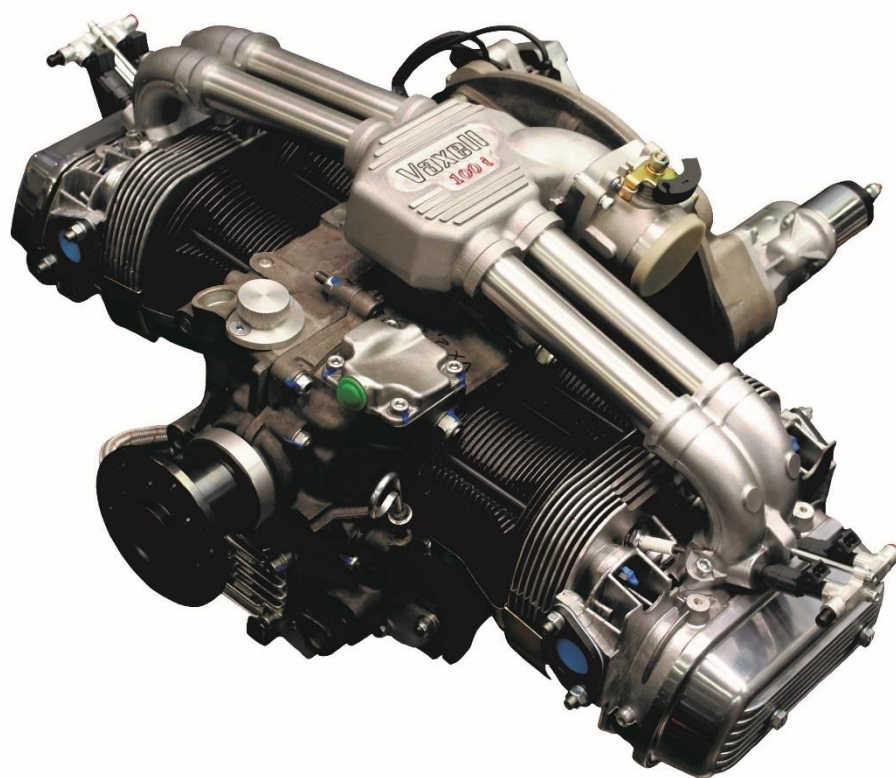




USER MANUAL
SPECIFICATION AND TECHNICAL
SERVICE



VAXELL 100 i

VAXELL 80 i

VAXELL 60 i

IMPORTANT NOTICE!

- Before starting the engine, it is essential to read the Operator's Manual, it contains important safety information.
- The engine must be used in accordance with the limits and information provided in this manual.
- This manual **MUST** always be available when the engine is operated and when servicing, inspecting and periodic work is performed on the engine.
- This engine is intended only for use in uncertified ultralight aircraft.
- First 10 Hours of flight should be considered as break-in process. User should pay special attention to the details of running engine. During this hours maximum load of the engine should be minimized to take off procedure only.

The names of other products in this manual are used only for easy identification and may be trademarks of the respective company or owner.

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Engine serial number:	#100.85.____#
Aircraft type:	
Aircraft Registration Number:	

Instruction edition: 22.02.2021

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1 Introduction

1.1 Foreword and general guidelines

Before starting the engine, carefully read and understand the information contained in this manual. The use of operating recommendations and maintenance of basic parameters will ensure safe use of the engine. Failure to follow the engine operating instructions can result in damage to the engine or its component. If there are any questions or concerns regarding the Manual, contact your Vaxell aircraft engine distributor.

This document contains important information on the safe operation of the engine. Its technical data, systems with their arrangement, operating fluids used and engine usage limits are described below.

The data contained in the manual apply only to the engine with **#SN 100.85.0007#**. The flight manual, the aircraft manufacturer's or the DIY kit's manual is valid and associated with the specific aircraft necessary for the safe conduct of the flight.

The manual is structured in such a way that single pages can be replaced instead of the entire document. The version number is listed in the footer of each page.

We wish you a lot of fun and satisfaction flying your Vaxell powered aircraft.

1.2 List of symbols and names used in the manual::

RON - research octane number

TBO – time between overhaul

Nm - Newton meter

°C – degree Celsius

V - volt

Amp - Ampere

kW - kilowatt

KM – horsepower

ECU – electronic control unit

RPM – revolutions per minute

IAT – Intake Air Temperature

EGT – Exhaust Gas Temperature

CCA - Cold Cranking Performance

2 Safety

IMPORTANT NOTICE !

- The use of this type of engine for the propulsion of any aircraft is the decision of the installer - user - owner and is entirely responsible for it.
- The engine is not designed to perform aerobatic flight (ie. Inverted flight).
- The engine should not be used in rotorcraft with an in-flight controlled rotor (helicopters).
- Know and follow all instructions in this manual.
- The aircraft should never be left unattended with the engine running.

The information and descriptions of components / systems contained in this Manual are correct at the time of publication. ŚWIĄTEK Lech Świątek Company reserves the right to remove, change or discontinue production: design, specification, equipment, or the like, at any time and without incurring any obligations.

Keep an engine log book and follow a periodic maintenance schedule for the engine and aircraft. Keep the engine in top working condition at all times. Do not operate any aircraft that is not properly maintained or has an engine that has not been repaired.

Graphical symbols used to indicate particularly important information:



WARNING - Failure to follow the information given may result in injury or death.



CAUTION - Failure to follow this information may result in damage to the engine or the equipment.



TIP - Additional Supplementary Information

3 System descriptions

Vaxell 100i, Vaxell 80i, Vaxell 60i, are four cylinder engines, four stroke with boxer cylinders layout. The engines are air-cooled, equipped with heads made of aluminum, the crankcase with the oil pan as cast from magnesium alloys and the forged crankshaft. At the top is an aluminum intake manifold with a single-throttle. Engines are equipped with multi-point injection and dual ignition system with two spark plugs per cylinder. The propeller drive is transmitted directly from the crankshaft.

The fuel supply is fully electronically controlled.

Propeller Shaft Rotation Direction: Anticlockwise - see Figure 3.1.

Definition of the motor sides according to Figure 3.1:

- I -front of the engine
- II - right side
- III - rear
- IV - left side

3.1 Engine drawings

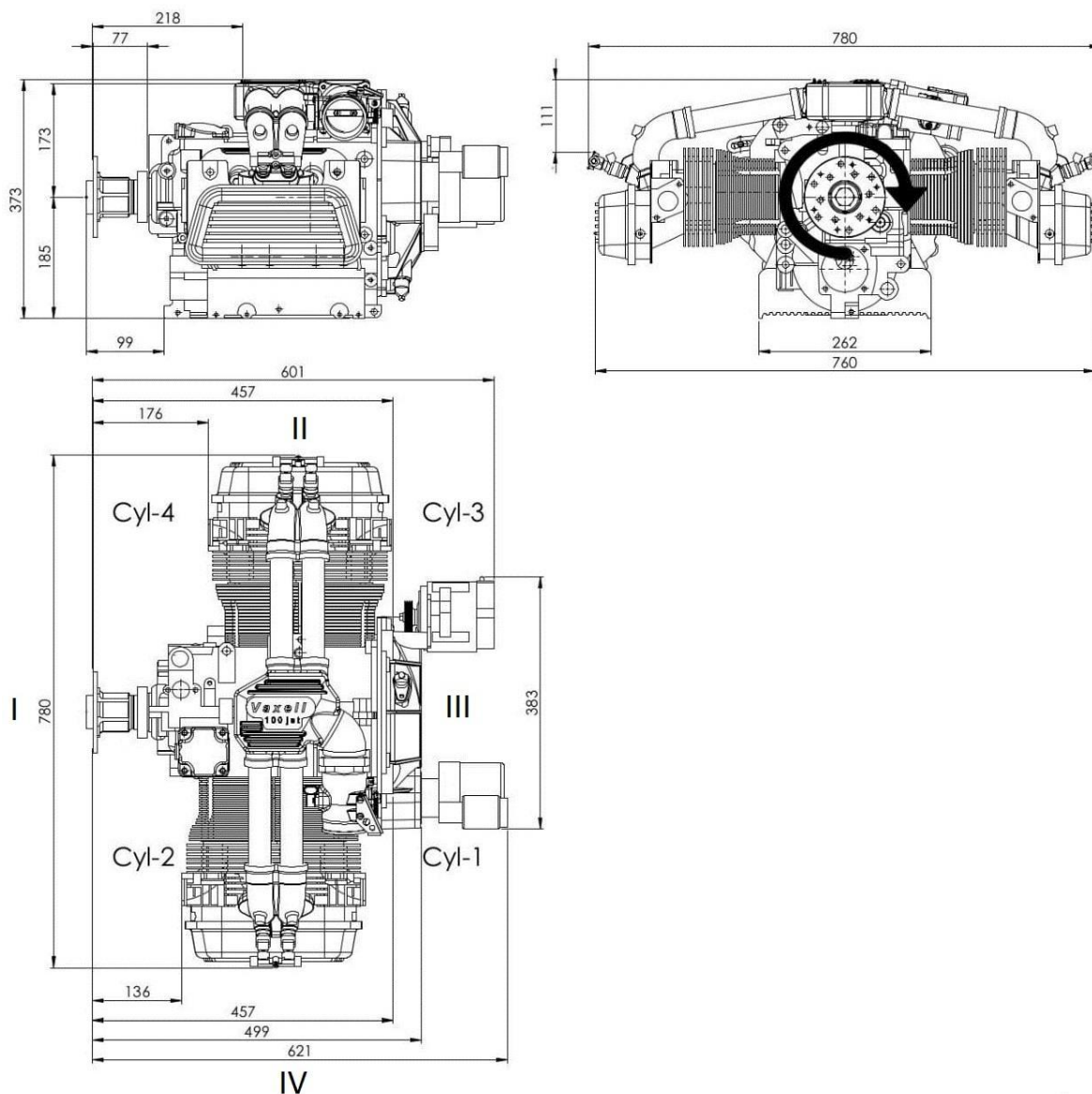


Figure 3.1 Overall dimensions, cylinder numbering and propeller rotation direction.

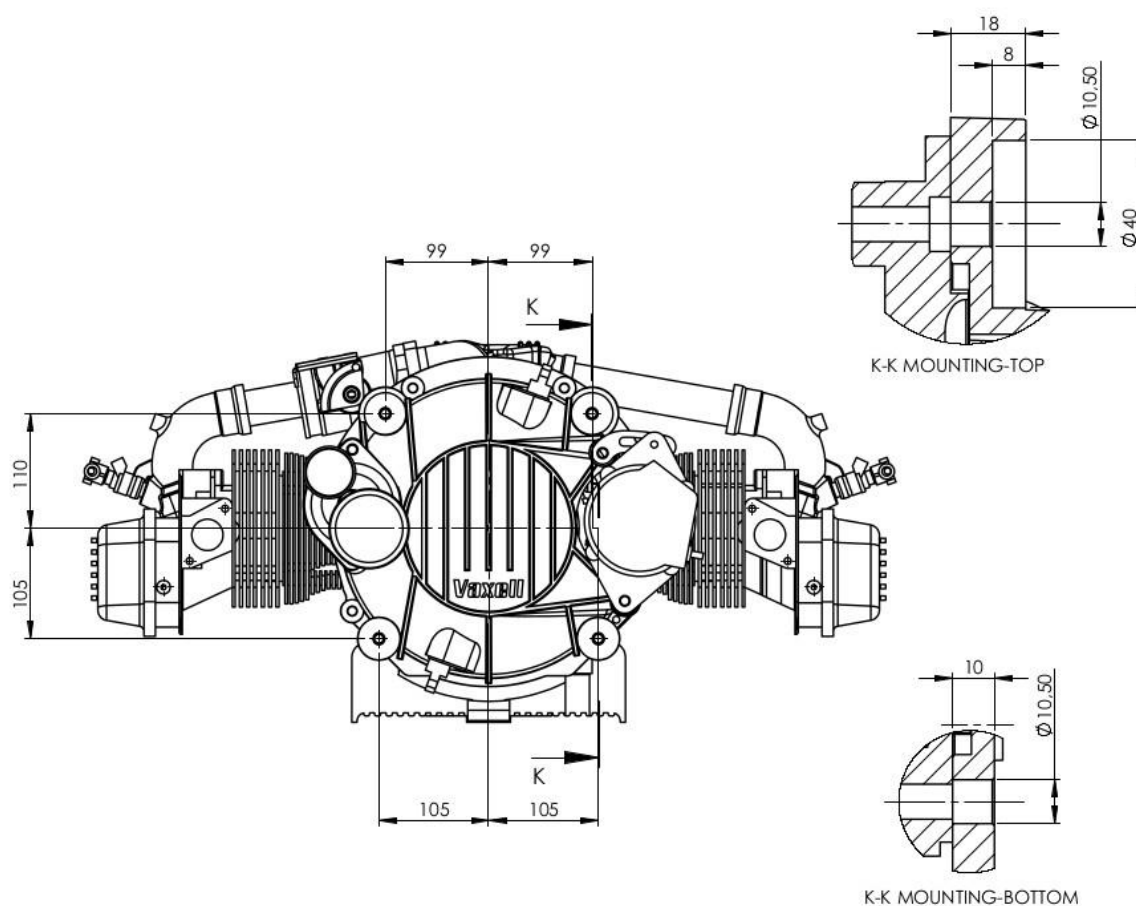


Figure 3.2 Dimensions of the engine mounts

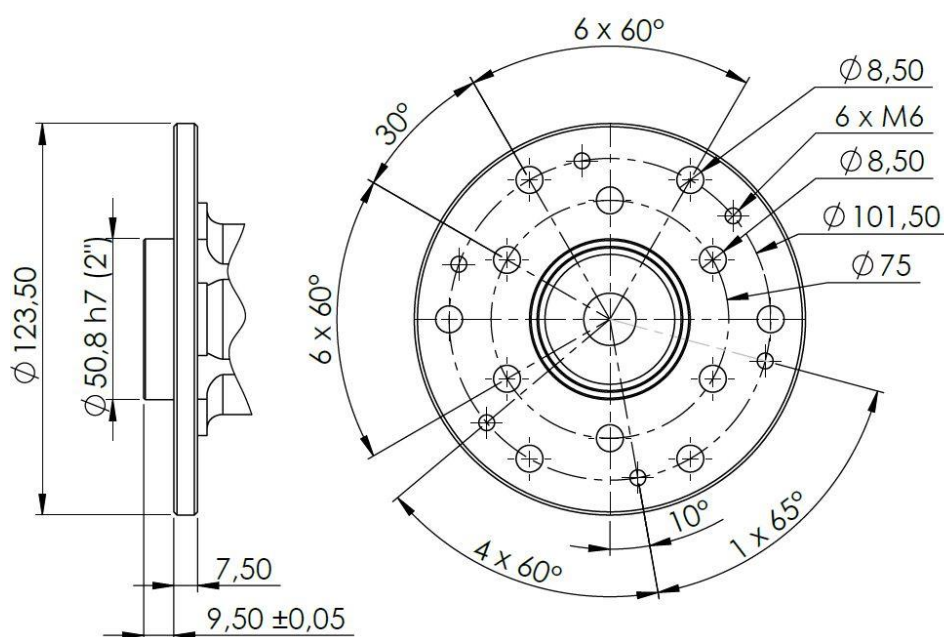


Figure 3.3 Propeller mounting hub

3.2 Basic technical data

Engine Model:	100i	80i	60i
Displacement, cm ³	2275	1914	1594
Bore, mm	94	94	85,5
Stroke, mm	82	69	69
Compression ratio	8,0	8,0	8,2
Continuous power, KM	91	75	60
Continuous power RPM ,	3180	3120	3180
Torque, Nm	221	208	145
Torque RPM,	2380	2050	2210
Weight *, kg	73,35	71,55	71,25
Cooling factor	Air		
Propeller drive	Direct		
Direction of the propeller rotation	Anticlockwise		
Fuel System	Electronic, multi-point fuel injection		
Ignition	Dual, electronically controlled		
Engine control unit (ECU)	EMU Black		
Firing order	1-4-3-2		

* weight shown is for engine with oil filter, starter and alternator installed, no fluids, fuel pump and oil cooler.

3.3 Detailed technical data

3.3.1 Performance parameters

Engine operating parameters (limits)

Idle (warm engine)	950 (+/- 50) obr/min
Cruising engine RPM	2200 - 2600 obr/min
Maximum engine RPM	3500 obr/min

Pressure

Minimum oil pressure (flight)	28 PSI = 1,9 bar (@ 2500 RPM 70°C oil temp.)
Oil pressure (average)	36 PSI = 2,5 bar
Maximum oil pressure (flight)	102 PSI = 7,0 bar (cold engine)
Nominal compression	114 – 142 PSI = 7,9 – 9,8 bar
Minimum compression	87 psi = 6 bar
Pressure difference between cylinders	29 psi = 2 bar

Temperature

Minimum oil temperature	70°C
Maximum oil temperature	110 -120 °C
Cruising oil temperature	85-105°C
Cylinder head temperature at cruising	177 - 190°C (under plug)
Cylinder head temperature at cruising CHT (CLT)	180 - 210°C (ECU – sensor)
Cylinder head temperature during the climb	216°C (max. 5 min)
Maximum cylinder head temperature DO NOT EXCEED	232°C (under plug)
Cruising exhaust gas temperature EGT	550 - 650°C
Maximum exhaust gas temperature EGT	850°C

Consumables

Fuel: - The engine is designed to run on unleaded automotive gasoline with an octane value of at least 98 RON at E5.

Oil: - The manufacturer recommends the use of the following oils for spark ignition combustion engines:

- for ambient temperatures from	0 to +35 °C	oil 5W-50
- for ambient temperatures from	-20 to + 25 °C	oil 5W-40

Recommended brands: MOBIL, ELF, MOTUL, VALVOLINE

The capacity of the lubrication system is 2.5 liters (without cooler)

3.3.2 Service parameters

The manufacturer is not responsible for accessories that he has not tested and does not recommend.

Equipment parts:

Oil filter:	FILTRON OP518
Upper spark plugs:	NGK BR7ES (optional BR8ES)*
Lower spark plugs:	NGK CR7HS (optional CR8HSA)*
Ignition wires:	MAGNETTI MARELLI MSK1197 (or BOSCH 0986356012)
Accessory belt:	CONTITECH 3pk690
Starter:	AS-PL S9010 (optional HC-CARGO 111214)
Alternator:	AS-PL A6188 (optional HC-CARGO 110374)
Ignition coils:	MAGNETTI MARELLI 060717029012
Fuel injectors:	MAGNETTI MARELLI 805001399403
Fuel filter:	FILTRON PP 831 (optional BOSCH 0986450119)
Fuel pump:	WALBRO GSL392 (or WALBRO 393, BOSCH 0280156374)

(*) for engine applications in hot climates

Valve clearances

Intake valve clearance	0,15 mm
Exhaust valve clearance	0,15 mm

Engine bolt tightening torques

Crankshaft front bolt:	M18 x 1,5 (propeller hub)	300 Nm
Crankshaft rear bolt:	M28 x 1,5 (flywheel)	300 Nm
Head bolts:		
preload:		10 Nm
final torque:		30 - 32 Nm
Connecting rod bolts:		32 Nm
Crankcase bolts:	M12 x 1,5	35 Nm
Crankcase bolts:	M 8	20 Nm
Spark plugs:	M 14 x 1,5	32 Nm
Spark plugs:	M 10 x 1	12 Nm
Oil drain:	M14 x 1,5	20 Nm
Crankcase breather cover screw:	M 8	12 Nm
Valve lash adjustment screw nut:		15 Nm
Alternator connection nut:		
	M8	20 Nm
	M6	10 Nm
Alternator mounting bolts:		
	M10	34 Nm
	M8	20 Nm
Rocker arm shaft assembly bolts:	M8	20 Nm

4 Description of engine systems

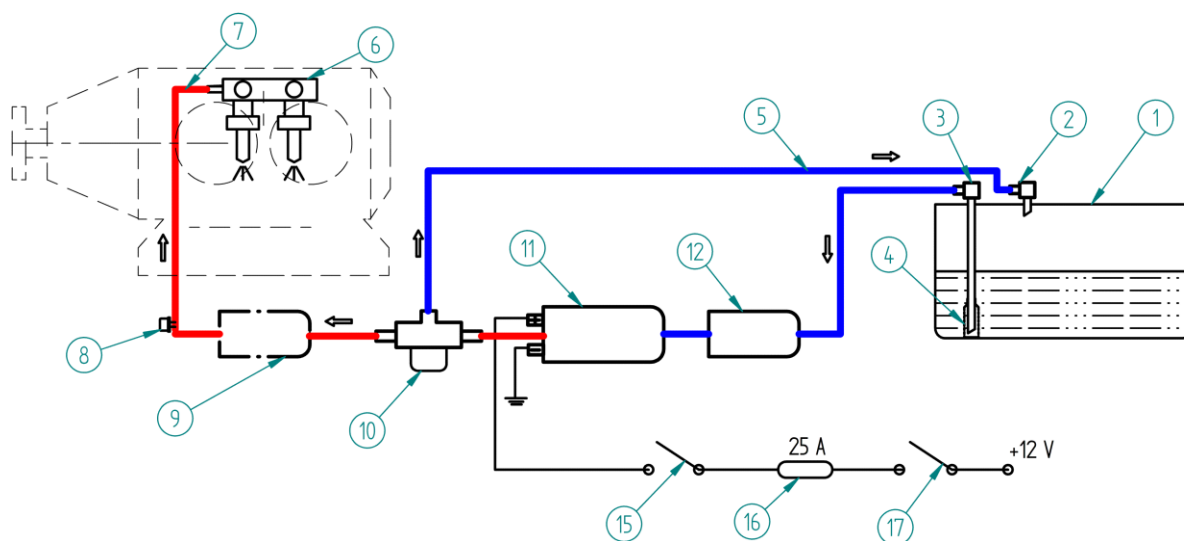
4.1 Cooling system

The motor is cooled by air that must flow around the block, cylinders, cylinder heads, oil coolers and accessories. In order to ensure adequate heat exchange, it is recommended to follow the recommendations below:

- the oil cooler must be installed in a place ensuring air flow - such that the oil temperature during operation remains within the permissible range;
- the size of the front engine air inlets and outlets must ensure an air flow sufficient for the engine version and the air intake system;
- air outlets from the engine compartment must be about 50% larger than the area of the inlets;
- the air outlet must be located in the low pressure zone - also during high angle flights (eg take-off), the pressure difference between the inlet and the outlet provide the flow of cooling air;
- particular attention should be paid to the construction of appropriate cooling docs forcing air to flow through the cylinders and heads, and to dissipate heat outside the engine compartment;
- at the edges of the enclosures, it is recommended to use seals closing the cooled spaces;
- it is recommended to install a propeller hub cover to eliminate air turbulence at the engine inlets;

4.2 Fuel system

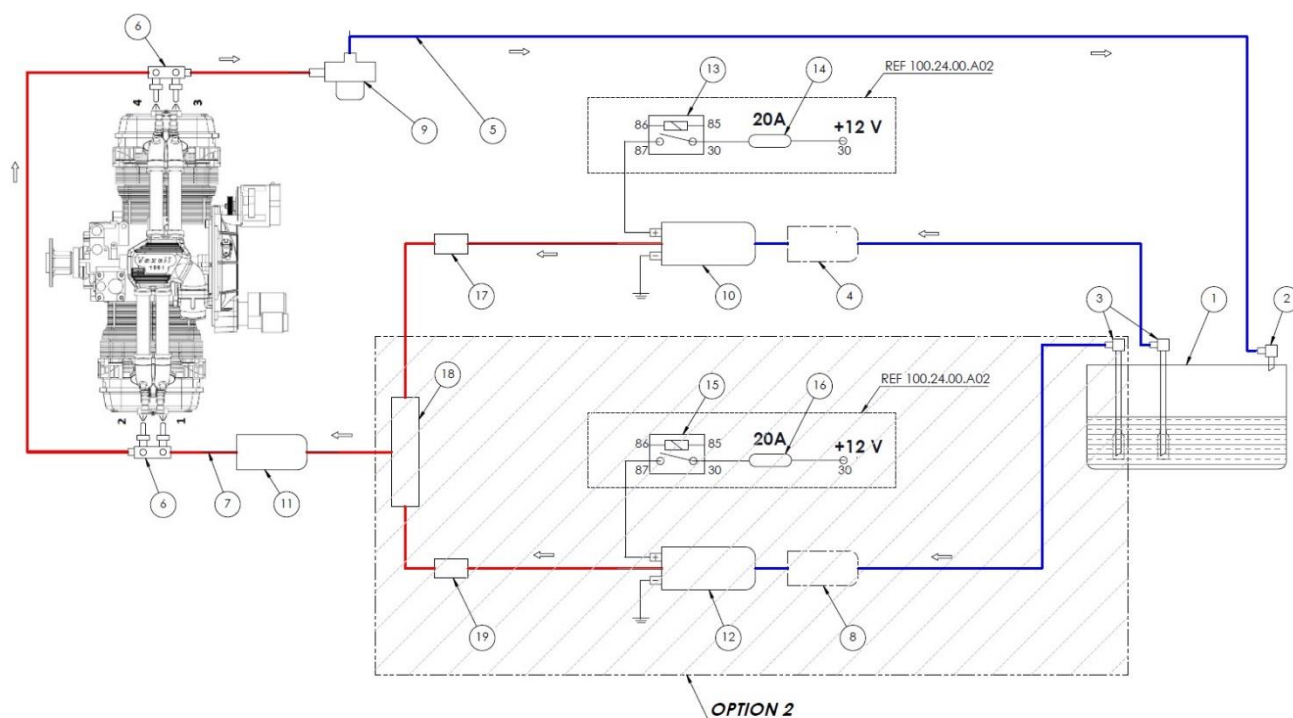
The aircraft engine manufacturer recommends installing an additional auxiliary fuel pump.



Rysunek 4.1 Diagram of the fuel system with 1 fuel pump

Blue color - low pressure Red - engine working pressure

1. fuel tank
2. overflow connection
3. fuel supply connection
4. preliminary fuel filter
5. overflow line
6. fuel rail
7. fuel pressure line
8. fuel pressure sensor
9. fuel filter
10. fuel pressure regulator
11. fuel pump
12. fuel filter (option)
15. pump switch
16. pump fuse
17. main switch or ignition switch

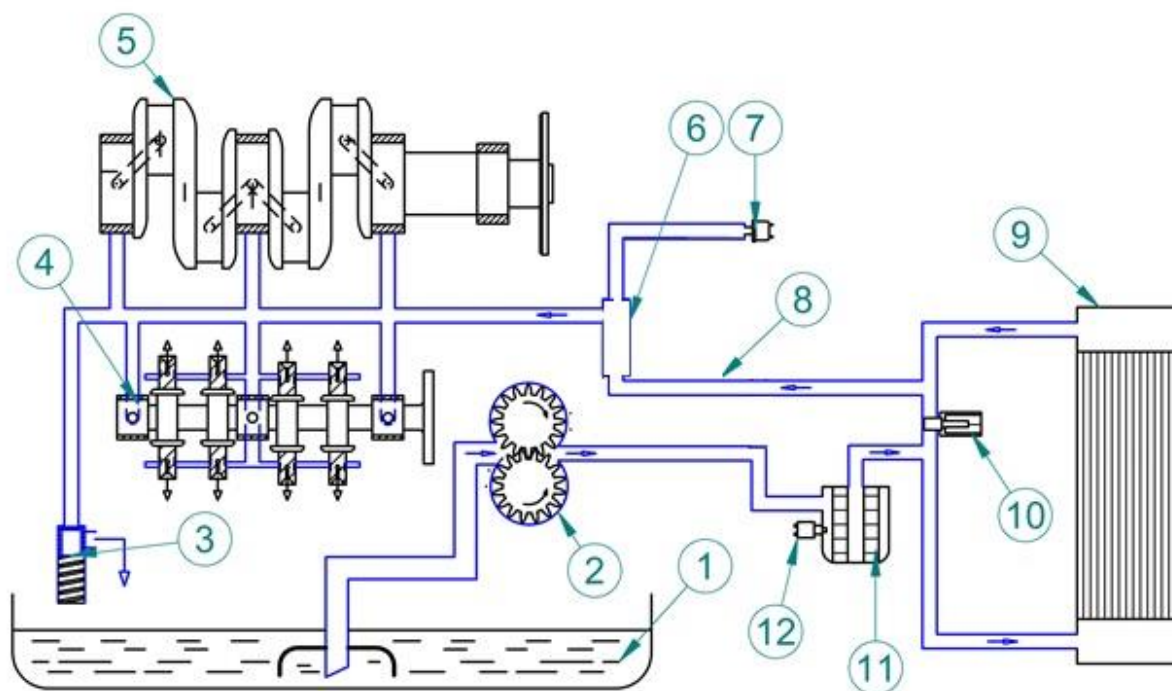


Rysunek 4.2 Diagram of the fuel system with 2 fuel pumps

Blue color - low pressure Red - engine working pressure

1. fuel tank
2. overflow connection
3. fuel supply connection
4. preliminary fuel filter (optional)
5. overflow line
6. fuel rail
7. fuel pressure line
8. fuel filter (option 2)
9. fuel pressure regulator
10. fuel pump I
11. fuel filter
12. fuel pump II
13. fuel pump relay I
14. fuel pump fuse I
15. fuel pump relay II
16. fuel pump fuse II
17. check valve I
18. tee connector
19. check valve II

4.3 Lubrication system



Rysunek 4.3 Diagram of the Vaxell engine lubrication system



The manufacturer requires an oil cooler!

1. oil pan
2. oil pump
3. oil pressure control valve (overflow)
4. camshaft, tappets, rocker arms
5. crankshaft
6. input connection
7. oil pressure sensor
8. oil lines
9. oil cooler
10. thermostat
11. oil filter
12. oil temperature sensor

4.4 Electronic control unit

Major features:

Working temperature range:	AECQ100 GRADE2 (-40 to +105°C)
High voltage protection:	YES (built-in)
Voltage operation range:	6-22V (according to ISO 7637)
Housing:	IP 65, aluminum
Dimensions (mm), weight (g):	150x72x31, 390
Types of connectors:	1x24, 1x39 FCI Automotive spec.
PC communication:	USB (PC Windows), serial, CAN-Bus

More information about the unit, drivers and features on the driver's manufacturer website:

<https://www.ecumaster.com/>

4.4.1 Electrical system components

The engine is equipped with the following electrical system components:

Starter

Brand:	AS-PL S9010 (optional HC-CARGO 111214)
Voltage:	12 V
Power:	1,0 kW

Alternator

(For lead acid batteries is only)

Brand:	AS-PL A6188 (optional HC-CARGO 110374)
Current:	45 Amp
Voltage:	14 V

Spark plugs

Type: Upper spark plugs:	NGK BR7ES (optional BR8ES)
Lower spark plugs:	NGK CR7HS (optional CR8HSA)

Ignition coils

Brand:	Magneti Marelli
Type:	060717029012

Fuel pump

Brand:	WALBRO GSL392 (optional WALBRO 393 or BOSCH 0280156374)
--------	--

Battery

The manufacturer recommends using two batteries - main and auxiliary.



The use of non-lead acid batteries is only possible in conjunction with an appropriate battery management system. If such a battery is used, responsibility rests with the manufacturer / user of the aircraft. It must be ensured that after a primary power failure, consumers are supplied with sufficient power for the safe operation of the aircraft for at least 30 minutes.



From the moment the engine is started, at least one battery must always be connected to the engine's electrical circuit - if two batteries are used, their selection must be controlled by a toggle switch. Disconnecting the battery while the alternator is running may cause irreparable damage to the engine's electrical system components. It may also cause the tachometer to read incorrectly.

Batteries must be used in accordance with the recommendations of their manufacturers and within their reservations.

Electrical requirements of batteries

- Rated voltage of 12V
- Minimum inrush current (CCA) of at least 350 Amp at -18 °C (-0.4 °F)
- Minimum capacity 16Ah



The decision to use a lower capacity battery rests with the assembler - user - owner of the aircraft. It should be noted that additional electrical loads, which are in some cases required by law, affect the battery's performance during the starting process (e.g. beacon (anti-collision lighting), navigation lighting, avionics).

The manufacturer is not responsible for accessories that he has not tested and does not recommend.

4.4.2 Electrical system diagrams

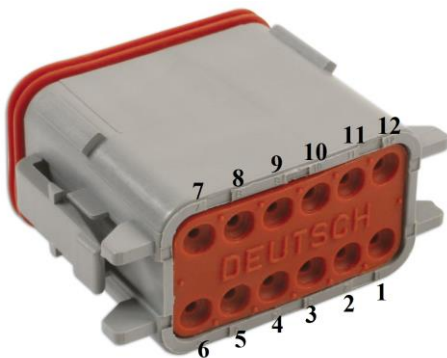
Marking of additional options

1 Additional sensors

2 Backup fuel pump

3 Display of operating parameters

Master connector (Deutsch 12PIN)



- | | | |
|-----|--------------------------------|--------------------------|
| 1. | Injectors cylinder 1+3 | +12V |
| 2. | Injectors cylinder 2+4 | +12V |
| 3. | Ignition coils 1 | +12V |
| 4. | Ignition coils 2 | +12V |
| 5. | ECU power supply (constant) | 30 +12V |
| 6. | ECU power supply (switched) | 15 +12V |
| 7. | WBO power supply | +12V |
| 8. | Fuel pump relay | GND |
| 9. | Alternator pin IG connector T1 | +12V |
| 10. | Alternator pin L connector T1 | |
| 11. | RPM signal | 10 impuls per revolution |

Additional sensors connector (Deutsch 6PIN)



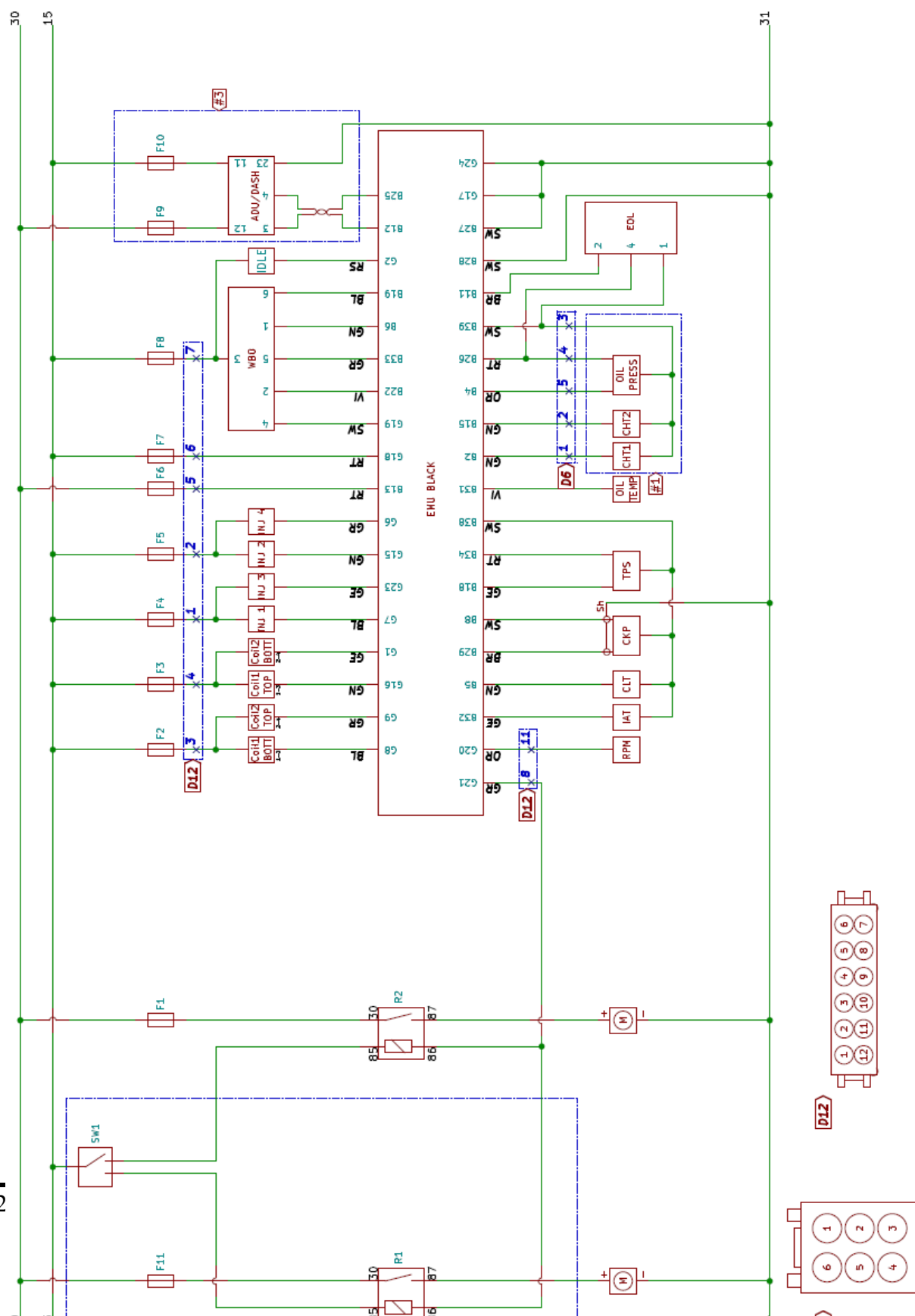
- | | |
|----|----------------------------------|
| 1. | Thermocouple No. 1 |
| 2. | Thermocouple No. 2 |
| 3. | Signal ground |
| 4. | + 5V |
| 5. | Oil pressure sensor input (0-5V) |

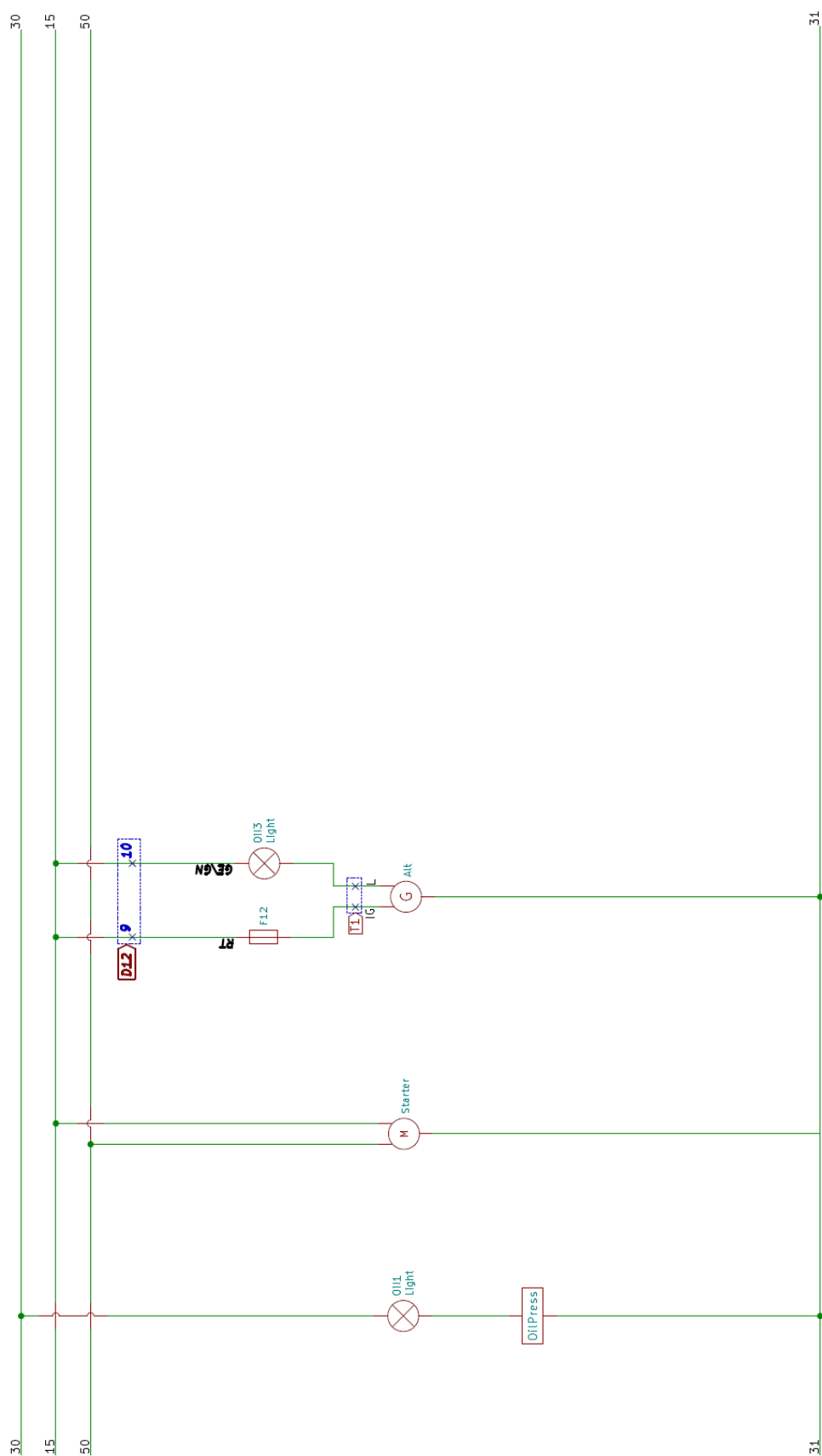
. CAN bus connector (Deutsch 2PIN)












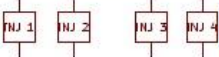




- | | |
|----|-------|
| 1. | CAN H |
| 2. | CAN L |


Edition: 22.02







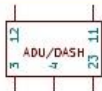
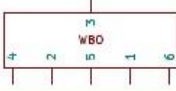




Drawing 4.5 Vaxell RYS 100.24.00.A02 (2/4) EMU circuits (2/2)

Symbol	Explanation
	Fuse
	On/Off Switch
	One from two switch
	Relay (On the left, coil, on the right contact)
	No connection
	Connection
	Fuel pump
	Ignition coils – top
	Ignition coils – bottom
	Fuel injectors
	Tachometer output
	Intake air temperature sensor
	Engine temperature sensor
	Crankshaft position sensor

	Company: Vaxell, Zywiecka 3, 85-378 Bydgoszcz, Poland		
	Title: Vaxell RYS 100.24.00.A02		Sheet title: Signs explanation pg 1/2
	Size: A4	Date: 2020-12-14	Page: 1/2

Drawing 4.6 Vaxell RYS 100.24.00.A02 Signs explanation (1/2)

Symbol	Explanation
	Throttle position sensor
	Engine oil temperature sensor
	Engine oil pressure sensor
	Cylinder head temperature sensor
	Advanced Display Unit
	Wideband lambda sensor
	Idle valve motor
	Data logger

Cable colours	
Shortcut	Explained
GR	Gray
GE	Yellow
BL	Blue
GN	Green
RT	Red
SW	Black
VI	Purple
WE	White
BR	Brown
OG	Orange
RS	Pink

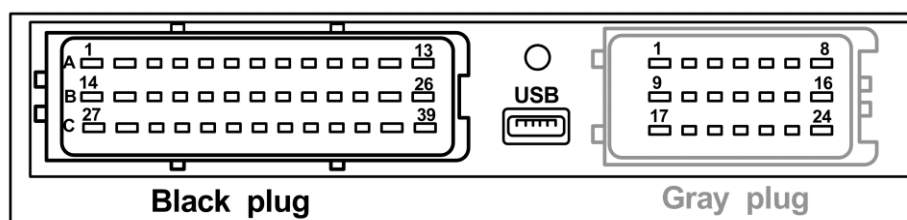
Connector coding
Shortcuts applied on the EMU BLACK symbol determines number of the pin in the EMU BLACK plug when looking from the plug back. For example, B13 means 13th pin of the black plug, G7 means 7th pin of the grey plug.

Vaxell engines		Company: Vaxell, Żywiecka 3, 85-376 Bydgoszcz, Poland	
Title: Vaxell RYS 100.24.00.A02		Sheet title: Signs explanation pg 2/2	
Size: A4	Date: 2020-12-14	Page: 2/2	

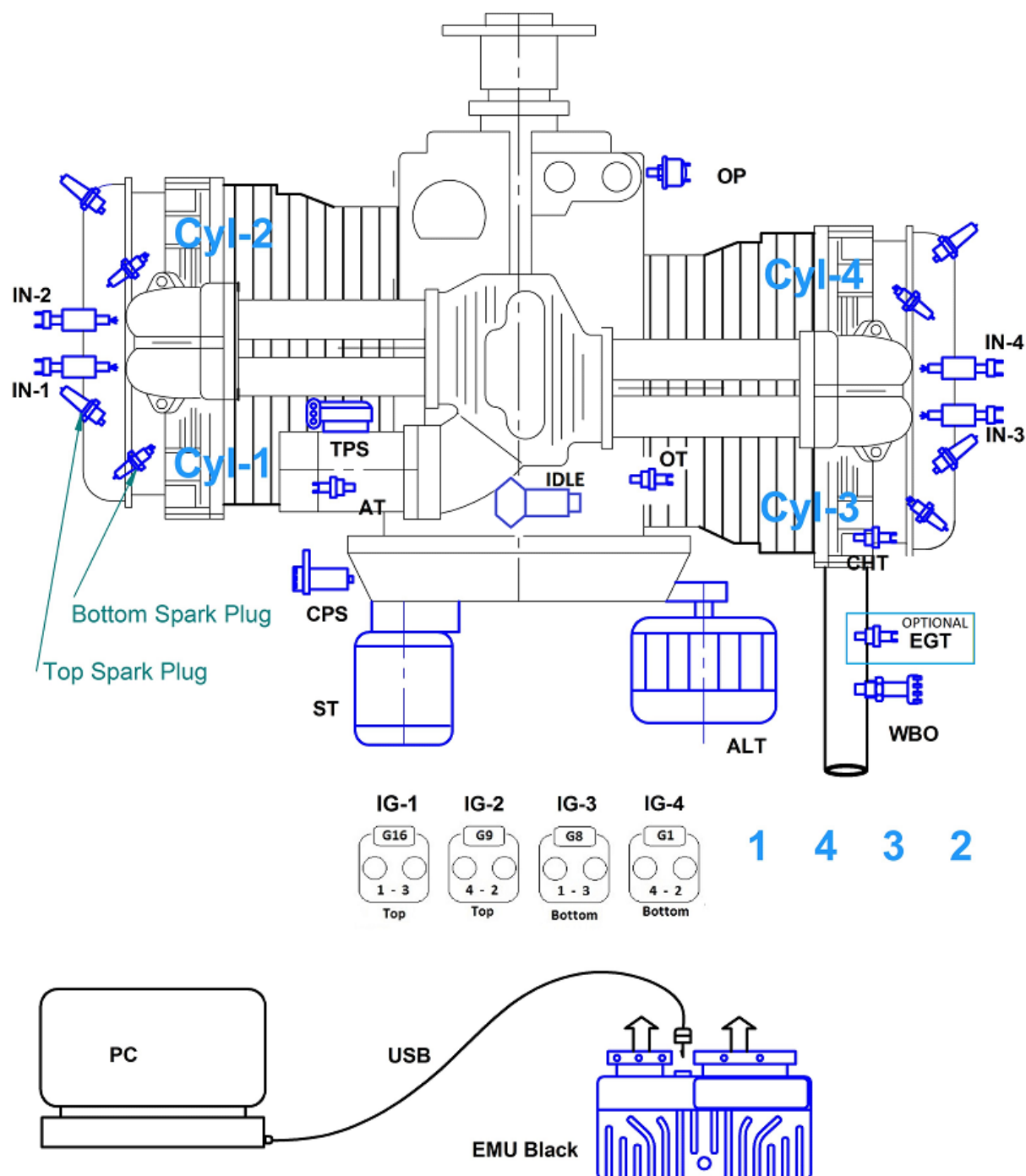
Drawing 4.7 Vaxell RYS 100.24.00.A02 Signs explanation (2/2)

FUSES

F1	Fuel pump I	20A
F2	Ignition coil	15A
F3	Ignition coil	15A
F4	Injectors	7,5A
F5	Injectors	7,5A
F6	ECU	7,5A
F7	ECU	7,5A
F8	Wide band oxygen sensor	7,5A
F9	Display unit	5A
F10	Display unit	5A
F11	Fuel pump II	20A



Drawing 4.8 EMU Black connectors numbering



Drawing 4.9 Vaxell Engine Controls Location

Component abbreviations on the Vaxell diagram (Drawing 4.9)

ST	- starter
ALT	- alternator
OP	- oil pressure sensor
OT	- oil temperature sensor
CHT	- cylinder head temperature sensors
EGT	- exhaust gas temperature sensor
CPS	- crankshaft position sensor
IN-1, IN-2, IN-3, IN-3	- injectors
IG-1, IG-2, IG-3, IG-4	- ignition coils
TPS	- throttle position sensor
IDLE	- idle controller
AT	- air temperature sensor
WBO	- broadband oxygen sensor
EMU Black	- engine control unit
PC	- personal computer

5 Operating the engine

5.1.1 Before starting the engine



- **The propeller can only be turned when the spark plugs disconnected from the wires.**
- Make sure that the plane is immobilized
- Perform the pre-flight inspection as per 5.1.2.
- Move the throttle control levers to maximum.
 - Check the throttle control lever freedom of movement
 - Check if the throttle lever in the cabin and on the engine operates in full range (from idle to maximum power).
- Switch the ignition systems to the "OFF" position
- Disconnect the ignition cables.
- Manually turn the propeller a few turns.
 - Check for abnormal rotation noises or resistance.
- Install the ignition cables.

5.1.2 Pre-flight inspection



- **Carry out the inspection with the ignition off!**
- Perform a pre-flight inspection on a cold engine.
- Remove the engine cover.
- Check bolted connections for visible loose or missing fasteners.
- Check for folding and proper position of the baffles
- Check the oil cooler and air guides for free air flow - clean if necessary.
- Check wiring harness.
- Check the condition of the drive belt.
- Check the engine casing for cracks and tightening.
- Check throttle and throttle cable.
- Check the oil level and top up if necessary.
- Check for oil or fuel leaks.
- Check the electrolyte level in the battery and top up if necessary.
- Remove any irregularities

5.1.3 Starting the engine



- **Nobody is allowed to stand near the propeller when starting the engine.**
- Open the fuel shut-off valve.
- Turn main power switch and electrical systems switch to "ON".
 - The fuel pump will start automatically for about 10 seconds.
- Turn the ignition system to the "ON" position.
- Leave the throttle lever at 0% throttle power.
- Make sure no one is near the propeller.
- The engine can be started after previously performed maintenance activities and the command FROM THE PROPELLER!
- Start the engine.
 - When the engine starts, release the starter button and set the engine speed to approximately 1300 rpm by setting the throttle lever.
- Check the oil pressure (must build up within 10 seconds).

5.1.4 Engine warm-up



- Keep the engine running at 1300 rpm for 2 minutes.
- Then increase the speed to 1500 rpm, until the oil temperature reaches 50 ° C.
- Check temperatures and pressures

5.1.5 Checking the engine



- **If the engine is run on the ground for a long time, it may overheat.**
- After warming up, move the throttle lever to full throttle.
- The engine should reach the maximum speed specified by the manufacturer.
- Move the throttle levers to the idle position.

5.1.6 Checking the ignition system



- **If the engine is run on the ground for a long time, it may overheat.**
- Use the throttle lever to set the engine speed to 2000 RPM.
- Check the operation of both ignition systems, starting from the "both systems on" position
- The engine must run smoothly without misfiring in all operating modes of the ignition system.
- The engine speed must not drop by more than 250 RPM in any mode comparing to the "both systems on" mode.
- Set to "both systems on" mode.

5.1.7 Start

- Increase the engine speed until the throttle is fully open
- Complete the first step of the climbing on this setting.
- Reduce the power to obtain the assumed flight speed.
- Control temperatures and pressures. It is not allowed to exceed the limit values.

5.1.8 Engine shutting down



- **After taxiing for a period of time or using power, let the engine run at approximately 1300 RPM for 2 to 3 minutes.**
- top the engine by switching off the ignition.
- Close the fuel valve.

5.1.9 Shutdown and restart of the engine during flight



- Put the throttle in position idle, switch off the ignition.
- Start the engine in the same way as on the ground (paragraph 5.1.3).
- Make sure you have enough altitude to restart the engine, especially in cold weather and prolonged gliding.

5.1.10 Emergency situations



Possible in-flight emergencies are listed below. This list is not exhaustive and is only intended to provide guidance in specific situations.



Exceeding the permissible engine speed

Reduce the engine speed. Each exceeding of the maximum permissible engine revolutions must be entered in the register along with a description of the duration and the value of the revolutions.



Head temperature exceeding

Reduce engine power to the necessary minimum and land at the nearest airport.

Any excess of the maximum permissible head temperature must be entered in the register (log book) along with a description of the duration and the temperature value.



Oil temperature exceeding

Reduce engine power to the necessary minimum and land at the nearest airport.

Any excess of the maximum permissible oil temperature must be entered in the register (log book) along with a description of the duration and the oil temperature value.



Oil pressure below minimum during the flight

Reduce engine power to the necessary minimum and land at the nearest airport.

Check the lubrication system.

**Oil pressure below minimum on the ground**

Stop the engine immediately and check for the cause of low pressure. Check the lubrication system. Check oil quantity and quality.

6 Maintenance

Your Vaxell engine should be inspected after a specified time or number of flight hours (whichever comes first). Additionally, an inspection is required prior to each flight.

6.1 Maintenance schedule

6.1.1 Inspection after the first 5 hours of flight

- Check the valve clearances, replace the valve cover gasket if necessary

6.1.2 Inspection after the first 25 hours of flight

- Check for oil or fuel leaks.
- Clean the engine.
- Change the oil and oil filter.
- Check the oil cooler and air guide blades for free air flow - clean if dirty.
- Check the crankcase ventilation.
- Check the air filter in the intake system, clean if necessary according to 6.2.4 or replace.
- Check the valve clearances, replace the valve cover gasket if necessary.
- Check cylinder compression.
- Clean and check spark plugs.
- Check the condition of the drive belt.
- Check connections and insulation of electric wires.
- Check the electric system cables for damage and correct routing.
- Check bolts, nuts, bolt locks and the motor frame for proper tightening and condition.
- Perform a test run of the engine.

6.1.3 Every 50 hours inspections

- Carry out tasks as per item 6.1.2

6.1.4 Every 100 hours inspections

- Carry out the tasks as per item 6.1.3
- Change the oil and oil filter.
- Replace the fuel filter

6.1.5 Every 200 hours inspections

- Carry out tasks as per item 6.1.2
- Carry out the tasks as per item 6.1.4
- Replace spark plugs.

6.1.6 Every 500 hours or annual inspection (whichever comes first)

- Carry out tasks as per item 6.1.2

- Carry out tasks as per item 6.1.5
- Check the tightening torque of the cylinder head bolts and the crankcase bolts.
- Check the exhaust system for cracks.
- Check rubber connections in the intake system.
- Check the tightening torque of the exhaust nuts.
- Check the exhaust and intake seals, and the oil cooler gaskets for leaks.

6.2 Service procedure instructions



Disconnect the main switch before servicing the engine .

The propeller area must be clear when starting the engine. Immobilize the plane.

It is recommended to mark the assembly positions of the parts before disassembly in order to assemble them correctly later. This only applies to parts that can be fitted in different orientations.

6.2.1 Oil change

- Warm up the engine.
- Stop the engine and drain the oil from the engine.
 - Unscrew the oil drain plug. Drain the oil in accordance with local environmental regulations
 - After draining all the oil, install the plug with a new seal.
- Change the oil filter.
 - Remove the old oil filter. Usunąć stary filtr oleju.
 - Check the oil filter insert for solid particles
 - Lubricate the rubber seal of the new filter with oil before installation.
 - Tighten the oil filter to the engine by hand.
- Pour new oil into the engine.
- Dispose of the filter and used oil in accordance with environmental regulations.

The capacity of the lubrication system is 2.5 liters with oil filter and hoses. Cooler capacity depending on the model used.

Check the oil level on the dipstick. The level must not be exceeded above the maximum level. The engine must be level.

6.2.2 Checking the oil filter cartridge (insert)

Each time when changing the oil, check the oil filter for metal filings. This procedure allows the internal condition of the engine to be assessed and provides information on possible damage. To check the filter correctly, follow these steps:

- Remove the filter cartridge,
- Cut out the bottom edges of the outer cover of the filter (do not use angle grinder !)
- Take out the filter mat and squeeze out the remaining oil,
- Unfold the mat and visually inspect the mat for metal chips and other foreign matter, then slide the mat over the magnet and check for metal chips.

If an increased amount of metal contamination is found in the filter, repair the engine:

- Install a new oil filter and pour in fresh oil,
- Carry out a test run of the engine according to point 6.2.11,
- Check the oil filter again

6.2.3 Adjusting the idle speed

Idle speed is govern by the engine control unit. They are not subject to manual adjustment.

6.2.4 Cleaning the air filter procedure



Preparing the filter to work again means not only washing it, but also soaking it with oil. An oil-free filter will not filter the air! It is very important to use the correct filter oil.

Cleaning procedure:

- Pre-cleaning - Tap the cartridge to remove large particles of accumulated dirt, then gently brush with a soft bristled brush.
- Applying the cleaning agent - Spray the entire cartridge with a large amount of K&N cleaning agent and leave for 10 minutes.
- Rinsing - Rinse the cartridge with low pressure water. You can use tap water. Always rinse from the clean side to the dirty side. This removes dirt and does not push it into the filter pores.
- Drying - Always dry the element naturally. After rinsing, shake off excess water and allow the cartridge to dry.
 - Do not use pressurized air!
 - Do not use open fire!
 - Do not use dryers!
- Soaking in oil - After cleaning the filter, re-soak it with the appropriate oil. Inject oil into each fold of the air filter. Each fold should be sprayed only once. After soaking, wait 10 minutes and cover any white spots that appear with the oil.
- Oil soaking from a bottle - Place 2 layers of oil on each fold.



Tips for soaking the K&N filter with oil :

Never use the K&N air filter without oil (the filter without oil will not trap dirt). Only use K&N filter oil. Red dye is added to make the oiled spots easier to see. The dye may fade, but the oil will remain and still filter the air.

What not to do with the K&N filter:

- **Do not steam clean!**
- **Do not use detergents!**
- **Do not clean with a pressure washer!**
- **Do not use parts cleaning agents!**

Improper washing and cleaning of the K&N filter may damage the filter!

6.2.5 Checking the fuel and lubrication system

Check all hoses, hose connections, connected devices and engine connections for leaks, damage, correct mounting and installation. Check the fluid levels.

The oil level must be between the minimum and maximum mark when engine is level.

Check the oil cooler for damage, foreign objects and dirt. Clean if necessary.

6.2.6 Checking the crankcase ventilation

Visually check for visible damage and clean the vent if necessary.

6.2.7 Checking the cylinder compression

Cylinder compression test must be done on the warm engine.

- Remove spark plugs and disconnect plugs from injectors.
- Take the same precautions as when starting the engine.
- Measure the compression with a suitable sensor.
 - Perform the measurement with the throttle fully open.
 - Turn the engine until the pressure indication does not rise.
 - Record the maximum pressure reading for a given cylinder.
- Put the spark plugs in and connect the injectors.

Minimum compression limit: 6 bar / 87 psi.

Pressure differences between cylinders limit: 2 bar / 29 psi.

6.2.8 Checking and valve clearances adjustment

Valve clearances should be adjusted when the engine is cold - that is, at a temperature of about 20 degrees C.

Clearance measurement procedure:

- Remove the spark plugs.
- Remove the valve cover.
- Measure the clearances.
 - The clearance is measured with a feeler gauge between the valve lever and the valve stem. The feeler gauge plate must move freely between them, it must not get blocked.
 - The shaft position should be changed by turning the crankshaft by hand (e.g. by the propeller) in the direction of engine rotation.
 - The clearances should be adjusted in the following positions of the crankshaft The clearances should be adjusted in the following positions of the crankshaft:
 - Set the cylinder No 1 at overlap point near TDC (the exhaust valve closes and the intake valve opens), adjust the valve clearances in cylinder no.3
 - At the valves overlap for cylinder No 3 set valve clearance for cylinder No 1
 - At the valves overlap for cylinder No 2 set valve clearance for cylinder No 4
 - At the valves overlap for cylinder No 4 set valve clearance for cylinder No 2
 - Record clearances for individual valves and cylinders.
- Change the valve cover gasket if necessary.

Intake valve clearance: 0,15 mm

Exhaust valve clearance: 0,15 mm

Clearance adjustment:

- Set the crankshaft at desired position for valve adjustments.
- Loosen the nut of the adjusting screw.
- Set the adjustment screw so that the feeler gauge plate of the appropriate thickness moves freely between the valve lever and the valve stem - it cannot get jammed.
- Tighten the adjustment screw nut.
- Check the play once more with a feeler gauge.
- Change the valve cover gasket if necessary.

6.2.9 Checking, cleaning, and setting the spark plugs

Spark plugs disassembly :



- **Do not remove the spark plugs if the engine is warm!**
- Remove the ignition wires from the spark plugs.
- Unscrew the spark plugs.

Spark plugs cleaning:

- Clean the spark plugs with a plastic brush with a degreasing agent.
- Do not use a steel or bronze brush. Do not sand blast the candles.

Checking the electrode gap:

- Check the electrode gap with a feeler gauge..
- If necessary, adjust the gap by bending the ground electrode.
- **Rounded edges of the spark plug electrodes should always be subject to change for a new spark plugs set.**

Desired gap between the electrodes: 0,7- 0,8 mm

Spark plugs installation:



- Lubricate the spark plug threads with graphite grease..
- **The electrodes must be clean of grease. Do not use grease with copper.**

Spark plugs recommendations : NGK - CR7HS (optional CR7HSA) / DR8ES

Change spark plugs every 200 hours of operation.

Visual inspection of spark plug electrodes:

- Light gray color:
 - Spark plug and engine mapping is correct .
- Black colour (Carbon fouling) :
 - Too large gap between the electrodes.
 - Too rich air / fuel mixture.
 - Too little air volume (dirty air filter of the intake system).
 - The engine does not reach the correct operating temperature.

- Oil fouling:
 - Misfiring.
 - Too much oil in the combustion chamber.
 - Wear of piston or piston rings.
- Black particles build up on the electrodes:
 - Incorrect spark plug type.
 - Loose spark plug.
 - The air / fuel mixture is too lean (false air).
 - Valves do not close properly.
 - Too high intake air temperature.

6.2.10 Checking, adjusting the tension and replacing the accessory drive belt

Drive belt check-up:

- Visually inspect the belt for wear and cracks.

Belt tension inspection:

- It must be possible to deflect the belt by applying pressure with a hand of approx. 50N for approx. 5-10 mm .

Belt tension adjustment:

- Loosen the alternator mounting bolts.
- Tension the belt by moving the alternator aside.
- Tighten the alternator mounting bolts.

Belt replacement:

- Loosen the alternator bolts, push the alternator towards the crankshaft and remove the old drive belt.
- Place the new drive belt on the main pulley (on the crankshaft side).
- Place the belt on the alternator pulley.
- Adjust the belt tension.
- Tighten the alternator bolts.
- Check for proper charging voltage after starting the engine.
- After 10 hours of operation, check the belt tension and adjust if necessary.

6.2.11 Test run of the engine

Starting parameters check-up of the engine.

The engine should have no problem starting under normal conditions (temperature, technical condition), if not, check the fuel supply and the ignition system.

**Do not use the starter for more than 15 seconds (risk of overheating)**

- Start the engine according to procedure 5.1.3
- Warming up the engine.
 - Run the engine at 1300 RPM for 2 minutes.
 - Then increase the speed to 1500 RPM and keep it until the oil temperature reaches 50 ° C.
- Check temperatures and pressures (see detailed technical data 3.3).
- Check engine response to changes in throttle position..
- Smoothly shift the throttle to maximum power. The engine must respond immediately, the engine speed must increase smoothly.
- Engine performance check-up.
 - Move the throttle lever to full power. The engine must be at maximum RPM speed.

6.2.12 Engine maintenance

The engine - which works under load for at least 20 minutes every two weeks and reaches its operating temperature - does not require corrosion protection.

If the engine will not be used for more than 4 weeks - it requires maintenance.

The use of special anti-corrosion additive for the oil is necessary if the engine will not be used for more than 3 months.

**Starting the engine after applying oil preservatives, will deactivate the corrosion protection!**

It is recommended to cover the end of the exhaust pipe when the aircraft is stationary for longer period of time especially in high air humidity.

Maintenance of the engine installed:

- Warm up the engine according to the procedure 5.1.4
- Stop the engine and drain the engine oil. Replace the oil filter.
- Clean the motor roughly.
- Pour approximately 3.5 liters of oil into the engine and run the engine for approximately 0.5 minutes at approximately 1300 RPM.
- Remove the air filter and slowly inject approximately 25 to 30 ml of engine oil into the intake system of a running engine. Stop the engine while injecting oil.
- Coat throttle cable with engine oil.

- In any case, add fresh oil to the engine to prevent corrosion.

Maintenance of the engine dismounted:

- Unscrew the spark plugs and inject engine oil into the combustion chamber (not more than 10cm³) so that the top of the cylinder liner is covered with oil.
- Turn the crankshaft by hand or with the starter - a few turns.
- Coat the spark plugs with engine oil and install them in the engine.
- Coat all linkages with engine oil.
- Cover all motor openings to prevent ingress of dirt or moisture.
- Coat the outer surfaces of the engine with engine oil. Take care not to cover the rubber parts and electrical connections with oil.

6.2.13 Operating the engine at low ambient temperatures



An engine inspection should be carried out before the start of winter. In addition, follow the guidelines when operating the engine in very low temperatures:

- Electrical system:
 - At low temperatures, the battery capacity is reduced. This can lead to problems with starting the engine.
 - Check all electrical wiring connections in the ignition system and clean if necessary. Oxidized connection surfaces can cause voltage drops and engine problems.
- Crankcase ventilation (breather system):
 - At low temperatures and high humidity, blockage of the vent hose is possible. Procedure an inspection as a precaution and clean it if necessary. Blocked venting can increase oil pressure and cause oil to leak through the seals. This can lead to oil loss and possible engine damage.

6.2.14 Using the engine in tropical climate conditions

In tropical climates, please follow the instructions below:

- Air filter:
 - If the engine is running in a dusty area, install a larger air filter.
- Oil dipstick:
 - Additionally, seal the oil dipstick by using a felt washer under the dipstick's collar.
- Oil cooling:
 - If the engine runs regularly in high ambient temperatures, a larger oil cooler is recommended.
- Parked engine dust protection:
 - Protect the exhaust pipe end, crankcase breather and air filter from dust.
- Anti-corrosion protection of the parked engine:
 - See section 6.2.12
- Service tips:
 - Air filter: before starting the engine check or clean replace and if necessary
 - Drive belt: before starting the engine check the belt if worn replace.
 - Oil cooler: before starting the engine check for erosive wear.

6.2.15 Overhaul

The overhaul must be performed by the manufacturer or by authorized work shop. Therefore, the engine must be delivered to the above place after it has reached its TBO limit.

TBO (Time Between Overhaul) – 1500h.

6.2.16 Major repairs

Major repairs and modifications to the engine may be performed by the manufacturer or by authorized work shop.

After the propeller collision with the ground or other foreign object, the engine must always be disassembled and the crankshaft must be checked. Crankshaft or propeller hub runout measurements on assembled engine are inaccurate and unacceptable.

7 Removal of minor faults related to engine running

The following list of engine problems and their possible causes and solutions. The presented lists do not exhaust the possibilities of solving the problems.

Repair work may only be performed by authorized personnel.

The most common problems with engine running:

- Engine starting problem
- Uneven or irregular motor running
- Incorrect engine idling
- Low power
- Overheating
- High oil temperature
- Low oil pressure
- Excessive oil consumption
- Excessive engine vibration

- **Engine starting problem**

Possible cause:	Solution:
Discharged, damaged or worn out battery.	Ładowanie lub wymiana akumulatora.
Electric cable between battery and starter is disconnected, damaged or not connected properly.	Clean up connections. Connect or replace cable.
Engine ground cable disconnected, damaged, or not properly connected.	Clean up connections. Connect or replace the ground cable.
Starter defected.	Repair or replace starter.
Starter relay damaged.	Replace starter relay.
Engine electrical system is OFF.	Turn ON the engine's electrical system.
Ignition wires disconnected, swapped, or damaged.	Connect the ignition wires or replace. Check the firing order.
Blown fuse.	Check fuses. Replace if necessary.
Wiring harness loose, plugs damaged or broken wire.	Check wires and plugs, repair if necessary.
Throttle position sensor damaged.	Check the throttle position sensor. Replace if necessary.
Crankshaft position sensor damaged or disconnected.	Check the crankshaft position sensor. Replace if necessary.
Engine Control Unit defective	Replace Engine Control Unit.
Ignition coil damaged.	Check the ignition coils. Replace if necessary.

Possible cause:	Solution:
Dirty spark plugs due to the too rich air fuel ratio.	Disassemble spark plugs, clean and dry. Investigate and eliminate the cause of too rich air fuel ratio.
The gap between electrodes of the spark plug is too big.	Adjust electrode gap or replace spark plugs.
No fuel in the tank (incorrect fuel level indication).	Pour fuel into the tank. Replace the fuel gauge if necessary.
Fuel valve closed or fuel filter blocked.	Open the fuel valve, clean or replace the fuel filter.
Fuel lines damaged or unconnected. Leaks in the fuel system.	Replace or connect fuel lines. Fix the leaks.
Damage to the fuel pump or fault in the electrical connection of the pump.	Check the fuel pump electrical connection and repair, if necessary replace the fuel pump.
Damage to the fuel pressure regulator.	Check fuel pressure using proper pressure gauge, replace regulator if necessary.
Air leak from the intake system.	Check the intake system for leaks. Replace seals or retighten fittings if necessary.
Throttle is closed.	Check throttle levers and linkages, check idle speed adjustment screw.
Compression too low (no valve lash, leaking valve, engine overheating)	Adjust the valve lash, repair the head, tighten the head bolts according to the documentation. Investigate and eliminate the cause of engine overheating.
Engine damaged (blocked or worn).	Perform a engine overhaul.
No fuel	Check the fuel system for leaks. Clean (unblock) the fuel lines and the fuel filter.
Engine flooded	Turn off the ignition. Set the throttle cable to the maximum position (full throttle), make a few turns, turn on the ignition and restart the engine.
Defective spark plugs	Clean, adjust the electrode gap, replace the spark plugs with new ones if necessary.
Defective ignition cables	Check the cables with a tester, replace if damaged.
Engine Control Unit - damaged	Replace.
Insufficient fuel flow (air purge blocked, damaged or blocked fuel lines, fuel filter blocked)	Check the fuel tank vent, fuel lines and filter and replace if necessary.
Incorrect fuel quality or type	Change the entire fuel to the correct one.

- **The engine does not reach maximum RPM**

Possible cause:	Solution:
Insufficient fuel pump flow	Check fuel pump flow efficiency and repair if necessary.
Fuel injector damaged.	Replace the injector.
Fuel pump damaged.	Repair or replace the fuel pump.
Fuel pressure regulator damaged.	Check the fuel pressure, replace the regulator if necessary.
Throttle does not fully opening.	Repair throttle control.
Air filter clogged or dirty.	Clean or replace air filter.
Air leak from the intake system	Check the intake system for leaks. Replace seals or retighten fittings if necessary
Incorrect fuel quality or type.	Change the entire fuel to the correct one.
Fuel is dirty	Drain tank, clean and refill with clean fuel. Attention! In some cases, fuel tanks made of composite materials may react with fuel and cause the tank material to dissolve. In this case, all components of the fuel system must be cleaned or replaced.
Incorrect propeller setup	Confirm proper setup with your propeller supplier

- **Incorrect engine idling**

Possible cause:	Solution:
Incorrect air fuel ratio	Check WBO (wide band oxygen sensor).
Air leak from the intake system	Check the intake system for leaks. Replace seals or retighten fittings if necessary.
Damage to the fuel pressure regulator	Check fuel pressure using proper pressure gauge, replace regulator if necessary.
Ignition system malfunction	Check the complete ignition system.

- **Low power**

Possible cause:	Solution:
Engine Control Unit - damaged	Replace.
Ignition coil damaged.	Check the ignition coils. Replace if necessary.

Defective spark plugs	Clean, adjust the electrode gap, replace the spark plugs with new ones if necessary.
Incorrect spark plugs.	Use proper spark plugs.
Defective ignition cables	Check the cables with a tester, replace if damaged. Check firing order
Wiring harness loose, plugs damaged or broken wire.	Check wires and plugs, repair if necessary.
Defective ignition switch	Check cables and switch and replace if necessary.
Blown fuse.	Check fuses. Replace if necessary.

- **Overheating**

Possible cause:	Solution:
Insufficient or damaged covers (air ducts) and / or air intakes.	Repair and / or seal covers.
Air flow disturbed around propeller (missing spinner) or too small cross section of the air inlets.	Install the propeller hub cover (spinner), check the engine cover air intakes for foreign objects.
Damage to the air ducts and the heating system.	Fix the air ducts.
Disturbances in the cooling air flow at the outlets (too small cross-section of air outlets or not fully opening of the engine cooling flaps).	Increase the air discharge in the engine covers

- **High oil temperature**

Possible cause:	Solution:
Engine oil level too low	Add up oil to proper level.
Low quality oil	Replace the oil with a new one
Faulty oil temperature readout	Check sender (sensor) for proper operation, replace damaged elements with new ones.

- Low oil pressure

Possible cause:	Solution:
Low quality oil	Replace the oil with a new one
Engine oil level too low	Add up oil to proper level.
Oil filter or cooler clogged.	Replace the oil filter. Clean the radiator, replace if necessary. ATTENTION! At low ambient temperatures, the cooler may lower the oil temperature too much, causing a blockage and high oil pressure. Cover part of the oil cooler in such a way as to ensure proper oil temperature during operation.
Thermostat or oil thermostat spring damaged	Check thermostat assembly, repair or replace if necessary.
Temperature sensor or indicator damaged.	Check sensor and indicator (oil pressure gauge), replace if necessary.
No oil in the oil pump.	Check the oil level and add oil if necessary. ATTENTION! If the engine has been started without oil, damage should be expected. It is advisable to inspect and disassemble the engine to ensure safe operation.
Oil pump damaged.	Repair or replace the oil pump
Oil pressure regulator valve or spring damaged.	Replace regulator valve or spring in oil pressure regulator
Oil leakage due to blocked crankcase breather.	Clean the vent, replace or install the vent hose correctly (no distortion or kinks).

- Excessive oil consumption

Possible cause:	Solution:
Piston rings worn	Replace for new.
Low quality oil	Replace the oil with a new one (proper quality)

- **Excessive exhaust noise**

Possible cause:	Solution:
Exhaust leak from the system.	Check connections, replace gaskets or holding springs if necessary.
Exhaust gasket damaged.	Replace the gasket
Insulation of the exhaust system damaged	Repair or replace.

- **Excessive engine vibration**

Possible cause:	Solution:
No valve lash clearance	Adjust the valve clearance. ATTENTION! this may also be a symptom of engine overheating, check the cooling, injection and ignition systems.
One of the engine valves is leaking or stuck.	Repair the cylinder head.
Large build-up of sludge in the combustion chamber	Disassemble heads, remove deposits.
Propeller out of balance.	Balance the propeller, check the propeller edge set-up
Damage to the rubber shock absorbers (cushions) of the engine mount	Replace the engine mount.
Main bearings of the engine damaged	Repair the engine.
Engine damage.	Repair the engine Naprawić silnik.
Engine mount frame damaged	Repair or replace the frame

8 Manufacturer

The Vaxell engine is manufactured by the company:

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9.1 Dyno chart

