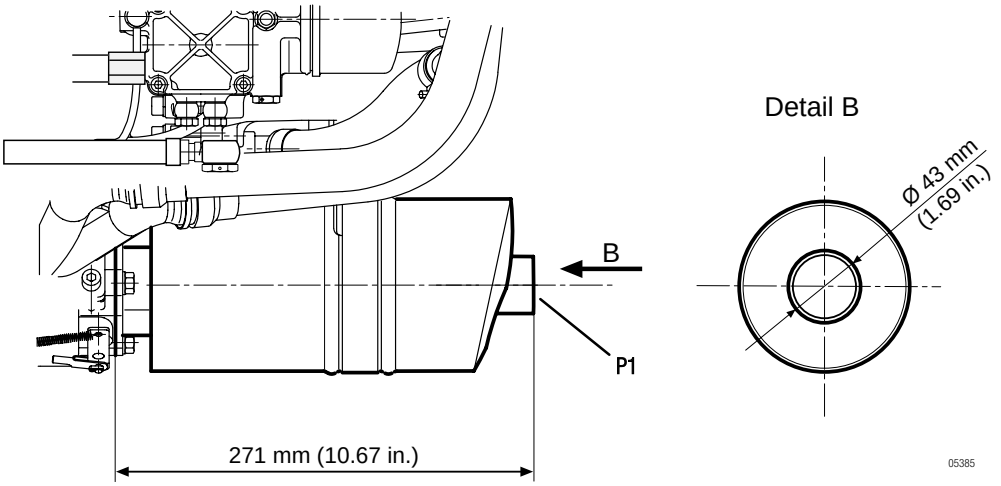

Figure 10.3: Position of exhaust tail pipe

Because of the high temperatures occurring, provide suitable protection against unintentional contact.

READING OF EGT TEMPERATURE

Reading

Reading of the exhaust gas temperature for certification to the latest requirements such as FAR or EASA must be conducted by the aircraft manufacturer.
Readings of EGT taken approx. 100 mm (3.93 in) from exhaust flange connections.

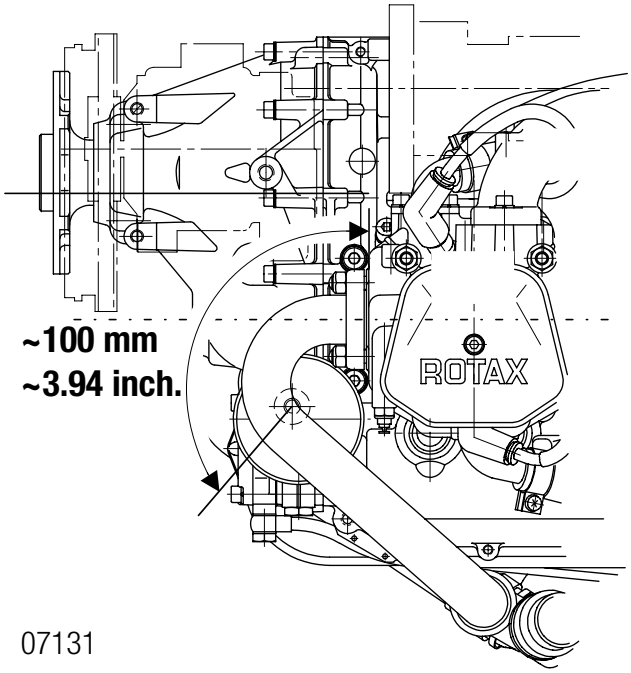

Figure 10.4: Readings of EGT

Operating limit

Exhaust gas temperature (EGT): (both ignition circuits active).
See the current 914 Series Operators Manual.

MEASUREMENT OF BACK PRESSURE AT HIGH PERFORMANCE

NOTE

When using silencer, this measurement must be performed.

- Both ignition circuits switched on
- max. 0.15 bar

The measurement should be taken in a distance of about 15 mm (0.6 in.) away from the exhaust flange. There is no standard connection provided to measure the back pressure.

Reading of the back pressure for certification to the latest requirements such as FAR or EASA must be conducted by the aircraft manufacturer.

CONTROL SYSTEM OF TURBOCHARGER

The correct adjustment of the servo cable and consequently the wastegate was made already during the test run at BRP-Rotax.

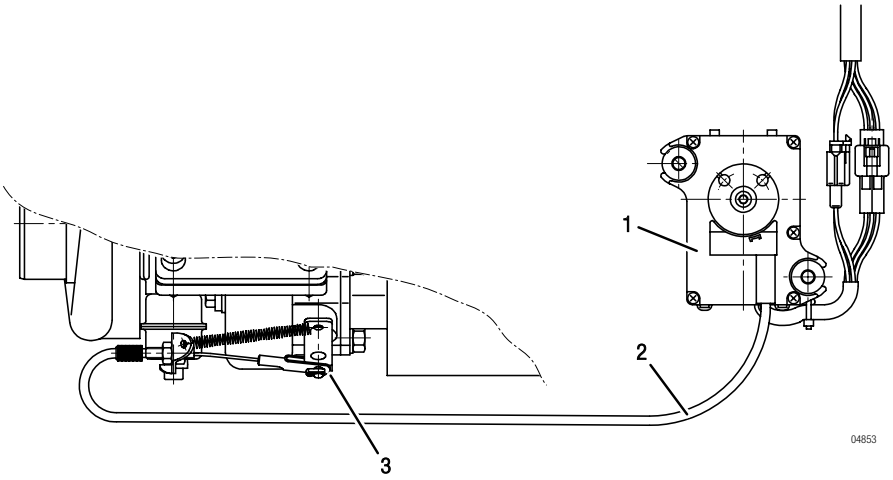

Figure 10.5: Control system of turbocharger

1 Servo motor
2 servo cable
3 Wastegate

SERVO MOTOR FOR WASTEGATE

Prior to engine operation check the position of the wastegate.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Switch off the engine– Ignition"OFF"

- Check of the waste gate accordance with the Maintenance Manual 914 Series
- Additionally, only the actual attaching of the servo motor has to be performed.

Operating temperature

min. -20 °C (-4 °F)/ max. +60 °C (140 °F)

Location of installation

A recommendable location is in the cockpit below the instrument panel.

⚠ WARNING

Non-compliance can result in serious injuries or death!
Installation in the engine compartment is not permitted since the components are not of a fire resistant construction.

Place of installation is limited by the length of the servo cable.
approx. 1000 mm (40”) from wastegate

Attachment points

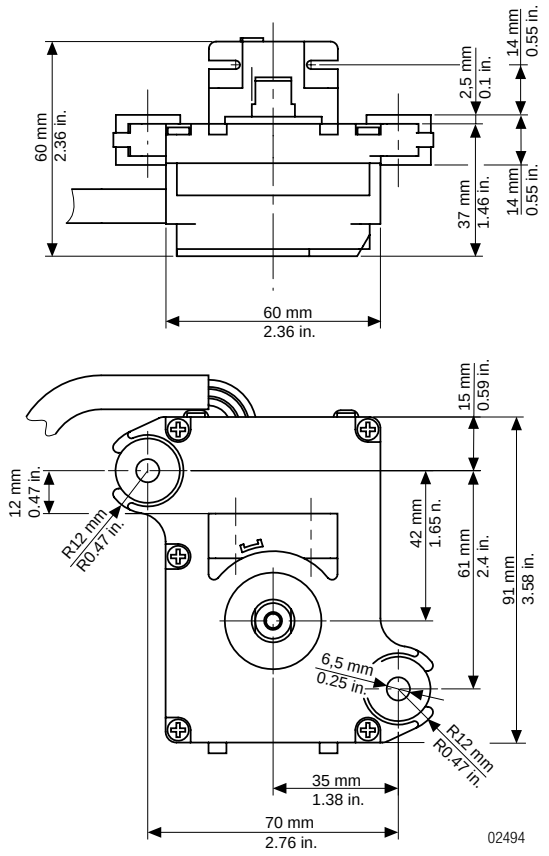

Figure 10.6: Dimensions and attachment

SERVO CABLE

Bending radius min. 50 mm (2”)

Temperature Following temperatures must be measured on the positions set and must not be exceeded during take-off and after engine stop (heat accumulation).

ATTENTION

All temperature limits must be verified at the first time of installation of the RO-TAX® 914 into an airframe, or at any modification of the airframe as it may influence such temperatures.

Position	Description	Temperature
1	Cable conduit	max. 120 °C (250 °F)
2	Cable support	max. 120 °C (250 °F)
3	Wire rope	max. 140 °C (284 °F)

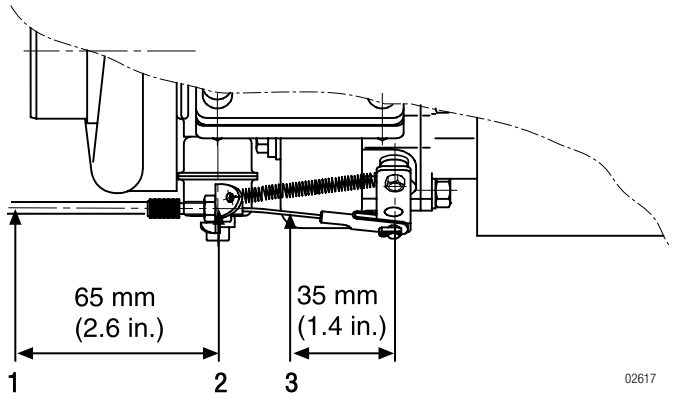

Figure 10.7: Measuring range for temperature

1 Cable conduit
2 Cable support
3 Wire rope

Chapter: 79–00–00
LUBRICATION SYSTEM

TOPICS IN THIS CHAPTER

SYSTEM DESCRIPTION

⚠ WARNING

Non-compliance can result in serious injuries or death!
The lubrication system must be designed such that the permissible operating temperatures and maximum values are not exceeded.

Description of the system

The ROTAX® 914 engine is provided with a dry sump forced lubrication system with a main oil pump with integrated pressure regulator and an additional suction pump.

NOTE

The oil pumps are driven by the camshaft.

The main oil pump sucks the motor oil from the oil tank (1) via the oil cooler (3) and forces it through the oil filter (4) to the points of lubrication (lubricates also the plain bearings of the turbocharger and the propeller governor).
The surplus oil emerging from the points of lubrication accumulates on the bottom of crankcase and is forced back to the oil tank by the blow-by gases.
The turbocharger is lubricated via a separate oil line from the main oil pump.
The sucked oil emerging from the turbocharger collects in the oil sump and is back by a separate pump to the oil tank via the oil line.

NOTE

The oil circuit is vented to atmosphere via a nipple in the neck of the oil tank.

For the completion of the lubrication system only the following connections need to be established:

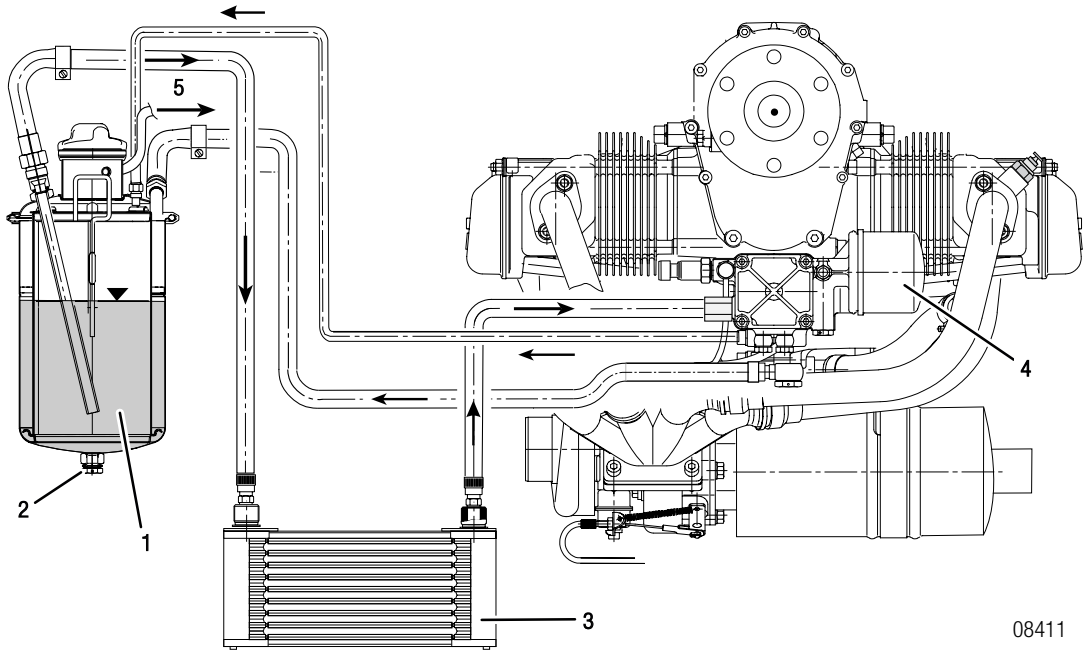

Figure 11.1: Lubrication system

1 Oil tank	*2 Oil drain screw*
3 Oil cooler	*4 Oil filter*
5 Vent	

Connections

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

Only the following connections need to be established to complete the lubrication system (oil system).

Oil circuit, engine (main oil pump):

- Oil tank (outlet) to oil cooler
- Oil cooler to oil pump (inlet)
- Oil return to oil tank (inlet)
- Oil tank vent hose to atmosphere

Oil circuit turbocharger (suction pump):

- Oil return to the oil tank (inlet)

NOTE

An oil tank is included with the standard engine version. No provision has been made for attachment of an oil cooler onto the engine.

LIMITS OF OPERATION

⚠ WARNING

Non-compliance can result in serious injuries or death!
The lubrication system must be designed such that the permissible operating temperatures and maximum values are not exceeded.

Oil pressure Limits refer to latest issue of the Operators Manual.

Oil temperature Limits refer to latest issue of the Operators Manual.

LOW AMBIENT TEMPERATURE

⚠ WARNING

Non-compliance can result in serious injuries or death!
At operation below normal operating temperature, formation of condensate in the oil system might negatively affect oil quality and may lead to corrosion.

Low temperature

NOTE

When operating at low temperatures, installation of an oil thermostat, parallel to the oil cooler is highly recommended.

⚠ WARNING

Non-compliance can result in serious injuries or death!
If the oil tank is located top high or “higher than recommended”, oil might trickle through bearing clearances into the crankcase during longer periods of engine stop. If fitted too low it might damage the oil circuit.

Advantages of oil thermostat:

- safe oil pressure after cold start,
- prevention of fuel and water accumulation in the oil

See the Service Letter SL-914-009 “Use of an oil thermostat”, current issue.

CHECKING OF THE LUBRICATION SYSTEM

General

To control the proper function of the lubrication system the following readings have to be taken on the running engine.

NOTE

The required pressure gauges and connection parts are not included in the ROTAX® engine delivery.

MEASURING OF THE VACUUM

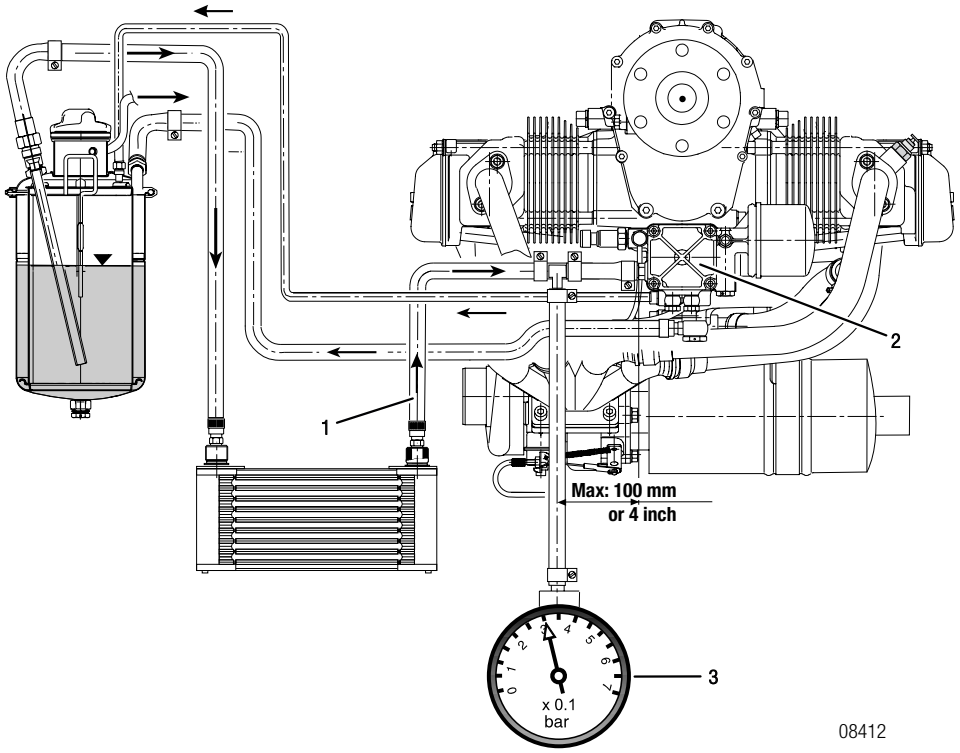

Figure 11.2: Measuring of the vacuum

1	*Suction oil hose*	*2*	*Oil pump*
3	*Pressure gauge with liquid damping for vacuum*		

Measure the vacuum in the suction oil hose- from the oil tank via the oil cooler to the engine oil pump - at a distance of max. 100 mm (4 in.) from the oil pump suction connector.

Full throttle

At full throttle the max. negative pressure must not exceed 0.3 bar (4.35 psi).

⚠ WARNING

Non-compliance can result in serious injuries or death!
The vacuum must be verified over the complete engine operation range. If the oil is cold, the flow resistance increases, which means that not enough oil will flow on the suction side.

CRANKCASE PRESSURE MEASUREMENT

Measurement of the mean crankcase pressure at full throttle, this ensures correct oil return from crankcase (blow-by gas).

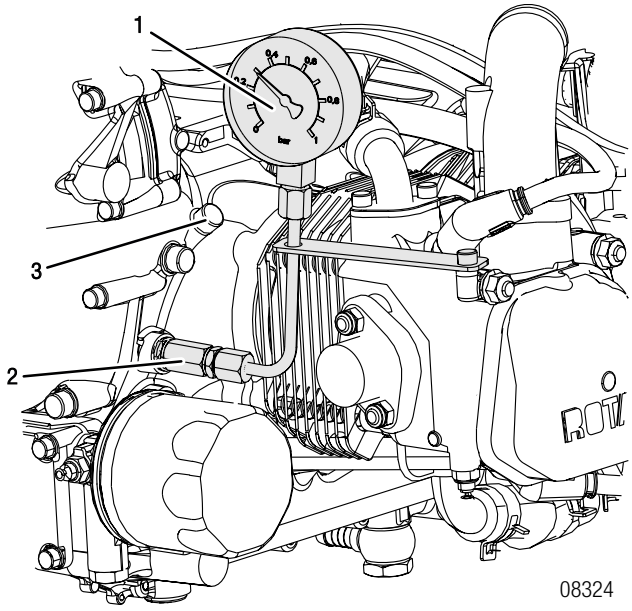

Figure 11.3: Measurement of crankcase pressure

1 Pressure indicator

2 Magnetic plug (position for adapter)

3 Allen screw M8x20 (position for crankshaft locking screw

ATTENTION

Do not remove the magnetic plug for prolonged periods and do not use the measurement equipment during flight operations.

A pressure sensor (pressure gauge with liquid damping) can be fitted instead of the magnetic plug or the crankshaft locking screw. The magnetic plug or the crankshaft locking screw is removed and the pressure sensor is fitted.

Magnetic plug

The thread for the magnetic plug must be M12x1.5 (metric) and M8x1.25 for the crankshaft locking screw.

NOTE

Always use a new gasket for crankshaft locking screw.

Pressure values

The pressure in the crankcase at (full throttle) must not exceed the prevailing ambient pressure by more than 0.45 bar (6.53 psi) at 90 °C (194 °F) oil temperature.

⚠ WARNING

Non-compliance can result in serious injuries or death!
If the readings exceed the pressure limits, then the flow resistance in the oil return line from oil sump to oil tank is too high in the current engine installation (contamination, restrictions of cross-section, etc.). This condition is unsafe and must be rectified immediately.

If crankcase pressure and measuring pressure of the vacuum readings and all operational data (flight attitude, temperatures, etc.) are within the specified limits, then it can be assumed that the oil circuit is working correctly.

OIL HOSE REQUIREMENTS

Main oil pump (Oil circuit, engine)

Temperature durability	min. 130 °C (266 °F)
Pressure durability	min. 10 bar (145 psi)
Bending radius[12]	min. 70 mm* (2.76 in.)
Minimum inner dia. of oil lines in relation to total length	
up to 1 m (39.37 in.)	inner diameter minimum 11 mm (0.43 in.)
up to 2 m (78.74 in.)	inner diameter minimum 12 mm (0.47 in.)
up to 3 m (118.11 in.)	inner diameter minimum 13 mm (0.51 in.)
max length of individual oil line	3 m (9.84 ft.)

Suction pump (Oil circuit, turbo charger)

Temperature durability	min. 130 °C (266 °F)
Pressure durability	min. 10 bar (145 psi)
Bending radius	min. 70 mm* (2.76 in.)
Minimum inside dia. of oil lines in relation to total length	
up to 1 m (39.37 in.)	inner diameter minimum 6 mm (.23")
up to 2 m (78.74 in.)	inner diameter minimum 7 mm (.27“)

VENT HOSE REQUIREMENTS

Oil tank

Route the vent hose without kinks and avoid sharp bends.

NOTE

Water is a by-product of the combustion of fuel. Most of this water will dissipate from the combustion chamber with the exhaust gases. A small amount will reach the crankcase and must be disposed of through the vent hose.

The vent hose must be routed in a continuous decline or furnished with a drain bore at its lowest point to drain any condensate.
The vent hose must be protected from any kind of ice formation from condensation, e.g.

- insulation protection or

12. unless otherwise stated by the hose manufacturer

- routing in a hose with hot air flow and
- furnishing the vent hose with a bypass opening before the cowling outlet.

OIL INLET

Depending on engine configuration, the oil feed line connectors may vary.

- 914 F: Thread M18 or optional UNF-thread (AN-8)
- 914 UL: Inlet nipple or optional M18 or UNF-thread (AN-8)

Variant 1

Thread:	M18x1,5x11
Tightening torque of inlet line:	25 Nm (18.5 ft.lb)

NOTE

Suitable for use of a swivel joint.

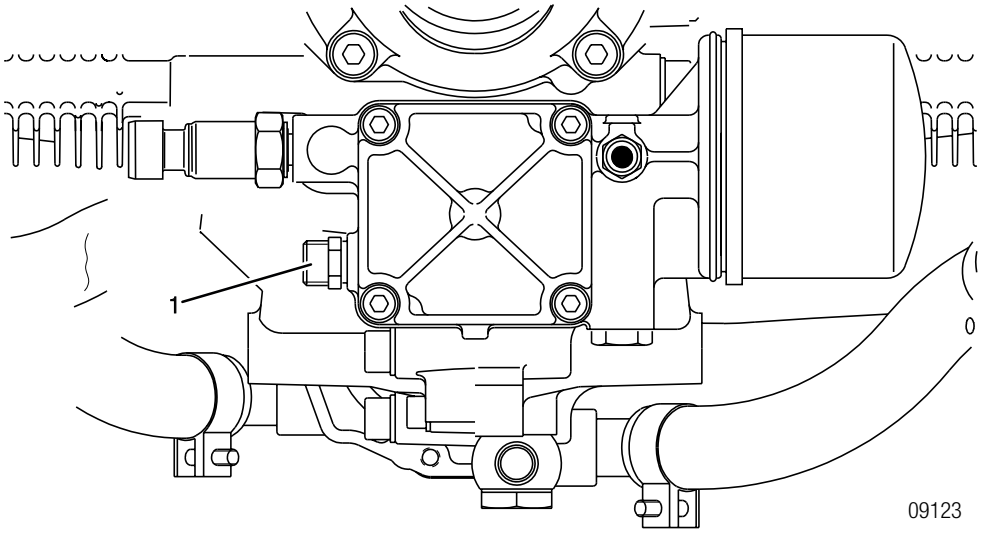

Figure 11.4: Connection variant 1

Variant 2

Inlet nipple outside dia:	13,2 mm (0.52 in)
Slip-on length:	max. 21 mm (0.83 in)

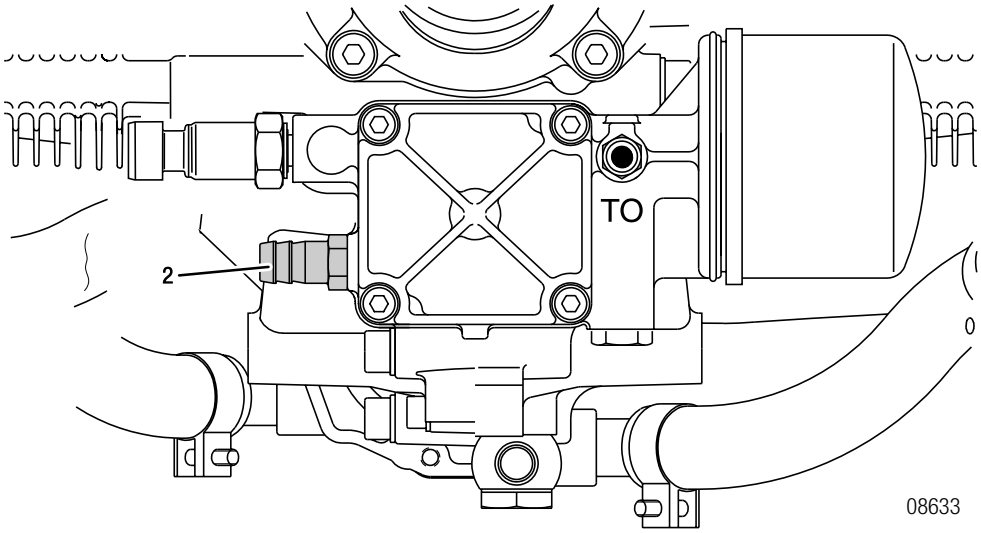

Figure 11.5: Connection variant 2

Variant 3

Thread:	3/4–16 UNF (AN-8)
Tightening torque of inlet line:	25 Nm 25 Nm (18.5 ft.lb)

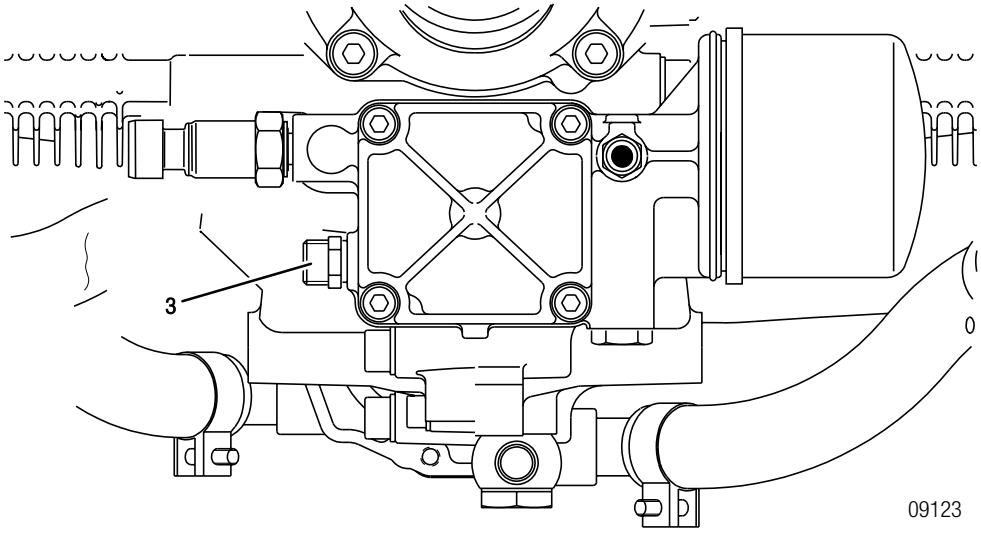

Figure 11.6: Connection variant 3

OIL RETURN

ATTENTION

The engine design is for a conventional, non-aerobatic, tractor or pusher configuration with the oil return port in the optimum position. Assuming these points are taken into consideration, the engine will be properly lubricated in all normal flight profiles. Aircraft that are not conventional (e.g. airships, gyrocopters, dive brake equipped aircraft, etc.) that require engine load at steep inclination angles may have special lubrication requirements.

Select the appropriate connection for the oil return line according to the propeller configuration and oil system layout.

- Position 1 for tractor configuration.
- Position 2 for pusher configuration.

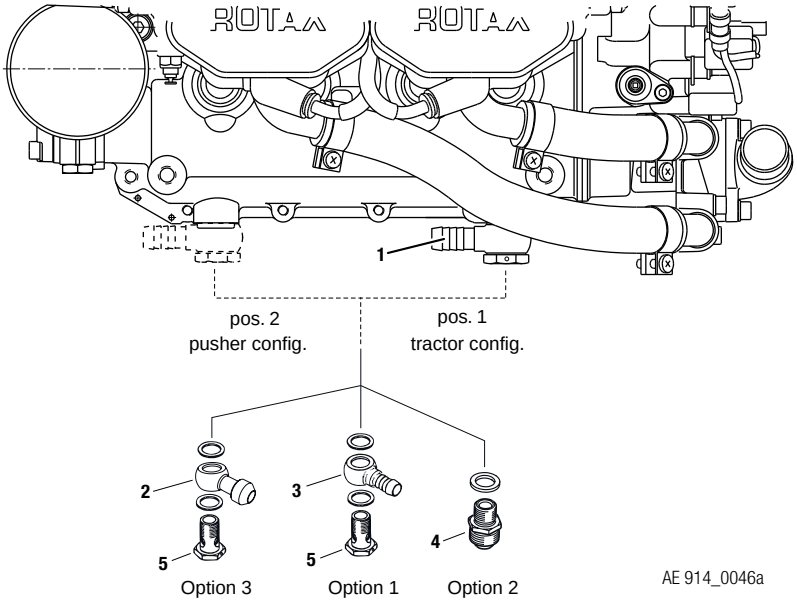

Figure 11.7: Connection oil return, typical

1 Slip-on connection

2 Hose nipple with 3/4–16 UNF (AN-8)

3 Hose nipple 10

4 Adapter 3/4-16 UNF (AN-8)/ M16x1,5

5 Banjo bolt M16x1.5x28

Variant 1 with slip-on connection

Hose nipple	10 DIN 7642
Outside diameter	13.5 mm (0.53 in)
Slip-on length	max. 24 mm (max. 0.94 in)
Tightening torque of banjo bolt M16x1.5x28	30 Nm (22 ft lb)

Variant 2 with adapter

Thread	3/4-16 UNF (AN-8)
Tightening torque of oil return line	25 Nm (18.5 ft lb)

Variant 3 with hose nipple

Thread	3/4-16 UNF
Tightening torque of banjo bolt M16x1.5x28	30 Nm

OIL CIRCUIT TURBOCHARGER

Oil return

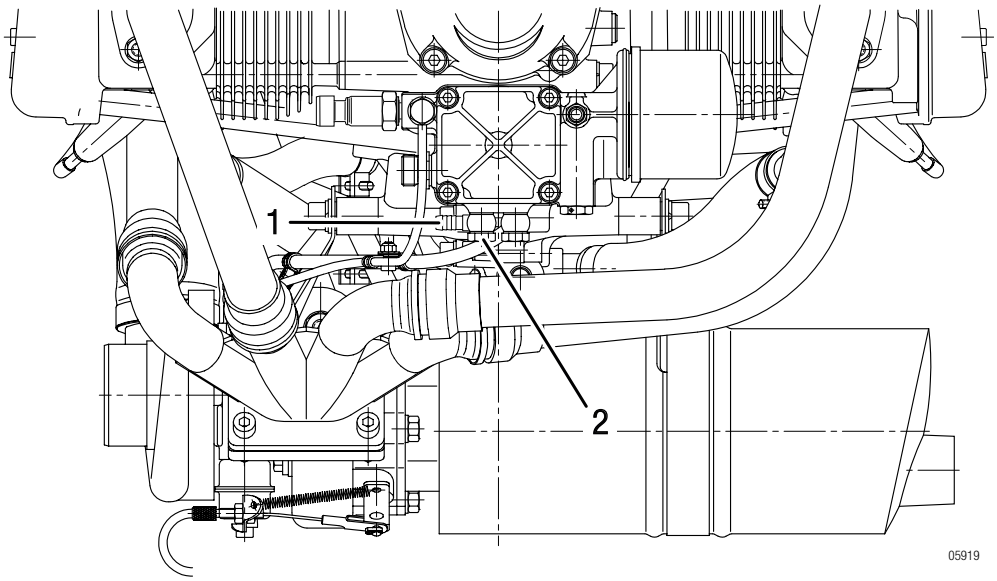

Figure 11.8: Connection oil return turbocharger

1 Hose nipple 4/6 DIN 7642 *2 Banjo bolt M10x1x19*

Connection with hose nipple

Hose nipple	4/6 DIN 7642
Outside dia.	8 mm (.31 in)
Slip-on length	max. 20 mm (.79 in)
Tightening torque of banjo bolt M10x1x19	17 Nm dry, 12 Nm lubricated

OIL TANK

ATTENTION

Only use the oil tank provided in the scope of delivery, as its design has changed compared with older tanks.

NOTE

Optional extra:
Fitting with either straight or with 90° elbow. Metric M18x1.5 or UNF 3/4-16 thread.

ATTENTION

Check what type of thread or connection is on the supplied oil tank.

ATTENTION

The oil tank cover is also marked with the designations IN - oil return line from crankcase OUT- outlet to oil cooler/oil pump.

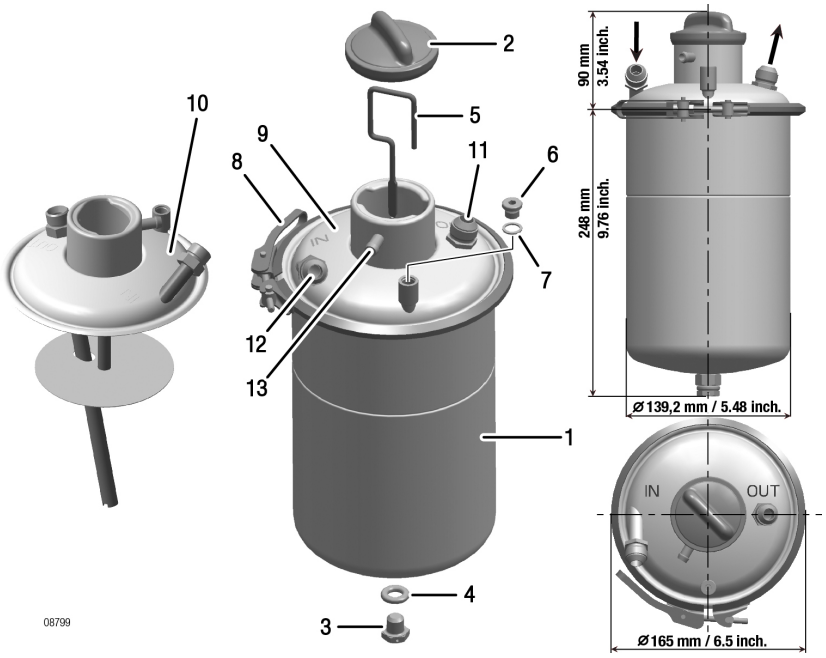

Figure 11.9: Oil tank

1 *Oil tank*
2 *Bayonet cap*
3 *Hex. screw M12x12*
4 *C12x18 gasket ring*
5 *Oil dipstick*
6 *M10x1 plug screw*
7 *A10x14 gasket ring*
8 *Profile clamp 163*
9 *Oil tank cover assy. (UNF 3/4-16)*
10 *Oil tank cover assy. (metric M18x1.5)*
11 *Oil outlet*
12 *Oil feed line*
13 *Vent nipple*

CONNECTIONS FOR OIL CIRCUIT (ENGINE)

	Thread/ Outer dia.	Slip-on length	Tightening torque
UNF-thread optional (Screw connection) for oil feed line and outlet	3/4–16 UNF		25 Nm (18.44 ft.lb.)
Vent nipple (Metric)	8 mm (0.31 in.)	max. 15 mm (0.59 in.)	
Bent socket 90° optional with cap nut (M18x1,5)	12 mm (0.47 in.)	max. 24 mm (0.94 in.)	25 Nm (18.44 ft.lb.)
Nipple optional with cap nut / straight	12 mm (0.47 in.)	max. 24 mm (0.94 in.)	25 Nm (18.44 ft.lb.)

CONNECTIONS FOR OIL CIRCUIT TURBOCHARGER

NOTE

In the standard supply volume the connection (12) is closed by the plug screw. This screw plug has to be removed and is replaced by the hose nipple, sealing ring 10x14 DIN 7603 and banjo bolt.

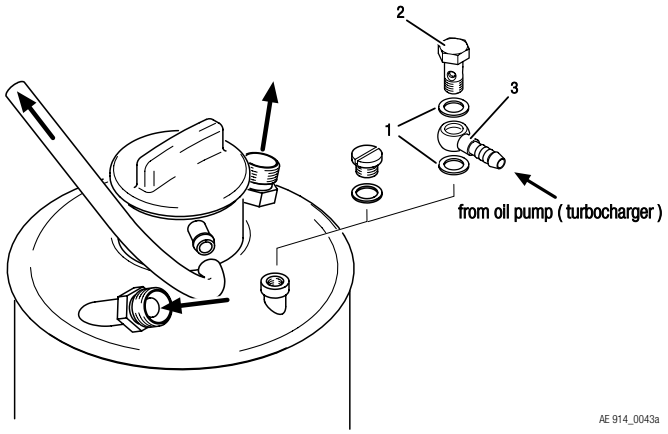

Figure 11.10: Connections oil circuit turbocharger

1 Sealing ring 10x14 DIN 7603
2 Banjo bolt M10x1x19
3 Hose nipple 4/6 DIN 7642

	Outside diameter	Slip-on length	Tightening torque
Hose nipple 4/6 DIN 7642	8 mm (0.31 in)	max. 20 mm (0.79 in)	17 Nm (12.53 lbf ft) dry, 12 Nm (8.85 lbf ft) lubricated

PERMISSIBLE POSITION AND LOCATION

⚠ WARNING

Non-compliance can result in serious injuries or death!
If the oil tank is located higher, oil might trickle through bearing clearances into the crankcase during longer periods of engine stop. If fitted too low it might damage the oil circuit.

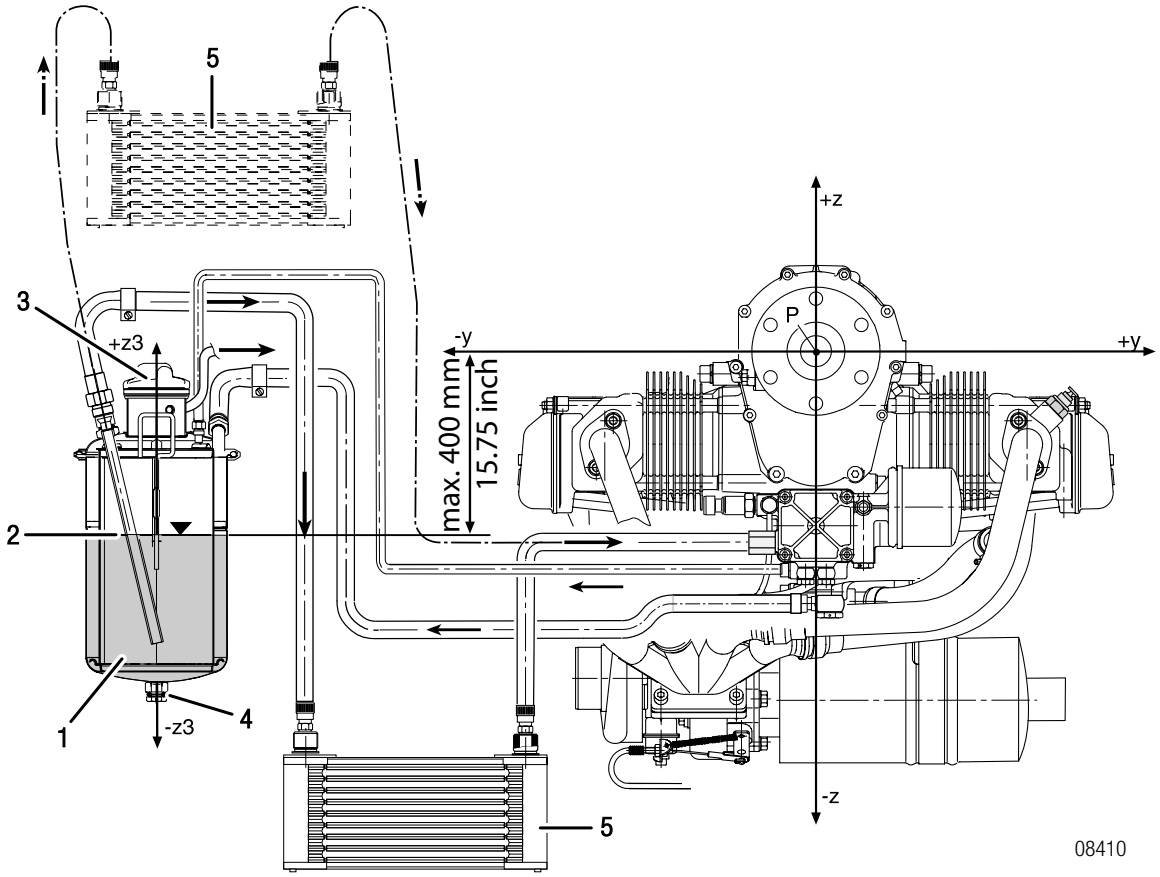

Figure 11.11: Position and location of the oil tank

1	*Oil tank*	*2*	*Oil level*
3	*Oil tank cover*	*4*	*Oil drain screw, hex. screw*
5	*Oil cooler*	*P*	*Zero reference point*

- Longitudinal axis z3 must be parallel to z-axis of the system of coordinates. The Permissible deviation from parallel: ±10°

NOTE

This applies to both planes.

- The oil tank must be positioned on its z-axis such that the normal oil level is always between 0 and -400 mm (-15.75 in.) on the z-axis.

NOTE

The profile clamp of oil tank should be between +40 mm (1.57 in) and -360 mm (-14.17 in.) on the z-axis.

- Install the oil tank free of vibrations and not directly on the engine.

- Oil tank cover and oil drain screw must be easily accessible.

CAPACITY

- Without oil cooler and connecting lines min. 3 l (0.8 US gal) depending on the respective installation.
- Volume of oil tank:
  Up to the MIN. mark 2.5 l (0.66 US gal)
  Up to the MAX. mark 3.0 l (0.79 US gal)
- Perform oil level check and add oil if necessary.

OIL RADIATOR (OPTIONAL)

Essential parts of the cooling system, such as radiator, etc., are available for this engine from BRP-Rotax.

⚠ WARNING

Non-compliance can result in serious injuries or death!
The furnishing of proof in accordance to the latest FAR and EASA, has to be conducted by the aircraft manufacturer.

ATTENTION

The radiator must be designed to dissipate approx. 10 kW (9.48 BTU/s) of thermal energy at take-off performance.

ATTENTION

The oil radiator must not restrict oil flow. Test system as per section "Checking the oil circuit".

NOTE

Experience has shown that an oil radiator of at least 160 cm² (25 in²) is required, provided that airflow is adequate.

Weight See Chapter 72-00-00 section Weight.

PERMISSIBLE POSITION AND LOCATION

⚠ WARNING

Non-compliance can result in serious injuries or death!
The components must be designed and installed such that the permissible operating temperatures are maintained and the max. values are not exceeded. This must also apply to "Hot day conditions"! If need be, take appropriate measures.

The oil cooler should always be installed below the engine oil pump.
If this position is not practical, install also the oil cooler with connections upwards i.e. in position direction on z-axis.

ATTENTION

Prevent unintentional draining of the oil cooler during longer periods of engine stop.
The oil cooler must be installed with the fittings pointing upwards i.e. in positive direction on the z-axis.

REPLENISHING AND PURGING OF THE OIL SYSTEM

⚠ WARNING

Risk of burns and scalds. Hot engine parts.
Always allow engine to cool down to ambient temperature before starting work.

See also SI-914–020 “Purging of lubrication system for ROTAX® Engine Type 914 (Series), current issue.

NOTE

Perform oil level check and add oil if necessary. Verify that the oil tank is filled up to the maximum level (to the top of the flat portion of the dipstick). Additional oil (up to 0.5 liter (0.13 US gal)) may be added to the tank for the purpose of this procedure.

Work procedures

ATTENTION

Danger of severe engine damage.
Incorrectly connected oil lines to the oil tank or to the engine will result in severe engine damage.

1. Disconnect oil return line from the oil tank.
2. Place the free end of the return line into a suitable container below the engine.
3. Plug open connection on oil tank with suitable air tight cap.
4. Remove the spark plug connectors.
5. For easier rotation of engine remove one spark plug from each cylinder.

ATTENTION

Prevent any foreign objects entering through hole.

6. Using a compressed air line, pressurize the oil tank through its vent nipple connection (on the neck of the tank). Adjust the compressor outlet regulator so that the air line pressure is between 0.4 bar (5.8 psi) and 1 bar (14.5 psi). Do not exceed 1 bar (14.5 psi).

⚠ WARNING

Non-compliance can result in serious injuries or death!
Do not remove the oil tank cover before ensuring that air pressure has been completely released from the tank.

NOTE

The oil tank cover is not pressure-tight, some air can escape.

ATTENTION

The oil tank may empty and as a result introduce air into the oil system.
The pressure in the oil tank has to be maintained. Pay attention to the oil level and fill tank as required. Turn the engine by hand in direction of normal rotation until the first pressure indication appears on the oil pressure gauge. Do not use the starter.

7. Turn the engine by hand in direction of normal rotation until the **first pressure indication appears on the oil pressure gauge**. Normally this will take approx. 20 turns. Depending on installation it may take up to 60 turns.

8. Stop the pressurization.

9. Open the cap for the oil return line on the oil tank and reconnect the engine oil return line to the tank.
   Ensure that the suction oil line and oil return lines are connected to the proper fittings on the oil tank.

ATTENTION

Carefully check all lubrication system connections, lines and clamps for leaks and tightness.

10. Re-fit the spark plugs. Restore aircraft to original operating condition.

11. Residual oil may have accumulated in the crankcase. Return it to the oil tank by following the oil level check procedure in the relevant Operators Manual.

12. Fill the oil in the tank up to the full mark on the dipstick.

ENVIRONMENTAL NOTE

Protect the environment.
Do not harm the environment by spilling oil. Dispose of oil in an environmentally friendly manner.

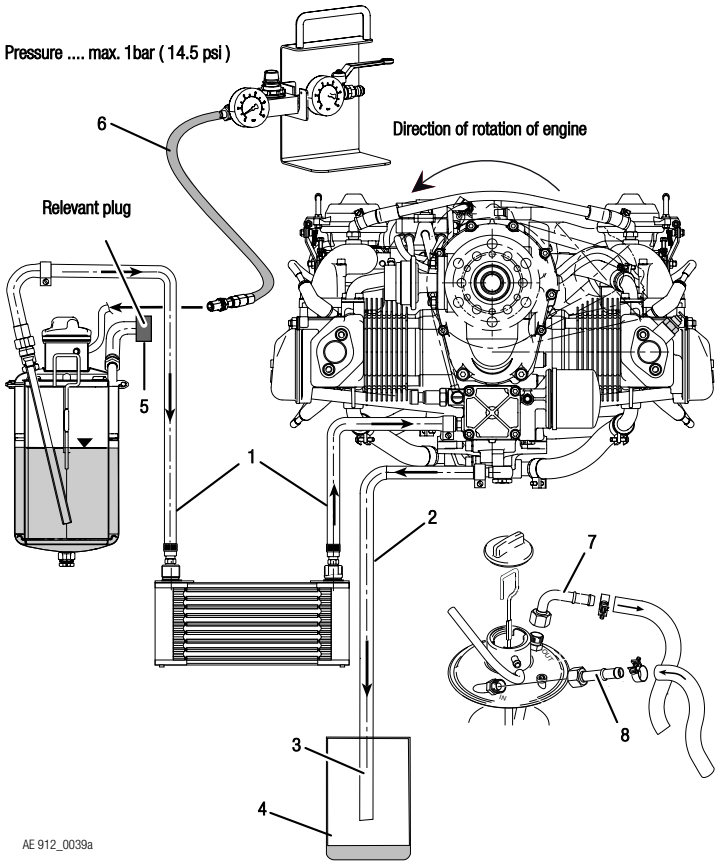

Figure 11.12: Purging the engine oil system

1	*Suction line*	*2*	*Oil return line*
3	*Free end*	*4*	*Tank*
5	*Plug*	*6*	*Pressurized air connection*
7	*To oil pump*	*8*	*Return from engine*

PURGING THE TURBOCHARGER LUBRICATION SYSTEM

⚠ WARNING

Non-compliance can result in serious injuries or death!

Observe the appropriate safety precautions.Make sure that there are no foreign items including tools in the engine compartment. Secure aircraft to the ground appropriately and place chocks under the wheels. Secure propeller zone to warrant safety for persons and property. Be sure to approach only from engine side of propeller. Permanently supervise engine operation from a secure position. The cockpit must be occupied during the testing by a licensed pilot or an authorized person to conduct test runs of an aircraft.

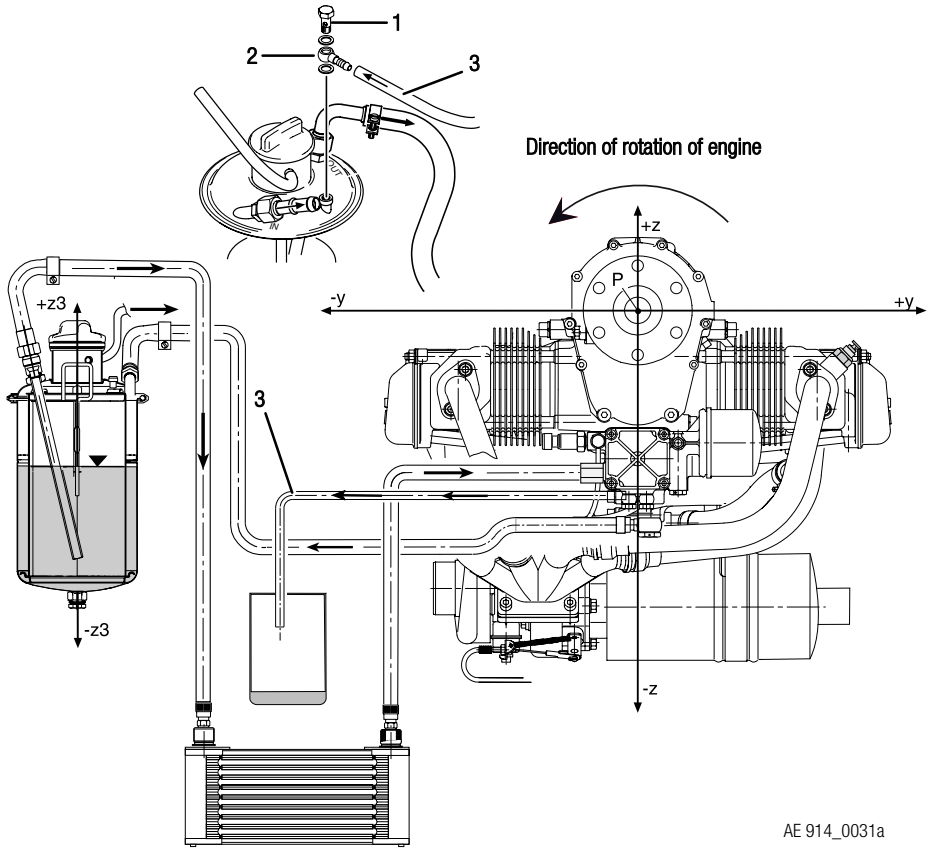

Figure 11.13: Purging the turbocharger lubrication system

1 Banjo bolt M10x1x19

2 Ring hose nipple 4/6 DIN 7642

3 Turbo sump oil return line

Work procedures

Step	Procedure
1	To verify operation of the turbocharger oil circuit detach the turbo sump oil return line on the oil tank (banjo bolt M10x1x19)
2	Route the open end from the turbocharger return line to a separate container.
3	Start the engine in accordance to the relevant Operators Manual and observe if oil is being returned back (into container).
	ATTENTION **If oil is not flowing back within 10 sec. stop the engine immediately and find the trouble.**
4	Repeat previous steps until proper oil flow is observed.
5	Fit the turbo sump oil return line on oil tank.
6	Fit the Banjo bolt M10x1x19. Tightening torque 17 Nm, lubricated 12 Nm
7	Restore aircraft to original operating configuration.

CHECKING THE HYDRAULIC VALVE TAPPET FOR CORRECT PURGING

⚠ WARNING

Risk of burns and scalds. Hot engine parts.
Always allow engine to cool down to ambient temperature before starting work.

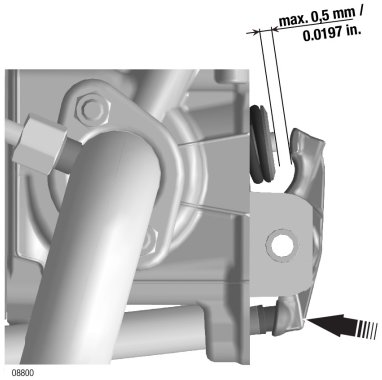

Figure 11.14: Hydraulic valve

1. Remove valve cover on cylinder 1.

2. Turn crankshaft in direction of normal rotation so that cylinder 1 is set to top dead centre ignition (both valves are closed).
3. Push down the rocker arm on the push rod side with a force (F) of around 70 N (15.74 lb-force) for about 3 seconds.
   You can using a fan belt tester, for example, to check approximately how much force is being exerted.
4. Check the size of the gap between the rocker arm and the valve contact surfaces.
   Max. permitted gap 0.5 mm (0.02 in.).

ATTENTION
If it is possible to push the hydraulic valve tappet further than this limit, an additional engine run for about 5 min. at 3500 rpm, after refitting the valve covers, is required. In order to vent the hydraulic valve tappet, this process can be repeated another 2 times.

Repeat on all other cylinders.

Replace hydraulic valve tappet

If an hydraulic valve tappet still malfunctions after several engine runs, it must be replaced and the valve spring support must be inspected for wear.

All work must be performed in accordance with the relevant Maintenance Manual Heavy .

VARIANTS OF CONNECTORS

ATTENTION

Use backup wrench to counter-hold screw sockets when securing the oil lines.

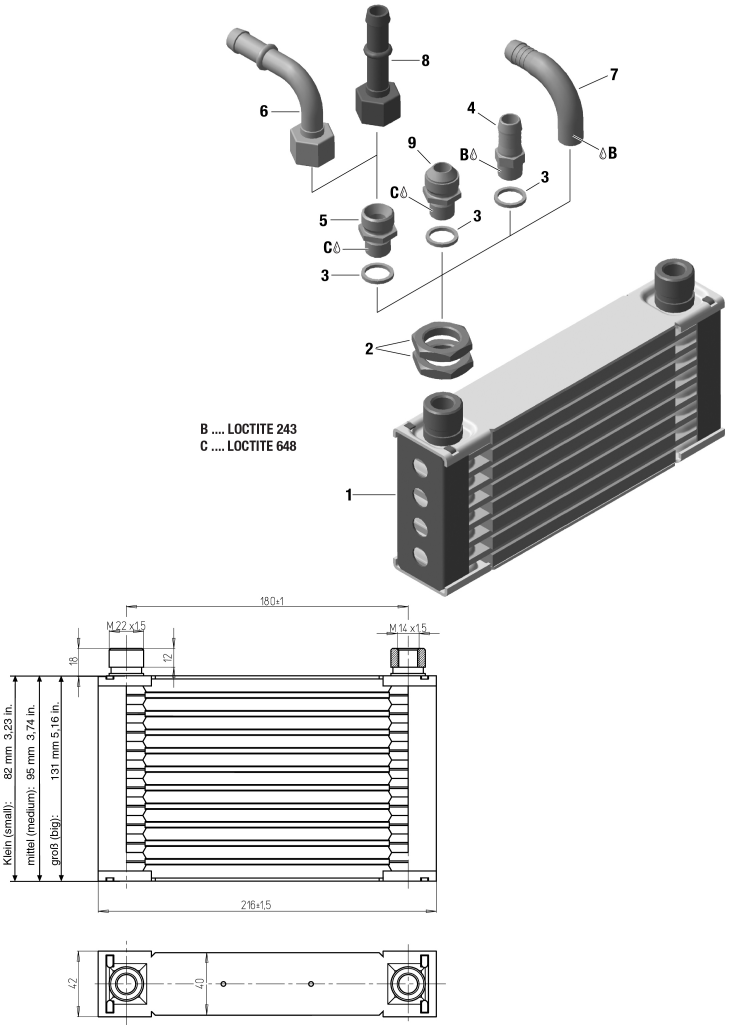

Figure 11.15: Oil cooler Variants of connectors

1 *Oil cooler*
2 *M22x1.5 hex. nut*
3 *Gasket ring 14.2/18/2*
4 *Nipple 13.2/9.5*
5 *M18x1.5/M14x1.5 screw socket*
6 *Bent socket assy.*
7 *M14x1.5 angular tube*
8 *Hose nipple with cap nut*
9 *3/4-16 UNF/M14x1.5 screw socket*

	Thread/ Outer dia.	Slip-on length	Tightening torque	Tightening torque of oil feed line and outlet, bent socket or hose nipple
UNF screw socket	3/4-16 UNF		22 Nm (16.23 ft.lb.) + LOCTITE 648	25 Nm (18.44 ft.lb.)
Nipple 13.2/9.5	13.2 mm (0.52 in.)	max. 21 mm (0.83 in.)	22 Nm (16.23 ft.lb.) + LOCTITE 243	
Metric screw sockets	M18x1,5		22 Nm (16.23 ft.lb.) + LOCTITE 648	25 Nm (18.44 ft.lb.)
Angular tube (90° Angular tube)	13.2 mm (0.52 in.)	max. 21 mm (0.83 in.)	22 Nm (16.23 ft.lb.) + LOCTITE 648	
Bent socket only for metric screw sockets (90° Bent socket)	12 mm (0.47 in.)	max. 24 mm (0.94 in.)	25 Nm (18.44 ft.lb.)	
Hose nipple with cap nut (straight nipple) only for metric screw sockets	12 mm (0.47 in.)	max. 24 mm (0.94 in.)	25 Nm (18.44 ft.lb.)	

Chapter: 80–00–00
STARTING

TOPICS IN THIS CHAPTER

SYSTEM DESCRIPTION

For a detailed System description refer to the latest issue of the Operators Manual.

SYSTEM LIMITATIONS

Operating limits Refer to latest issue of the Operators Manual.

Ambient temperatures

System Limit	Min.	Max.
Electric Starter	– 40 °C (- 40 °F)	80 °C (176 °F)

Thermal durability Suitable for short starting periods only. Activate starter for max. 10 seconds (without interruption), followed by a cooling period of 2 minutes.

Aircraft ground The engine block must be connected to the aircraft using a properly sized line (minimum the same cable cross section as starter supply), to supply the required starter current and to avoid static electricity between the engine and the aircraft.

POWER SUPPLY WIRES FROM STARTER RELAY TO THE ELECTRIC STARTER

Cross section	At least 16 mm² (2.48 in²)
Output	0.7 kW
Grounding cable	Grounding cable via engine block.
Positive terminal	M6 screw connection (tightening torque 4 Nm (36 in.lb)) suitable for cable terminals according to DIN 46225 (MILT7928; PIDG or equivalent).

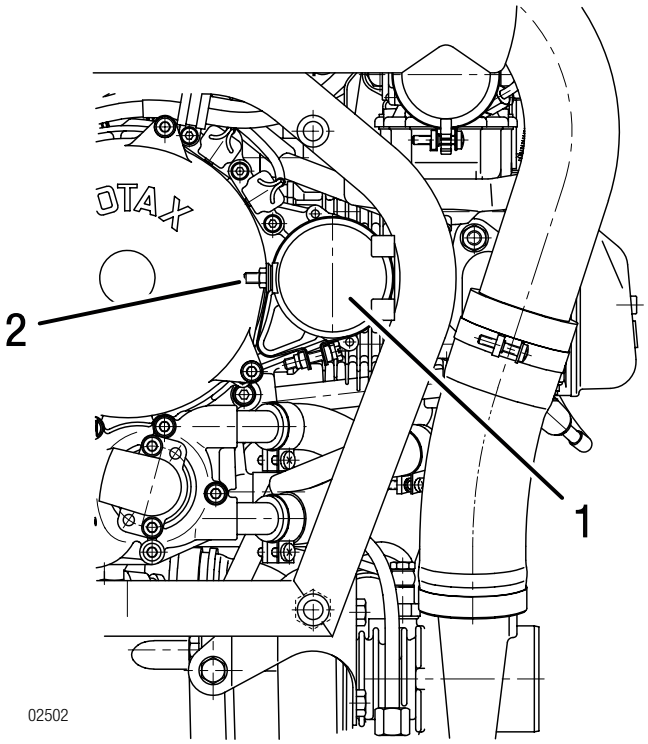

Figure 12.1: Positive terminal

1 Electric starter

2 Positive terminal

STARTER RELAY ASSY. TECHNICAL DATA

ATTENTION
Activation of starter relay limited to short duration. The duty cycle over an interval of 4 minutes is 25%.

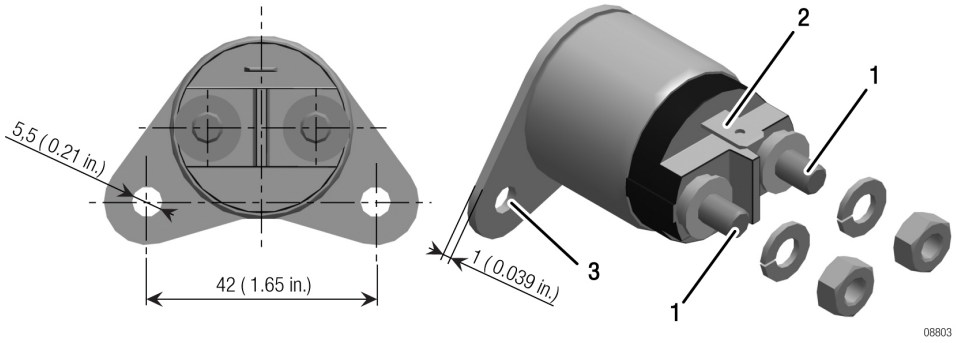

Figure 12.2: Starter relay

1 Main current connections
2 Control wiring
3 Ground

Nominal voltage	12 V/DC
Control voltage	min. 6 V / max. 18 V
Switching current	max. 75 A (permanent) max. 300 A/1 s (short duration)
Permissible ambient temperature	min. -40 °C (-40 °F) / max. +100 °C (212 °F)
Weight	See Chapter 72-00-00 section Weight
Main current connections	M6 screw connection (tightening torque 4 Nm (36 in.lb.)). suitable for cable terminals according to DIN 46225 (MIL-T-7928; PIDG or equivalent).
Control wiring	6.3x0.8 plug connector suitable for Faston connector (female) according to DIN 46247 (MIL-T-7928; (PIDG) or equivalent).
Grounding	about engine housing.

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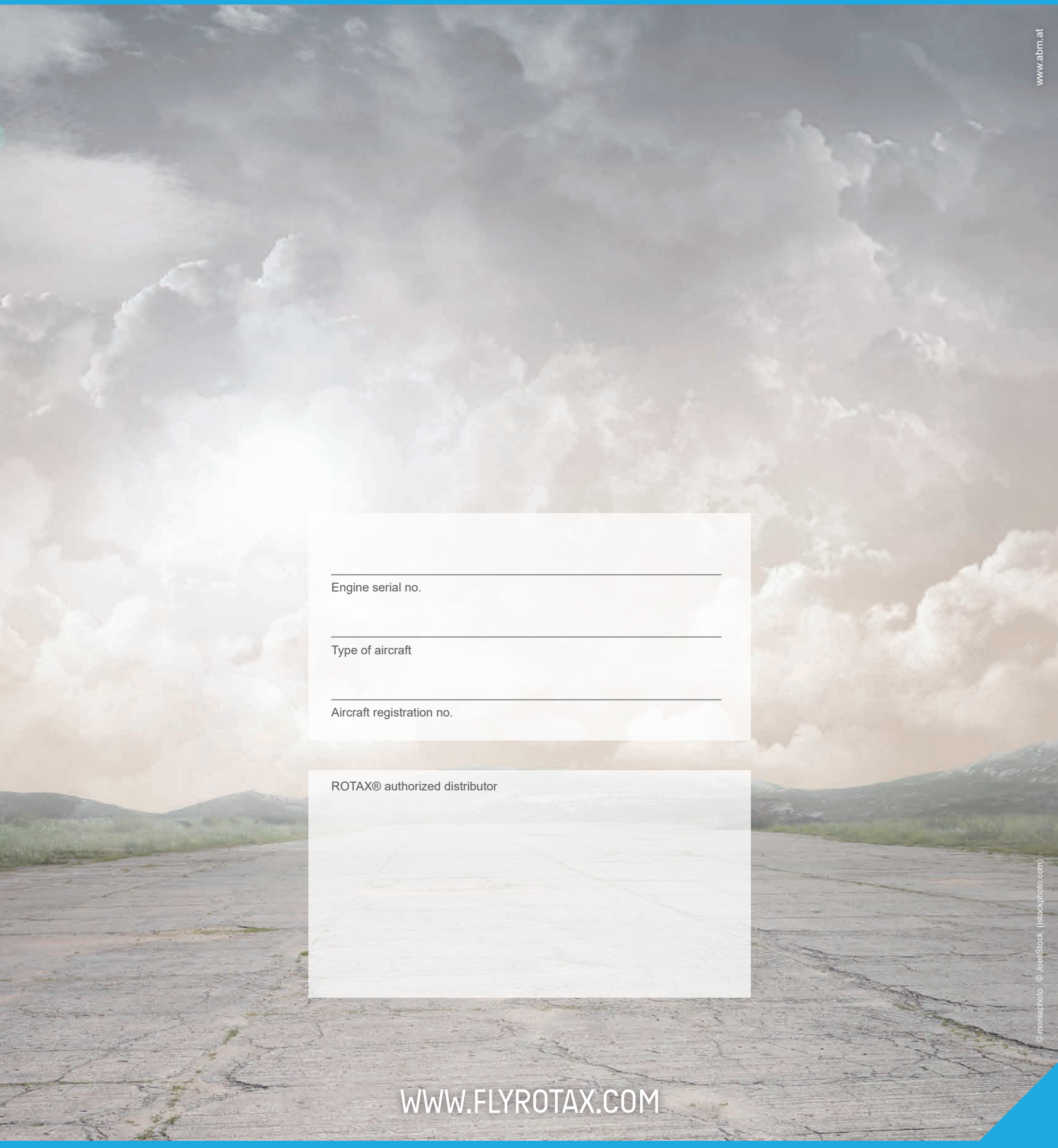

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