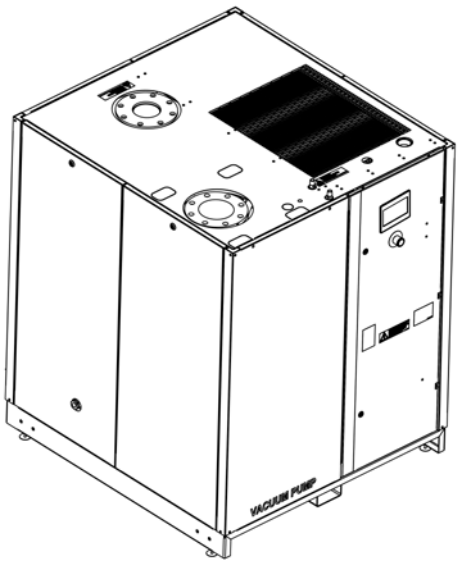
Instruction manual



Oil-Sealed Rotary Screw Vacuum Pumps

MSV030, MSV040, MSV050

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Product warranty and limit of liability are dealt with in our standard terms and conditions of sale or negotiated contract under which this document is supplied.

You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

Instruction manual compiled with software version 0.12.15.

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1. Safety and compliance

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use. Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions.

The instruction manual is an important safety document that we often deliver digitally. It is your responsibility to keep the instruction manual available and visible while working with the equipment. Please download the digital version of the instruction manual for use on your device or print it if a device will not be available.

1.1. Definition of Warnings and Cautions

Important safety information is highlighted as warning and caution instructions which are defined as follows. Different symbols are used according to the type of hazard.

WARNING:

If you do not obey a warning, there is a risk of injury or death.

CAUTION:

If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.

NOTICE:

Information about properties or instructions for an action which, if ignored, will cause damage to the equipment.

We reserve the right to change the design and the stated data. The illustrations are not binding.

1.2. Trained personnel

For the operation of this equipment “trained personnel” are:

- skilled workers with knowledge in the fields of mechanics, electrical engineering, pollution abatement and vacuum technology and
- personnel specially trained for the operation of vacuum pumps

1.3. Safety symbols

The safety symbols on the products show the areas where care and attention is necessary.

The safety symbols that we use on the product or in the product documentation have the following meanings:

	**Warning/Caution** Risk of injury and/or damage to equipment. An appropriate safety instruction must be followed or a potential hazard exists.
	**Warning - Automatic start up** Risk of injury. The equipment can be started remotely and without warning.
	**Warning - Dangerous voltage** Risk of injury. Identifies possible sources of hazardous electrical shock.
	**Warning - Heavy object** Risk of injury or damage to equipment. Identifies a possible hazard from a heavy object.
	**Warning - Pressurised** Risk of injury or damage to equipment. Identifies equipment containing pressurised gases or liquids.
	**Mandatory action symbol** Failure to comply with this action may result in injury or damage to equipment.
	**Symbol – Waste Electrical & Electronic Equipment (WEEE)** The equipment must be discarded carefully. Obey local and national regulations for disposal of this equipment. Identifies compliant product supplied without a manufacturing date.

1.4. General safety precautions

WARNING: AUTOMATIC RESTART

Risk of injury and damage to equipment. If the pump has an automatic restart function and it is set to on, the pump will restart automatically when the power is restored after the power interruption.

WARNING: RADIO INTERFERENCE

Risk of injury. In a domestic environment, the pump can cause radio interference which requires supplementary mitigation measures.

WARNING: FLAMMABLE FUMES OR EXPLOSIVE MATERIAL

Risk of injury or damage to equipment. The inlet air must have no flammable fumes, vapours or particles (for example, paint solvents can cause internal fire or explosions).

WARNING: READ THE MANUAL

Risk of injury or damage to equipment.Read the manual and obey the work safety requirements and regulations.

- Obey the work safety requirements and regulations.
- Obey all the local site safety and operating procedures.
- If any of the statements do not match with the applicable legislation, the stricter of the two statements takes priority.
- The personnel responsible for the installation, operation, maintenance and repair work must be trained and approved by us.
- The pump is designed for handling atmospheric air only. Other gases, vapours or fumes must not be exposed to the pump intake or processed by the pump.
- Before you do the maintenance, repair, adjustment or other non-routine checks, refer to *Preventive maintenance schedule* on page 108.
- For units that have a supply from a frequency converter, wait for 10 minutes after disconnection before you start the electrical work.
- Do not rely on the indicator lamps or electrical door locks. Before you do maintenance work, disconnect and check for electrical safety with a measuring device.
- Do not touch the pump intake when the pump is in operation.
- Keep the pump in safe operating condition. Replace parts and accessories that are not safe for operation.
- Do not walk or stand on the pump or on its components.

Note:

1. These precautions apply to a pump that processes or uses air or inert gas. When the pump is used with other gases, it is necessary to use more safety precautions.

2. Some precautions are general and are applicable for all types of pumps and equipment. Some of the statements, might not apply to your pump.

3. If the installation, operation, maintenance, and repair is done without our prior written approval, or if the pump is not installed in accordance with our recommendations, we will not accept liability or warranty claims in accordance with the standard terms and conditions.

1.5. Safety precautions during installation

1. When you lift the pump, make sure that:
   - you use the correct lifting equipment and you obey the local safety regulations
   - you tighten all the loose and movable parts before you lift the pump
   - no personnel are in the risk zone below the lifted load
   - the speed of the lifting equipment is in safety limits
   - personnel wear safety helmets in the area of overhead or lifting equipment.
2. The pump is made to be installed and used inside. If the pump is installed outside, contact us.
3. Install the pump in an area with cool and clean air.
4. Do not cause an air inlet blockage.
5. Refer to *Technical data* on page 21 for liquid handling capacity.
6. Remove the blanking flanges, plugs, caps and desiccant bags before you connect the pipes.
7. The vacuum connection and discharge pipes must be of correct size and applicable for the working pressures and temperatures.
8. Do not use frayed, damaged or worn hoses.

9. Distribution pipes and connections must be of correct size and applicable for the working pressures.
10. The inlet air must have no flammable fumes, vapours or particles (for example, paint solvents can cause internal fire or explosions). Refer to the material safety guidelines.
11. The maximum external force on the inlet connection is 200 kg and on the outlet connection is 50 kg. Make sure that there is no strain on the pipe connections. Supports must not be installed to the external body (canopy) of the pump.
12. Before maintenance and repairs, the operator must make sure that:
    - the machine is stopped
    - the machine is depressurised
    - the electrical isolating switch is open
    - the pump is locked with a temporary warning attached

    Persons that use a remote controlled machine must obey the necessary precautions. When you operate the machine you must make sure that no one is working on the machine.
13. The air-cooled pumps must be installed in such a way that an adequate flow of the cooling air is available. Make sure that the exhausted air does not recirculate to the pump air inlet or cooling air inlet.
14. For water-cooled pumps, the cooling water system installed outside the machine has to be protected by a safety device with set pressure according to the maximum cooling water inlet pressure.
15. The electrical connections must be same as the applicable codes. Make sure that the machines are grounded and protected against short circuits by fuses in all phases. Install a power isolation switch near the pump. You must be able to lock the power isolation switch.
16. The pumps with an automatic start/stop system or an Automatic Restart After Voltage Failure (ARAVF) function must have the sign: "This pump can start without warning" attached near to the instrument panel.
17. Do not remove or adjust the safety devices, guards or insulation installed on the pump.
18. There are pipes and parts with temperatures more than 70 ˚C (158 ˚F). Install insulation or guards to prevent contact with hot surfaces. All pipes and parts with high temperatures must be clearly marked.
19. If the ground is not flat or it has slope, contact the manufacturer.
20. Make sure that the pump is compatible with the working environment.
21. If a pump is installed in a system with inlet gas-stream temperatures more than the maximum temperature permitted, contact us. The installation must be approved by us before the pump is started.
22. The frequency converter comes with a built-in EMC filter. The EMC filter switch is in ON position by default. Move the screw positions to switch ON (enable) and OFF (disable).

1.6. Safety precautions during maintenance or repair

1. Use the correct safety equipment (for example, safety glasses, gloves, safety shoes).
2. Use the correct tools for maintenance and repair.
3. Use only genuine spare parts.
4. Do not start maintenance until the pump is cool.
5. Attach a warning sign "Work in progress, do not start" next to the pump before you start the maintenance or repair.
6. Persons that use a remote-controlled machine must obey the necessary precautions. Before you operate the machine you must make sure that no one is working on the machine. Attach a sign next to the remote start equipment as follows:

   "Danger: The machine is remotely controlled and can start without warning."

7. Before components are removed from the pump, make sure that:
   - the pump is isolated from all sources of under and overpressure
   - the pump is at atmospheric pressure.
8. Do not use flammable solvents or carbon tetrachloride to clean the parts. Obey the safety precautions for toxic vapours of cleaning liquids.
9. During maintenance and repair:
   a. clean the pump carefully with a clean cloth
   b. install protective covers on the parts and openings of the pump.
10. Do not weld or do any operation involving heat near the oil system. Oil tanks must be completely purged (for example, by steam cleaning) before you do such operations. Do not weld or modify the pressure vessels.
11. If there is an indication or suspicion that an internal part of a pump is overheated:
    a. stop the pump
    b. do not open the inspection covers until enough cooling time is completed to prevent the risk of spontaneous ignition of the oil vapour.
12. Do not use a light source with an open flame to examine the inside of the pump.
13. Make sure that no tools, parts or other items are left in or on the pump.
14. Be careful when you handle the regulating and safety devices. Make sure that they operate correctly. For safety, do not disconnect the regulating and safety devices.
15. Before you use the machine after maintenance or overhaul make sure that:
    - the operating pressures, temperatures and time settings are correct
    - the control and shutdown devices are installed, and they operate correctly
    - the coupling guard of the pump drive-shaft is installed.
16. Every time the separator element is renewed, examine the discharge and the inside of the oil separator vessel for carbon deposits. If there is excessive carbon deposits, remove the carbon deposits.
17. Install protection to the motor, electrical and regulating components to prevent damage from moisture when the pump is cleaned (for example, steam cleaning).
18. Make sure that the sound-damping material and vibration dampers of the pump (for example, the sound-damping material on the body and in the air inlet and outlet systems) are in serviceable condition. Replace all damaged material with genuine material from the manufacturer.
19. Do not use caustic solvents which can damage the materials of the air net (for example, polycarbonate bowls).
20. Faults or wearing of seals can cause leakage of oil lubricant. Prevent the dispersion in soil and pollution of the other materials.
21. The electric motor contains permanent magnets, be aware of possible interference with devices like cardiac pacemakers and implantable cardioverter defibrillators.

1.7. Safety precautions during operation

1. Do not touch pipes or pump components during operation.
2. Use the correct type and size of hose end - fittings and connections. Make sure that the hose is depressurised before you disconnect it.
3. Persons that use a remote-controlled machine must obey the necessary precautions. Before you operate the machine you must make sure that no one is working on the machine. If a remote control is installed, the pump must have the sign that follows:

   "Danger: The machine is remotely controlled and can start without warning."

4. Do not operate the pump:
   - near flammable or toxic fumes, vapours or particles
   - near oxidants or pyrophoric gas
   - near the decomposition of gas
   - outside the specified limit ratings.
5. Make sure that all bodywork doors are closed during the operation of the pump. The doors can be opened for short periods (for example, routine service operation). Persons must wear ear protection when the doors are open. For pumps without external bodywork, ear protection must be worn near the pump.
6. Persons must wear ear protection when the sound pressure level is equal to or higher than 85 dB(A).
7. At regular intervals make sure that:
   - the guards are correctly installed
   - the guards are in the correct position
   - the hoses and pipes inside the pump are in serviceable condition
   - there are no leaks
   - the fasteners are tight
   - the electrical leads are serviceable
   - safety valves and other pressure relief devices are not clogged
   - the inlet valve and the air net components (for example, pipes, couplings, manifolds and valves) are in serviceable condition
   - electrical cabinet air cooling filters are not clogged.
8. If warm cooling air coming out from the pumps is used in air heating systems (for example, to warm up a workroom), take precautions against air pollution and possible contamination of the breathing air.
9. Do not remove or adjust:
   - the sound-damping material
   - the safety devices
   - the guards
   - the insulation installed on the pump.
10. The oil separator tank can be slightly pressurised. Do not open the oil filler or drain plugs, when the pump is in operation. Do not keep the oil filler or drain plugs open when the pump is in operation.
11. Do not use the pump as a compressor.
12. Do not operate the pump without installing the air intake filter.
13. In open circuit cooling water towers on water-cooled pumps, take protective steps to prevent the growth of harmful bacteria (for example, legionella pneumophila).

2. General description

2.1. Vacuum and flow rate

A vacuum is a pressure in a system that is less than the ambient atmospheric pressure. It can be shown in absolute terms or in effective gauge terms:

- mbar(a) - the absolute pressure shows how much the pressure is above the absolute zero pressure (perfect vacuum).
- (minus) mbar(e) - the effective or gauge pressure shows how much the pressure is below the local atmospheric pressure.

Flow rate definitions

The two ways to show the flow rate in a vacuum are:

1. The displacement or volumetric flow rate (Am^3/hr)
2. Throughput or mass flow rate

Displacement/volumetric flow rate

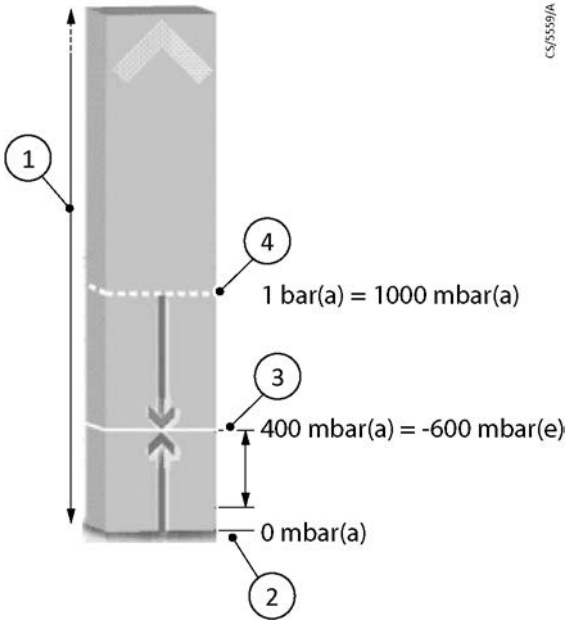
For the relevant pressure range, when the pump operates at quasi constant motor speed (rotations per minute) and since the compression chambers have fixed dimensions, the same volume of air is pumped from inlet to outlet with decrease in pressure level. Over the relevant pressure range, this makes the volumetric flow rate quasi independent of the vacuum level. It is the expression of the flow rate inside the piping at the governing vacuum level (Am^3/hr) and is always higher than the throughput or mass flow rate.

Throughput or mass flow rate

If the volumetric flow does not change with the decrease in pressure level, the number of molecules in the volume of air can change. The deeper the vacuum, the less number of molecules in the same volume of air.

The mass flow rate will decrease with a decrease in (absolute) pressure. A flow rate must be shown at a specified vacuum level when you use throughput or mass flow rate.

Figure 1 Vacuum and flow rate



1. *Pressure*
2. *Absolute vacuum*
3. *Typical pump range (400 mbar(a) to 10 mbar(a))*
4. *Atmospheric pressure*

Atmospheric pressure at sea level is approximately 1 bar(a) or 1000 mbar(a). The typical working range for the pumps is 400 mbar(a) to 10 mbar(a) (-600 mbar(e) to -990 mbar(e)).

It is important to understand the type of reference to select a correct pressure gauge to measure the vacuum. Note that the distinction does not matter for a pressure difference (delta P, example, pressure loss), since it is always the result of subtracting two pressures (as absolute or effective pressures).

Our pump uses volumetric flow rate to denote the performance.

2.2. Introduction

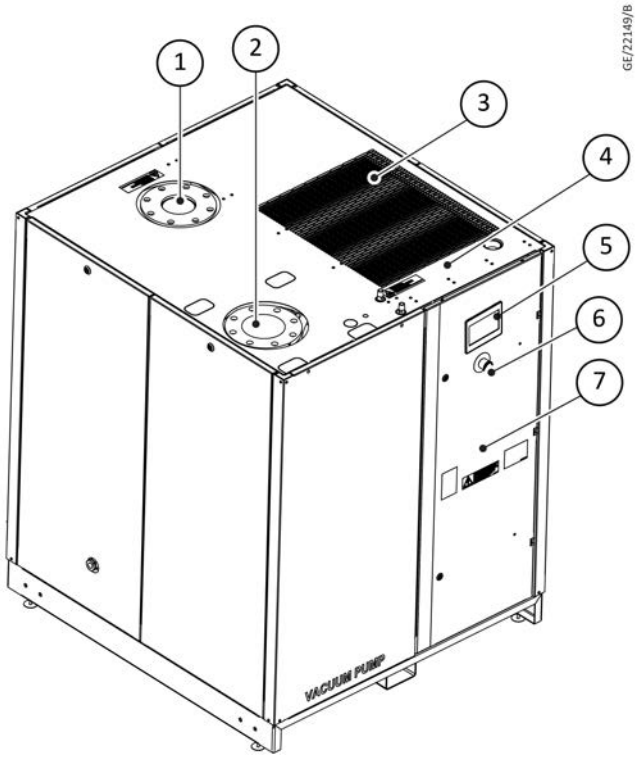
The pumps are single-stage, oil-sealed screw pumps driven by an electric motor. The pumps are controlled by our controller.

The controller is attached to the front door. An electric cabinet is installed behind the front door. The electric cabinet contains fuses, transformers, relays, etc.

The pumps use Variable Speed Drive (VSD) technology. The VSD technology helps to automatically adjust the motor speed as necessary.

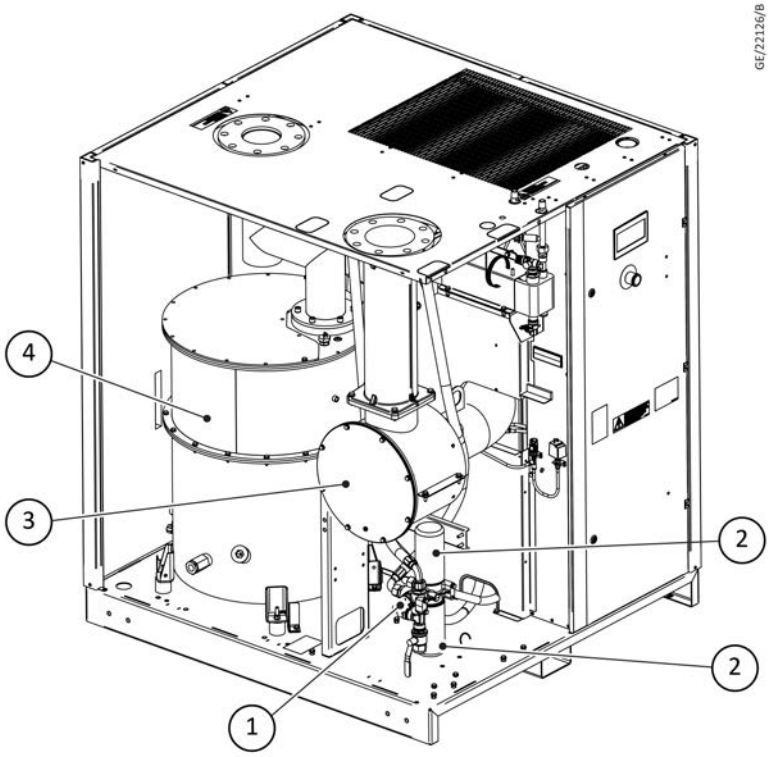
The pumps are available as air-cooled version. The pumps have a sound-insulated canopy.

Figure 2 General view



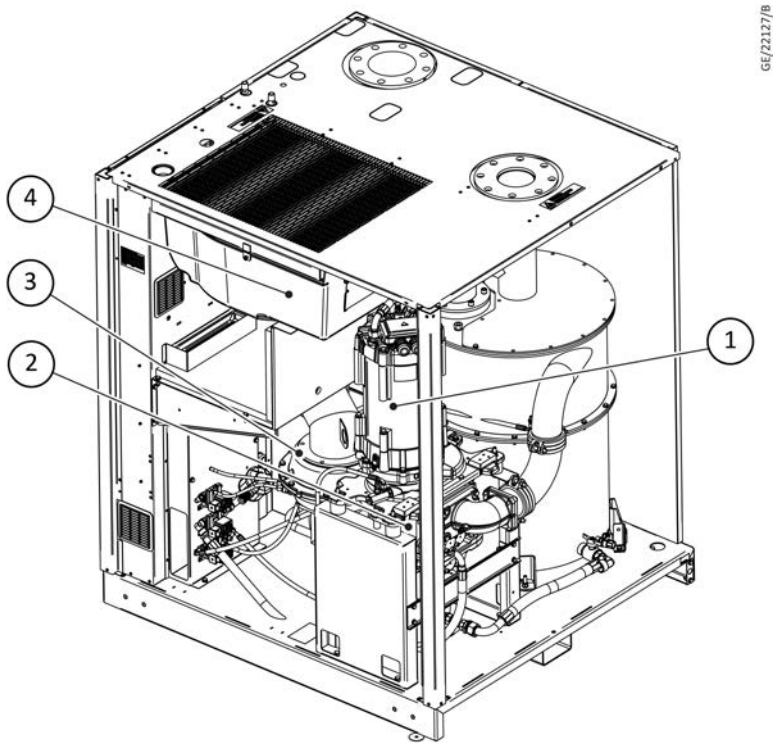
1. *Discharge connection*
2. *Inlet connection*
3. *Oil cooler*
4. *Cable entry*
5. *Controller*
6. *Emergency stop button*
7. *Electric cabinet*

Figure 3 General view (open)



1. *Thermostatic bypass valve*
2. *Oil filter*
3. *Air intake filter*
4. *Oil separator tank*

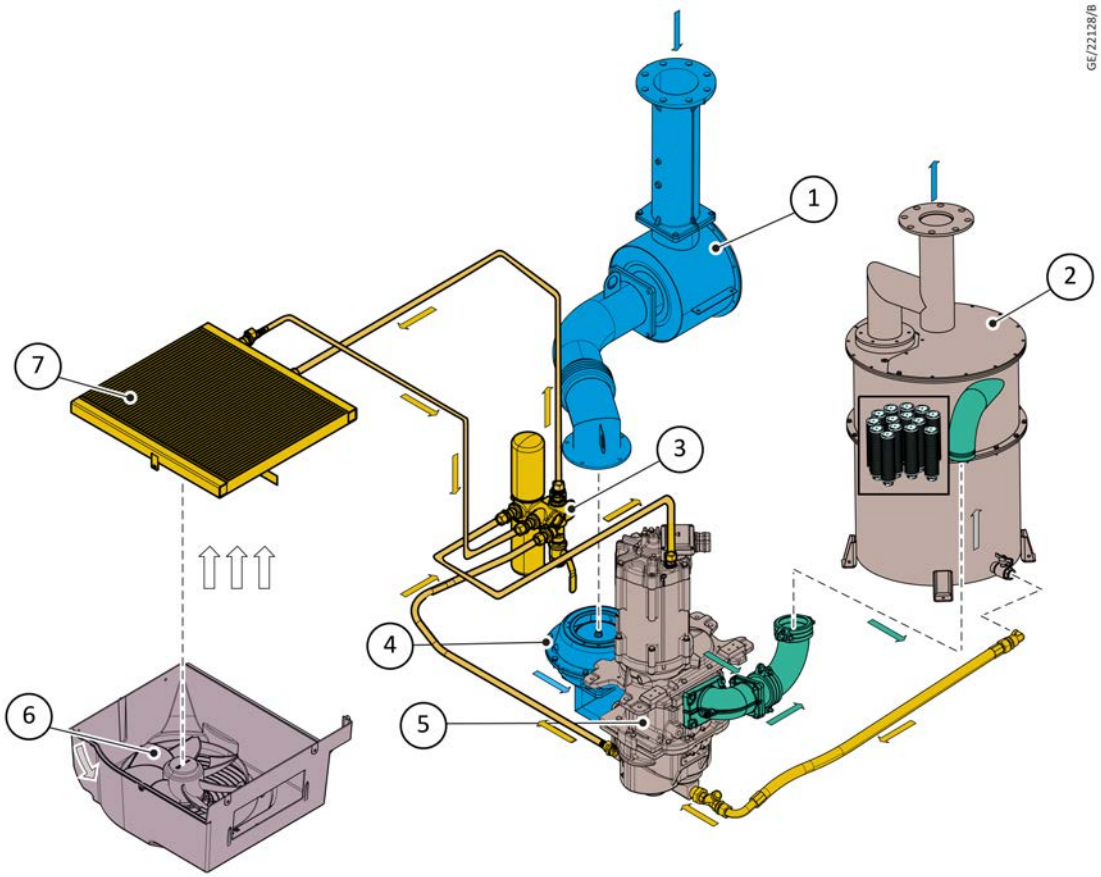
Figure 4 Rear view (open)



1. Drive motor
2. Element
3. Vacuum control valve
4. Cooling fan

2.3. Flow diagram

Figure 5 Flow diagram of air cooled version



	Air atmospheric pressure
	Air Working Pressure
	Air/oil mixture
	Oil

1. *Air filter*
2. *Oil mist separator*
3. *Oil filter*
4. *Vacuum control valve*
5. *Element*
6. *Fan*
7. *Oil cooler*

Air flow

The air comes in through the air intake filter and the control valve and is displaced by the pump element. A mixture of air and oil flows into the oil separator tank. After passing the air/oil separator filter, clean air, conditioned to a few parts per million, is released through the outlet.

Oil system

The oil separator tank removes most of the oil from the air/oil mixture by the centrifugal action. The oil separator removes the remaining oil. The oil collects in the lower part of the oil separator tank.

The oil system has a thermostatic bypass valve to stop the oil supply from the oil cooler. An oil pump, integrated in the screw element, circulates the oil from the oil separator tank through the oil filter. The filtered oil flows through the motor housing into the pump element.

Cooling

The cooling system has an oil cooler. The fan blows air over the coolers. The fan is set to on or off, depending on the operating conditions, as per the specific algorithm.

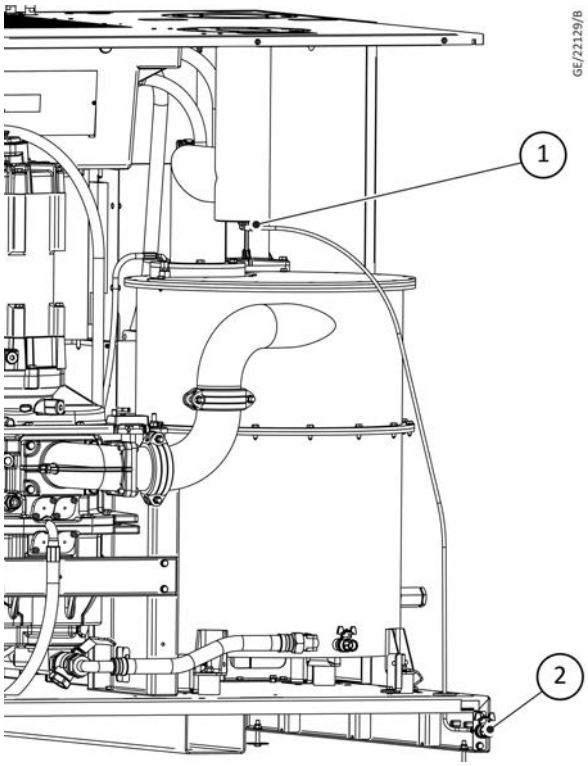
2.4. Condensate system

When discharge pipes are used, water in the discharge air can condense in the pipes. This water is collected in the collector of the outlet pipe where a drain point is available.

Initially, the drain point is connected to the external valve. Prevent condensate collection in the oil separator to extend the oil life. Refer local regulations which are applicable for water drainage.

For humid applications or low ambient temperature environments we recommend to install exhaust pipe sloping away from the pump or, if not possible, to install a drain leg at pump outlet before long vertical lines.

Figure 6 Condensate system



1. Drain point *2. External valve*

2.5. Regulating system

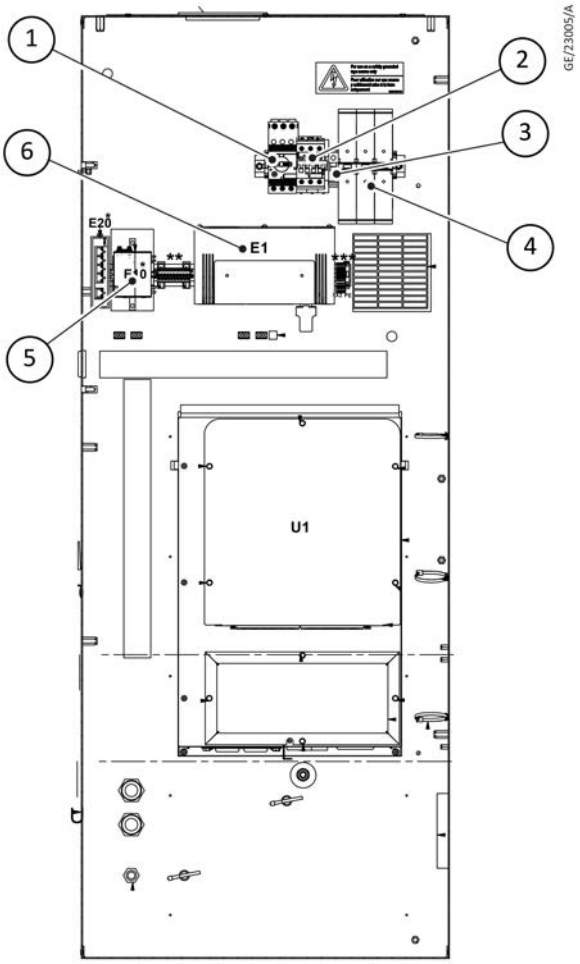
If the vacuum process demand is less than the throughput of the pump, the vacuum pressure decreases. When the pressure is lower than the set-point (necessary vacuum pressure), the regulator decreases the motor speed.

If the vacuum pressure decreases and the motor operates at minimum speed, the regulator stops the motor. When the motor is stopped automatically and the vacuum pressure reaches the set-point, the regulator starts the motor again.

2.6. Electrical system

Electric components

Figure 7 Electrical cabinet (typical example)



1. *Circuit breaker*
2. *Contactor*
3. *Earthing Terminal*
4. *Power Terminal Block*
5. *Cellular Gateway*
6. *CONTROLLER 4.0*

Electrical diagrams

You can find the electrical diagram in the electric cabinet.

3. Technical data

3.1. Reference condition and limitations

Table 1 Reference conditions

Parameter	Unit	Value
Relative humidity	%	0
Air inlet temperature	°C	20
	°F	68
Exhaust back pressure	mbar(g)	0
	psig	0
Ambient barometric pressure	mbar(a)	1013
	psia	14.7

Table 2 Limitations

Parameter	Unit	Value
Minimum ambient temperature	°C	0
	°F	32
Maximum ambient temperature	°C	46*
	°F	115
Minimum permitted inlet temperature	°C	-10
	°F	14
Maximum permitted inlet temperature	°C	70
	°F	158
Maximum (absolute) inlet pressure	mbar(a)	1050
	psia	15.2
Maximum vessel pressure	mbar(a)	1500
	psia	21.8

** High ambient version (50 °C / 122 °F) optional available*

3.1.1. Vacuum pump data

Reference condition

Note:

The data given is to be used with the reference conditions, refer to Reference condition and limitations on page 21.

Table 3 Common pump data

Parameter	Unit	Value
Number of compression stages	-	1
Ultimate pressure	mbar(a)	0.35

Parameter	Unit	Value
	Torr	0.4
Maximum exhaust back pressure	mbar(g)	100
	psig	1.45
Temperature of the air leaving the discharge (approximate)	°C	83
	°F	181

The pump is developed to work constantly at inlet pressures from ultimate vacuum up to atmospheric pressure. The maximum allowed inlet pressure is 200 mbar(g). In case of even higher inlet pressure, please contact your pump manufacturer.

Table 4 MSV 030

Parameter	Unit	Standard	With high water handling capacity
Nominal motor power	kW	22	22
	HP	30	30
Maximum motor shaft speed	rpm	5000	5000
Minimum motor shaft speed	rpm	600	600
Oil capacity	L	45	45
	US GAL	11.8	11.8
	Imp. GAL	9.9	9.9
	cu. ft.	1.59	1.59
Sound pressure level (according to ISO 2151 (2004))	dB(A)	74 (±3)	74 (±3)
Maximum inlet pressure for water vapour	mbar(a)	12	89
Maximum water vapour pumping rate	kg/hr	11	84

Table 5 MSV 040

Parameter	Unit	Standard	With high water handling capacity
Nominal motor power	kW	30	30
	HP	41	41
Maximum motor shaft speed	rpm	6000	6000
Minimum motor shaft speed	rpm	600	600
Oil capacity	L	45	45
	US GAL	11.8	11.8
	Imp. GAL	9.9	9.9
	cu. ft.	1.59	1.59
Sound pressure level (according to ISO 2151 (2004))	dB(A)	77 (±3)	77 (±3)
Maximum inlet pressure for water vapour	mbar(a)	10	82
Maximum water vapour pumping rate	kg/hr	12	89

Table 6 MSV 050

Parameter	Unit	Standard	With high water handling capacity
Nominal motor power	kW	37	37
	HP	50	50
Maximum motor shaft speed	rpm	7000	7000
Minimum motor shaft speed	rpm	600	600
Oil capacity	L	45	45
	US GAL	11.8	11.8
	Imp. GAL	9.9	9.9
	cu. ft.	1.59	1.59
Sound pressure level (according to ISO 2151 (2004))	dB(A)	78 (±3)	78 (±3)
Maximum inlet pressure for water vapour	mbar(a)	9	77
Maximum water vapour pumping rate	kg/hr	12	92

3.2. Electrical cable size

WARNING: ELECTRICAL CABLE SIZE

Risk of injury and damage to equipment. Do a check of the fuse size and the calculated cable size. If necessary, decrease the fuse size or increase the cable size. The cable length must not be more than the maximum limit given in IEC 60204.

Note:

- The voltage on the pump terminals must not deviate more than 10% of the nominal voltage.

- It is recommended to keep the voltage drop over the supply cables at nominal current below 5% of the nominal voltage (IEC 60204-1).

- If cables are grouped together with other power cables, it can be necessary to use cables of a larger size than those calculated for the standard operating conditions.

- Use the original cable entry. Refer to Dimension drawing on page 31.

- To keep the IP protection degree of the electric cubicle and to protect its components from dust from the environment, it is mandatory to use a correct cable gland when you connect the supply cable to the pump.

- Local regulations remain applicable if they are stricter than the values given in the manual.

Leakage breaker (optional)

If a leakage breaker is necessary for installation, use an all current sensitive leakage breaker, RCM or RCD Type B (refer to IEC/EN 60755). Make sure that the leakage breaker has a sufficient trip level.

Table 7 Currents and fuses (IEC and UL/cUL approval)

Pump specification				Itot		Imax under voltage	
				Primary	Secondary	Primary	Secondary
Pump	Voltage	Frequency	Approval	Itot	Itot	Itot	Itot
	V	Hz		A	A	A	A
MSV 030	380	60	IEC	45.7	-	50.3	-
	400	50	IEC	43.1	-	47.4	-
	460	60	IEC/CSA/UL	37.9	-	41.7	-
	200	50	IEC	86.2	43.1	94.9	47.4
	230	60	CSA/UL	76.1	38.0	83.7	41.8
	500	50	IEC	34.5	43.1	37.9	47.4
	575	60	CSA/UL	30.4	38.0	33.5	41.8
MSV 040	380	60	IEC	62.0	-	68.2	-
	400	50	IEC	58.6	-	64.4	-
	460	60	IEC/CSA/UL	51.4	-	56.5	-
	200	50	IEC	117.2	58.6	128.9	64.4
	230	60	CSA/UL	103.0	51.5	113.3	56.6
	500	50	IEC	46.9	58.6	51.5	64.4
	575	60	CSA/UL	41.2	51.5	45.3	56.6
MSV 050	380	60	IEC	75.9	-	83.5	-
	400	50	IEC	71.8	-	79.0	-
	460	60	IEC/CSA/UL	62.9	-	69.1	-
	200	50	IEC	143.6	71.8	157.9	79.0
	230	60	CSA/UL	125.9	63.0	138.5	69.3
	500	50	IEC	57.4	71.8	63.2	79.0
	575	60	CSA/UL	50.4	63.0	55.4	69.3

Note:

I: current in the supply lines at maximum load and nominal voltage

Fuse calculations for IEC:

For the IEC fuse calculations refer to 60364-4-43 electrical installations of buildings, part 4: protection for safety- section 43: protection against over current.
Fuse sizes are calculated to give the necessary protection to the cable against short circuits.

Fuse calculations for cUL and UL:

The given fuse size is the maximum fuse size to protect the motor against short circuit. For cUL fuse HRC form II (200-230, 500-575 V)/class T (380-460 V), for UL fuse class K5 (200-230, 500-575 V)/class T (380-460 V).

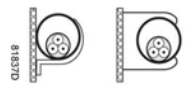
Earthing

The earthing cable connected to the pump should be minimum as per the EN 60204-1 section 828.

Cable sizing according IEC

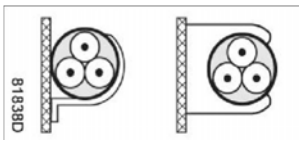
The tables show the current carrying capacities of cables for three commonly used installation methods, calculated as per the standard 60364-5-52 - electrical installations of buildings part 5 - selection and erection equipment and section 52 - current carrying capacities in wiring systems.

The permitted currents are valid for PVC insulated cables with three loaded copper conductors (maximum conductor temperature 70 °C).

	Installation method B2 as per table B.52.1. Multi-core cable in conduit on a wooden wall.

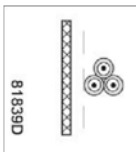
Maximum permitted current in function of the ambient temperature for installation method B2.

	Ambient temperature				
Cable section	**30 °C**	**40 °C**	**45 °C**	**50 °C**	**55 °C**
4 mm^2	< 27 A	< 23 A	< 21 A	< 19 A	< 16 A
6 mm^2	< 34 A	< 30 A	< 27 A	< 24 A	< 21 A
10 mm^2	< 46 A	< 40 A	< 36 A	< 33 A	< 28 A
16 mm^2	< 62 A	< 54 A	< 49 A	< 44 A	< 38 A
25 mm^2	< 80 A	< 70 A	< 63 A	< 57 A	< 49 A
35 mm^2	< 99 A	< 86 A	< 78 A	< 70 A	< 60 A
50 mm^2	< 118 A	< 103 A	< 93 A	< 84 A	< 72 A
70 mm^2	< 149 A	< 130 A	< 118 A	< 106 A	< 91 A
95 mm^2	< 179 A	< 156 A	< 141 A	< 127 A	< 109 A
120 mm^2	< 206 A	< 179 A	< 163 A	< 146 A	< 126 A

	Installation method C as per table B.52.1. Single-core or multi-core cable on a wooden wall.

Maximum permitted current in function of the ambient temperature for installation method C.

	Ambient temperature				
Cable section	**30 °C**	**40 °C**	**45 °C**	**50 °C**	**55 °C**
4 mm^2	< 32 A	< 28 A	< 25 A	< 23 A	< 20 A
6 mm^2	< 41 A	< 36 A	< 32 A	< 29 A	< 25 A
10 mm^2	< 57 A	< 50 A	< 45 A	< 40 A	< 35 A
16 mm^2	< 76 A	< 66 A	< 60 A	< 54 A	< 46 A
25 mm^2	< 96 A	< 84 A	< 76 A	< 68 A	< 59 A
35 mm^2	< 119 A	< 104 A	< 94 A	< 84 A	< 73 A
50 mm^2	< 144 A	< 125 A	< 114 A	< 102 A	< 88 A
70 mm^2	< 184 A	< 160 A	< 145 A	< 131 A	< 112 A
95 mm^2	< 223 A	< 194 A	< 176 A	< 158 A	< 136 A
120 mm^2	< 259 A	< 225 A	< 205 A	< 184 A	< 158 A

	Installation method F as per table B.52.1. Single-core cables, touching in free air clearance to wall not less than one cable diameter.

Maximum permitted current in function of the ambient temperature for installation method F.

	Ambient temperature				
Cable section	**30 °C**	**40 °C**	**45 °C**	**50 °C**	**55 °C**
25 mm^2	< 110 A	< 96 A	< 87 A	< 78 A	< 67 A
35 mm^2	< 137 A	< 119 A	< 108 A	< 97 A	< 84 A
50 mm^2	< 167 A	< 145 A	< 132 A	< 119 A	< 102 A
70 mm^2	< 216 A	< 188 A	< 171 A	< 153 A	< 132 A
95 mm^2	< 264 A	< 230 A	< 209 A	< 187 A	< 161 A
120 mm^2	< 308 A	< 268 A	< 243 A	< 219 A	< 188 A

Calculation method for IEC:

- Single supply cables (3 phases + PE - configuration (1)):
  - Add 10% to the total pump current (Itot from the tables)
  - Install the specified fuse on each cable.
- Parallel supply cable (2 x 3 phases + PE - configuration (2)):
  - Add 10% to the total pump current (Itot from the tables) and divide by 2
  - Multiply the ampacity of the cables with 0.8 (refer to table A.52.17 (52-E1))
  - Install fuses of half the size of the recommended maximum fuse size on each cable.
- When using 2 x 3 phases + PE as in (3):
  - Add 10% to the total pump current (Itot from the tables) and divide by √3
  - Multiply the ampacity of the cables with 0.8 (refer to table A.52.17 (52-E1))
  - Fuse size: the recommended maximum fuse size divided by √3 on each cable.
- Size of the PE cable:

- For supply cables up to 35 mm²: same size as supply cables
- For supply cables larger than 35 mm²: half the size of the supply wires
- Always check the voltage drop over the cable (less than 5% of the nominal voltage is recommended).
- Example: Itot= 89 A, maximum ambient temperature is 45 °C, recommended fuse = 100 A

- Single supply cables (3 phases + PE - configuration (1)):
  - I = 89 A + 10% = 89 x 1.1 = 97.9 A
  - The table for B2 and ambient temperature = 45 °C permits a maximum current of 93 A for a 50 mm² cable. For a cable of 70 mm², the maximum permitted current is 118 A, which is sufficient. Use a 3 x 70 mm² + 35 mm² cable.

If method C is used, 50 mm² is sufficient. (35 mm² for method F) =>cable 3 x 50 mm² + 25 mm².

- Parallel supply cable (2 x 3 phases + PE - configuration (2)):
  - I = (89 A + 10%)/2 = (89 x 1.1)/2 = 49 A
  - For a cable of 25 mm², B2 at 45 °C, the maximum current is 63 A x 0.8 = 50.4 A. So, 2 parallel cables of 3 x 25 mm² + 25 mm² are sufficient.
  - Install 50 A fuses on each cable instead of 100 A.

Cable sizing according UL/cUL

Calculation method according UL 508A, table 28.1 column 5: permitted ampacities of insulated copper conductors (75 °C (167 °F)).

Maximum permitted current in function of the wire size

AWG or kcmil	Maximum current
10	< 30 A
8	< 50 A
6	< 65 A
4	< 85 A
3	< 100 A
2	< 115 A
1	< 130 A
1/0	< 150 A
2/0	< 175 A
3/0	< 200 A

Calculation method for UL:

- Single supply cables (3 phases + 1 PE - configuration (1)):
  - Add 25% to the total current from the tables (refer to UL 508A 28.3.2: “Capacity shall have 125% of the full load current”)
  - Install the specified maximum fuse on each cable.
- Parallel supply cable (2 x 3 phases + 2 PE - configuration (2)):
  - Add 25% to the total current from the tables and divide by 2
  - Multiply the capacity of the cables with 0.8 (refer to UL 508A table 28.1 continued)
  - Install fuses of half the size of the recommended maximum fuse size on each cable.
- When using 2 x 3 phase + 2 PE as in (3):
  - Add 25% to the total current from the tables and divide by √3
  - Multiply the capacity of the cables with 0.8 (refer to UL 508A table 28.1 continued)
  - Fuse size: the recommended maximum fuse size divided by √3 on each cable.
- Size of the PE cable:

- For supply cables up to AWG8: use same size as the supply cables
- For supply cables larger than AWG8: use maximum permitted capacity.

< 100 A	use AWG8
< 200 A	use AWG6
< 300 A	use AWG4

Always check the voltage drop over the cable (less than 5% of the nominal voltage is recommended).

Example of supply cable calculation: Itot= 128 A, maximum ambient temperature is 45 °C, recommended fuse = 150 A.

- Single supply cables (3 phases + 1 PE - configuration (1)):
  - I = 128 A + 25% = 128 x 1.25 = 160 A
  - For AWG2/0, the maximum current is 175 A, which is sufficient => use AWG2/0
  - Install the specified maximum fuse (150 A) on each cable.
- Parallel supply cable (2 x 3 phases + 2 PE - configuration (2)):
  - I = (128 A + 25%)/2 = (128 x 1.25)/2 = 80 A
  - For an AWG4, the maximum current is 85 A x 0.8 = 68 A, which is not sufficient. For an AWG3, the maximum current is 100 x 0.8 = 80 A. So, 2 parallel cables of 3 x AWG3 + 2 x AWG8 are sufficient.
  - Install 80 A fuses on each cable.

4. Instructions for use

4.1. Air/oil separator vessel

WARNING: PRESSURISED AIR

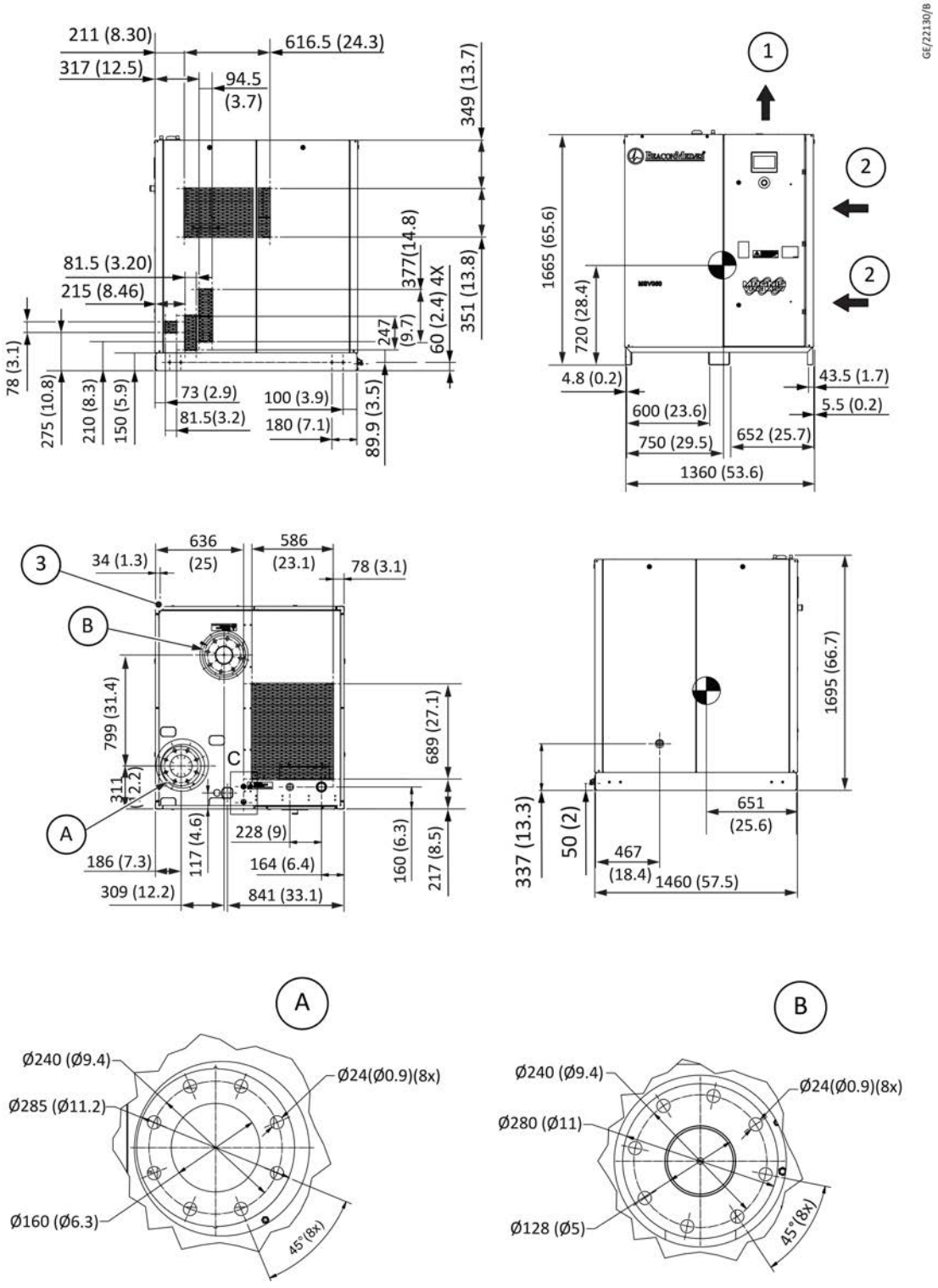
Risk of injury and damage to the equipment. The vessel can contain pressurised air, this can be dangerous if the equipment is misused.

- The vessel must only be used as an air/oil separator.
- The vessel must be operated at less than 0.5 bar(g).
- Do not make changes to the vessel by welding, drilling or by other mechanical methods without the written permission of the manufacturer.
- Only use oil as specified by the manufacturer.
- The vessel needs a yearly visual inspection.

5. Installation

5.1. Dimension drawing

Figure 8 Dimension drawings



1. Cooling air outlet
2. Cooling air inlet
3. Air inlet
4. Air outlet

Table 8 Centre of gravity and weight

Type	Centre of gravity			Weight#
	X mm (inch)*	Y mm (inch)*	Z mm (inch)*	Kg (lbs)
MSV 030	652 (25.7)	651 (25.6)	720 (28.4)	1083 (2388)
MSV 040				1083 (2388)
MSV 050				1088 (2399)

** Dimensions: ± 10 mm or ± 0.39 inches*

 # Weights: ± 10 kg or ± 22 lbs

5.2. Installation proposal

Install the pump on a level surface that:

- is clean
- is vibration free
- has sufficient lighting
- is ventilated
- supports the weight of the pump.

The complete length of the frame base must be supported. Add a shim where it is necessary. Do not use wood.

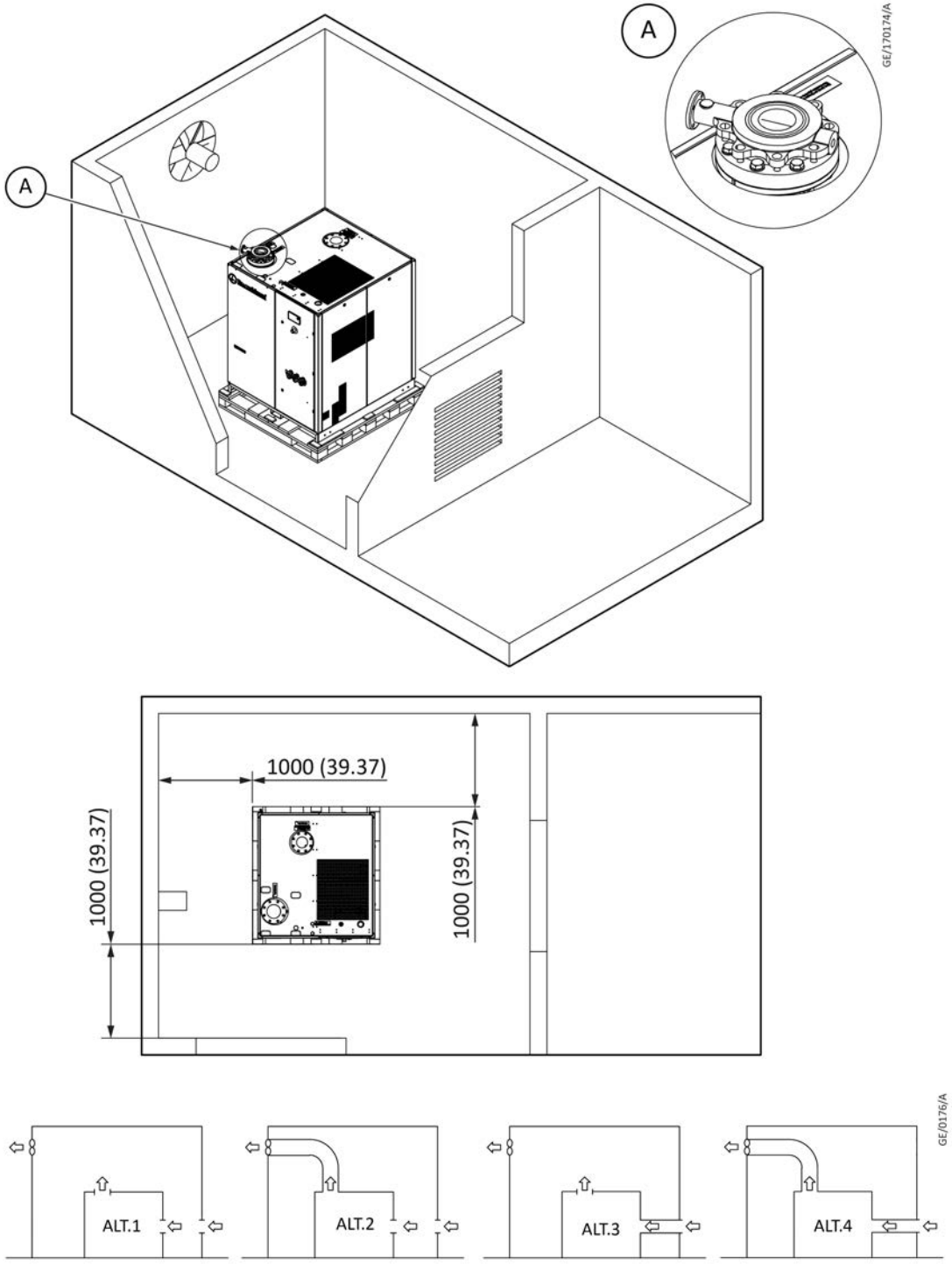
Make sure that the ambient temperature is not more than the specified temperature.

All models are intended for indoor installation.

Do not locate the pump where the hot exhaust air from other pumps or heat generating equipment can be drawn into the pump. Never prevent the flow of exhaust air from the fluid cooler.

Release the hot exhaust air outside to prevent the high ambient conditions in the room.

Figure 9 Installation proposal



A. Isolation valve

Note:

A sufficient space is necessary (1 m of clearance on all sides and top of the pump) for the safe and correct installation, daily inspection and maintenance.

5.3. Piping

The vacuum distribution and piping system, including the vacuum pump and all related components must be designed in accordance with generally accepted engineering practices. Improperly designed distribution systems can cause damage to the vacuum pump.

Whenever there is the risk of liquids in the vacuum network we recommend the installation of a drainable catchpot to the process inlet pipe.

It is very important to use adequate pipe diameter for the vacuum network. The combination of restrictive pipe diameter and long pipe runs can create a significant pressure drop. A rule of thumb on single pump installations: maintain the diameter of the pump inlet as far into the process as possible.

A dripleg with a drain point provision is given in the pump to prevent condensate to go back to the oil reservoir, anyhow for humid applications or low ambient temperature environments we recommend to install exhaust pipe sloping away from the pump or, if not possible, to install a drain leg at pump outlet before long vertical lines. Exhaust piping must be installed such that it does not create additional back pressure on the vacuum pump. Do not install the vacuum pump such that it will cause stress on the inlet or outlet flanges or any connecting pipework

Full pump isolation is crucial for efficient pump maintenance or replacement, we recommend to equip isolation valves for process inlet.

5.4. Ventilation

Install the inlet grids and the ventilation fan to prevent the recirculation of the cooling air to the inlet grating of the pump. The air velocity to the grids must not be more than 5 m/s.

The maximum air temperature at intake opening at the intake opening is 46 °C (115 °F), (minimum 0 °C / 32 °F).

Refer to *Figure: Installation proposal*.

Ventilation alternative 1 and 3: The necessary ventilation to limit the pump room temperature is calculated from:

$Q_v = SF * P_{nom} / (1.21 * dT)$

Where,

Q_v = necessary cooling air flow (m^3/s)

SF= Service factor of Motor (-)

P_{nom} = Nominal motor power of the pump (kW)

dT= Temperature increase in the pump room (°C)

Ventilation alternative 2 and 4:
The fan capacity should match the pump - fan capacity at a pressure head equal to the pressure drop caused by cooling air ducts.

Maximum permitted pressure drop in ducting before or after the pump = 10 Pa.

Outdoor/altitude operation

The pumps are designed according to the IP2X classification. The electrical cabinet and motor are designed according to the IP54 classification. If the pump is installed outdoors, special precautions must be taken. Contact us.

The pumps can only be used in temperatures above 0 °C (+32 °F). If frost occurs, take applicable protective steps to prevent damage to the pump and its ancillary equipment. In this case, contact us.

If it is necessary to operate the pump at more than 1000 m (3300 ft), contact us.

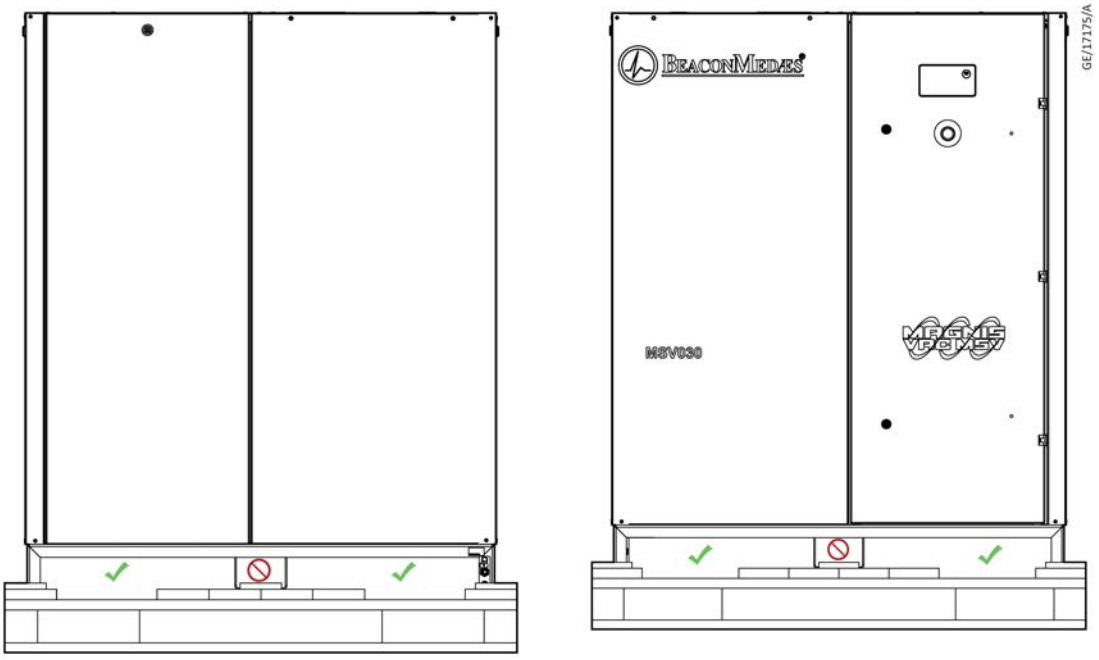
5.5. Position the pump

WARNING: HEAVY OBJECT

Risk of injury and damage to the equipment. Do not lift the pump if the external body (canopy) parts or lifting supports are not fully installed. When the pump is being lifted, do not stand below the load or do maintenance.

- The pumps can be moved by a lift truck using the slots in the frame. Make sure that the bodywork is not damaged while lifting or transport of the pump.
- Before lifting, install the transport securing bolts.
- Make sure that the forks extend to the other side of the frame.
- The pumps can also be lifted after you insert beams in the slots.
- Make sure that the beams do not slide and extend uniformly from the frame.
- Hold the chains parallel to the bodywork by the chain spreaders to prevent damage to the pump.
- Lift the pump vertically.
- Carefully lift the pump without twisting.

Figure 10 Lifting slots



5.6. Acclimatization

CAUTION: MOISTURE FORMATION

Risk of damage to equipment. To prevent moisture that can damage the electrical components, make sure that a minimum of 2 hours of acclimatization is done before you start the pump.

When you move the pump to the installation room, condensation can occur on some components. Make sure that the pump is left idle for minimum 2 hours to adjust in the installation room condition.

5.7. Electrical connections

WARNING: NETWORK CONNECTIONS

Risk of injury. Take special safety precautions when you use the machines controlled by a frequency converter. The safety precautions depend on the type of network used (TN, TT, IT system). Contact us for information.

Most pumps are designed for use in TT/TN networks and are intended for an industrial environment where the electrical supply is separated from the residential/commercial supply network.

To use the pump in light industrial, commercial or residential environments with a shared supply network, or in an IT network, extra precautions are necessary. Contact us for information.

Note:

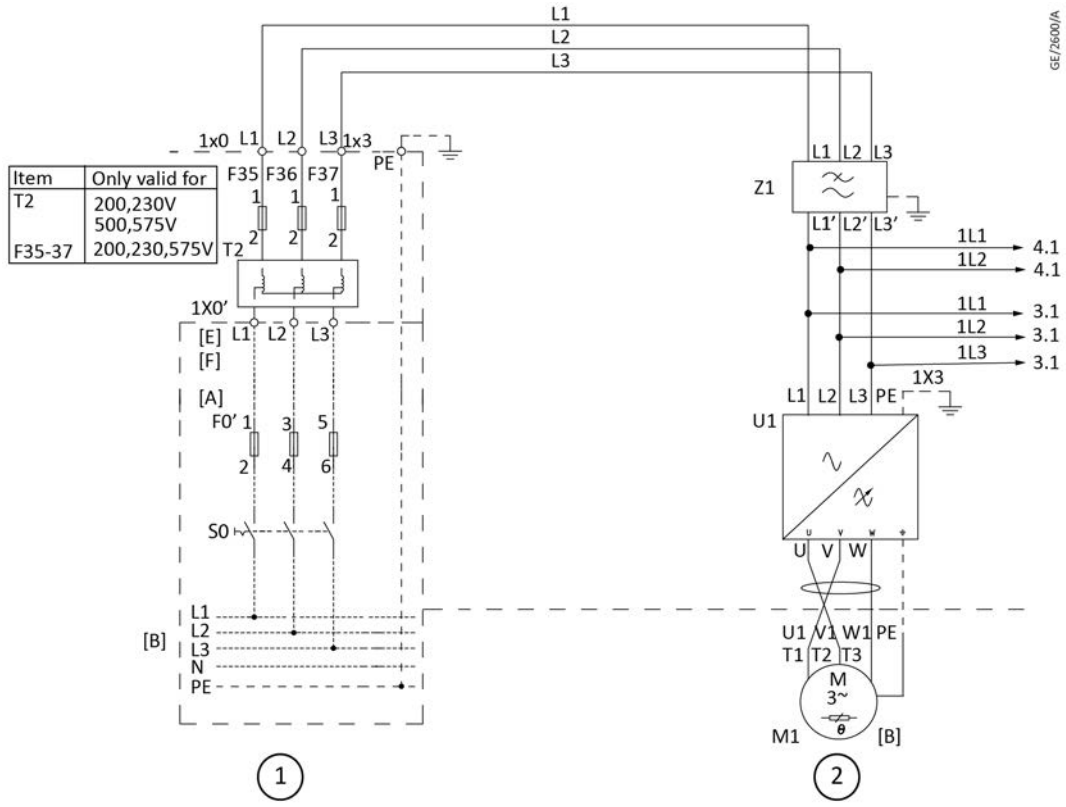
You can find the correct position for the electrical connection on the dimension drawings.

A correct cable gland must be used when the supply cable is connected to the pump. This will give the necessary protection to the electrical cubicle and its components from dust.

1. Install an isolating switch.
2. Check that the motor cables and wires in the electric cabinet are connected to their terminals.
3. Check the fuses. Refer to Electrical cable size.
4. Connect the power supply cables to the terminals (1, 3 and 5).
5. Connect the earth conductor to the earth bolt.

Power supply requirements

For more information about the power supply requirements, refer to the document 9820910350.

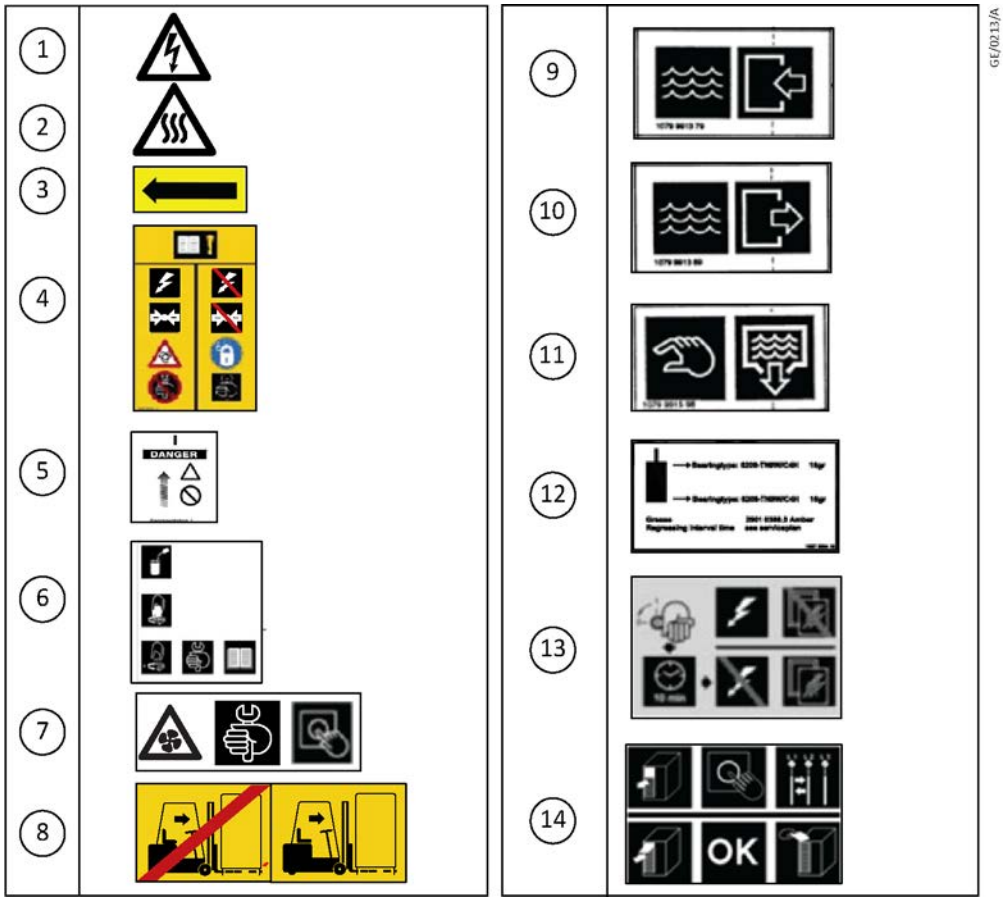


1. Customer's installation *2. Pump motor*

You can find the electrical diagram in the electric cabinet.

5.8. Pictographs

Figure 11 Pictographs



1. *Warning, voltage*
2. *Warning, hot surface*
3. *Motor rotation arrow*
4. *Set the voltage to off and depressurise the pump before you start the maintenance or repair.*
5. *Warning, loaded spring*
6. *Lightly apply oil to the gasket of the oil filter, install it and tighten by hand (approximately half a turn)*
7. *Stop the pump before the coolers are cleaned.*
8. *Lifting instruction*
9. *Water in*
10. *Water out*
11. *Manual drain*
12. *Grease the motor instruction*
13. *Set the voltage to off and wait for 10 minutes before the maintenance is started.*
14. *If the rotation direction is wrong, open the isolating switch in the voltage supply line and reverse the two incoming electric lines.*

6. Options

Energy recovery unit

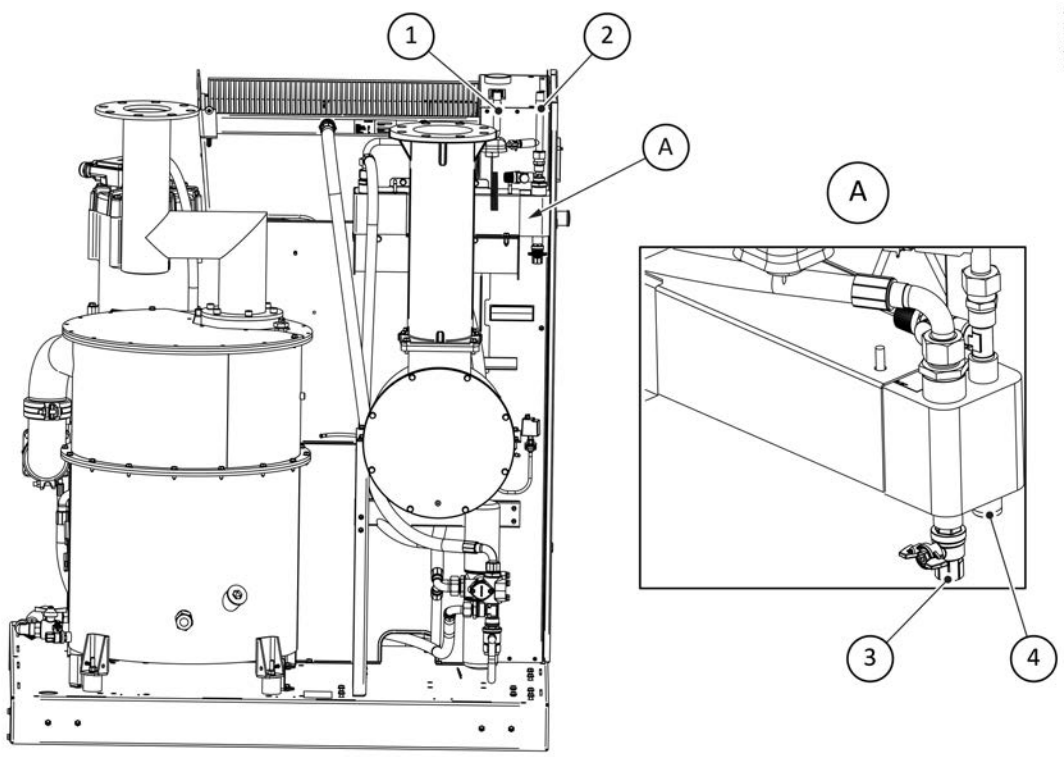
A large part of the energy necessary for the compression process is transformed into heat. For the oil-injected screw pump, most of the compression heat is dissipated through the oil system. Our energy recovery systems are designed to recover most of the heat by transforming it into a warm or hot water without any adverse influence on the vacuum performance. The water can be used for diverse applications.

Components

The energy recovery system is integrated and has:

- a stainless steel oil/water heat exchanger
- the necessary bolts, flexibles, etc.
- Pressure relieve valve with pressure setting of 10 bar
- Oil drain valve.

Figure 12 Main components of the energy recovery unit (typical installation)



1. *Water outlet pipe*
2. *Water inlet pipe*
3. *Oil drain valve*
4. *Water drain plug*

Field installation

The main components are assembled ex-factory as a compact unit which installs in the bodywork of the pump. Contact us for installation and connection of the energy recovery unit.

6.1. Energy recovery systems

General

The energy recovery systems can be applied as low temperature rise/high water flow systems or as a high temperature rise/low water flow systems.

Low temperature rise/high water flow systems

The temperature difference between the water in the energy recovery system and the pump oil is low. A high-water flow is necessary for maximum energy recovery.

For example, The heated water is used to keep another medium at a moderately high temperature in a closed circuit (for example, central heating).

High temperature rise/low water flow systems

A high-water temperature increase in the energy recovery system is obtained, which causes a low flow rate.

For example, An open circuit where cold water from the main supply is heated by the energy recovery system to use in a factory (for example, pre-heating of boiler feed water).

Recovery water flow

The recovery water enters the unit at the inlet connection. In the heat exchanger, the compression heat is transferred from the pump oil to the water. The water leaves the heat exchanger through the outlet connection.

Water requirements for the closed water circuits

The use of a closed water circuit decreases the make-up water requirements. The use of soft or demineralised water is economically feasible and removes the problem of scale deposits. The heat exchanger water circuit is made of stainless steel, the corrosion inhibitors for the water circuit connected to the pump can be necessary. Refer to *Cooling water requirement* on page 44 to decrease the problems because of the bad water quality. If in doubt, contact us.

Add an anti-freeze product (for example, ethylene-glycol) to the water in proportion to the expected temperature level to prevent freezing.

Water requirements for the open water circuits

For open, non-recirculation water circuits the problems are related to deposit control, corrosion control and microbiological growth control. To decrease the problems the water must meet the requirements given in *Cooling water requirement* on page 44. If in doubt, contact us.

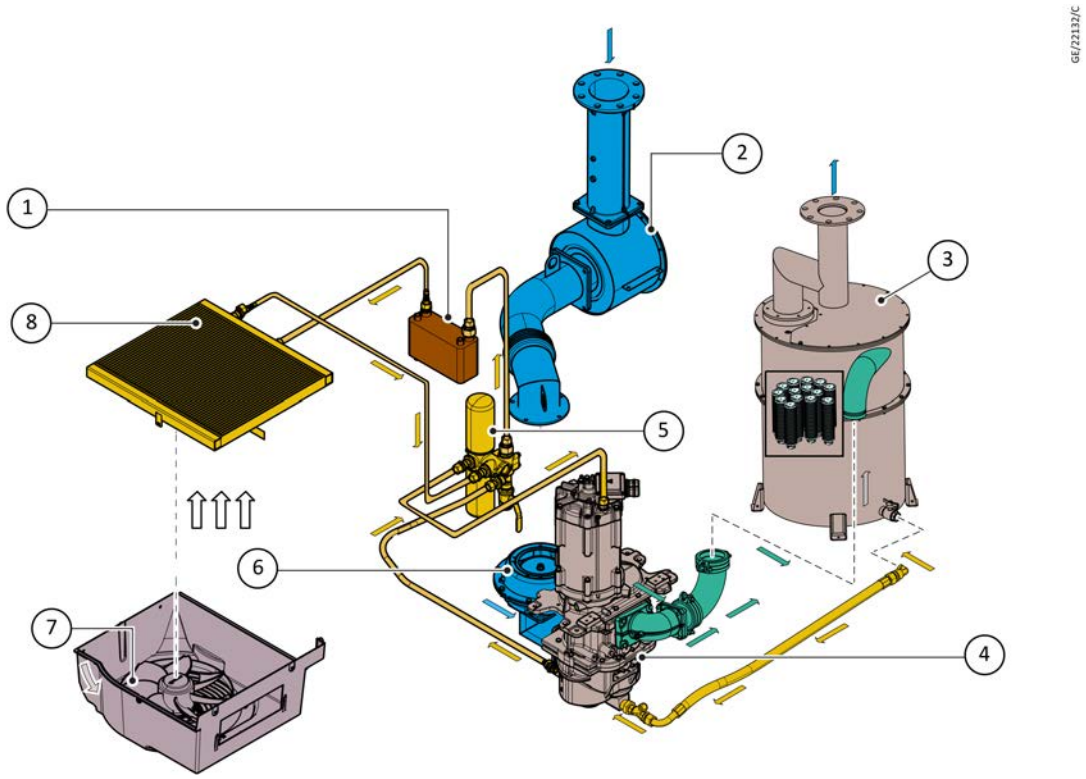
6.1.1. Energy recovery systems operation

The pump oil flow is controlled by a thermostatic bypass valve for the correct operation of the pump and optimum energy recovery.

The thermostatic bypass valve is integrated in the oil filter housing of the pump. The thermostatic bypass valve controls the oil flow to the oil/water heat exchanger and the main oil cooler of the pump.

The thermostatic bypass valve starts closing the bypass line over the oil cooling circuit at the lower limit of its temperature range. At the upper limit of its temperature range, the bypass line is completely closed and all the oil flows through the oil cooling circuit.

Figure 13 Figure: Flow diagram (with energy recovery systems)



	Air atmospheric pressure
	Air Working Pressure
	Air/oil mixture
	Oil

1. *Plate heat exchanger*
2. *Inlet filter*
3. *Oil mist separator*
4. *Element*
5. *Oil filter*
6. *Vacuum control valve*
7. *Fan*
8. *Oil cooler*

Energy recovery system in use

Pump start-up

When the pump is started, the oil temperature is low. The thermostatic bypass valve stops the oil supply to the oil cooling system to prevent the pump oil from being cooled. The oil flows from the oil separator vessel through the oil filters back to pump element.

All energy input is used to quickly warm up the pump oil. No energy is recovered.

Maximum energy recovery

When the oil temperature reaches the set-point (opening temperature) of the thermostatic bypass valve, the thermostatic bypass valve starts closing the bypass over the oil cooling system. The oil gradually flows through the heat exchanger. As the oil temperature increases, all the oil passes through the cooling system. The exchange of the heat between the pump oil and the heat recovery water is maximum. The oil from the heat exchanger

outlet flows through the oil cooler, oil filter, pump element, and separator back to the inlet of the heat exchanger.

Recovery water flow too high/temperature too low

The thermostatic bypass valve 1 will open the bypass line to permit the oil from the heat exchanger to be mixed with the oil from the oil mist separator. The energy is transferred from the pump oil to the water, but at a relatively low temperature level.

Recovery water flow too low/temperature too high/not connected

When the element outlet temperature reaches the cut in temperature, the oil cooler fan starts running and it will not stop till the temperature drops below the cut out temperature, providing extra cooling flow to prevent pump shutdowns.

Stopping the unit for a long period

For the open water system or if the freezing temperatures are possible, isolate the pump water system and blow it through with the compressed air.

6.1.2. Maintenance for the energy recovery system

Vacuum pump oil

Refer to *Energy recovery unit* on page 39.

To change the oil, do the steps that follow:

1. Operate the pump until warm and stop the pump.
2. Switch off the isolation switch.
3. Close the air outlet valve of the pump.
4. Depressurize the vacuum pump.
5. Drain the oil by opening the drain valve.
6. Drain the oil from the heat exchanger by opening the drain plug on the heat exchanger.
7. Close the drain plug after oil is drained.
8. Obey the instructions given in Oil and oil filter change.

Heat Exchanger (HE)

If the increase in the temperature over the energy recovery system declines over a period of time with the same basic working conditions, examine the heat exchanger. To clean the oil side, soak the heat exchanger in a degreasing solution. To remove the scale formation in the water compartment, a correct descaling process must be applied. Contact us.

6.1.3. Energy recovery data

Reference conditions

Refer to *Reference condition and limitations* on page 21.

Effective working pressure

Refer to *Vacuum pump data* on page 21 for the normal working pressure.

Maximum permitted pressure of the heat exchanger

Oil side	bar	22
	psi	319
Water side	bar	15
	psi	217

Reading settings

The temperatures that follow can be shown on the controller display for air-cooled units:

- The water inlet temperature of the energy recovery system
- The water outlet temperature of the energy recovery system

Modifying settings

If the programmed warning settings for the water temperatures are exceeded, a warning indication is shown on the controller.

Table 9 Modifying settings

Temperature input	Unit	Minimum setting	Nominal setting	Maximum setting
Water inlet temperature of energy recovery	°C	0	50	99
	°F	32	122	210
Water outlet temperature of energy recovery	°C	0	Depends on application	99
	°F	32	Depends on application	210

To change a setting, check the related section in the description of the controller.

Recoverable energy

The recoverable energy can be calculated from:

Recovered energy (kW) = 4.2 x water flow (l/s) x water temperature rise (°C)

Table 10 Data for low temperature rise/high water flow systems

Parameter	Unit	MSV030			MSV040			MSV050		
		50 mbar	100 mbar	400 mbar	50 mbar	100 mbar	400 mbar	50 mbar	100 mbar	400 mbar
Recoverable energy	kW	21.3	23.3	18.5	28	30.4	24.8	37.7	38.3	30.2
	hp	28.5	31.2	24.8	37.6	40.8	33.2	50.5	51.4	40.5
Water flow	l/min	30	33	27	40	44	36	53	55	44
	cfm	1.07	1.18	0.95	1.40	1.54	1.27	1.89	1.94	1.54
Temperature at inlet	°C	26	27	27	26	27	27	26	27	27
	°F	79	81	81	79	81	81	79	81	81
Temperature at outlet	°C	36	37	37	36	37	37	36	37	37
	°F	97	99	99	97	99	99	97	99	99
Pressure drop over energy recovery	bar	0.077	0.092	0.062	0.126	0.150	0.105	0.220	0.231	0.151
	psig	1.11	1.33	0.90	1.83	2.17	1.52	3.19	3.36	2.18

Table 11 Data for high temperature rise/low water flow systems

Parameter	Unit	MSV030			MSV040			MSV050		
		50 mbar	100 mbar	400 mbar	50 mbar	100 mbar	400 mbar	50 mbar	100 mbar	400 mbar
Recoverable energy	kW	21.4	23	17.8	28.1	30.1	23.8	37.4	37.2	28.9
	hp	28.6	30.9	23.9	37.7	40.4	32	50.2	49.8	38.8
Water flow	l/min	15	16	13	20	21	17	27	27	21
	cfm	0.54	0.58	0.45	0.71	0.76	0.60	0.95	0.94	0.73
Temperature at inlet	°C	27	27	26	27	27	26	27	27	26
	°F	81	81	79	81	81	79	81	81	79
Temperature at outlet	°C	47	47	46	47	47	46	47	47	46
	°F	117	117	115	117	117	115	117	117	115
Pressure drop over energy recovery	bar	0.024	0.027	0.019	0.038	0.043	0.029	0.065	0.063	0.040
	psig	0.35	0.39	0.28	0.55	0.62	0.42	0.94	0.92	0.58

6.2. Cooling water requirement

The cooling water must have specified requirements to prevent problems of scaling, fouling, corrosion, bacterial growth.

Note:

In open circuit cooling towers, take applicable protective measures to prevent the growth of harmful bacteria (for example, legionella pneumophila) when there is a risk of inhalation of the water droplets.

General recommendations cannot include all the effects of combinations of the various compounds, solids and gases that are in the cooling water (in interaction with the different materials). The recommendations given in the cooling water specifications are a general guideline for the permitted coolant quality. A statement is given in the specification where the strict limits are necessary.

The water requirements are applicable for the untreated water. When the water is treated, some parameters will change.

The water treatments should be done by a specialised water treatment company (taking the responsibility for the performance of the treated cooling water and the compatibility with the materials in the cooling circuit). This includes:

- selection of the correct additives
- selection of the correct application
- monitoring the concentrations and properties
- prevention of the sludge formation
- maintenance of the system.

This is also applicable to the treatment with the antifreeze products. The antifreeze products must be given with applicable stabilisers and inhibitors. The specifications depends on the:

- type of the cooling circuit: open, once through/recirculating with tower/closed.
- application:
  - Standard - maximum 65 °C cooling water temperature at the outlet
  - Energy recovery - water temperature up to 95 °C

If the water is not as per the recommended values or you are not sure about the quality of the water, contact the manufacturer.

Cooling water parameters

pH

The effect of pH is included in the Ryznar Stability Index (RSI). The pH itself is subjected to limitations:

Type of cooling system	Materials	pH	
		Standard	Energy recovery
Single pass	Contains copper	6.8 - 9.3	6.8 - 9.3
	Stainless steel with carbon steel and/or cast iron	6.8 - 9.3	6.8 - 9.3
	Stainless steel only	6.0 - 9.3	6.0 - 9.3
Recirculating (with tower)	Contains copper	6.8 - 9.3	not applicable
	Stainless steel with carbon steel and/or cast iron	6.8 - 9.3	
	Stainless steel only	6.0 - 9.3	
Closed loop	Contains copper	7.5 - 9.3	7.5 - 9.3
	Stainless steel with carbon steel and/or cast iron	7.5 - 9.3	7.5 - 9.3
	Stainless steel only	6.0 - 9.3	6.0 - 9.3

When the system contains Zn or Al, the pH must be < 8.5.

Total dissolved solids (TDS) and conductivity

The conductivity is given in S/cm. The TDS is given in ppm.

The conductivity and the TDS are related with each other. The conductivity is convenient for quick monitoring of general water quality. The TDS is necessary for calculating the RSI. If only one of the parameters is measured, you can get the estimation by using a theoretical conversion factor (0.67):

TDS = Conductivity x 0.67

Hardness

Different types of hardness are in relation with each other. Different types of hardness with the pH and the alkalinity of the water give the equilibrium situation of the water (given and specified by the RSI).

The calcium hardness must be limited to:

Type of cooling system	Ca (ppm $CaCO_3$)	
	Standard	Energy recovery
Single pass	< 500	< 2
Recirculating (with tower)	< 500	not applicable
Closed loop	< 1000	< 50

The Ryznar Stability Index (RSI)

The RSI is a parameter to predict if the water will tend to dissolve or precipitate calcium carbonate. The adhesion of scaling depositions and their effects are different on different materials. The equilibrium of the water (scaling or corrosive) is calculated by its actual pH value and saturation pH value (pHs). The saturation pH value is calculated by the relationship between the calcium hardness, the total alkalinity, the total solids concentration, and the temperature.

RSI is calculated as follows:

RSI = 2*pHs - pH,

in which,

- pH = measured pH (at room temperature) of the water sample
- pHs= pH at saturation

pHs is calculated from:

pHs = (9.3 + A + B) - (C + D),

in which:

- A: depends on the total solids concentration
- B: depends on the water temperature at the outlet of the heat exchanger
- C: depends on the calcium hardness ($CaCO_3$)
- D: depends on the HCO_3 concentration or M-alkalinity

The values of A, B, C and D are given in *Table: Ryznar Stability Index (RSI)*.

Table 12 Ryznar Stability Index (RSI)

Total dissolved solids (mg/l)	A	Temperature (°C)	B	Ca hardness (ppm $CaCO_3$)	C	M-Alkalinity (ppm $CaCO_3$)	D
< 30	0.1	0 - 1	2.3	09 - 11	0.6	10 - 11	1
30 - 320	0.2	2 - 6	2.2	12 - 14	0.7	12 - 14	1.1
> 320	0.3	7 - 11	2.1	15 - 17	0.8	15 - 17	1.2
		12 - 16	2	18 - 22	0.9	18 - 22	1.3
		17 - 22	1.9	23 - 28	1	23 - 28	1.4
		23 - 27	1.8	29 - 35	1.1	29 - 35	1.5
		28 - 32	1.7	36 - 44	1.2	36 - 44	1.6
		33 - 38	1.6	45 - 56	1.3	45 - 56	1.7
		39 - 43	1.5	57 - 70	1.4	57 - 70	1.8
		44 - 49	1.4	71 - 89	1.5	71 - 89	1.9
		50 - 55	1.3	90 - 112	1.6	90 - 112	2
		56 - 61	1.2	113 - 141	1.7	113 - 141	2.1
		62 - 67	1.1	142 - 177	1.8	142 - 177	2.2
		68 - 73	1	178 - 223	1.9	178 - 223	2.3
		74 - 79	0.9	224 - 281	2	224 - 281	2.4
		80 - 85	0.8	282 - 355	2.1	282 - 355	2.5
		86 - 91	0.7	356 - 446	2.2	356 - 446	2.6
		92 - 95	0.6	447 - 563	2.3	447 - 563	2.7
				564 - 707	2.4	564 - 707	2.8
				708 - 892	2.5	708 - 892	2.9
				893 - 1000	2.6	893 - 1000	3

Explanation of the values obtained:

- RSI < 6: boiler scale formation
- 6 < RSI < 7: neutral water
- RSI > 7: corrosive water

Note:

The RSI should be between 5.6 and 7.5. If the RSI is not in between the values, contact a specialist.

Free chlorine (Cl_2)

Do not do the disinfection with chlorine in a closed system or in a energy recovery system.

Do not exceed a continuous level of 0.5 ppm. For shock treatments a maximum limit of 2 ppm for maximum 30 minutes/day applies.

Chlorides (Cl^-)

Chloride ions will create pitting corrosion on stainless steel. The concentration of chloride ions should be limited, based on the RSI value.

Range	Cl^- (ppm)
RSI < 5.5	200
5.6 < RSI < 6.2	350
6.3 < RSI < 6.8	500
6.9 < RSI < 7.5	350
7.6 < RSI	200

Sulphate

For the energy recovery systems, the limit is 100 ppm.

Type of cooling system	Sulphate (ppm)	
	Standard	Energy recovery
Single pass	< 1000	< 200
Recirculating (with tower)	< 1000	not applicable
Closed loop	< 400	< 200

Iron and manganese

Type of cooling system	Dissolved iron (ppm)		Dissolved manganese (ppm)	
	Standard	Energy recovery	Standard	Energy recovery
Single pass	< 1	< 0.2	< 0.2	< 0.05
Recirculating (with tower)	< 1	not applicable	< 0.2	not applicable
Closed loop	< 1	< 0.2	< 0.2	< 0.05

Copper

Type of cooling system	Copper (ppm)	
	Standard	Energy recovery
Single pass	< 1	< 0.2
Recirculating (with tower)	< 1	not applicable
Closed loop	< 1	< 0.2

Ammonium

The rejection limit for ammonia is 0.5 ppm (only for the systems that contain copper).

Suspended solids

Filter the large particles (size > 10 µm). Only the particles smaller than 5 µm can go through the filter. For the particles between 0.5 µm and 10 µm, the limits that follow are applicable.

Type of cooling system	Suspended solids (ppm)	
	Standard	Energy recovery
Single pass	< 10	< 1
Recirculating (with tower)	< 10	not applicable
Closed loop	< 10	< 1

Oil or grease

< 1 ppm (rejection value)

Biology

If biology is present, it must be aerobic. Prevent anaerobic biology in the closed systems.

Type of cooling system	Biology (CFU/ml)	
	Standard	Energy recovery
Single pass	$< 10^5 / < 10^7$	$< 10^3 / < 10^5$
Recirculating (with tower)	$< 10^5 / < 10^7$	not applicable
Closed loop	$< 10^3 / < 10^5$	$< 10^3 / < 10^5$

The use of additives in the cooling water changes the cooling capacity.

$\Delta m = ((C_{pw} - C_{pa}) * X)/(C_{pw} *(1-X) + X * C_{pa}) * 100\%$

Δm: change of mass flow of the coolant

C_{pw}: specific heat capacity of water

C_{pa}: specific heat capacity of the additives

X: the percentage of additives

7. Connect and configure the controller

The controller is an intelligent control box that can fully control and monitor the vacuum pumps with its multiprocessors. It is directly connected to a vacuum pump to control and monitor it. You can also collect data and analyse pump performance to improve processes and lower your operating costs.

The controller can be connected to the cloud, data virtualization, and execute complex algorithms to provide a rich interface for the user on touch screen. It also provides support for inputs and outputs to connect multiple sensors for data acquisition and has customizable industrial Ethernet Fieldbus connections such as EtherCAT, Ethernet/IP, Modbus-TCP, and Profinet. It is delivered with touch screen.

7.1. List of abbreviations

Table 13 Abbreviations

HEX@	HEX@AtlasCopco controller
UI	User Interface
HMI	Human Machine Interface
IP address	Internet Protocol address
DHCP	Dynamic Host Configuration Protocol
ARAVF	Automatic Recovery After Voltage Failure

7.2. Touch HMI

The HMI touch screen is mounted on the cabinet door. You can modify the pump settings and control the vacuum pump without any additional hardware. Also you can customize the parameters on the HMI display based on your priorities.

GE/20681/A

This equipment is not suitable for use in locations where children are likely to be present.

7.3. Configuring the controller

Configure the controller for your situation and usage.

7.3.1. Accessing User Interface

You can access the controller via the X11 port from appropriate devices.

Connection to X11 supports adjustable IP addresses, which allows connecting multiple devices to a network.

To access the controller

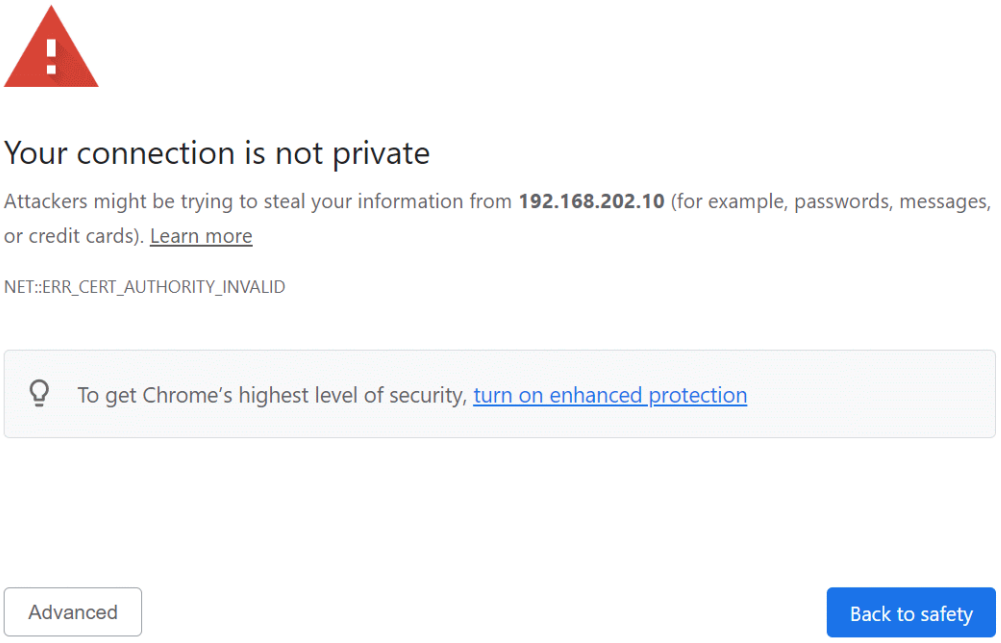
Note:

Your computer must not be connected to another network when you access the controller.

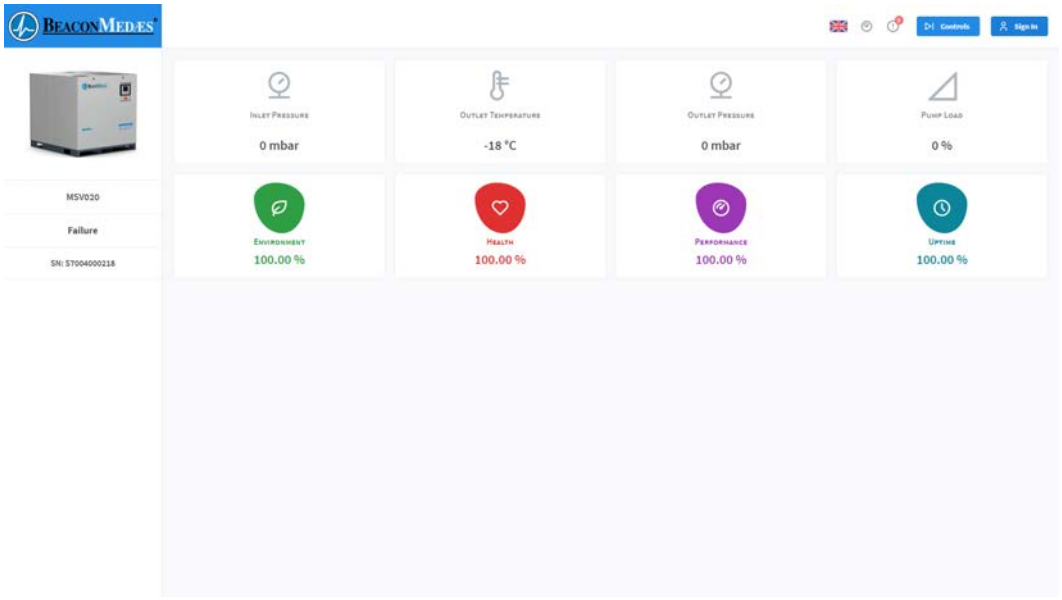
1. Click the browser's address bar.
2. Type the IP address and press Enter (For the IP address, check **Connectivity > LAN setting**. Refer to *Connecting the pump to the local LAN network* on page 54, *Connecting the pump to the local LAN network* on page 71).

Note:

*When you access the user interface, you may get a message "Your connection is not private". Click on **Advanced** and **Proceed to (IP address).***



You will land on the following default page when you have an access to the user interface.



3. To change the display language
   a. Click **Flag** icon.
   b. Select the language of your choice.
4. To change the units
   a. Click **Unit** icon.
   b. Select the unit of your choice.

Note:

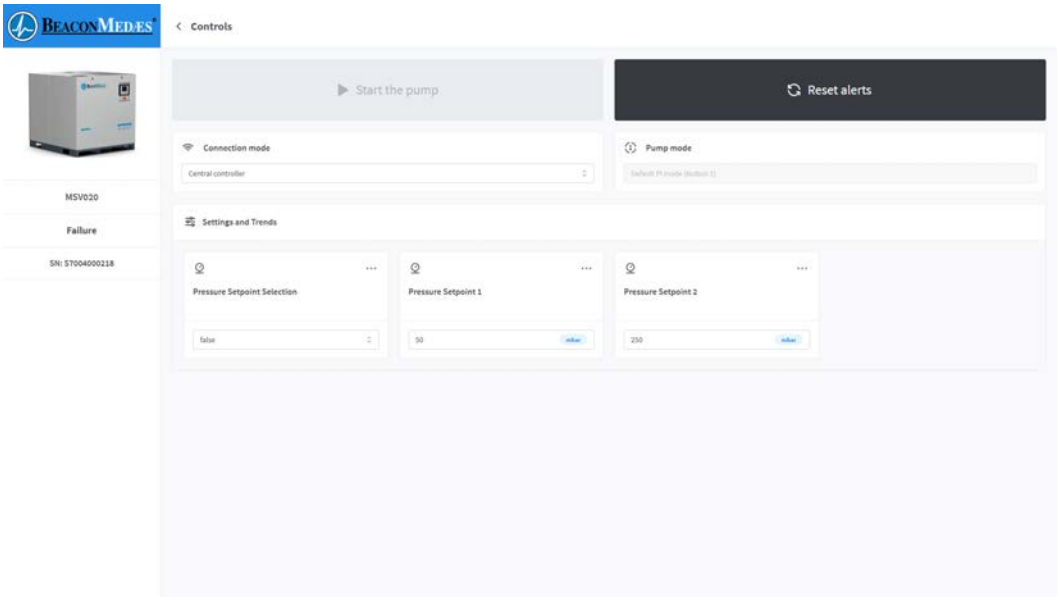
You can also choose the measurement system based on the specific country.

The notifications are displayed along with the **Alert** icon.

5. To access some Controls without login on the touch screen
   a. Click **Controls** button.
   b. Select the controls
   c. Modify the values as per requirements.

Note:

You can see the controls such as Start Pump, Reset Alerts, Setting Pressure Set points, Pump Modes, Connection Modes, Team Viewer & Docker. The descriptions of these controls are defined in the below chapters.



6. To Sign-in
   a. Click on **Sign in** button
   b. Type Username and Password.
   c. Click **Sign in**.
   d. Use your login credentials or the credentials available on the label on the controller.

Troubleshooting Windows connection problems

If you cannot access the IP address in your web browser,

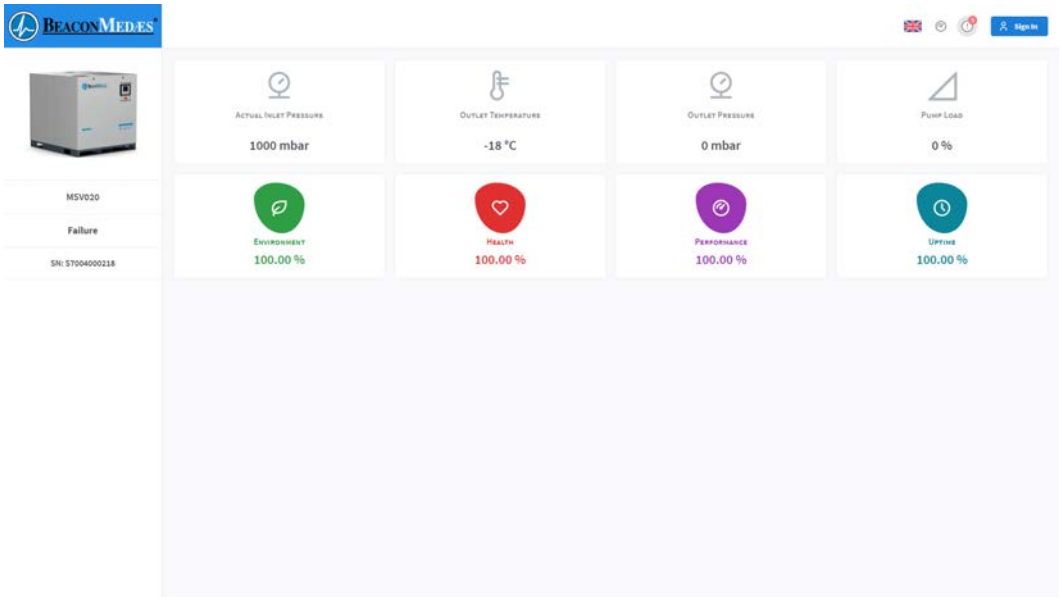
1. Press the "**Windows**" button on the keyboard.
2. Search "**View network connections**".
3. Right click on **Ethernet** or **Adapter** (depending on the ethernet connection).
4. Click **Properties** > **Internet protocol version 4 (TCP/IPv4)** > **Properties** > Use following IP address.
5. Enter IP address within the allowed range based on the LAN settings, refer to *Connecting the pump to the local LAN network* on page 54, *Connecting the pump to the local LAN network* on page 71.

   Note:

   The IP address placed in IPv4 needs to be different from the IP and Gateway entered in LAN settings, for example IP address is 10.75.100.50 and Gateway is 10.75.100.1, set local IP address on adapter to 10.75.100.99.

6. Click on **Subnet mask** and 255.255.255.0 number must appear.
7. Click **OK**.

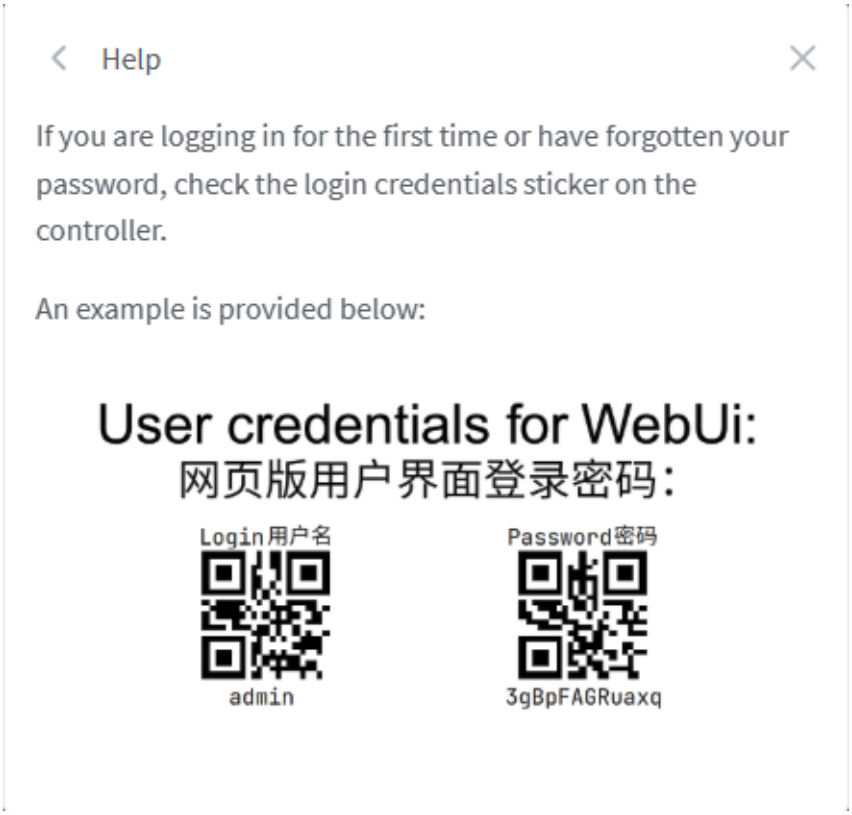
Try to connect through your web browser again.



Entering login credentials

If you are signing in first time or forgot the password, please follow the below procedures:

1. Click **Help** on the sign in page.



2. Make a note of the login credentials.
3. Click "**<**" symbol to go back to previous page.
4. Type Username and Password.
5. Click **Sign in.**

You can change login credentials after your login, refer to *Creating and updating the user profile* on page 58, *Creating and updating the user profile* on page 75.

Viewing controller home page

The default home page displays after the first login.

1. *Genius connection (active/inactive)*
2. *ARAVF function (active/inactive)*
3. *Scheduler (active/inactive)*
4. *Mode number (active)*

The home page is divided into four segments

Section	Functions
Navigation bar	You can see key parts of controller such as ▪ Home ▪ Controls ▪ Trends ▪ Settings ▪ Options ▪ Alerts ▪ Scheduler ▪ Maintenance ▪ More
KPI functionalities	You can see pump parameters such as Eco, Health, Performance and Uptime.
Pump sensor values	You can see pump sensor values.
KPI insight card	Highlights valuable feedback from the machine by showing custom insights.

7.3.2. Connecting the pump to the local LAN network

Note:

Connect the controllers directly to the company network through the X11 port on the rear of the controller with Ethernet cables.

Make sure to use only **Private IPs** for X11 with the following ranges.

Private IPs range	
Use below range	**Do not use below range**
10.0.0.0 - 10.255.255.255	-
172.16.0.0 - 172.31.255.255	172.17.X.X and 172.18.X.X*
192.168.0.0 - 192.168.255.255	192.168.0.X and 192.168.202.X*

** Contact service, If these subnetworks are used and cannot be changed.*

To connect to the controller

1. Navigate to the IP address in a web browser.
   If you do not have the IP address, use the touch screen or contact service.
2. Click **Sign in**.
3. Enter login credentials to access the home page.
4. Click **More > Preferences > Connectivity > LAN**.
5. Check and confirm with the IT department, if the DHCP has been set automatically.
   - If the DHCP is set automatically, the connection is complete.
   - If the DHCP is not set automatically, connect the ethernet manually

Note:

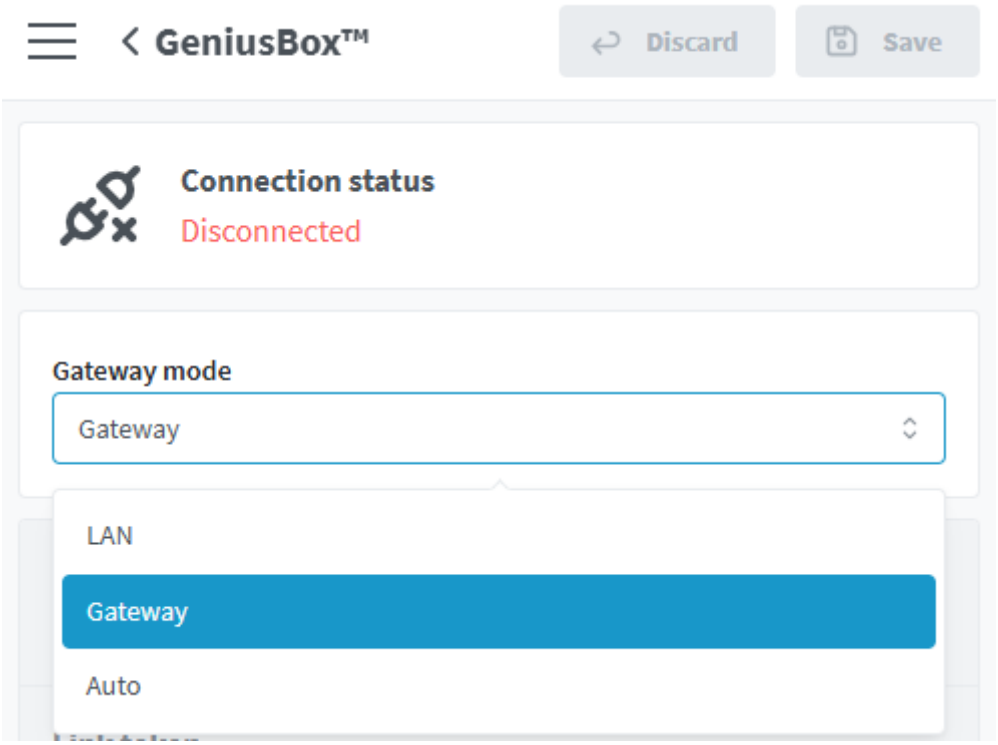
If the DHCP is enabled and supported by the network, the connection details will be selected automatically. If it is not displayed, enter the details manually.

a. Click **Edit.**
b. Deactivate **DHCP**.
c. Enter the connection details manually.
d. Click **Save**.
e. Activate **Proxy** if you have to add the Proxy IP address.

7.3.3. Connecting the GeniusBox

To connect the GeniusBox to the controller

1. Connect the GeniusBox to the LAN switch and connect the LAN switch to the X10 port on the controller.
2. Configure the GeniusBox on the controller interface as follows:
   a. Click **More > Preference > Accessories > GeniusBox**.
   b. Select **Gateway mode > Gateway**.
   c. Click **Save** to set.



Note:

This pump may send data to Genius Cloud if it's connected. For more information, see P50100048.

Telemetry mode

There are 2 modes available:

All telemetry - The controller sends all telemetry (trends) messages to Genius Cloud.

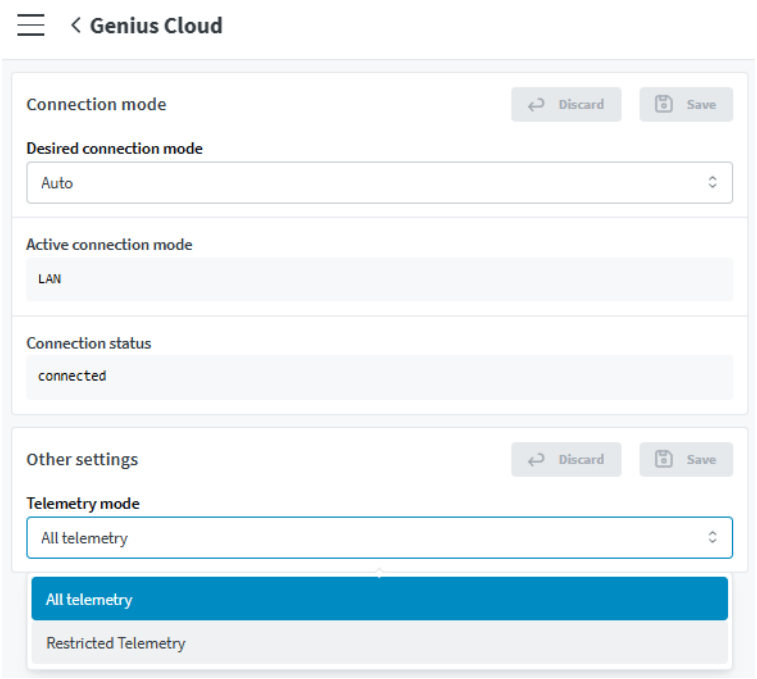
Restricted telemetry - The controller does not send any telemetry (trends) messages to Genius Cloud.

Note:

Message types	All telemetry	Restricted telemetry
Device Information	Sent	Sent
Alerts	Sent	Sent
Telemetry	Sent	Not sent

To change the Telemetry mode, proceed as follows:

1. Navigate to **More**.
2. Click **Preference > Connectivity > Genius Cloud**.
3. Select **Telemetry mode** (All telemetry, Restricted telemetry) based on preferences.



7.3.4. Setting the preferred language

To set your desired language

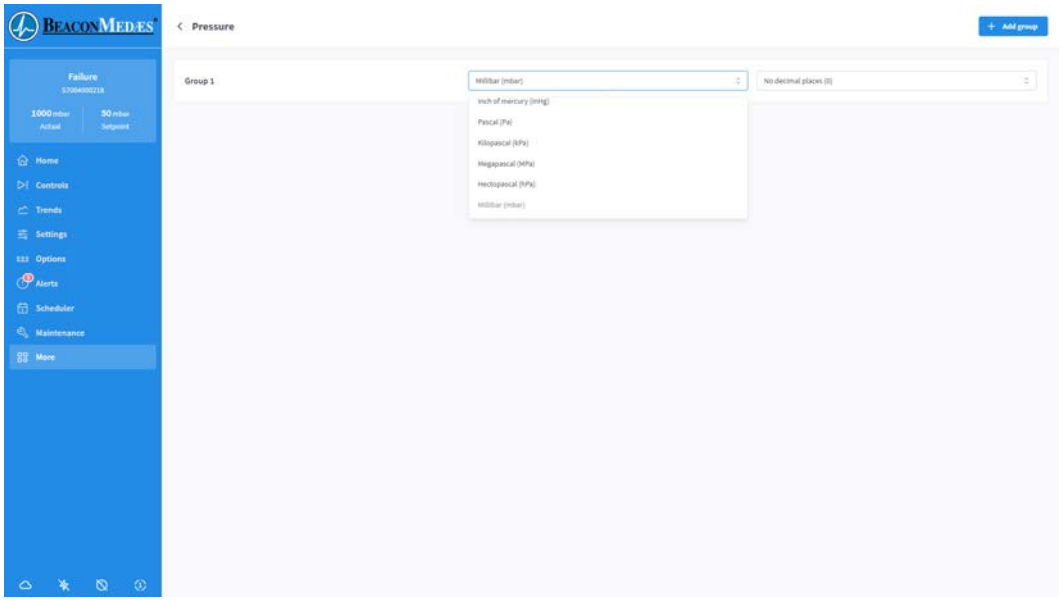
1. Click **More**.
2. Navigate to **Preferences > General > Language.**
3. Select the preferred language.

7.3.5. Setting the physical units

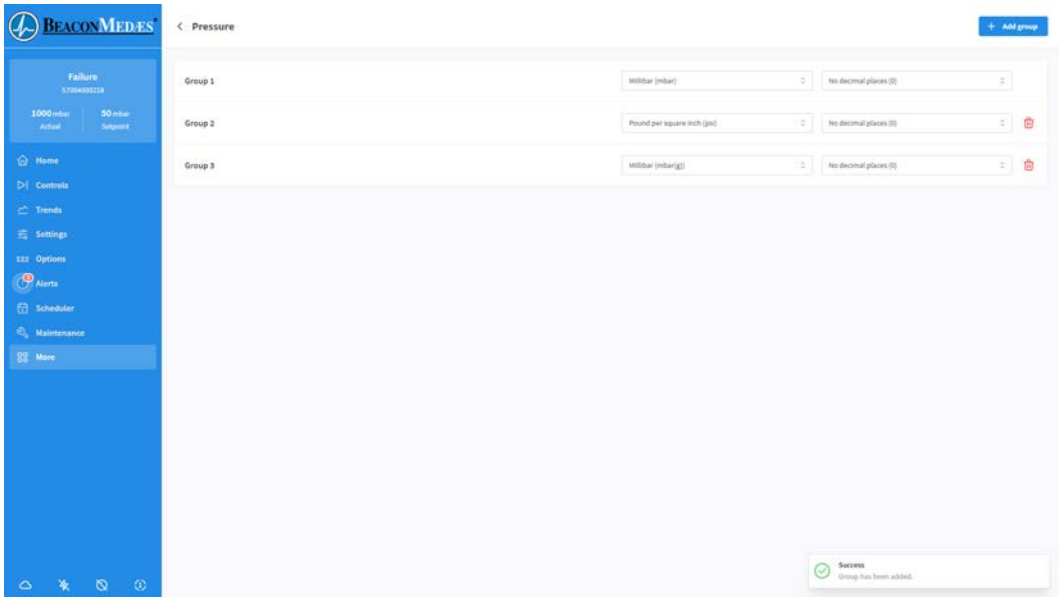
To set the physical parameters units

1. Navigate to **More > Preferences > General > Measures and accuracy**.
2. Here, the units can be modified for individual physical quantities.

3. After selecting the desired physical quantity, the units in **Group 1** can be modified to apply the changes everywhere on the user interface.



4. Additional groups can be created with specific units. These groups can be selected for each parameter on the user interface to change its units.



Note:

*Units for all physical quantities can be quickly switched between **Metric** and **Imperial** using the button in the top right corner in the **Measures and accuracy** page.*

5. To change the units for **Actual Pressure** and **Pressure Setpoint** on the general status box:
   - Modify **Group 1** to change units across the entire user interface. Or
   - Create additional groups and apply them to **Actual Pressure** and **Pressure Setpoint** in:
     - Navigate to **Trends** > **Sensor data** > **Actual Inlet Pressure**
     - Navigate to **Trends** > **Pump data** > **Pressure Setpoint**

Note:

*Relative units (gauge) for pressure can also be used. This represents the difference between the absolute pressure and reference atmospheric pressure. The atmospheric pressure for relative units can be set in **Settings** > **Pressure Regulation** > **Atmospheric Pressure**.*

7.3.6. Setting the date and time

To set the date and time

1. Click **More**.
2. Navigate to **Preferences > General > Date and time**.
3. Modify the time zone, date and time, format of date and time as per requirement.

7.3.7. Creating and updating the user profile

Note:

You must create an admin profile for the user (tier level 1). The admin can use his access to create different user profiles for their use.

To create the user profile

1. Click **More > Manage users > Add user**.
2. Enter the user details.
3. Click **Add.**

To edit or delete the user profile

1. Click **More > Manage users.**
2. Click the dots on the top right corner of user card.
3. Select **Edit or Delete**.

7.3.8. Backup and restore parameter setting

This feature enables the user to backup and restore the parameters saved in the settings.

To backup the parameter values:

1. Navigate to **More > Preference > Software updates**.
2. Click **Backup**.
3. Click **Download**.

To restore the parameter settings:

1. Navigate to **More > Preference > Software updates**.
2. Click **Restore**.
3. Drop or Upload the backup file from your computer.
4. Click **Restore**.

7.3.9. Updating the software

To update the software online:

Update the software online by updating automatically from the controller.

Note:

Make sure to stop the pump before you do the software update. During the software update, do not switch off the power, as this may cause system failure or damage the controller.

1. Click **Download update file** which has been received from the cloud.
2. Click **Install update > Done**.

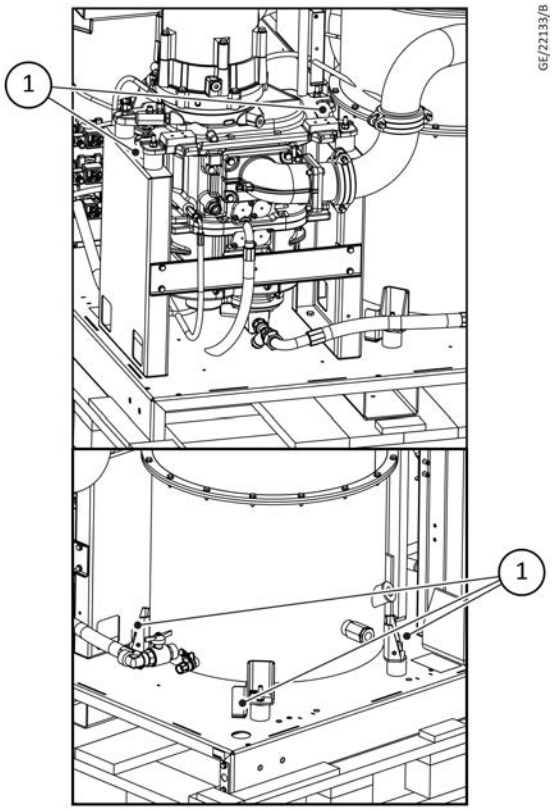
Troubleshooting software update failure

There is a chance of failure when updating the software. To fix the failure issue

1. Click **View log**.
2. Click **Failed** updates.
3. Check more information on failed updates.
4. Click **Download log**.
5. Restart the controller.
6. Repeat the software update.
7. If the problem persists
   - Click on **Download log**.
   - Send the log file and the software update file (if available) through TechConnect to the second level support.

8. Operation

Figure 14 Initial start-up

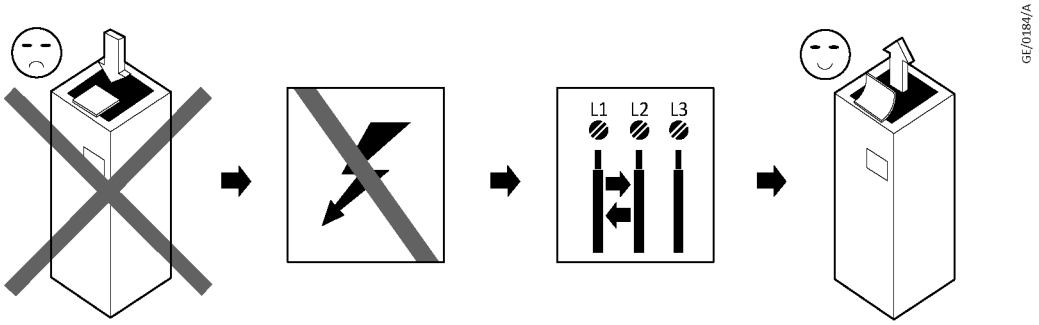


1. Transport spacers

8.1. Initial start-up

1. The operator must obey all relevant safety precautions.
2. Remove the external body (canopy) panels to get access to the internal components.
3. Remove the red transport spacers and the related bolts below the element, coupling housing and oil separator tank.
4. Make sure that the electrical connections correspond to the local codes and that all wires are clamped tight to their terminals.
5. The installation must be earthed and protected against short circuits by fuses of the inert type in all phases. Install an isolating switch near the pump.
6. Check that the process lines are of correct size to prevent high pressure drop and for cleanliness to protect the pump. Also check for leaks.
7. Make sure that the pump outlet is not blocked.
8. Install the inlet isolation valve. Refer to *Installation* on page 31 for the position of the valve.
9. Close the valve.
10. Connect the inlet pipework to the valve.
11. Check the oil level. The oil level must reach the top of the oil sight glass.
12. If necessary, fill the oil through the oil filler plug.
13. Make sure that no dirt enters the oil system.

14. Give labels, warnings as follows:
    - The pump can automatically restart after a voltage failure (if ARAVF is activated, contact us).
    - The pump is automatically controlled and can be automatically restarted.
    - The pump can be remotely controlled.



15. Check the programmed settings.
16. Close the isolation valve.
17. Start and operate the pump for a few minutes. Check that the pump operates normally.
18. Open the inlet isolation valve.

8.2. Start the pump

To start the pump do the steps that follow:

1. Set the electrical supply to on.
2. Make sure that the voltage on LED illuminates.
3. Open the inlet isolation valve.
4. Push the start button on the control panel. The pump operates and the automatic operation LED illuminates.

8.3. During operation

WARNING: OPERATION SAFETY

Risk of injury or damage to equipment. Do not operate the pump with the enclosure panels removed.

Note:

When the automatic operation LED is on, the pump can start automatically.

When the automatic operation LED is on, the controller controls the pump, for example, to load, stop and restart the motors.

Regularly check the oil level during the operation.

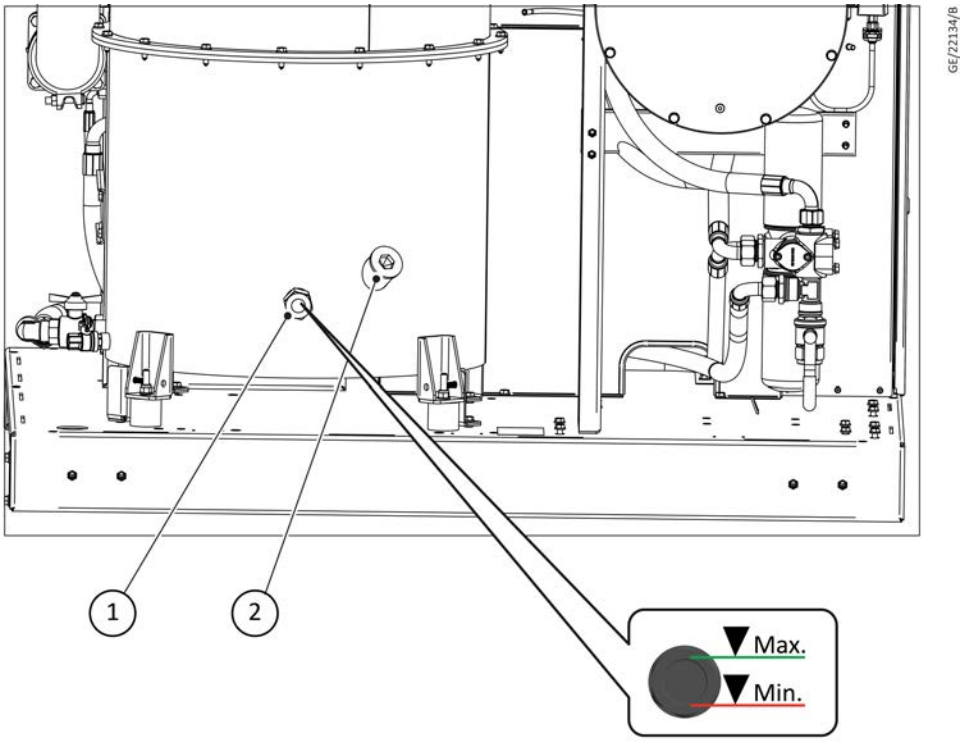
A few minutes after the pump is stopped the oil level should touch the top of the oil sight glass.

If the oil level is too low:

1. Wait until the pump has vented.
2. Push the emergency stop button to prevent the pump from starting unexpectedly.
3. Close the inlet isolation valve.
4. Remove the oil filler plug.
5. Add oil until the oil level touches the top of the oil sight glass.
6. Install and tighten the plug.

7. Unlock the emergency stop button.
8. Select the STOP icon on the display and push reset before you restart.

Figure 15 During operation



1. Oil filler plug *2. Oil sight glass*

Check the display

- Regularly check the display for readings and messages.
- The display shows the vacuum pressure of the pump, and the different icons show the status of the pump.
- If the alarm LED is lit or flashes, correct the fault.
- The display will show a service message:
  - If a service plan interval is exceeded, or
  - If a service level for a monitored component has been exceeded.

8.4. Stop the pump

To shutdown the pump do the steps that follow:

1. Push the stop button. The automatic operation LED flashes and the pump stops.
2. To stop the pump if there is an emergency, push the emergency stop button. An alarm LED flashes.
3. Correct the problem.
4. Pull the button to unlock it.
5. Use the Scroll keys to move the cursor to the blinking icon.
6. Push the Enter key.
7. Push Reset icon.
8. Close the air isolation valve.
9. Set the voltage to off.

Note:

Do not use the emergency stop button to stop the pump unless there is an emergency.

8.5. Taking out of operation

1. Set the electrical supply to off.
2. Shut off and vent the system connected to the pump.
3. To vent the system connected to the pump, open the plug given on the lid of the air inlet filter.
4. Isolate the pump from the vacuum system.
5. Drain the oil.

9. Operating the controller

Start the pump, view the status, pressure, motor speed, and outlet temperature. Change pressure setpoints, change the mode between load-dependent or fixed-speed modes, adjust automatic restart, or set schedule actions.

9.1. Controller data

Table 14 General

Description	Values
Dimension	62.5 x 225 x 124 mm
Weight	450 g
Housing	Plastic
Storage temperature	-30 °C to +70 °C (-22 °F to 158 °F)
Operating temperature	-10 °C to +60 °C (14 °F to 140 °F)
Relative Humidity	10% to 95% (non condensing)
Overvoltage Category	II
Pollution Degree	2
Means of Protection	Class III
Protection powder/liquid	IP20 - Not UL evaluated
Maximum operational altitude	3000 m
Power supply Input	24 V d.c. (-15%/+20%) class 2*
Maximum input Current	1.5 A
Power consumption	8 to 28 W
Auxiliary Relay	10 A@250 V a.c. general use

* Devices shall be supplied with limited energy according to UL 61010-1 3rd Ed, section 9.4 or LPS in conformance with UL 60950-1 or Class 2 in compliance with UL 1310 or UL 1585.

Table 15 External digital outputs

Description	Values
Number of outputs	3
Type	Voltage free contact - Polarized. Do not invert the polarity (refer to Service diagram)
Related voltage/current	maximum 24 V d.c./maximum 0.5 A (Resistive load)

Table 16 External digital inputs

Description	Values
Number of inputs	2
Supply by controller	24 V d.c.

Table 17 External analog outputs

Description	Values
Number of outputs	1 (0-10 V)
	1 (0-20 mA)

Table 18 External analog inputs

Description	Values
Number of inputs	2 (0-10 V)
	2 (0-20 mA)

Table 19 Recommended cable size

Description	Values
Terminal for X1, X2, X6, X15	Solid or fine-stranded conductor = 0.08-1.5mm^2/28-16 AWG; fine-stranded-conductor with ferrule = 0.25-1mm^2
Terminal for X14	Solid or fine-stranded conductor = 0.08-2.5mm^2/28-12 AWG; fine-stranded-conductor with insulated ferrule = 0.25-1.5mm^2 fine-stranded-conductor with uninsulated ferrule = 0.25-2.5mm^2

The controller is an intelligent control box that can fully control and monitor the vacuum pumps with its multiprocessors. It is directly connected to a vacuum pump to control and monitor it. You can also collect data and analyse pump performance to improve processes and lower your operating costs.

The controller can be connected to the cloud, data virtualization, and execute complex algorithms to provide a rich interface for the user on HMI. It also provides support for inputs and outputs to connect multiple sensors for data acquisition and has customizable industrial Ethernet Fieldbus connections such as EtherCAT, Ethernet/IP, Modbus-TCP, and Profinet. It is delivered with Front Panel or Touch HMI (optional), based on your requirements.

9.2. List of abbreviations

Table 20 Abbreviations

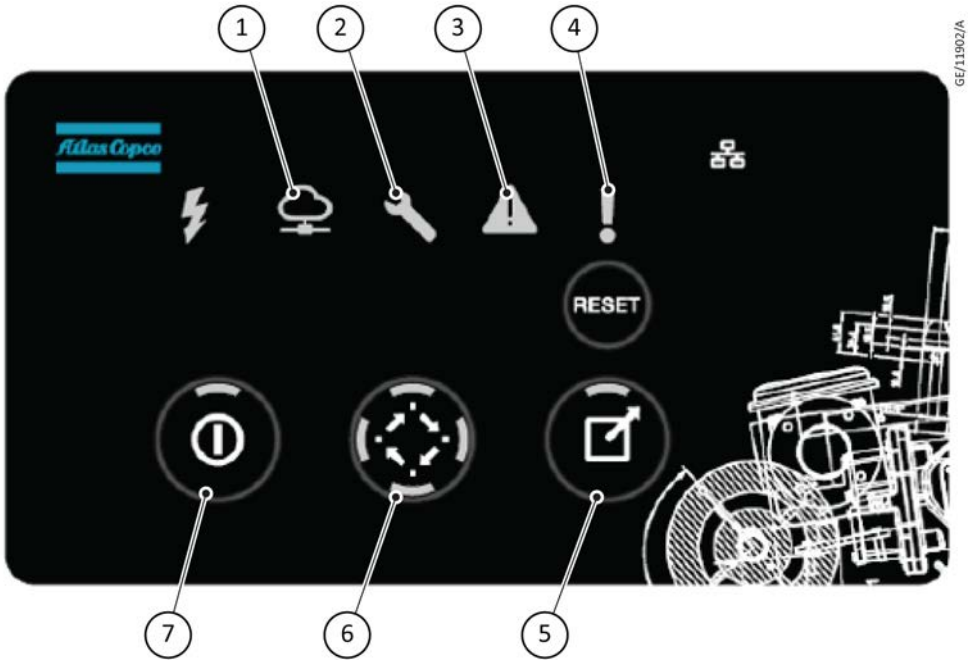
HEX@	HEX@AtlasCopco controller
UI	User Interface
HMI	Human Machine Interface
IP address	Internet Protocol address
DHCP	Dynamic Host Configuration Protocol
ARAVF	Automatic Recovery After Voltage Failure

9.3. Viewing front panel controls

There are following four icons on the front panel that influence the start and stop command.

1. Start/Stop icon - It is a lit up LED which indicates that the pump is in operation.

2. Mode icon - It switches the mode on the pump. A LED is lit up to indicate the active mode.
3. Connection mode icon - It declares the source of pump control.
   - A lit up LED indicates that the pump can be controlled from the front panel.
   - A non-lit LED indicates that the pump is controlled from a different source like from an external PLC.
4. Reset icon - It resets a failure on the pump after the problem is solved.



1. *Cloud connect*
2. *Service*
3. *Warning*
4. *Failure*
5. *Local or Remote control*
6. *Mode select*
7. *Power*

9.4. Touch HMI

The HMI touch screen is mounted on the cabinet door and it is an optional for the front panel. You can modify the pump settings and control the vacuum pump without any additional hardware. Also you can customize the parameters on the HMI display based on your priorities.

GE/20681/A

This equipment is not suitable for use in locations where children are likely to be present.

9.5. Configuring the controller

Configure the controller for your situation and usage.

9.5.1. Accessing User Interface

You can access the controller via the X11 port from appropriate devices.

Connection to X11 supports adjustable IP addresses, which allows connecting multiple devices to a network.

To access the controller

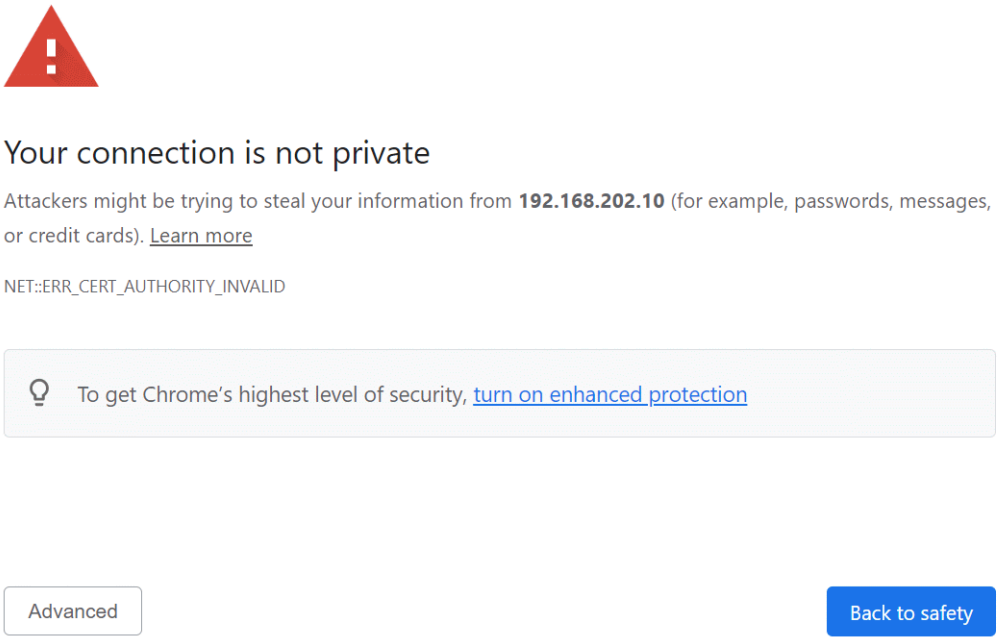
Note:

Your computer must not be connected to another network when you access the controller.

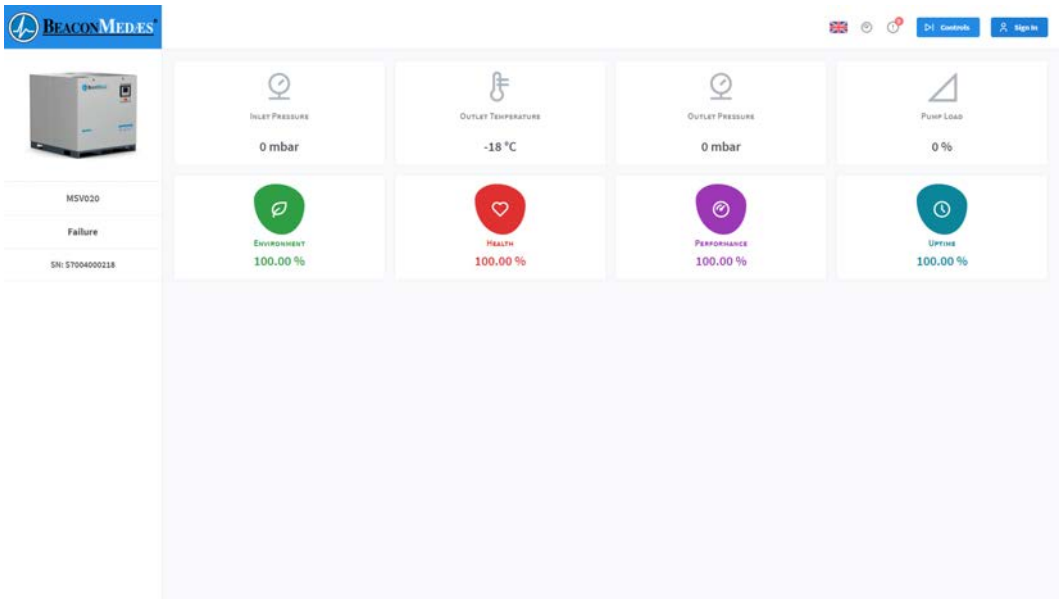
1. Click the browser's address bar.
2. Type the IP address and press Enter (For the IP address, check **Connectivity > LAN setting**. Refer to *Connecting the pump to the local LAN network* on page 54, *Connecting the pump to the local LAN network* on page 71).

Note:

*When you access the user interface, you may get a message "Your connection is not private". Click on **Advanced** and **Proceed to (IP address).***



You will land on the following default page when you have an access to the user interface.



3. To change the display language
   a. Click **Flag** icon.
   b. Select the language of your choice.
4. To change the units
   a. Click **Unit** icon.
   b. Select the unit of your choice.

Note:

You can also choose the measurement system based on the specific country.

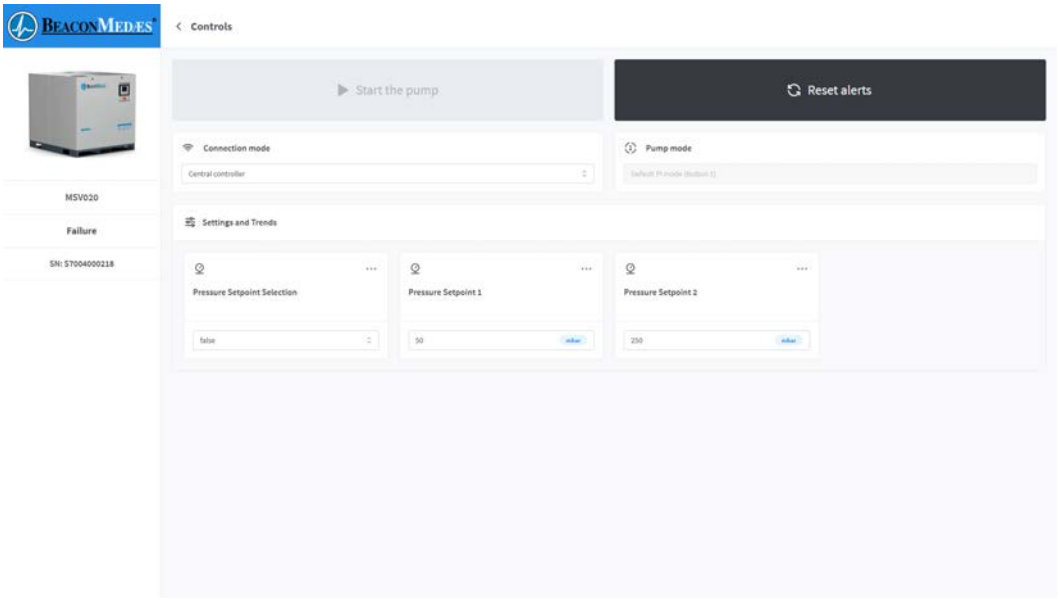
The notifications are displayed along with the **Alert** icon.

5. To access some Controls without login on the touch screen
   a. Click **Controls** button.
   b. Select the controls

c. Modify the values as per requirements.

Note:

You can see the controls such as Start Pump, Reset Alerts, Setting Pressure Set points, Pump Modes, Connection Modes, Team Viewer & Docker. The descriptions of these controls are defined in the below chapters.



6. To Sign-in
   a. Click on **Sign in** button
   b. Type Username and Password.
   c. Click **Sign in**.
   d. Use your login credentials or the credentials available on the label on the controller.

Troubleshooting Windows connection problems

If you cannot access the IP address in your web browser,

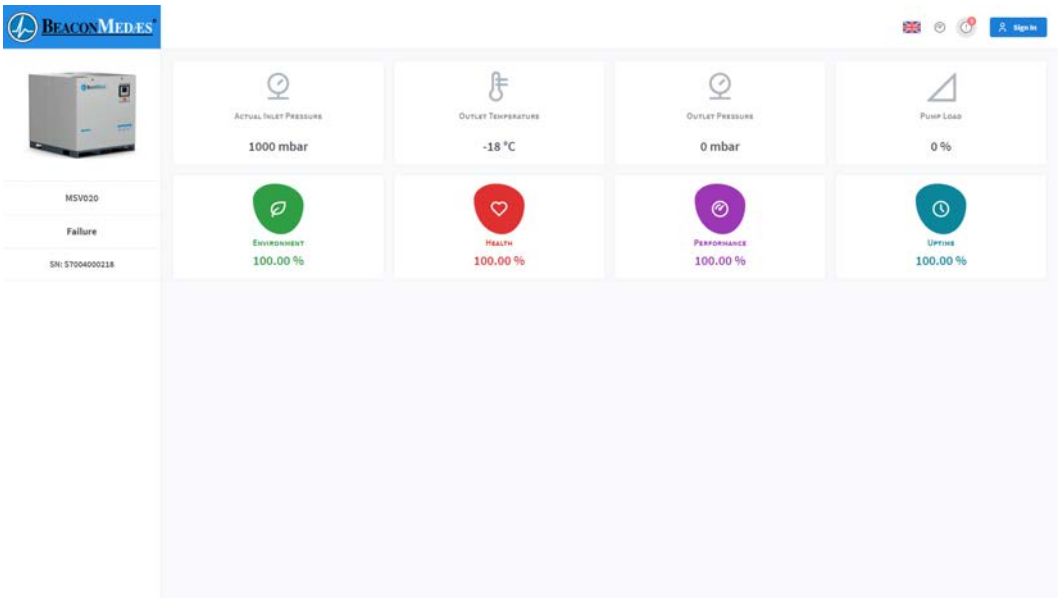
1. Press the "**Windows**" button on the keyboard.
2. Search "**View network connections**".
3. Right click on **Ethernet** or **Adapter** (depending on the ethernet connection).
4. Click **Properties** > **Internet protocol version 4 (TCP/IPv4)** > **Properties** > Use following IP address.
5. Enter IP address within the allowed range based on the LAN settings, refer to *Connecting the pump to the local LAN network* on page 54, *Connecting the pump to the local LAN network* on page 71.

Note:

The IP address placed in IPv4 needs to be different from the IP and Gateway entered in LAN settings, for example IP address is 10.75.100.50 and Gateway is 10.75.100.1, set local IP address on adapter to 10.75.100.99.

6. Click on **Subnet mask** and 255.255.255.0 number must appear.
7. Click **OK**.

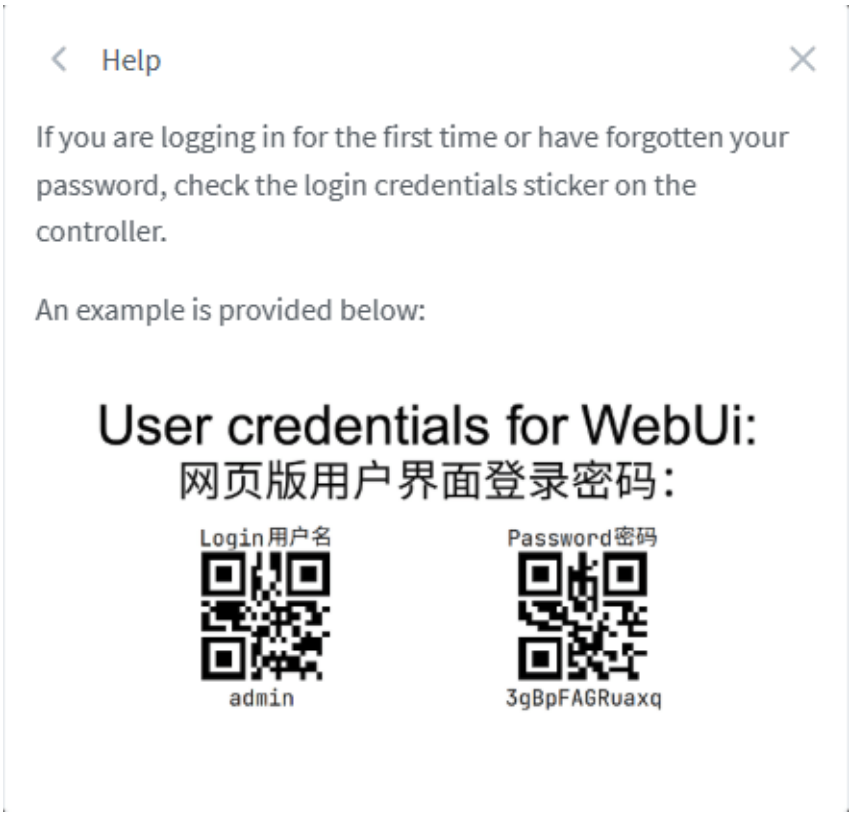
Try to connect through your web browser again.



Entering login credentials

If you are signing in first time or forgot the password, please follow the below procedures:

1. Click **Help** on the sign in page.



2. Make a note of the login credentials.
3. Click "**<**" symbol to go back to previous page.
4. Type Username and Password.
5. Click **Sign in.**

You can change login credentials after your login, refer to *Creating and updating the user profile* on page 58, *Creating and updating the user profile* on page 75.

Viewing controller home page

The default home page displays after the first login.

1. *Genius connection (active/inactive)*
2. *ARAVF function (active/inactive)*
3. *Scheduler (active/inactive)*
4. *Mode number (active)*

The home page is divided into four segments

Section	Functions
Navigation bar	You can see key parts of controller such as ▪ Home ▪ Controls ▪ Trends ▪ Settings ▪ Options ▪ Alerts ▪ Scheduler ▪ Maintenance ▪ More
KPI functionalities	You can see pump parameters such as Eco, Health, Performance and Uptime.
Pump sensor values	You can see pump sensor values.
KPI insight card	Highlights valuable feedback from the machine by showing custom insights.

9.5.2. Connecting the pump to the local LAN network

Note:

Connect the controllers directly to the company network through the X11 port on the rear of the controller with Ethernet cables.

Make sure to use only **Private IPs** for X11 with the following ranges.

Private IPs range	
Use below range	**Do not use below range**
10.0.0.0 - 10.255.255.255	-
172.16.0.0 - 172.31.255.255	172.17.X.X and 172.18.X.X*
192.168.0.0 - 192.168.255.255	192.168.0.X and 192.168.202.X*

** Contact service, If these subnetworks are used and cannot be changed.*

To connect to the controller

1. Navigate to the IP address in a web browser.
   If you do not have the IP address, use the touch screen or contact service.
2. Click **Sign in**.
3. Enter login credentials to access the home page.
4. Click **More > Preferences > Connectivity > LAN**.
5. Check and confirm with the IT department, if the DHCP has been set automatically.
   - If the DHCP is set automatically, the connection is complete.
   - If the DHCP is not set automatically, connect the ethernet manually

Note:

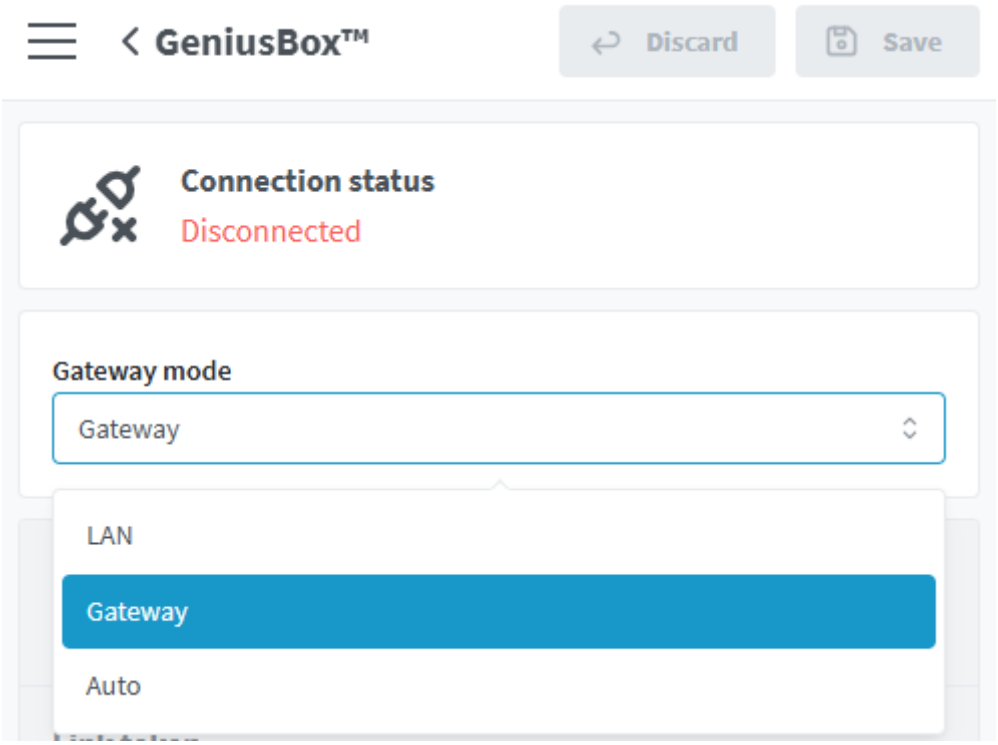
If the DHCP is enabled and supported by the network, the connection details will be selected automatically. If it is not displayed, enter the details manually.

a. Click **Edit.**
b. Deactivate **DHCP**.
c. Enter the connection details manually.
d. Click **Save**.
e. Activate **Proxy** if you have to add the Proxy IP address.

9.5.3. Connecting the GeniusBox

To connect the GeniusBox to the controller

1. Connect the GeniusBox to the LAN switch and connect the LAN switch to the X10 port on the controller.
2. Configure the GeniusBox on the controller interface as follows:
   a. Click **More > Preference > Accessories > GeniusBox**.
   b. Select **Gateway mode > Gateway**.
   c. Click **Save** to set.



Note:

This pump may send data to Genius Cloud if it's connected. For more information, see P50100048.

Telemetry mode

There are 2 modes available:

All telemetry - The controller sends all telemetry (trends) messages to Genius Cloud.

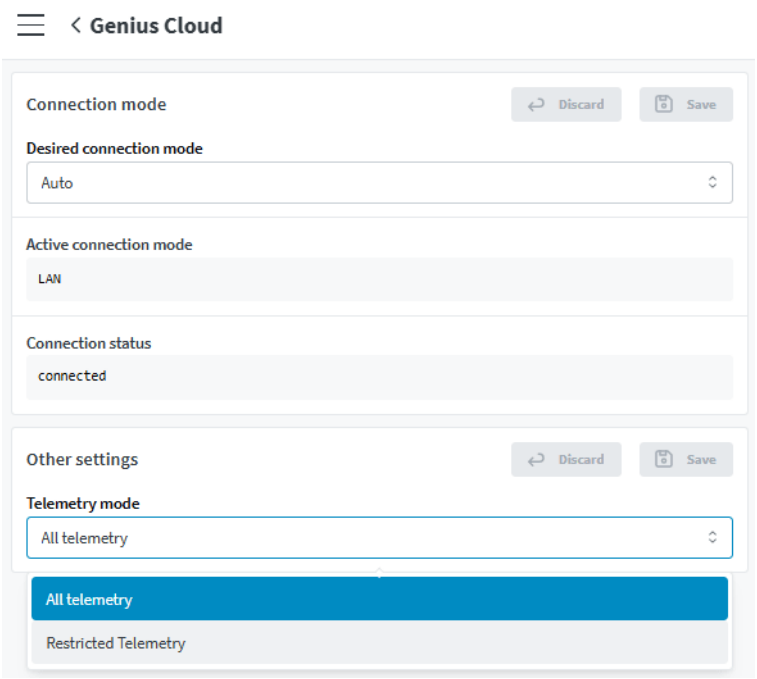
Restricted telemetry - The controller does not send any telemetry (trends) messages to Genius Cloud.

Note:

Message types	All telemetry	Restricted telemetry
Device Information	Sent	Sent
Alerts	Sent	Sent
Telemetry	Sent	Not sent

To change the Telemetry mode, proceed as follows:

1. Navigate to **More**.
2. Click **Preference > Connectivity > Genius Cloud**.
3. Select **Telemetry mode** (All telemetry, Restricted telemetry) based on preferences.



9.5.4. Setting the preferred language

To set your desired language

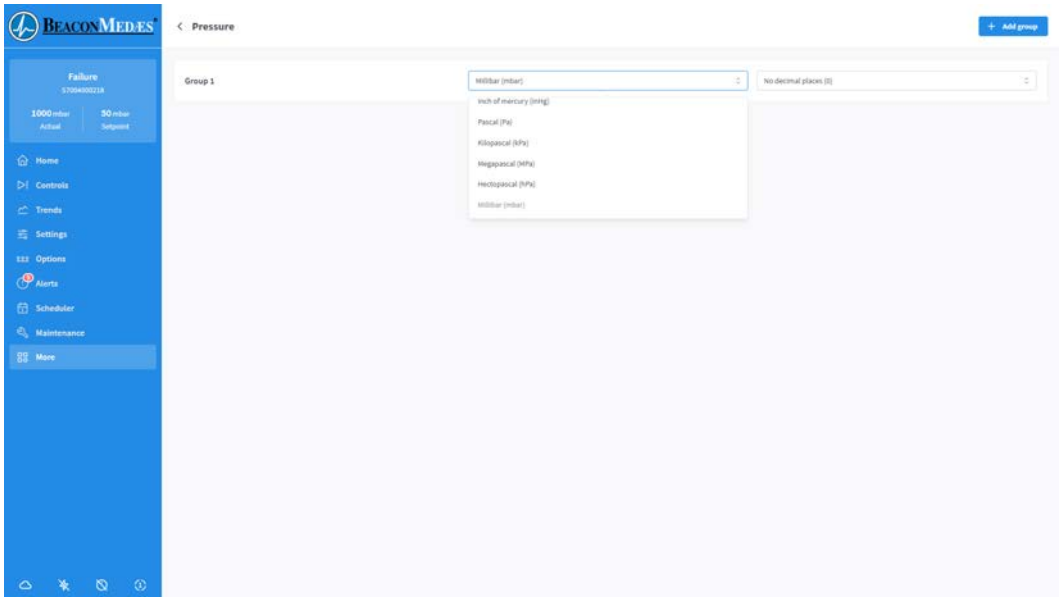
1. Click **More**.
2. Navigate to **Preferences > General > Language.**
3. Select the preferred language.

9.5.5. Setting the physical units

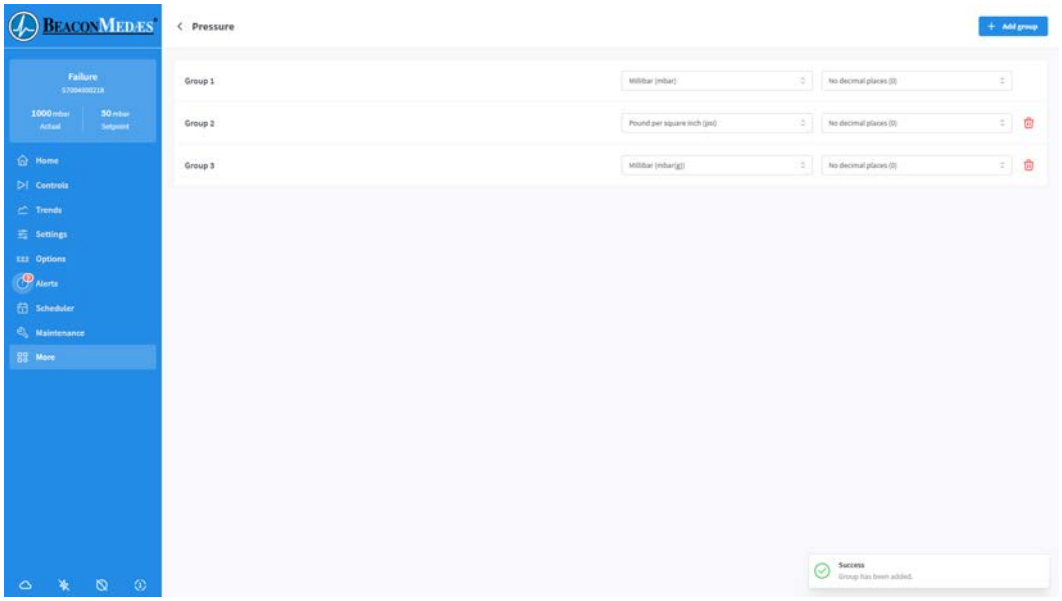
To set the physical parameters units

1. Navigate to **More > Preferences > General > Measures and accuracy**.
2. Here, the units can be modified for individual physical quantities.

3. After selecting the desired physical quantity, the units in **Group 1** can be modified to apply the changes everywhere on the user interface.



4. Additional groups can be created with specific units. These groups can be selected for each parameter on the user interface to change its units.



Note:

*Units for all physical quantities can be quickly switched between **Metric** and **Imperial** using the button in the top right corner in the **Measures and accuracy** page.*

5. To change the units for **Actual Pressure** and **Pressure Setpoint** on the general status box:
   - Modify **Group 1** to change units across the entire user interface. Or
   - Create additional groups and apply them to **Actual Pressure** and **Pressure Setpoint** in:
     - Navigate to **Trends** > **Sensor data** > **Actual Inlet Pressure**
     - Navigate to **Trends** > **Pump data** > **Pressure Setpoint**

Note:

*Relative units (gauge) for pressure can also be used. This represents the difference between the absolute pressure and reference atmospheric pressure. The atmospheric pressure for relative units can be set in **Settings** > **Pressure Regulation** > **Atmospheric Pressure**.*

9.5.6. Setting the date and time

To set the date and time

1. Click **More**.
2. Navigate to **Preferences > General > Date and time**.
3. Modify the time zone, date and time, format of date and time as per requirement.

9.5.7. Creating and updating the user profile

Note:

You must create an admin profile for the user (tier level 1). The admin can use his access to create different user profiles for their use.

To create the user profile

1. Click **More > Manage users > Add user**.
2. Enter the user details.
3. Click **Add.**

To edit or delete the user profile

1. Click **More > Manage users.**
2. Click the dots on the top right corner of user card.
3. Select **Edit or Delete**.

9.5.8. Backup and restore parameter setting

This feature enables the user to backup and restore the parameters saved in the settings.

To backup the parameter values:

1. Navigate to **More > Preference > Software updates**.
2. Click **Backup**.
3. Click **Download**.

To restore the parameter settings:

1. Navigate to **More > Preference > Software updates**.
2. Click **Restore**.
3. Drop or Upload the backup file from your computer.
4. Click **Restore**.

9.5.9. Updating the software

To update the software online:

Update the software online by updating automatically from the controller.

Note:

Make sure to stop the pump before you do the software update. During the software update, do not switch off the power, as this may cause system failure or damage the controller.

1. Click **Download update file** which has been received from the cloud.
2. Click **Install update > Done**.

Troubleshooting software update failure

There is a chance of failure when updating the software. To fix the failure issue

1. Click **View log**.
2. Click **Failed** updates.
3. Check more information on failed updates.
4. Click **Download log**.
5. Restart the controller.
6. Repeat the software update.
7. If the problem persists
   - Click on **Download log**.
   - Send the log file and the software update file (if available) through TechConnect to the second level support.

10. Fieldbus protocol

Fieldbus is a two way communication device. It connects with I/O devices to exchange the data between the system without connecting each individual device to the controller.

10.1. Setup Fieldbus communication

Choose the correct procedure to setup fieldbus communication as per your requirements.

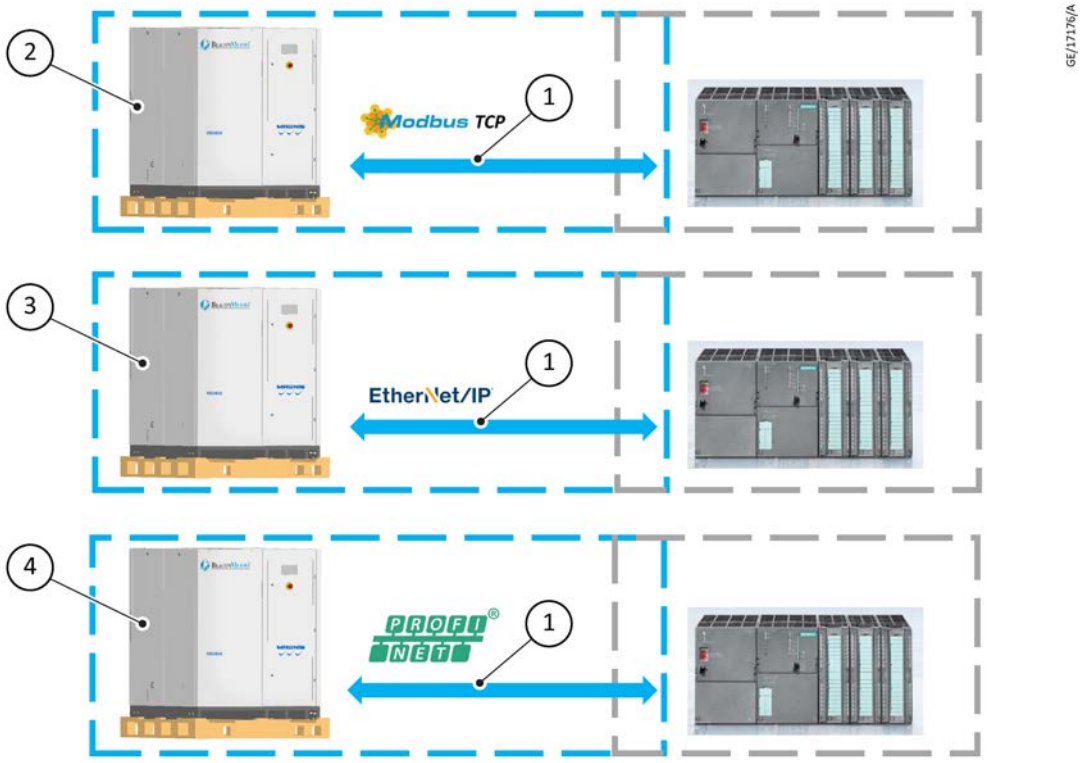
If a fieldbus protocol without gateway needed, refer to *Modbus TCP, EthernetIP, Profinet (without Gateway)* on page 77.

If a fieldbus protocol with gateway needed, do the steps that follows:

- for connecting gateway to one pump, refer to *Gateway connected to one pump* on page 79
- for connecting gateway to multiple pumps, refer to *Gateway connected to multiple pumps* on page 89

10.1.1. Modbus TCP, EthernetIP, Profinet (without Gateway)

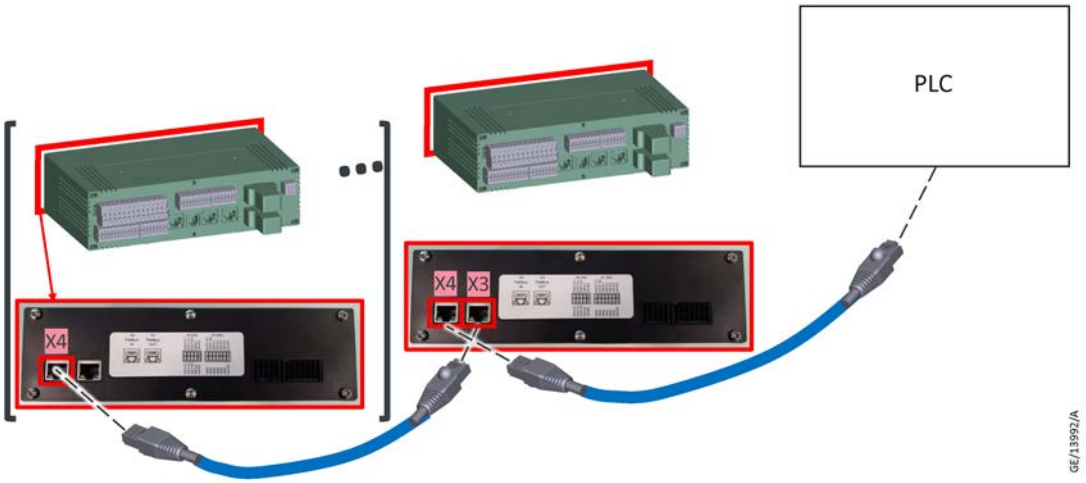
Figure 16 Fieldbus gateway



1. *Ethernet cable*
2. *Modbus TCP license*
3. *EthernetIP license*
4. *Profinet license*

Note:

To connect multiple controllers to the your PLC, connect them in series with Ethernet cables by using ports X3 and X4 of the consecutive controllers.



1. Connect the first controller with the your PLC through port X4.
2. Login to controller user interface.
3. Go to **Options > Fieldbus**.
4. Set the Fieldbus IP address (according to your PLC expert)
5. Set the Fieldbus Subnet Mask (according to your PLC expert).
6. **Set the Fieldbus Gateway** (according to your PLC expert).

Note:

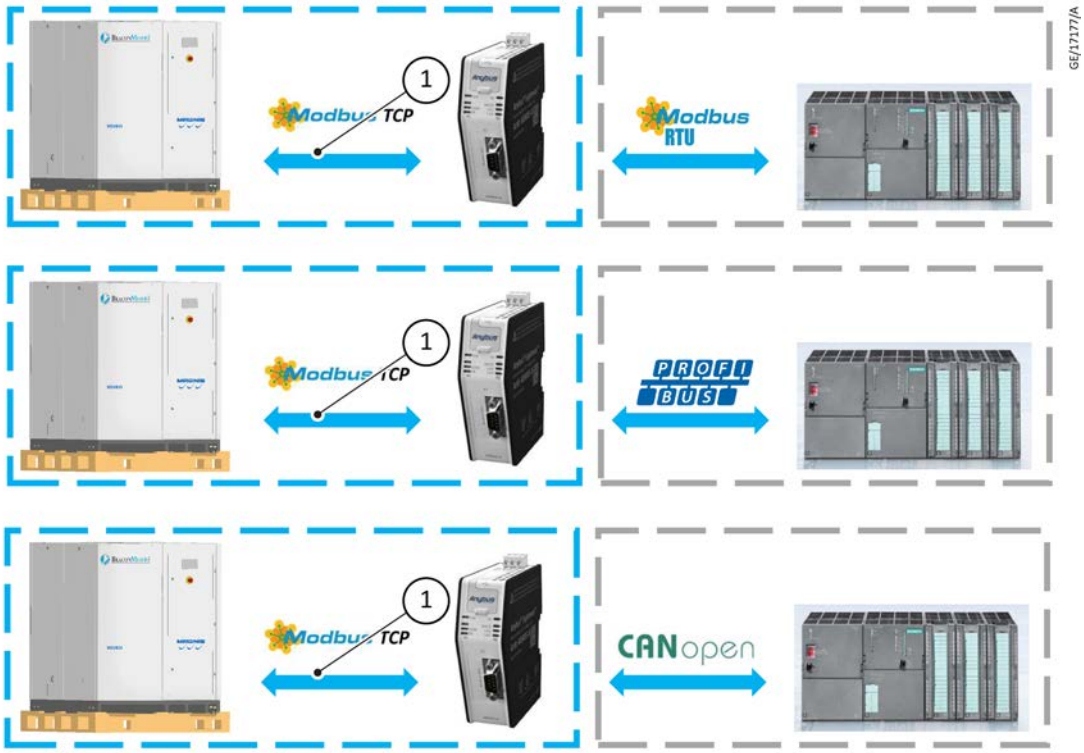
The remaining parameters should be set according to the instruction book or user manual and depending on what you wants to control with your PLC.

Setting a value to true means that the respective setting in the controller is overwritten by your PLC through fieldbus.

7. Power cycle the controller (at least 30 sec) to make sure that fieldbus settings become effective.

10.1.2. CANopen, Profibus, Modbus RTU (with Gateway)

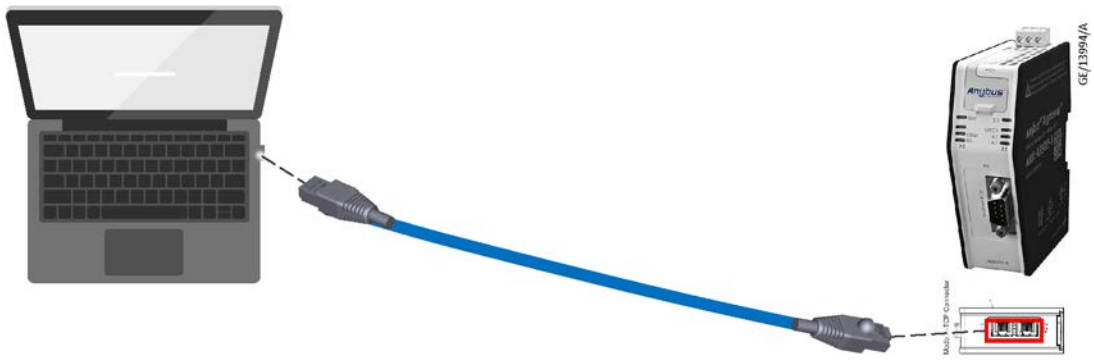
Gateway connected to one pump



1. *Ethernet cable*

There are two possible way to configure the Gateway:

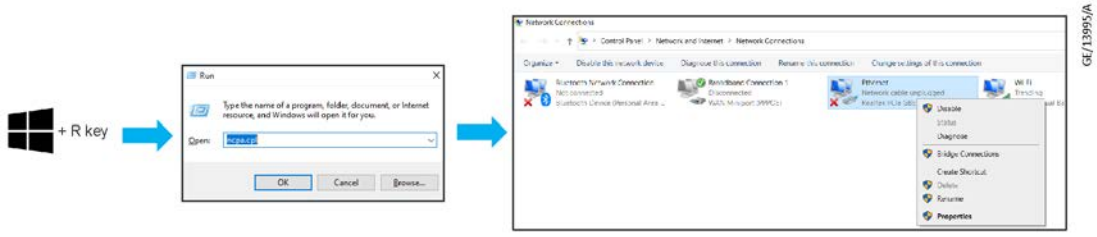
1. If your PLC set up according to pre-configured gateway, then no actions required, continue with Step 28.
2. If pre-configuration of gateway has to be adjusted according to your PLC, do the actions that follow:
   - Connect to gateway with Service Laptop (Step 1-10)
   - Open Anybus Configuration Web Page through default IP address (Steps 12-13)
   - Set fieldbus and gateway IP addresses, subnet masks and standard gateways (Steps 14-27)
   - Possibly adjust other customer-specific settings



Note:

Any of the two ports on the bottom of the gateway works.

1. Connect Laptop to Gateway.
2. Press **Windows + R** button on keyboard to open **Run** window.

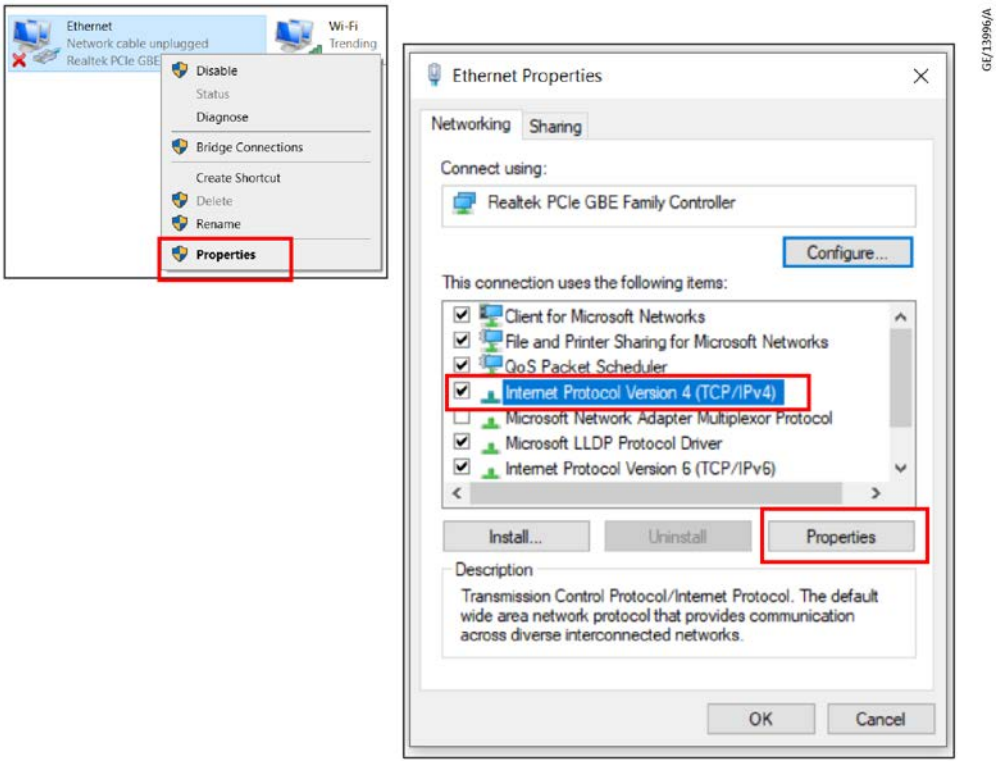


3. Type in **ncpa.cpl** and enter.
4. Right click on Ethernet or Adapter (depending on the ethernet connection).

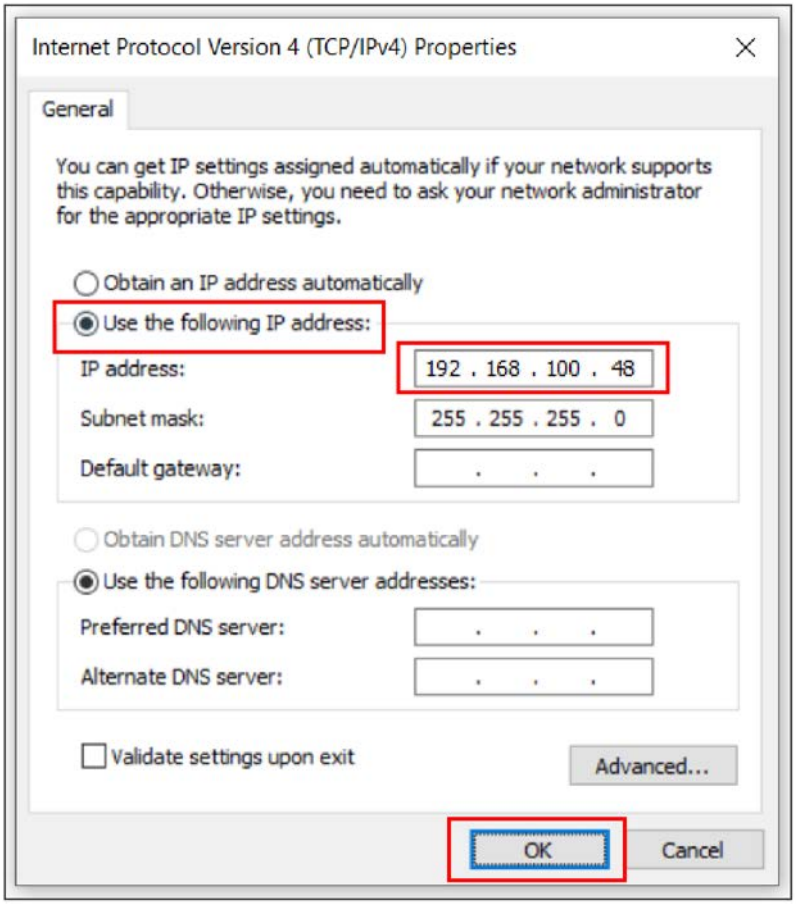
Note:

If you do not know which Ethernet connection is the right one, unplug Ethernet cable to see which Ethernet connection disappears. Then plug in again and proceed with the right one.

5. Click on Properties.

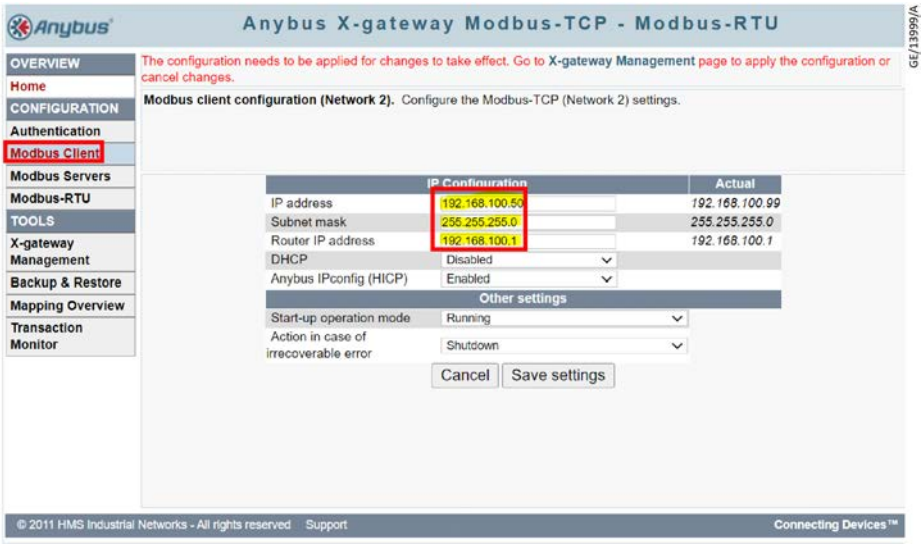


6. Click on **Internet protocol version 4 (TCP/IPv4)**.
7. Click on **Properties**.
8. Click on **Use following IP address**.



9. Enter details as below:
   IP address: 192.168.100.XX (e.g. 48, anything except default gateway IP address)
10. Click on **Subnet mask** and 255.255.255.0 number must appear.
11. Click **OK**.
12. Go to browser.

13. Access the Anybus Configuration Web Page by entering default IP (192.168.100.99).
14. Go to **Client Tab**.



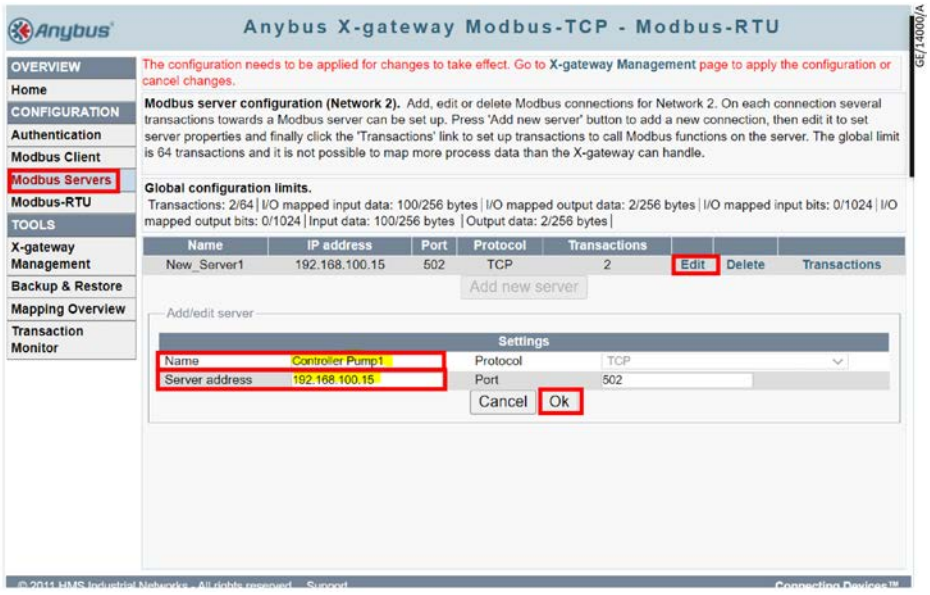
15. Set Gateway IP address, Subnet mask and Router IP address according to your setup.

Note:

Here, IP address is the Gateway IP address in the fieldbus network. It should be different, but in the same range as the IP address of the Controller (fieldbusIpAddress in the Controller user interface).

Subnet mask and Router IP address are usually the same as fieldbusNetMask and fieldbusGateway in the Controller user interface.

16. Go to **Servers Tab**.



17. Click on **Edit**.
18. Change Name (optional).
19. Set Server address (according to your setup).

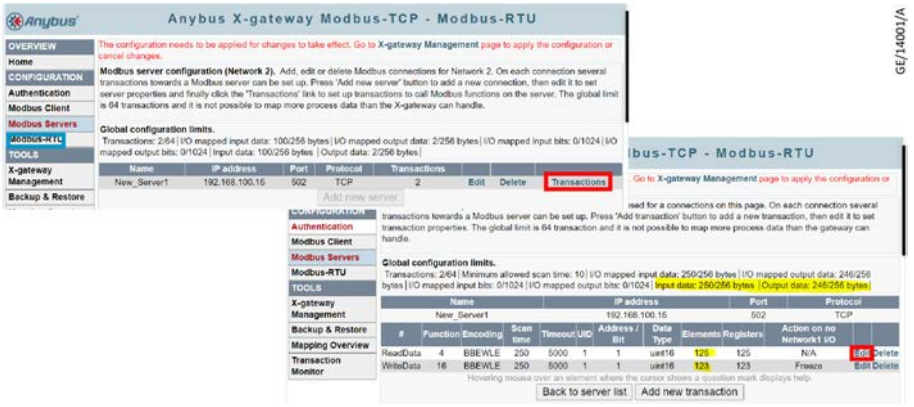
Note:

Server address is the IP address of the Controller in the fieldbus network (same as fieldbusIpAddress in the Controller user interface)

20. Click **Ok** to confirm.
21. Click on **Transactions**.

Note:

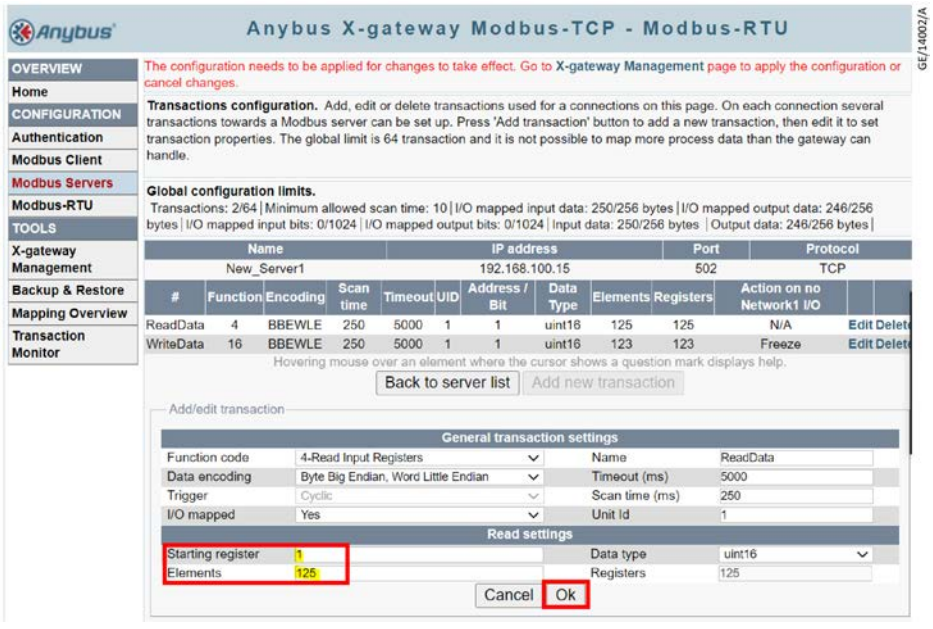
This will change for each protocol (Modbus-RTU, Profibus, CANopen).



22. Click on **Edit or ReadData**.
23. Change the Starting register and number of Elements according to your requirements with help of the read register list in the fieldbus manual.

Note:

Additional Read transactions can be created, if necessary.



For example, If you want to read next 125 elements starting from register 1 then write as follow:

Starting register: 1

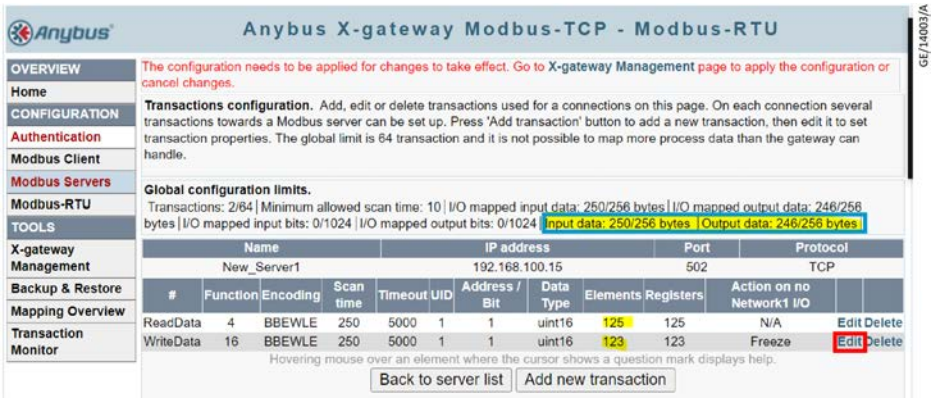
Elements: 125

Example read register list, refer to Table: Reading

↑ Register		Parameter	Type	Unit
0	0x0	systemControl.Started	BOOL	
1	0x1	systemControl.SystemWarning	BOOL	
2	0x2	systemControl.SystemFailure	BOOL	
3	0x3	systemControl.ServiceNeeded	BOOL	
4	0x4	emergencyStop.Active	BOOL	
5	0x5	fan.Energized	BOOL	
6	0x6	gasballast.Energized	BOOL	
9	0x9	mainMotorRunEnable.Energized	BOOL	
10	0xa	inletValve.Energized	BOOL	
11	0xb	outletPressure.Pressure	WORD	mbar
12	0xc	inletPressure.Pressure	WORD	mbar
14	0xe	outletTemperature.Temperature	INT	°C
15	0xf	remoteTemperature.Temperature	INT	°C
16	0x10	remotePressureSensor.Pressure	WORD	mbar
17	0x11	deltaP_RemoteSensor.Pressure	WORD	mbar

GE/14010/A

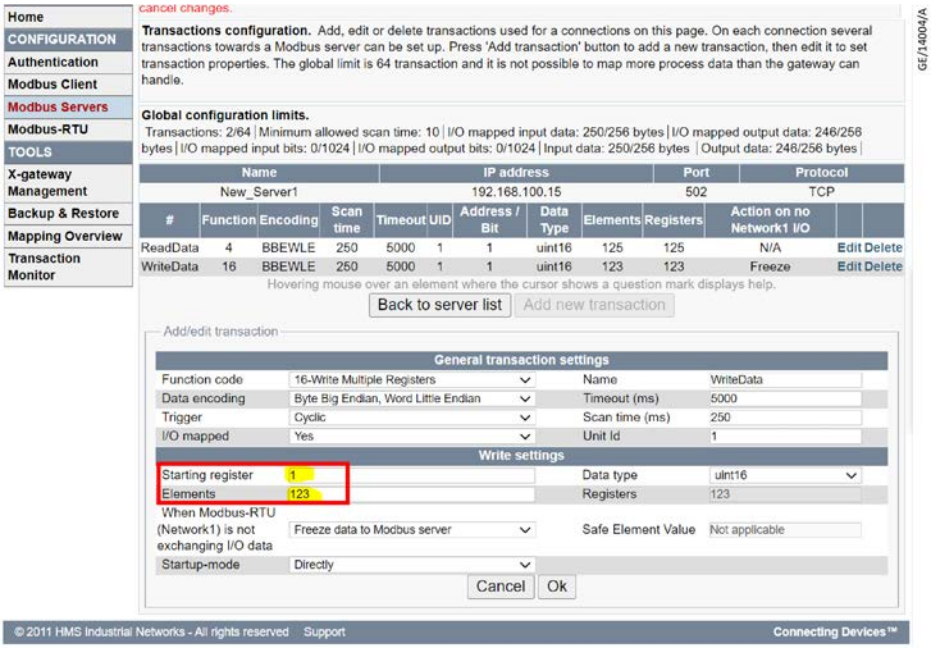
24. Click **Ok** to confirm.



Note:

Take attention to the maximum number of bytes for input (read) and output (write) data. One element corresponds to 2 bytes by default, and the maximum number of bytes for input and output data respectively is 256. If exceeded, a warning will be shown when entering the number of Elements.

25. Click on **Edit or WriteData**.
26. Change the Starting register and number of Elements according to your requirements with help of the write register list in the fieldbus manual.



Note:

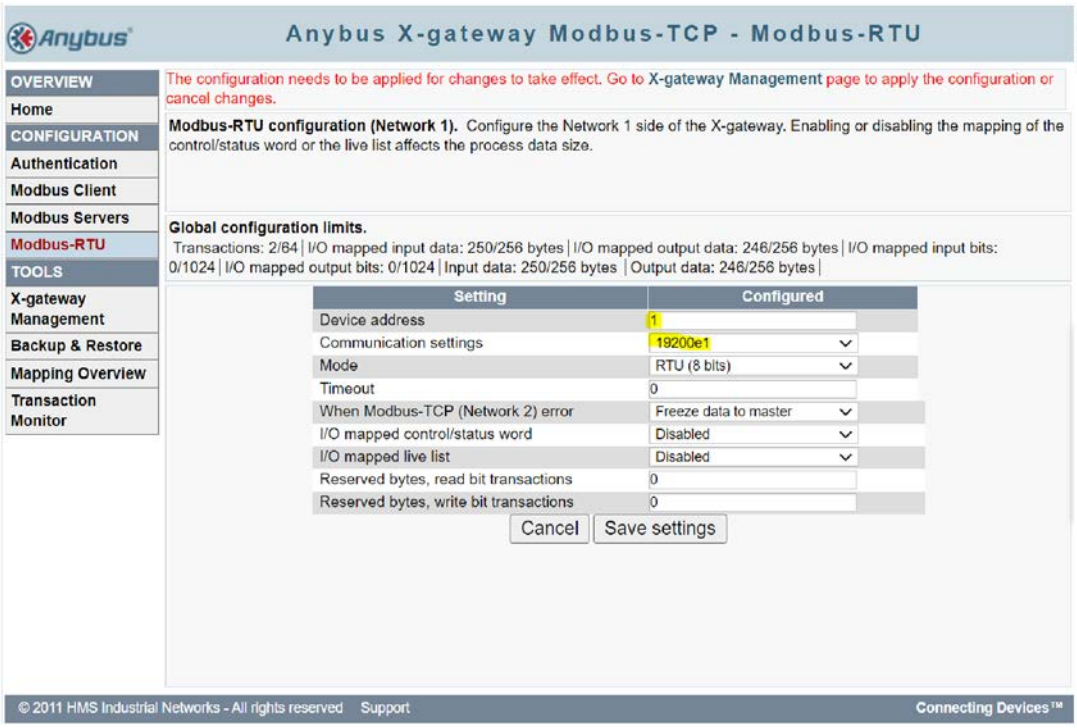
Additional Write transactions can be created, if necessary.

Example of write register list, refer to Table: Writing.

Register		Parameter	Type	Unit
0	0x0	systemControl.FieldbusStart	BOOL	
1	0x1	systemControl.FieldbusResetFailure	BOOL	
2	0x2	systemControl.FieldbusSpeedReference	WORD	rpm
4	0x4	systemControl.FieldbusPurge	BOOL	
5	0x5	systemControl.FieldbusMode	WORD	
7	0x7	pressureSetpoint1.Value	WORD	mbar
8	0x8	pressureSetpoint2.Value	WORD	mbar
9	0x9	forceMaximumSpeed.Value	BOOL	
10	0xa	enableGasBallast.Value	BOOL	
11	0xb	enableFixedSpeedMode.Value	BOOL	
12	0xc	fixedSpeedMode.HoldingSpeed	WORD	rpm
13	0xd	pumpdownOptimization.HoldingSpeed	WORD	rpm
14	0xe	pumpdownOptimization.ActiveDefault	BOOL	
15	0xf	enableLeakDetection.Value	BOOL	
16	0x10	setpointSelection.Value	BOOL	

GE/14011/A

Example of Modbus-RTU settings.



Note:

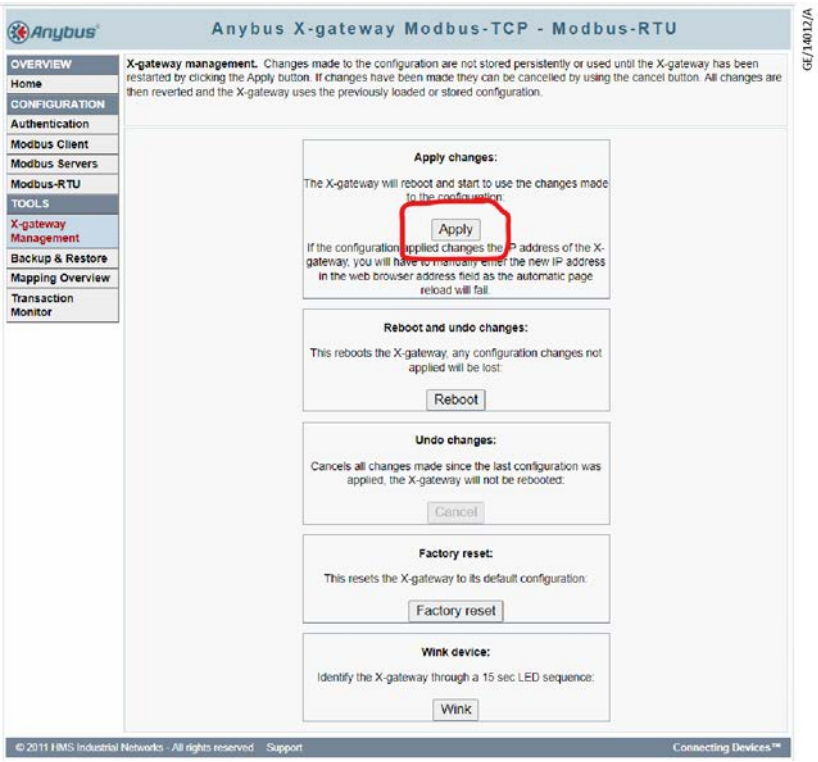
If necessary. additional settings like Device address and communication settings can be done according to the customer requirements.

These settings are different for each protocol (Modbus-RTU, Profibus, CANopen).

27. Go to X-gateway Management and apply the configuration changes.

Note:

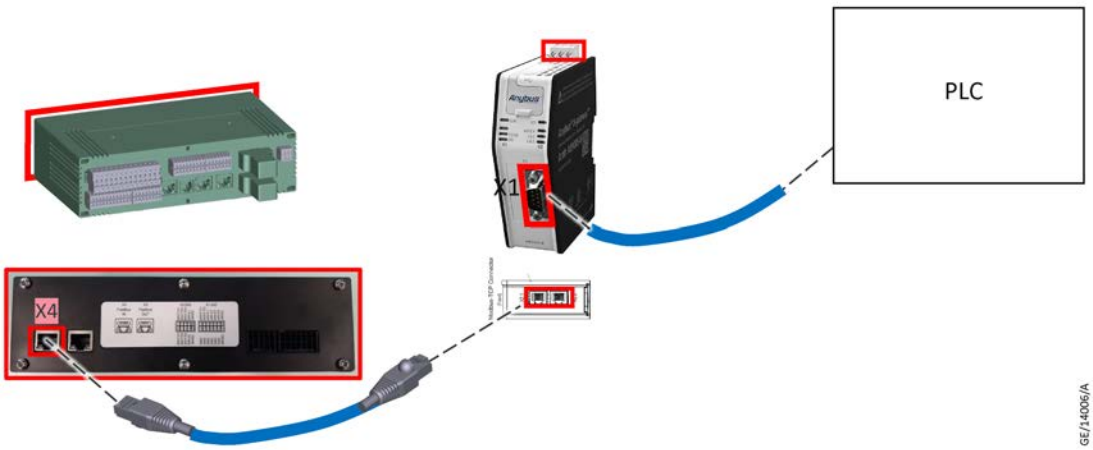
After you click on apply, anybus gateway will reboot and will start automatically with new configuration changes.



28. Connect the controller (port X4) with the Gateway.

Note:

Any of the two ports on the bottom of the Gateway works.



29. Connect power to Gateway.

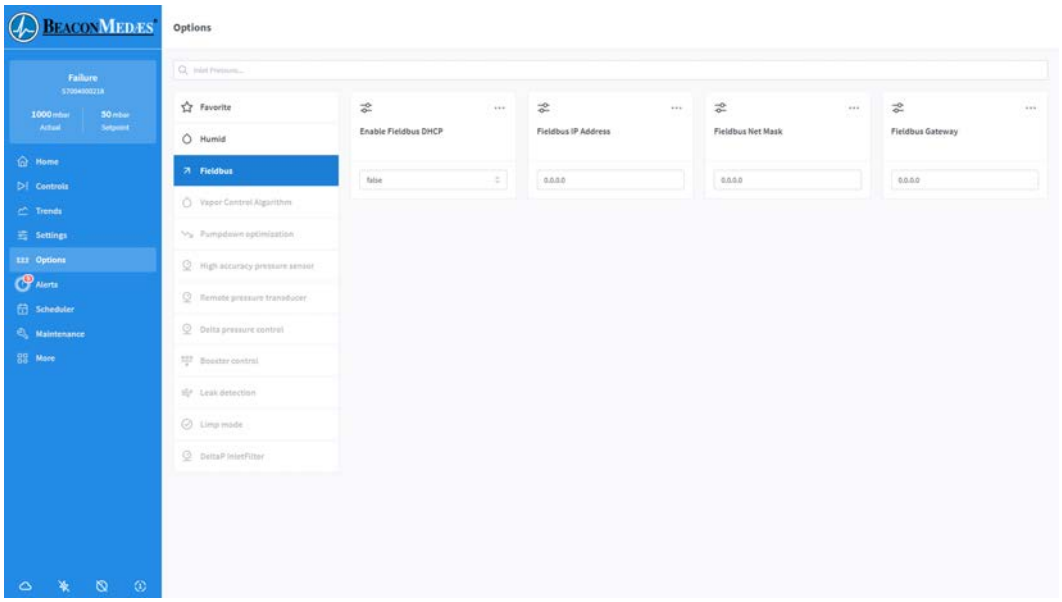
Note:

Pin-assignment depends on fieldbus protocol. Refer to Pin assignments for different fieldbus protocols.

30. Connect the Gateway with the your PLC.
31. Login to controller user interface.

32. Go to **Options > Fieldbus**.

Figure 17 Configuration of fieldbus



33. Set the Fieldbus IP address (according to your PLC expert).
34. Set the Fieldbus Subnet Mask (according to your PLC expert).
35. Set the Fieldbus Gateway (according to your PLC expert).

Note:

The remaining parameters should be set according to the instruction book or user manual and depending on what you wants to control with your PLC.

Setting a value to true means that the respective setting in the controller is overwritten by your PLC through fieldbus.

36. Power cycle the controller (at least 30 sec) to make sure that fieldbus settings become effective.

Pin assignments for different fieldbus protocols

Table 21 CANopen

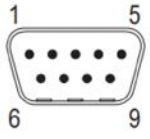
Pin no.	Signal	Description	
1	-	-	 (Male)
2	CAN_L	-	
3	CAN_GND	-	
4	-	-	
5	CAN_SHLD	-	
6	-	-	
7	CAN_H	-	
8	-	-	
9	-	-	

Table 22 PROFIBUS

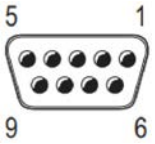
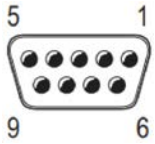
Pin no.	Description	
1	-	 (Female)
2	-	
3	B Line, positive RxD/TxD, RS485 level	
4	RTS	
5	GND bus	
6	+5V bus output	
7	-	
8	A Line, negative RxD/TxD, RS485 level	
9	-	
Housing	Shield	

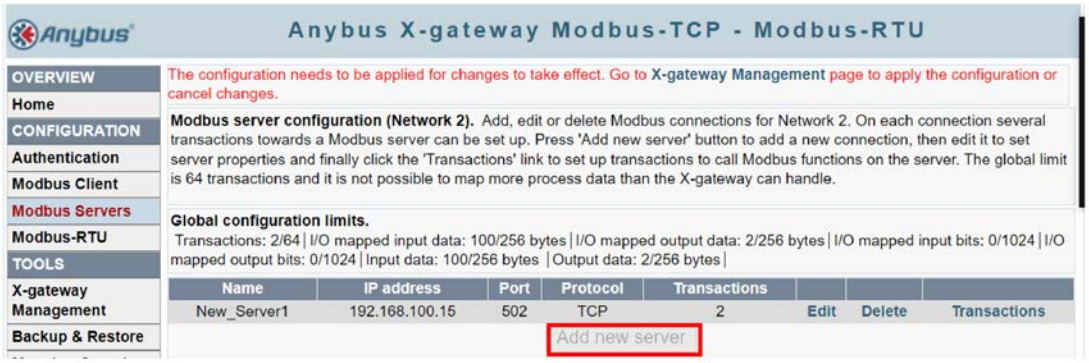
Table 23 Modbus RTU

Pin no.	Signal	Description	
1	GND	Ground	 (Female)
2	5V DC output	-	
3	PMC	Connect to pin 2 for RS-232 operation Leave unconnected for RS-485 operation	
4	-	Not used	
5	A-Line	RS-485+ (D1) (A-Line)	
6	-	Not used	
7	Rx	RS-232 Receive	
8	Tx	RS-232 Transmit	
9	B-Line	RS-485- (D0) (B-Line)	

Gateway connected to multiple pumps

Follow the below procedures to connect the Gateway to multiple pumps:

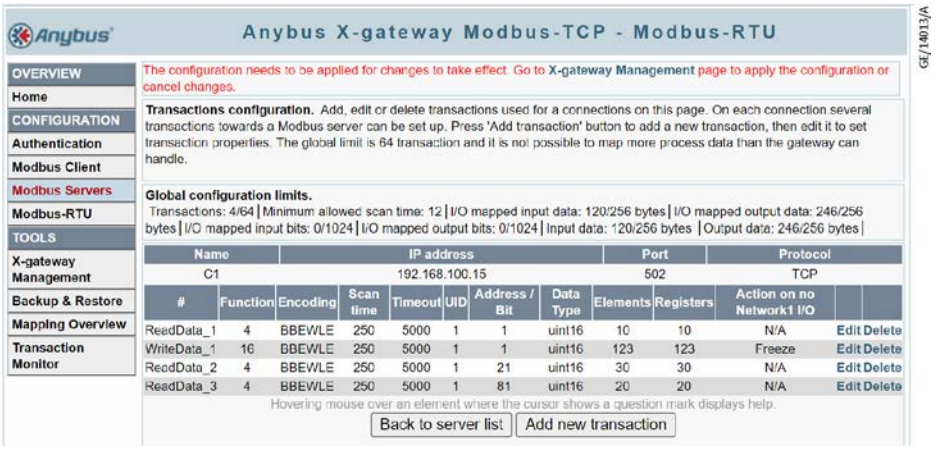
1. Do the procedure to connect the Gateway to one pump. Refer to *Gateway connected to one pump* on page 79.
2. Create Read and Write transactions through the Anybus Configuration Web Page for every pump servers.
3. Click on Add new server and follow the steps of *Gateway connected to one pump* on page 79.
4. Make sure to set the Fieldbus IP address, subnet mask and gateway as well as remaining parameters (to enable writing through the PLC) in each controllers user interface according to your requirements.



Connection of controllers with PLC:

- Daisy chain between controllers, refer to *Modbus TCP, EthernetIP, Profinet (without Gateway)* on page 77.
- Connection to PLC through Gateway, refer to *Gateway connected to one pump* on page 79.

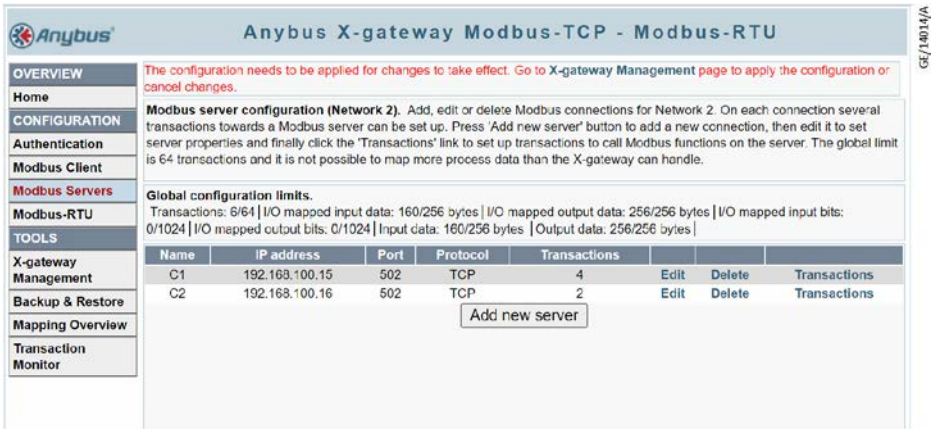
Example for break sequence of registers and addition of multiple controllers with transaction bytes limitations:



If you want to read/write registers with break sequence, for example from Reg 1 – Reg 10, from Reg 21 – Reg 50 and from Reg81 – Reg100, you can create individual transactions for the same as per need of read/write.

Note:

Limit for total read and write data is 256 bytes individually.



If you want to add multiple controllers then click **Add new server** and add number of controllers as per the limit.

Note:

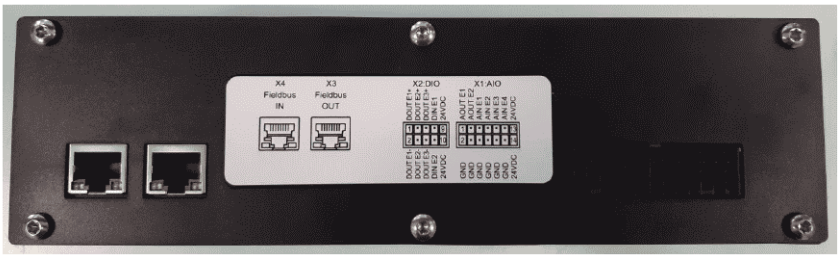
Limit for total read and write data is 256 bytes individually.

10.2. Setup reading and writing of data from fieldbus

The fieldbus functionality is an optional functionality which gives the possibility to connect to the machine over ModbusTCP, Profinet, EtherCAT or Ethernet/IP. Over ethernet, the user can readout machine data and/or control the machine remotely.

10.2.1. Configuration of fieldbus

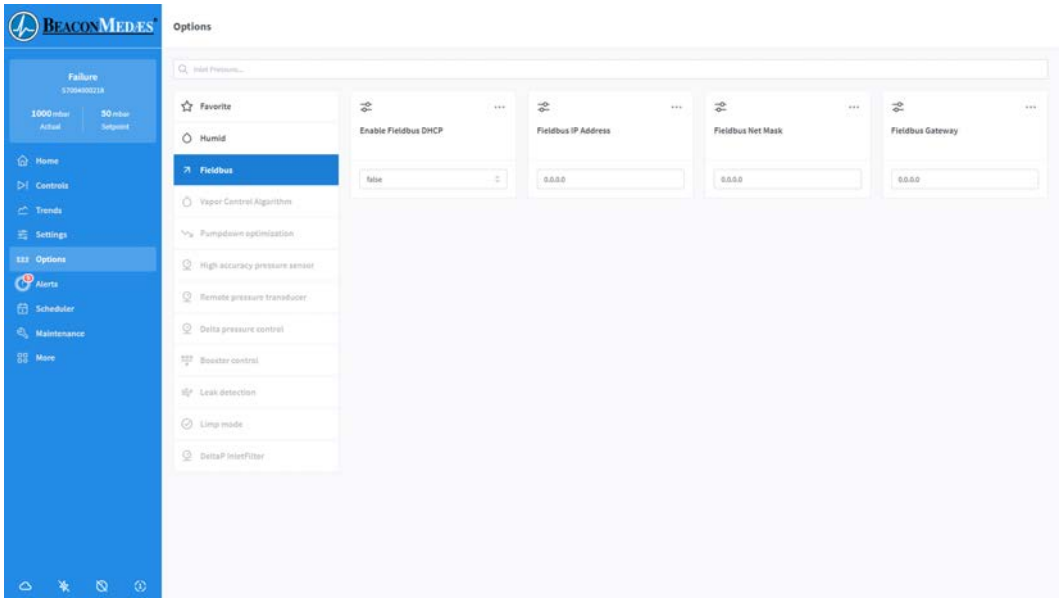
1. Connect an external PLC over ethernet to fieldbus in X4 connector on rear of the controller.
2. If multiple controllers are present, they can be interlinked by connecting controller 1 Out (X3) to controller 2 In (X4).



To setup desired IP address:

1. Navigate to the **Options > Fieldbus** menu.
2. Setup the IP address, gateway, and netmask as required.

Figure 18 Configuration of fieldbus



The Profinet setup requires a GSDML file for the PLC, which can be delivered by the nearest service representative.

10.2.2. Reading

Reading one of the output registers from the mapping can be done without necessary to set any other settings besides the IP address, gateway and Netmask.

There is an Offset of +30000 for Modbus.

The below table shows what information is available in the register.

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (30001+Register no.)
0	systemControl	Started	BOOL		True indicates the pump is started, false indicates it is not started	30001 (bit 0)*
1	systemControl	SystemWarning	BOOL		True indicates a warning is active	30002 (bit 0)*
2	systemControl	SystemFailure	BOOL		True indicates a failure is active, a manual reset is required	30003 (bit 0)*
3	systemControl	ServiceNeeded	BOOL		True indicates service is required	30004 (bit 0)*
4	emergencyStop	Active	BOOL		True indicates the emergency stop is in its normal position, false indicates the button is pressed	30005 (bit 0)*
5	fan	Energized	BOOL		True indicates the fan is running	30006 (bit 0)*
6	gasballast	Energized	BOOL		True indicates the gas ballast valve is open	30007 (bit 0)*
7	scavengeLine	Energized	BOOL		True indicates the scavenge line is closed	30008 (bit 0)*
8	purgeValve	Energized	BOOL		True indicates the purge valve is opened	30009 (bit 0)*
9	mainMotorRunEnable	Energized	BOOL		True indicates the main motor is started	30010 (bit 0)*
10	inletValve	Energized	BOOL		True indicates the inlet valve is opened	30011 (bit 0)*
11	outletPressure	Pressure	WORD	mbar	Indicates pumps outlet pressure	30012
12	inletPressure	Pressure	WORD	mbar	Indicates pumps inlet pressure before the inlet valve	30013
13	inletTemperature	Temperature	INT	°C	Process gas temperature at the inlet of the machine	30014
14	outletTemperature	Temperature	INT	°C	Indicates compressor element outlet temperature	30015
15	remoteTemperature	Temperature	INT	°C	If available, indicates process air temperature	30016
16	remotePressureSensor	Pressure	WORD	mbar	If available, indicates process pressure	30017
17	deltaP_RemoteSensor	Pressure	WORD	mbar	If available, indicates process pressure used for the deltaP option	30018
18	wikaSensor	Pressure	FLOAT	mbar	If available, indicates process pressure	30019

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (30001+Register no.)
20	fanCircuitBreaker	Active	BOOL		True indicates the breaker is normal position, false indicatres it tripped on overcurrent	30021 (bit 0)*
21	mainInverter	ActualSpeed	INT	rpm	Indicates pump motor speed	30022
22	powerCalculator	Sum	DWORD	W	Total active power of the machine	30023
24	mainInverter	RunningTime	DWORD	h	Indicates running hours of the main motor	30025
26	dOut_E1	Energized	BOOL		Indicates the status of digital output contact E1. true means its closed	30027 (bit 0)*
27	dOut_E2	Energized	BOOL		Indicates the status of digital output contact E2. true means its closed	30028 (bit 0)*
28	dOut_E3	Energized	BOOL		Indicates the status of digital output contact E3. true means its closed	30029 (bit 0)*
29	dOut_I1	Energized	BOOL		Indicates the status of digital input contact I1. true means its closed	30030 (bit 0)*
30	dOut_I2	Energized	BOOL		Indicates the status of digital input contact I2. true means its closed	30031 (bit 0)*
31	dOut_I3	Energized	BOOL		Indicates the status of digital input contact I3. true means its closed	30032 (bit 0)*
32	remoteStartStop	Energized	BOOL		True indicates a start is requested from a digital input	30033 (bit 0)*
33	digitalSetpointSelection	Energized	BOOL		True indicates setpoint 2 is requested from a digital input, false indicates setpoint 1 is requested	30034 (bit 0)*
34	remoteManualPurge	Energized	BOOL		True indicates a manual purge is requested from a digital input	30035 (bit 0)*
35	remoteMaxSpeed	Energized	BOOL		True indicates a maximum pump speed is requested from a digital input	30036 (bit 0)*
36	pressureSetpointSelec-tor	Setpoint	WORD	mbar	Currently active pressure setpoint	30037
37	systemControl	CloudConnected	BOOL		True means the pump is connected to the cloud	30038 (bit 0)*

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (30001+Register no.)
38	systemControl	CurrentMode	WORD		Indicates the current pump mode	30039
39	inletPressureAI	Failure	BOOL		True means the inlet pressure sensor of the pump failed	30040 (bit 0)*
40	outletPressureAI	Failure	BOOL		True means the outlet pressure sensor of the pump failed	30041 (bit 0)*
41	mainInverter	Failure	BOOL		True means the main inverter of the pump failed	30042 (bit 0)*
42	outletTemperature	Failure	BOOL		True means the outlet temperature sensor of the pump failed	30043 (bit 0)*
43	ain_E4	Failure	BOOL		True means the analog input A4 signal is not valid	30044 (bit 0)*
44	ain_E2	Failure	BOOL		True means the analog input A2 signal is not valid	30045 (bit 0)*
45	prePurge	Ready	BOOL		Indicates if the pump has a sufficiently hot outlet temperature so that pre purge is not required	30046 (bit 0)*
46	powerIntegrator	Work	DWORD		Indicates total energy consumption of the pump since start	30047
48	pressureSensorSelector	Setpoint	WORD	mbar	Indicates the currently active pressure sensor used for pressure setpoint control	30049
49	loadCounter	Time1to20	DWORD	h	Indicates the pumps operating time between 1 and 20% of its maximum load	30050
51	loadCounter	Time20to40	DWORD	h	Indicates the pumps operating time between 20 and 40% of its maximum load	30052
53	loadCounter	Time40to60	DWORD	h	Indicates the pumps operating time between 40 and 60% of its maximum load	30054
55	loadCounter	Time60to80	DWORD	h	Indicates the pumps operating time between 60 and 80% of its maximum load	30056
57	loadCounter	Time80to100	DWORD	h	Indicates the pumps operating time between 80 and 100% of its maximum load	30058
59	mainMotorRunEnable	SwitchCount	DWORD		Indicates number of motor starts	30060

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (30001+Register no.)
61	fan	SwitchCount	DWORD		Indicates number of fan starts	30062
63	numberOfEmergency-Stops	Count	DWORD		Indicates number of emergency stops	30064
65	systemControl	UseSpeedRefer-ence	BOOL		True means the pump is listening to an exter-nal speed reference	30066 (bit 0)*
66	inletTemperature	Failure	BOOL		Indicates the gas temperature at the inlet of the machine	30067 (bit 0)*
67	energy_Recovery_Wa-ter_In	Failure	BOOL		Indicates the inlet water failure in the option-al water cooler	30068 (bit 0)*
68	energy_Recovery_Wa-ter_Out	Failure	BOOL		Indicates the outlet water failure in the op-tional water cooler	30069 (bit 0)*
69	energy_Recovery_Wa-ter_In	Temperature	INT	°C	Indicates the inlet water temperature to the optional water cooler	30070
70	energy_Recovery_Wa-ter_Out	Temperature	INT	°C	Indicates the outlet water temperature to the optional water cooler	30071
71	systemControl	CurrentState	WORD		System current state 1 = Startup 2 = Off 3 = Run up 4 = Standby 5 = Run down 6 = Failure 9 = Vacuum control 10 = Pre purge 11 = Post purge 13 = Manual purge 14 = Leak detection	30072

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (30001+Register no.)
72	systemControl	CurrentMaster	INT		System current master 1 = Front panel 2 = Fieldbus 3 = Hardware IO 4 = Central controller 5 = Local webUI 6 = Remote webUI	30073
74	performanceDataEsti-mator	ExpectedFlow	WORD	m^3/h		30075
75	ain_E1	Failure	BOOL			30076 (bit 0)*

** The register type of our controller side is BOOL, but the type read and written by our PLC side is WORD.*

Note:

Output data will be in Big Endian format. For example, if the pressure value in the pump is 700 mbar. Then in Hex, the value will be 02 BC, but in the output you will get BC 02.

10.2.3. Writing

Writing a setting defined in the mapping below requires an extra setting from the user.

To write any of the inputs,

1. Enable the linked **'enablefieldbus'** setting in the **Options > Fieldbus** menu.
   - For example, if the user wants to start/stop the pump over fieldbus, the enablefieldbustart should be set to true. Only then it will get overwritten by the fieldbus.
   - The others will use the local setting.

Figure 19 Fieldbus setting

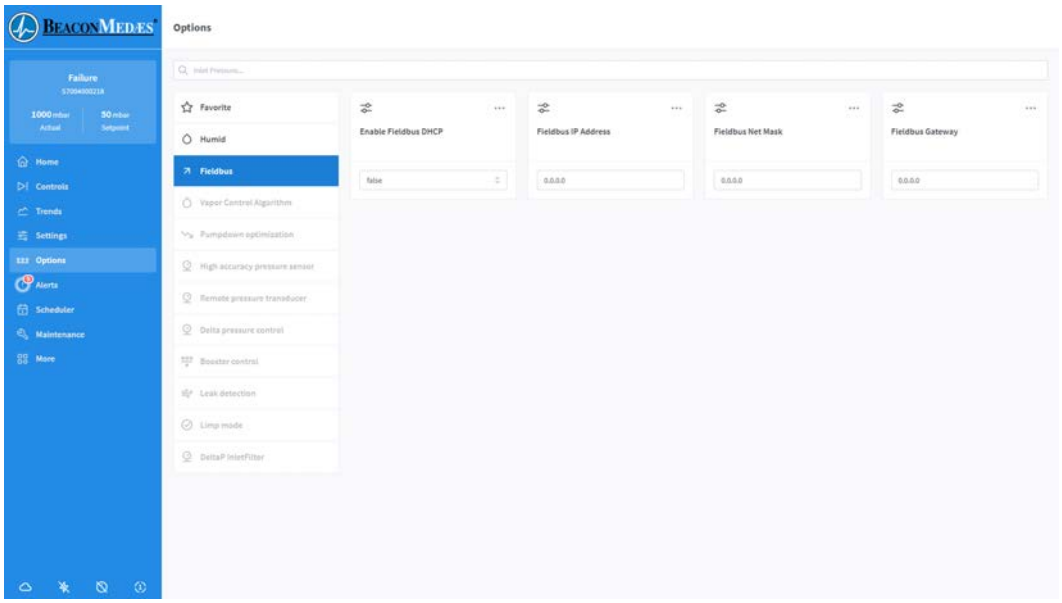


Table 24 Writing register data

In order to write registers 0, 2, 4 and 5 the connection mode must be set to fieldbus.

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (40001+Register no.)
0	systemControl	FieldbusStart	BOOL		True means the pump will start, false means the pump will stop	40001 (bit 0)*
1	systemControl	FieldbusResetFailure	BOOL		Shortly enable to reset any pump alarm	40002 (bit 0)*
2	systemControl	FieldbusSpeedReference	WORD	rpm	Enable to control the motor speed over fieldbus. Faulty motor speeds will be limited automatically to avoid harm to the pump	40003
4	systemControl	FieldbusPurge	BOOL		Enable to request a manual purge to the pump. Disable will stop the manual purge	40005 (bit 0)*
5	systemControl	FieldbusMode	WORD		Sets the pump mode	40006
7	pressureSetpoint1	Value	WORD	mbar	Sets pressure setpoint 1	40008
8	pressureSetpoint2	Value	WORD	mbar	Sets pressure setpoint 2	40009
9	forceMaximumSpeed	Value	BOOL		Forces the pump to maximum speed	40010 (bit 0)*
10	enableGasBallast	Value	BOOL		Forces the gas ballast open	40011 (bit 0)*
11	enableFixedSpeedMode	Value	BOOL		Enabled fixed speed mode, meaning the pump will run at predefined speeds	40012 (bit 0)*
12	fixedSpeedMode	HoldingSpeed	WORD	rpm	Sets the holding speed of the fixed speed mode	40013
13	pumpdownOptimization	HoldingSpeed	WORD	rpm	Sets the holding speed of the pump-down optimization option	40014
14	pumpdownOptimization	ActiveDefault	BOOL		Enables the pumpdown optimization option if available on the pump	40015 (bit 0)*

Register	Component	Parameter	Type	Unit	Notes	PLC side Modbus RTU/TCP Address (40001+Register no.)
15	enableLeakDetection	Value	BOOL		Enable to start a leak detection cycle next time a start command is given when this option is available	40016 (bit 0)*
16	setPointSelection	Value	BOOL		Set to true to switch from Setpoint1 to Setpoint2	40017 (bit 0)*
17	speedLimit	MaxSpeedFactor	WORD			40018

** The register type of our controller side is BOOL, but the type read and written by our PLC side is WORD.*

Note:

Output data will be in Big Endian format. For example, if the pressure value in the pump is 700 mbar. Then in Hex, the value will be 02 BC, but in the output you will get BC 02.

10.2.4. Direct communication with Modbus TCP - Customer side PLC expert

Defined the address mapping in the Modbus network according to the Register address of the controller. You can query the register address of the controller, then it read and write according to Modbus function code.

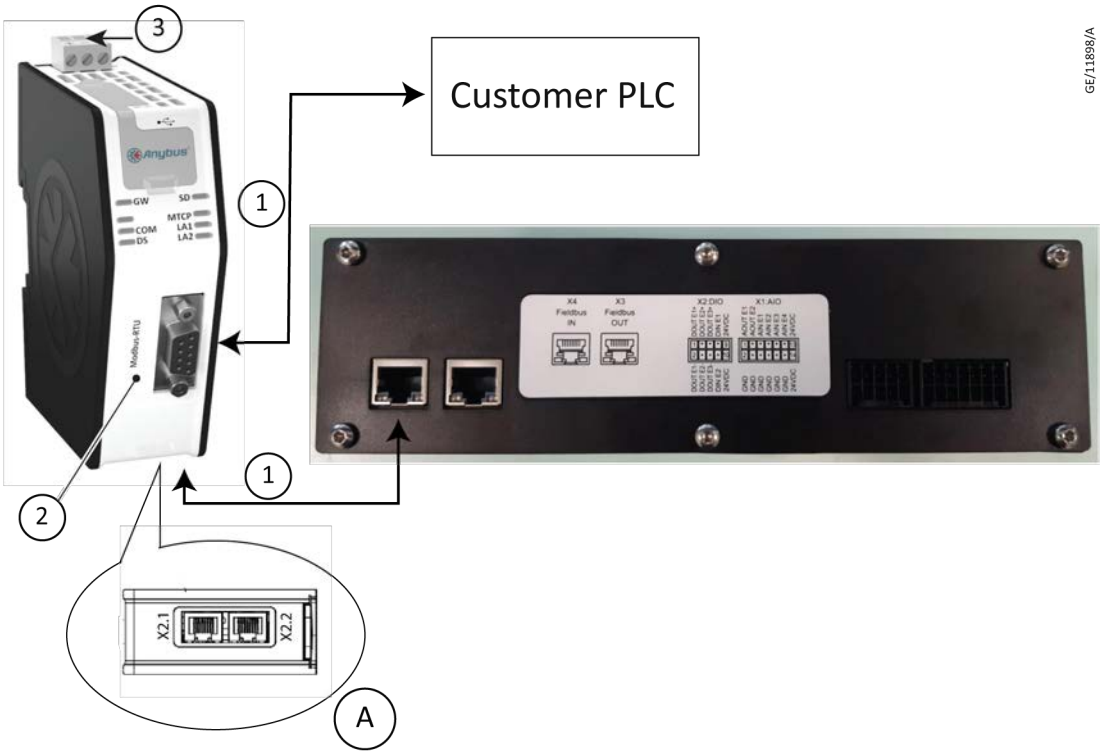
10.3. Fieldbus gateway

Fieldbus gateway allows you to seamlessly inter-connect PLC control systems and their connected devices between Modbus-TCP and other networks such as Modbus-RTU, Profibus and CANOpen.

The primary function of the gateway is the fast transfer of cyclic I/O data between the two networks. This offloads your PLC from working with additional calculations. The gateway acts as a follower on the PLC side network and as a full Master/Client on the Modbus-TCP Controller.

10.3.1. Anybus X-Gateway Modbus-TCP to Modbus-RTU with the Controller

1. Get the pre-configured gateway.
2. Connect the 24V power supply to the power port in gateway.
3. Connect Ethernet Cable in any Modbus TCP Port (there are two ports) in gateway. The other end to the Controller Fieldbus X4 IN.



1. Ethernet cable
2. Modbus-RTU port
3. Ethernet cable
4. Power supply

Status LEDs

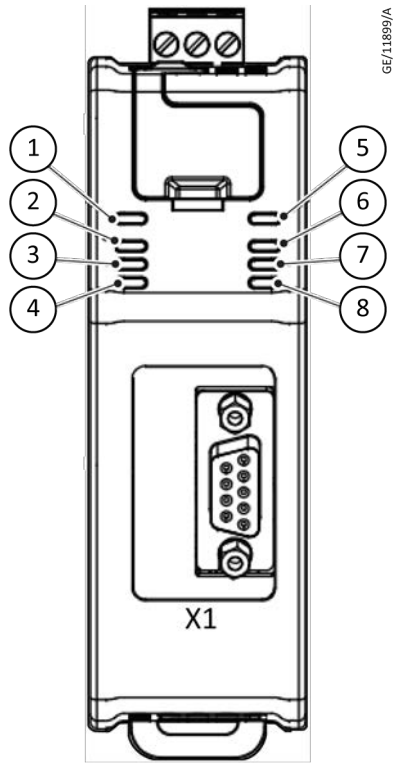


Table 25 LEDs: X-gateway and Modbus-TCP Network

No	Name	Indication	Meaning
1	Gateway Status (GW)	Off	Power off
		Alternating red/green	Missing configuration
		Flashing green	Idle
		Green	Running
		Flashing red	Invalid configuration
		Red	Fatal error
5	SD Card Status (SD)	Green	Accessing SD card
		Flashing red	Failure
6	Modbus-TCP Status (MTCP)	Off	No Modbus-TCP network communication
		Green	Communicating with Modbus-TCP network
		Flashing red	Transaction error or timeout
		Red	Fatal error
7	Ethernet Link 1 and 2 (LA1, LA2)	Off	No link
		Flashing green	Receiving/transmitting Ethernet packets at 100 Mbit
8		Flashing yellow	Receiving/transmitting Ethernet packets at 100 Mbit

Table 26 LEDs: Modbus-RTU Network

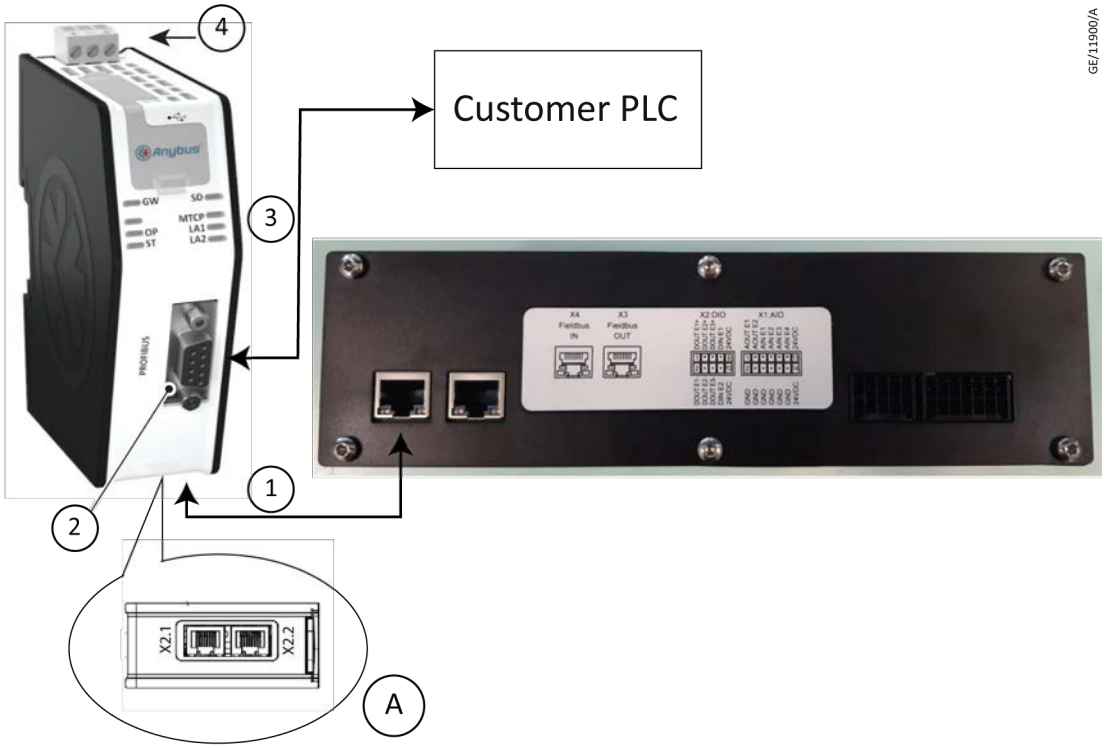
No	Name	Indication	Meaning
2	Not used	-	-
3	Modbus-RTU Communication (COM)	Off Yellow Red	No traffic Frame reception or transmission Fatal error
4	Device Status (DS)	Off Green Red Red, one flash	Initializing Module initialized, no error Fatal error Communication error or configuration error

Note:

Output data will be in Big Endian format. For example, if the pressure value in the pump is 700 mbar. Then in Hex, the value will be 02 BC, but in the output you will get BC 02.

10.3.2. Anybus X-Gateway Modbus-TCP to Profibus with the Controller

1. Get the pre-configured gateway.
2. Connect the 24V power supply to the power port in gateway.
3. Connect Ethernet Cable in any Modbus TCP Port (there are two ports) in gateway. The other end to the Controller Fieldbus X4 IN.



1. Ethernet cable
2. Profibus port
3. Profibus connector
4. Power supply

Status LEDs

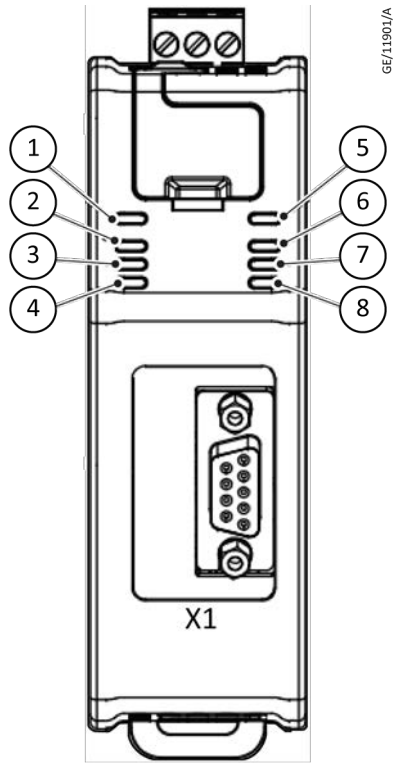


Table 27 LEDs: X-gateway and Modbus-TCP Network

No	Name	Indication	Meaning
1	Gateway Status (GW)	Off	Power off
		Alternating red/green	Missing configuration
		Flashing green	Idle
		Green	Running
		Flashing red	Invalid configuration
		Red	Fatal error
5	SD Card Status (SD)	Green	Accessing SD card
		Flashing red	Failure
6	Modbus-TCP Status (MTCP)	Off	No Modbus-TCP network communication
		Green	Communicating with Modbus-TCP network
		Flashing red	Transaction error or timeout
		Red	Fatal error
7 8	Ethernet Link 1 and 2 (LA1, LA2)	Off	No link
		Flashing green	Receiving/transmitting Ethernet packets at 100 Mbit
		Flashing yellow	Receiving/transmitting Ethernet packets at 100 Mbit

Table 28 LEDs: Profibus Network

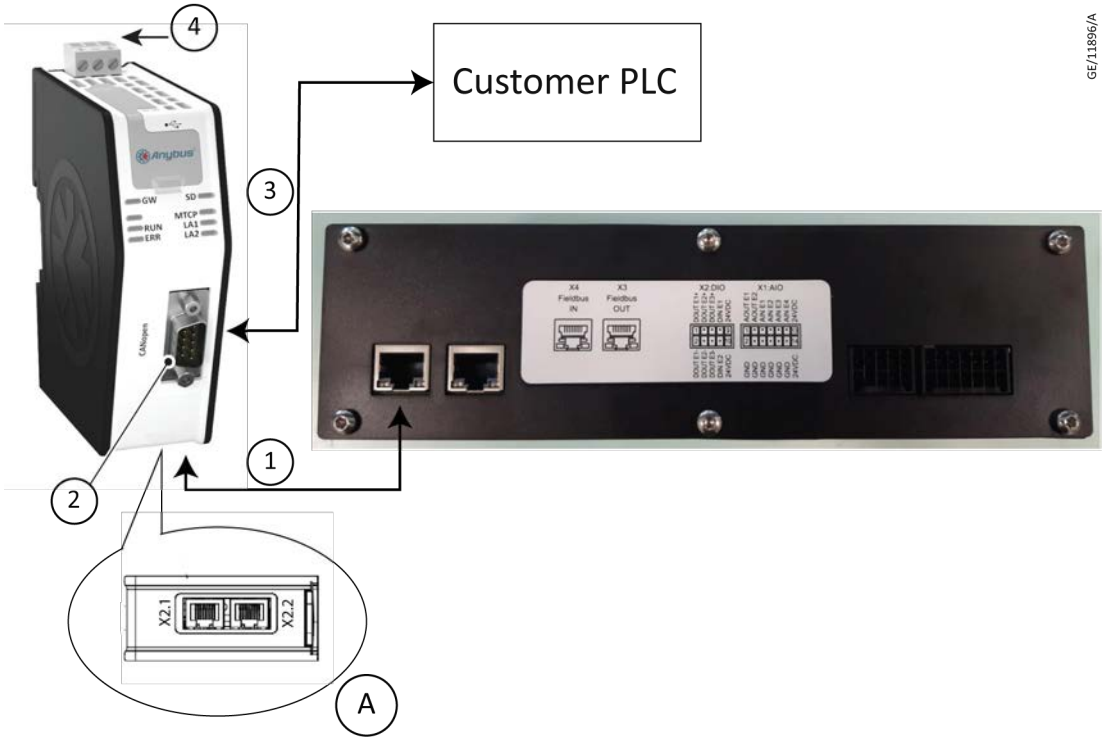
No	Name	Indication	Meaning
2	Not used	-	-
3	Network Status (OP)	Off Flashing green Green Flashing red (1 flash) Flashing red (2 flashes)	Not online Online, clear Online, data exchange Parameterization error Configuration error
4	Module Status (ST)	Off Green Red	Not Initialized Initialized Fatal error

Note:

Output data will be in Big Endian format. For example, if the pressure value in the pump is 700 mbar. Then in Hex, the value will be 02 BC, but in the output you will get BC 02.

10.3.3. Anybus X-Gateway Modbus-TCP to CANOpen with the Controller

1. Get the pre-configured gateway.
2. Connect the 24V power supply to the power port in gateway.
3. Connect Ethernet Cable in any Modbus TCP Port (there are two ports) in gateway. The other end to the Controller Fieldbus X4 IN.



1. *Ethernet cable*
2. *CANOpen port*
3. *Profibus connector*
4. *Power supply*

Status LEDs

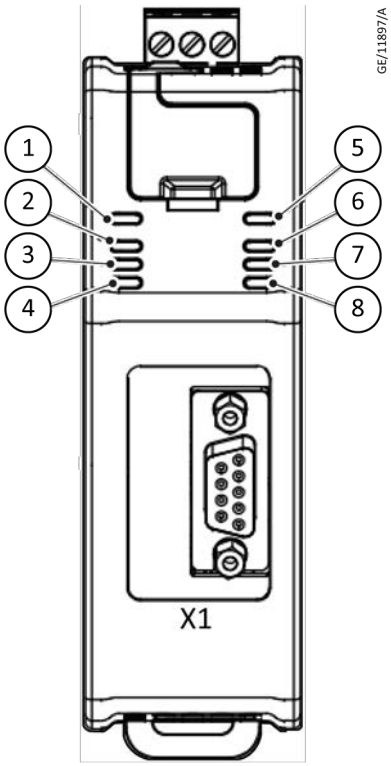


Table 29 LEDs: X-gateway and Modbus-TCP Network

No	Name	Indication	Meaning
1	Gateway Status (GW)	Off	Power off
		Alternating red/green	Missing configuration
		Flashing green	Idle
		Green	Running
		Flashing red	Invalid configuration
		Red	Fatal error
5	SD Card Status (SD)	Green	Accessing SD card
		Flashing red	Failure
6	Modbus-TCP Status (MTCP)	Off	No Modbus-TCP network communication
		Green	Communicating with Modbus-TCP network
		Flashing red	Transaction error or timeout
		Red	Fatal error
7 8	Ethernet Link 1 and 2 (LA1, LA2)	Off	No link
		Flashing green	Receiving/transmitting Ethernet packets at 100 Mbit
		Flashing yellow	Receiving/transmitting Ethernet packets at 100 Mbit

Table 30 LEDs: CANOpen Network

No	Name	Indication	Meaning
2	Not used	-	-
3	(RUN)	Off	Power off
		Green	I/O data exchanged, normal operation
		Flashing green	No I/O data exchanged
		Green, single flash	No I/O data exchanged
		Flickering green	Baud rate detection in progress
		Red	Fatal error
4	(ERR)	Off	Module in working condition
		Red, single flash	A bus error counter reached or exceeded its warning level
		Flickering red	LSS services in progress
		Red, double flash	An error control event has occurred
		Red	Fatal error, or bus off

Note:

Output data will be in Big Endian format. For example, if the pressure value in the pump is 700 mbar. Then in Hex, the value will be 02 BC, but in the output you will get BC 02.

11. Maintenance

11.1. Preventive maintenance schedule

WARNING: MAINTENANCE SAFETY

Risk of injury and damage to equipment. The operator must obey the safety precautions. Only approved personnel trained by us is permitted to do the maintenance.

WARNING: HIGH VOLTAGE CAPACITOR

Risk of injury and damage to equipment. Dangerous high voltage remains on the capacitors of the start and the speed regulation unit for some minutes after the current supply is off. Wait for minimum 10 minutes before you start the electrical repairs.

Before the maintenance, repair or adjustments, do the steps as follow:

1. Stop the pump.
2. Close the air inlet isolation valve.
3. Push the emergency stop button.
4. Set the current supply to off.
5. To vent the pump, open the plug given on the cover of the air inlet filter.
6. Make sure that the pump system is at atmospheric pressure level.
7. Lockout - Tagout (LOTO): Open the power isolation switch and lock it with a personal lock. Tag the power isolation switch with the name of the service technician.
8. Make sure that the power supply is set to off and disconnected.

Warranty - Product liability

Use only approved parts. The damage or malfunction caused by the use of the parts that are not approved is not covered in the warranty or product liability.

Service kits

To do an overhaul or a preventive maintenance, service kits are available. Refer to Service kits.

Service contracts

We offer different types of service contracts, to relieve you of all preventive maintenance work. Contact our customer centre.

General

Replace the O-rings and washers that are removed during servicing.

Intervals

- Our local customer centre can overrule the maintenance schedule, specially the service intervals, depend on the environmental and working conditions of the pump.
- Include the shorter interval checks with the longer interval checks.
- The service plans are shown for the pump with the controller.
- Each plan has a programmed time interval in the plan for the service actions.
- When you reach the interval, a message is shown on the screen that shows which service plans are permitted.
- After servicing, reset the intervals.

Depending on the process and machine room specifications, the pump conditions are defined as normal, medium or harsh for your application. These pump conditions have a dedicated service requirements and they are dependent on the used oil type. For more information and service plan, contact your pump manufacturer to guarantee your warranty or product liability coverage in line with the used oil of your pump manufacturer.

Table: Preventive maintenance schedule shows the intervals for a normal application with synthetic oil, the service visits are programmed in the controller.

Table 31 Preventive maintenance schedule

Action	Normal applications	
	Vacuum fluid Basic (Mineral)	**Vacuum fluid (Synthetic)**
Check oil level and condition	Daily	Daily
Check LEDS on display		
Remove the air filter elements and inspect. Replace damaged or heavily contaminated elements	Monthly	Monthly
Check for possible air and oil leakages		
Check coolers, clean if necessary	3-Monthly	3-Monthly
Check strainer at oil pump		
Check the filter elements of the electric cabinet. Replace if necessary		
Check the silencer of the vacuum control valve, clean if necessary		
Replace the air filter elements	4000 hours*	4000 hours*
Clean the scavenge line and blow out the restriction nozzle		
Clean coolers		
Check pressure and temperature readings		
Check operation of cooling fans of converter and clean heatsink		
Check vacuum control valve solenoid and gas ballast solenoid valve		
Check oil pump		
Check and clean cooling fan assembly		
Clean strainer at oil pump		
Change oil(1)	4000 hours*	8000 hours†
Change oil filter	4000 hours*	8000 hours†

Action	Normal applications	
	Vacuum fluid Basic (Mineral)	Vacuum fluid (Synthetic)
Replace the oil separator elements	8000 hours†	8000 hours†
Replace the filter elements of the electric cabinet		
Replace the thermostatic valve		
Check element blow-off valves, replace O-rings and spring		
Check oil pump, replace bypass valve		
Carry out a LED/display test		
Test pressure (& temperature) switch		
Motor overhaul	48000 hours	48000 hours
Inlet valve overhaul		
Element overhaul	100000 hours	100000 hours
Oil pump overhaul		
Blow-off valve replacement		

** Or yearly, whichever comes first.*
† Or every 2 years, whichever comes first.
(1) In medium and harsh applications an optional 500 hrs oil sample is recommended

11.2. Oil specification

Note:

Do not mix lubricants of different brands or types as they can possibly not be compatible and the oil mix will have inferior properties. A label, showing the type of oil filled ex-factory, is given on the air receiver/oil tank.

We recommend to use genuine vacuum lubricants supplied by manufacturer. They are the result of years of field experience and research. Refer to *Preventive maintenance schedule* on page 108 for the applicable replacement intervals. Refer to spare parts list for the part number information.

Vacuum fluid basic

The vacuum fluid basic is a mineral fluid specially developed lubricant for use in single stage oil-sealed screw pumps. Its specific composition keeps the pump in excellent condition. The vacuum mineral fluid can be used for the pumps that operates at the ambient temperatures between 0 °C (32 °F) and 40 °C (104 °F). If the pump regularly operates in the ambient temperatures above 35 °C (95 °F), the oil lifetime decreases significantly. In such case, use our vacuum synthetic fluid for a longer interval for oil exchange.

If the pump regularly operates in the ambient temperatures more than 35 °C (95 °F), the oil lifetime decreases.

Vacuum fluid premium and ultra

The vacuum fluid premium and ultra are high quality synthetic lubricant for oil-sealed screw pumps which keeps the pump in excellent condition. Because of its excellent oxidation stability, vacuum synthetic fluid can be used for the pumps that operates at the ambient temperatures between 0 °C (32 °F) and 46 °C (115 °F).

If the pump regularly operates in the ambient temperatures more than 40 °C (104 °F), the oil lifetime decreases.

Vacuum fluid FG (food grade)

The vacuum fluid FG is a special oil, delivered as an option.

The vacuum fluid FG is a unique high-quality synthetic lubricant, specially created for oil-sealed screw pumps for the food industry. This lubricant keeps the pump in excellent condition. The vacuum food grade fluid can be used for the pumps that operates at the ambient temperatures between 0 °C (32 °F) and 40 °C (104 °F).

If the pumps regularly operates in the ambient temperatures more than 35 °C (95 °F), the oil lifetime decreases.

Note:

For oil lifetime, refer to Preventive maintenance schedule on page 108.

11.3. Drive motor

The motor bearing is lubricated by oil injection, re-greasing is not necessary.

11.4. Air filter

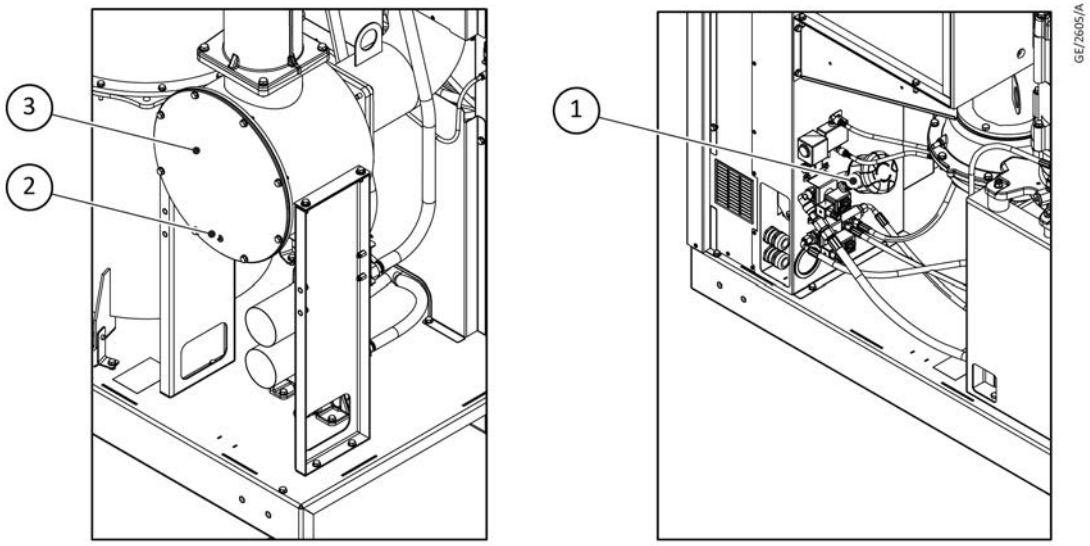
Refer to *Figure: Air filter*. To change the air filter, do the steps that follows:

1. Stop the pump.
2. Set the voltage to off.
3. Vent the pump by opening the plug on the lid of the air inlet filter.
4. Remove the cover of the air filters (AF and GBF).
5. Remove the filter elements.
6. Install the new filter elements.
7. Install the cover of the air filters (AF and GBF).
8. Set the air filter service warning again.

Note:

When you install the air filter element, make sure that the seal is in good condition.

Figure 20 Air filter



1. Air filter (GBF)
2. Plug
3. Air filter (AF)

11.5. Oil and oil filter change

WARNING: OIL CONTAMINATION

Risk of damage to equipment. Always drain the pump oil at all drain points. Used oil that is not drained from the pump can contaminate the oil system and can decrease the lifetime of the new oil.

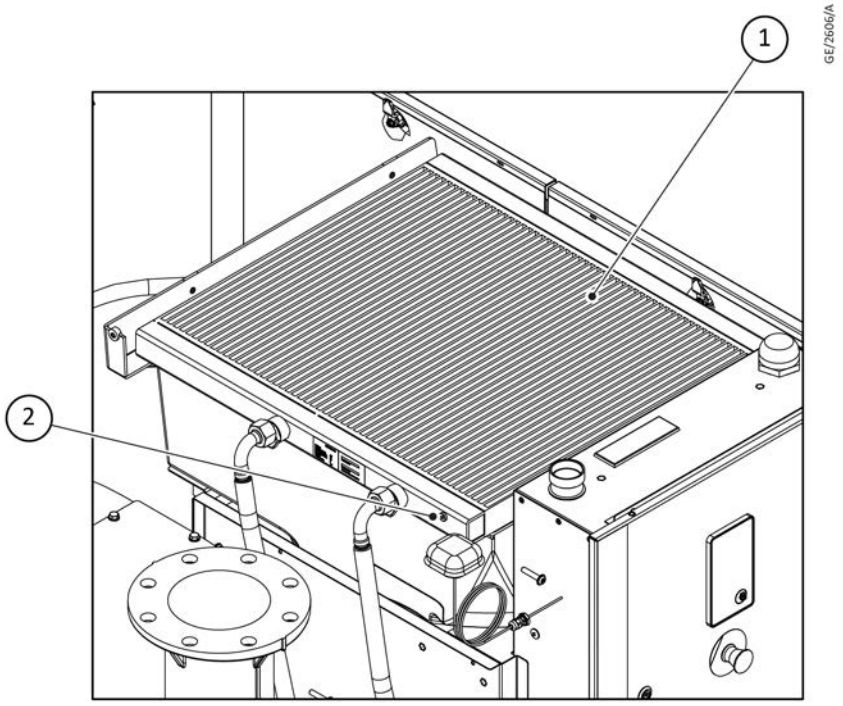
Note:

Do not mix lubricants of different brands or types as they can possibly not be compatible and the oil mix will have inferior properties. A label, showing the type of oil filled ex-factory, is given on the air receiver/oil tank.

To replace the oil and oil filter, do the steps that follow:

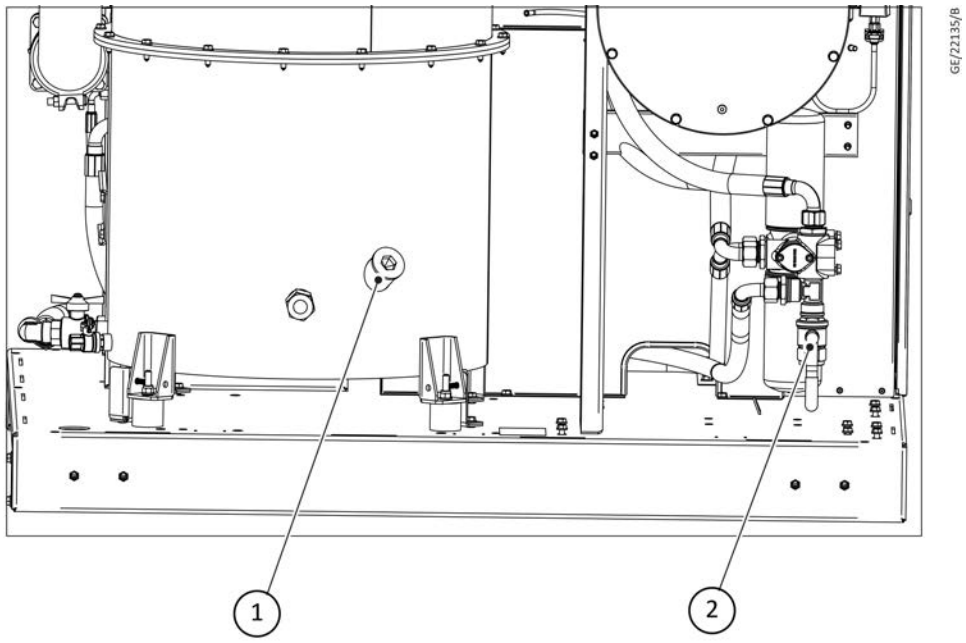
1. Operate the pump until warm and stop the pump.
2. Close the air inlet isolation valve.
3. Set the voltage to off.
4. Vent the pump by opening the plug on the cover of the air inlet filter.

5. Remove the vent plug of the oil cooler.



1. Oil cooler
2. Vent plug

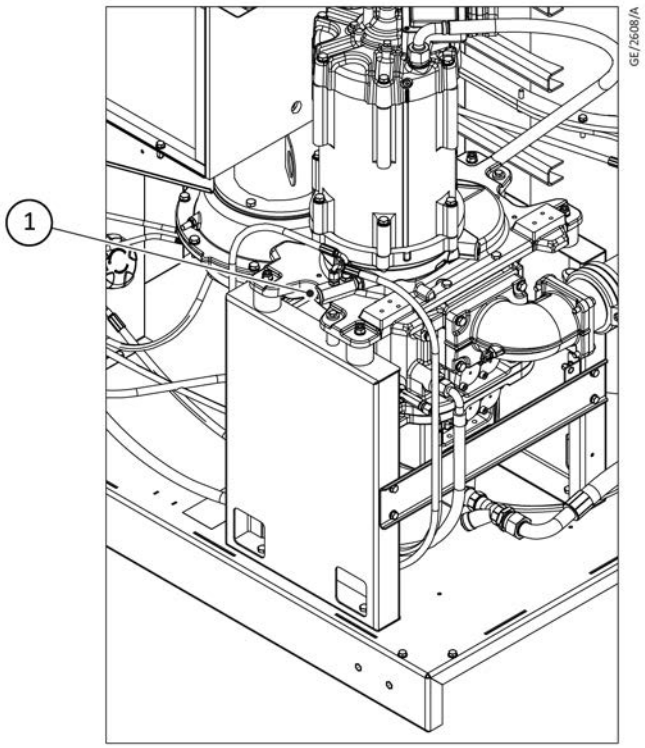
6. Open the oil drain valve. The oil drain valve drains the vessel and drains the pump element, and the injection hose. Insert the tubes (delivered as loose parts) into the drain couplings.



1. Filler plug
2. Oil drain valve

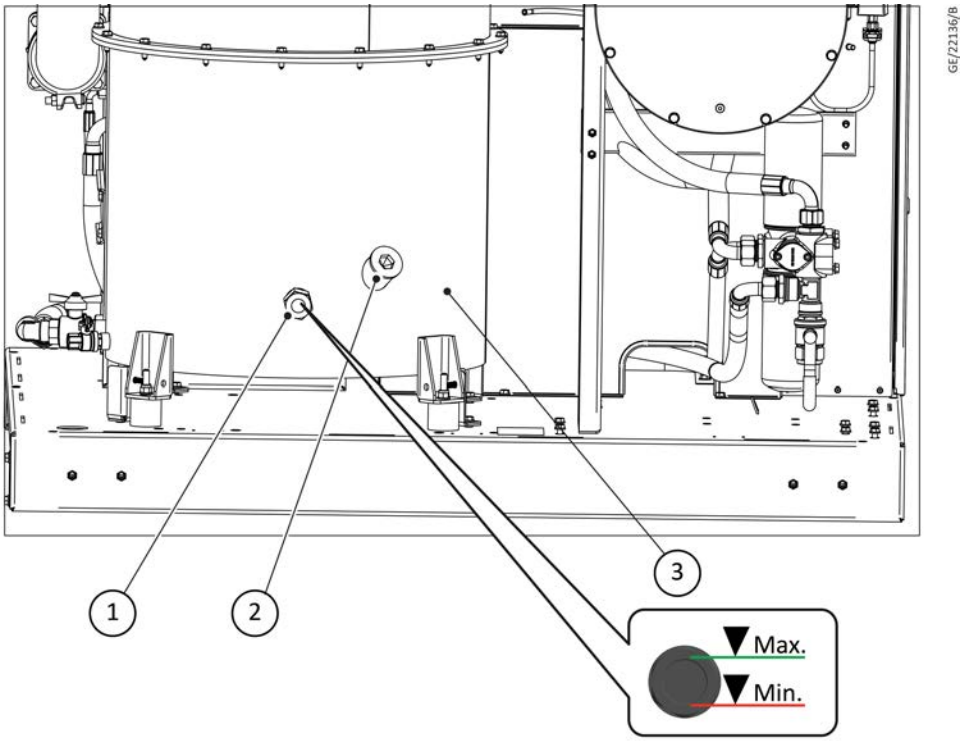
7. Collect the oil in a collector and deliver it to the local collection service.
8. Install the vent plugs after the oil is drained.
9. Close the oil drain valves.
10. Clean the seat on the manifold.
11. Lubricate the gasket of the new oil filters.

12. Install the gasket of the new oil filters. Tighten them firmly by hand.



1. Drain plug

13. Open drain valve g and drain the oil from the pump element.
14. Collect the oil in a collector and deliver it to the local collection service.
15. Install the vent plugs after the oil is drained.
16. Clean the strainer filter at the inlet of the oilpump.
17. Remove the filler plug.
18. Fill the oil separator vessel with oil until the level reaches the top of the oil sight glass.



1. Oil sight glass
2. Filler plug
3. Oil separator tank

19. Make sure that no dirt enters into the system.
20. Install the filler plug.
21. Operate the pump for a few minutes.
22. Stop the pump.
23. Close the isolation valve.
24. Set the voltage to off.
25. Wait for a few moments for the pump to vent the vessel.
26. Turn the oil filler plug by one turn to remove the remaining pressure in the pump.
27. Fill the oil separator tank with oil until the level reaches the top of the oil sight glass. Refer to *Operation* on page 60 and *During operation* on page 61.
28. Install the filler plug.
29. When the oil level is too low, go back to step 16.

11.6. Coolers

CAUTION: LOOSE PARTS

Risk of damage to equipment. Remove the loose parts that are used as a cover after the maintenance on the fan and on the cooler.

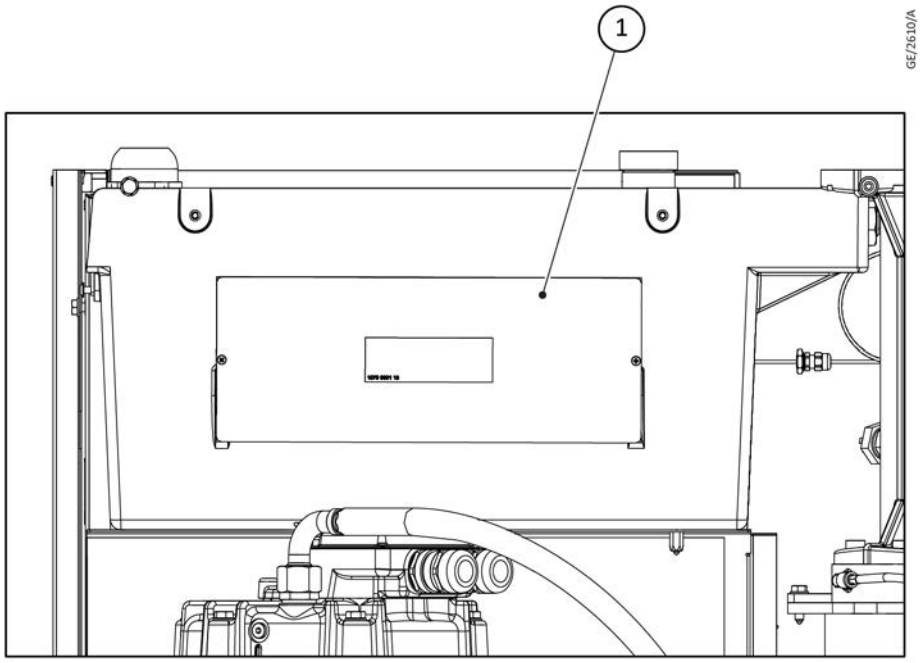
Note:

Keep the coolers clean to maintain their efficiency.

To replace the cooler, do the steps that follow:

1. Stop the pump.
2. Set the isolation valve to off.
3. Set the voltage to off.
4. Cover all the parts under the coolers.
5. Remove the service plate at the fan compartment.
6. Remove the dirt from the coolers with a fibre brush. Brush in the direction of the cooling fins.
7. Clean with an air jet in the reverse direction to normal flow.
8. If it is necessary to wash the coolers with a cleaning agent, contact us.
9. Install the service plate at the fan compartment.

Figure 21 Coolers



1. Service plate

11.7. Oil separator change

WARNING: INSTALLATION SAFETY

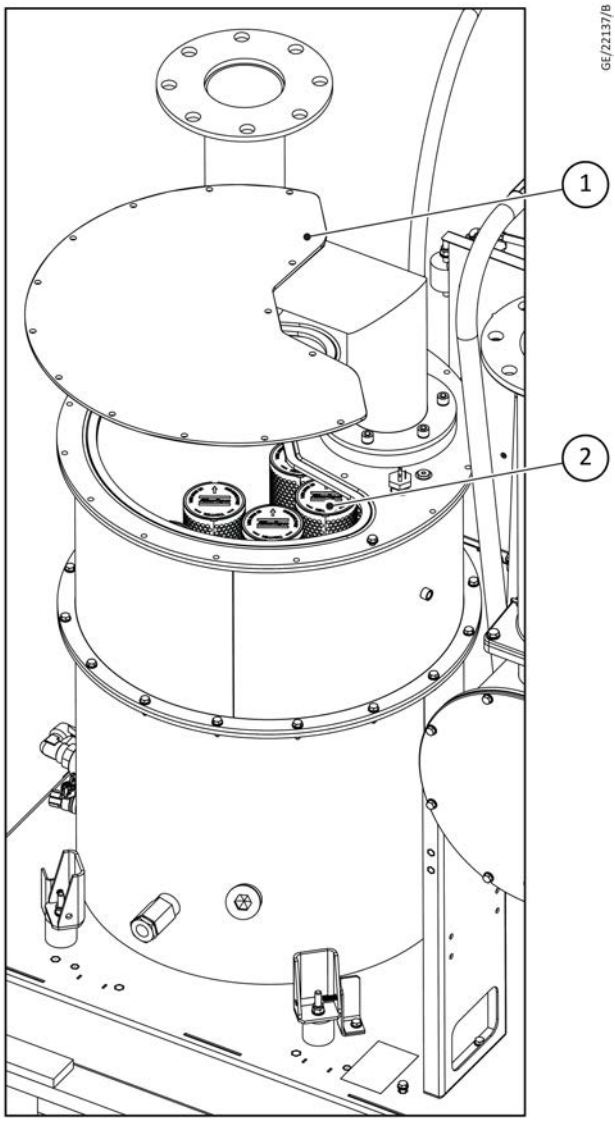
Risk of injury or damage to equipment. Make sure all separator elements are installed in the correct position. An arrow is given on the cover of the separator elements and at the bottom of the shield. All arrows must point in the same direction after the installation.

To remove the oil separator:

1. Stop the pump.
2. Close the isolation valve.
3. Set the voltage to off.
4. Wait for a few moments for the pump to vent the vessel.
5. Open the service panels.
6. Remove the bolts of the oil separator tank cover 1 and oil separator tank cover 2.
7. Slide the oil separator tank cover 1 to the rear side.
8. Remove the oil separator elements by turning one quarter counter-clockwise.
9. Clean the seat on the shield.
10. Lubricate the gasket of the new oil separator using the pump oil.
11. Install the gasket of the new oil separator and tighten it firmly by hand.
12. Slide the oil separator tank cover 1 back in the position. Make sure not to squeeze the O-ring.
13. Install the bolts.
14. Slide the oil separator tank cover 2 to the rear side.
15. Remove the oil separator elements by turning one quarter counter-clockwise.
16. Clean the seat on the shield.
17. Lubricate the gasket of the new oil separator using the pump oil.

18. Install the gasket of the new oil separator and tighten it firmly by hand.
19. Slide the oil separator tank cover 2 back in the position. make sure not to squeeze the O-ring.
20. Install the bolts.

Figure 22 Oil separator change



1. Oil separator tank cover *2. Oil separator element*

11.8. Pressure switch

CAUTION: PRESSURE SWITCH

Risk of damage to equipment. Adjustments are not permitted. Do not operate the pump without the pressure switch.

Note:

The pressure switch test can only be done by the authorised personnel and is protected by a security code.

If the pressure switch does not open at the set pressure of 1500 mbar (a), replace the pressure switch.

11.9. Service kits

For overhaul and for the preventive maintenance, a wide range of service kits are available. The service kits have the necessary parts to service the components of the pump and offer the benefits of our genuine parts with a low maintenance budget.

A full range of tested lubricants are available to keep the pump serviceable and in a good condition.

Refer to the spare parts list for the part numbers.

12. Fault finding

WARNING: HIGH VOLTAGE

Risk of injury or damage to equipment. Wait for 10 minutes before you start electrical repairs as dangerous high voltage remains on the capacitors of the start and speed regulation unit for several minutes after you set the voltage to off.

Before you do maintenance, repair work or adjustment, stop the pump. Close the isolation valve and wait for 3 minutes.

The operator must obey all relevant safety precautions.

Push the emergency stop button and set the voltage to off.

Vent the pump by opening the plug on the cover of the air inlet filter. For location of components, refer to:

Installation on page 31

Operation on page 60

Maintenance on page 108

Open and lock the isolating switch.

Lock the air inlet valve during the maintenance and repair.

12.1. Pump faults and remedies

Table 32 Fault finding

Condition
The pump cannot reach ultimate pressure on page 119
The pump cannot reach stated vacuum on page 120
Pressure switch trips on page 120
Pump element outlet temperature above normal on page 121

Fault	**The pump cannot reach ultimate pressure**
Cause	**Air leakage in the inlet piping connections**
Remedy	Examine the inlet filter assembly and pipes for leaks. Check the seals between components.
Cause	**Low oil level**
Remedy	Fill the oil.
Cause	**Oil contaminated**
Remedy	Replace the oil.
Cause	**Solenoid-valve malfunctioning**
Remedy	Replace the valve.
Cause	**Pump element out of order**
Remedy	Contact us.

Cause	**Blow-off valve sealing of the vacuum pump element damaged**
Remedy	Replace the blow-off valve sealing.

Fault	**The pump cannot reach stated vacuum**
Cause	**Air consumption is more than air delivery of the pump**
Remedy	Check the equipment connections.
Cause	**Clogged air filter element**
Remedy	Replace the filter.
Cause	**Too high pressure drop between process and pump inlet**
Remedy	Make sure that the process lines are of the correct size. Examine the process lines for leaks.
Cause	**Low oil level**
Remedy	Fill the oil.
Cause	**Oil contaminated**
Remedy	Replace the oil.
Cause	**Solenoid valve malfunctioning**
Remedy	Replace the valve.
Cause	**Pump element out of order**
Remedy	Contact us.
Cause	**Air leakage**
Remedy	Examine the process lines for leaks.
Cause	**Inlet valve defect or malfunctioning**
Remedy	Verify condition of valve membrane, seals and tubing. Replace if necessary.

Fault	**Pressure switch trips**
Cause	**Oil separator elements clogged**
Remedy	Replace the elements.
Cause	**Oil filter clogged**
Remedy	Replace the oil filter.
Cause	**Discharge clogged**
Remedy	Check couplings and the outlet.
Cause	**Bypass valve or oil injection system clogged**
Remedy	Clean the bypass valve or replace the bypass valve.
Cause	**Pressure switch out of order**
Remedy	Replace the pressure switch.

Fault	Pump element outlet temperature above normal
Cause	**Oil level too low**
Remedy	Check and fill the oil. Refer to *During operation* on page 61.
Cause	**Cooling air or cooling air temperature is not sufficient or relative humidity is too high**
Remedy	Check for the cooling air restriction or increase the ventilation of the pump room. Prevent the recirculation of the cooling air. If installed, check the capacity of the pump room fan.
Cause	**Oil cooler clogged**
Remedy	Clean the cooler.
Cause	**Oil filter clogged**
Remedy	Replace the oil filter.
Cause	**Scavenge line clogged**
Remedy	Clean the scavenge line.
Cause	**By-pass valve malfunctioning**
Remedy	Test the valves.
Cause	**Degraded oil**
Remedy	Check the service intervals. Refer to *Preventive maintenance schedule* on page 108.
Cause	**Temperature of the process air too high**
Remedy	Check the process air temperature.
Cause	**Pump element out of order**
Remedy	Contact us.
Cause	**Oil pump strainer clogged**
Remedy	Clean strainer filter
Cause	**Oil pump defect**
Remedy	Repair or replace oil pump
Cause	**Blow-off valve sealing of the vacuum pump element damaged or blocked**
Remedy	Replace the blow-off valve sealing
	If a problem is detected by the inverter, a specific warning will appear on the controller, together with a fault code. Refer the below *Table: Error codes*.

Table 33 Error codes

Fault code (Hexa decimal)	Fault code (Decimal)	Fault description	Cause	Actions
0x2313	8979	Common mode current	Common mode failure detected at motor side	Try to reset the fault. If fault code still shows, contact us.
0x2312	8978	Motor over current	Over current detected at motor side	Make sure that the main supply voltage is in limits.
0x2314	8980			
0x2315	8981	Motor over current	Short circuit detected in U phase	Try to reset the fault. If fault code still shows, contact us.
0x2316	8982	Motor over current	Short circuit detected in V phase	
0x2317	8983	Motor over current	Short circuit detected in W phase	
0x2320	8992	Fan Motor over current	Over current detected at motor side.	Check fan motor and coolers. If the error returns, contact your supplier.
0x2321	8993	Fan Motor over current	Over current detected at motor side.	Check fan motor and coolers. If the error returns, contact your supplier.
0x3210	12816	Over voltage	Over voltage detected	Make sure that the main supply voltage is in limits. Do a check of the main fuses.
0x3211	12817	Over voltage	Over voltage on DC bus detected.	Check if the main supply is within specifications. Check for transient voltage phenomena (e.g. voltage dips, surges, etc.). Check main fuses.
0x3221	12817	Under voltage	Main power supply voltage too low.	Make sure that the main supply voltage is in limits. Do a check of the main fuses.
0x3222	12834	Under voltage	Under voltage on DC bus detected.	Check if the main supply is within specifications. Check for transient voltage phenomena (e.g. voltage dips, surges, etc.). Check main fuses.
0x4001	16385	Drive over temperature	Pt1000 Temperature measurements exceed 130 °C.	Check which temperature measurement is too high in the controller.
0x4211	16913	Drive over temperature	Over temperature detected in fan inverter IGBT.	Let the drive cool off. Check for excessive ambient temperature. Clean heat sink with compressed air. Clean inlet filter cubicle. Ensure proper flow of cooling air in compressor room.
0x4212	16914	Drive over temperature	Over temperature detected in control board micro-controller.	
0x4213	16915	Drive over temperature	Over temperature detected in bridge board micro-controller.	

Fault code (Hexa decimal)	Fault code (Decimal)	Fault description	Cause	Actions
0x4311	17169	Drive over temperature	Over temperature detected in an IGBT	Let the drive cool. Make sure that the ambient temperature is not too high and in limits. Clean the heat sink with compressed air. Clean the inlet filter cubicle. Make sure that there is a flow of cool air in the area of the pump.
0x4314	17172	Drive over temperature	Over temperature detected in IGBT junction UH	
0x4315	17173	Drive over temperature	Over temperature detected in IGBT junction UL	
0x4316	17174	Drive over temperature	Over temperature detected in IGBT junction VH	
0x4317	17175	Drive over temperature	Over temperature detected in IGBT junction VL	
0x4318	17176	Drive over temperature	Over temperature detected in IGBT junction WH	
0x4319	17177	Drive over temperature	Over temperature detected in IGBT junction WL	
0x4320	17184	Drive over temperature	Over temperature detected in power board	
0x4321	17185	Drive over temperature	Over temperature detected in control board	
0x4330	17200	Drive over temperature	Over temperature detected on bridge board PCB.	Let the drive cool off. Check for excessive ambient temperature. Clean the heat sink with compressed air. Clean the inlet filter of the cubicle. Ensure proper flow of cooling air in the compressor room.
0x4331	17201	Drive over temperature	Over temperature detected on PSU board PCB.	
0x4334	17202	Drive over temperature	Over temperature detected in rectifier.	
0x4336	17206	Drive Over temperature	Over temperature detected by simplified thermal model.	Check for overloads. Let the drive cool off. Check for excessive ambient temperature. Clean the heat sink with compressed air. Clean the inlet filter of the cubicle. Ensure proper flow of cooling air in the compressor room.
0x4337	17207	Drive Over temperature	Over temperature detected in main IGBT.	Let the drive cool off. Check for excessive ambient temperature. Clean the heat sink with compressed air. Clean the inlet filter of the cubicle. Ensure proper flow of cooling air in the compressor room.
0x4338	17208	Drive Over temperature	Over temperature detected in AC choke.	
0x4339	17209	Drive Over temperature	Over temperature detected in fan IGBT.	
0x4343	17219	Drive Over temperature	Over temperature detected in rectifier.	

Fault code (Hexa decimal)	Fault code (Decimal)	Fault description	Cause	Actions
0x4344	17220	Drive over temperature	Main motor overload.	Check for overloads.
0x5020	20512	Emergency off (STO)	Emergency stop circuit opened	Do a check of the emergency control button. Make sure that there are no loose connectors at the control unit of the converter.
0x5021	20513	Emergency off (STO)	Emergency stop circuit opened	
0x5114	20756	Drive failure (hardware)	Internal power supply tripped	Try to reset the fault. If the fault code still shows, contact us.
0x5401	21505	Drive failure (hardware)	General fault detected in power section	
0x5403	21507	Drive failure (hardware)	General fault detected in power section.	Try to reset the error. If the error returns, contact your supplier.
0x5404	21508	Drive failure (hardware)	Internal power supply tripped.	Check if the main supply is within specifications. Check for transient voltage phenomena (e.g. voltage dips, surges, etc.). Check main fuses.
0x6100	24832	Drive failure (hardware)	General software fault, conditions not respected inside the CB app FW code.	Reboot the system or turn off the unit and then turn it on again. If the error returns, contact your supplier.
0x6102	24834	Drive failure (hardware)	Failed temperature reading of power board Timeout communication at initialisation	Try to reset the fault. If the fault code still shows, contact us.
0x6108	24840	Drive failure (hardware)	Internal communication timeout	
0x610E	24846	Drive failure (hardware)	Not able to identify power board	
0x6113	24851	Drive failure (software)	CAN communication overload	Do a check of the CAN cable connection between the controller and the converter. Do a check of the positions of the CAN termination switches at the two ends of the CAN cable. The two switches should be in the off position.
0x6115	24853	Drive failure (software)	Foreground part 2 runs out of time (not concluded before the next foreground part 1 update event).	Try to reset the error. If the error returns, contact
0x6116	24854	Drive failure (software)	BB MCU did not jump into bootloader state during the initialization phase.	Reboot the system or turn off the unit and then turn it on again. If the error returns, contact your supplier.
0x6117	24855	Drive failure (software)	BB MCU did not jump into bootloader state	

Fault code (Hexa decimal)	Fault code (Decimal)	Fault description	Cause	Actions
			during the initialization phase.	
0x6118	24856	Drive failure (software)	Timeout, CB MCU not able to read the BB Boot firmware version.	
0x6119	24857	Drive failure (software)	Timeout, CB MCU not able to read the BB Boot irm ware version.	
0x611A	24858	Drive failure (software)	Serializer 24 V for read/write of CB I/O's not properly configurated.	
0x611B	24859	Drive failure (software)	BB hardware revision is not recognized by CB MCU.	
0x611C	24860	Drive failure (software)	PB hardware revision is not recognized by CB MCU.	
0x611D	24861	Not used	Not used	Not used
0x611E	24862	Drive failure (software)	CB hardware revision is not recognized by CB MCU.	Reboot the system or turn off the unit and then turn it on again. If the error returns, contact your supplier.
0x611F	24863	Drive failure (software)	BB FW Boot version is not recognized by CB MCU.	
0x6120	24864	Drive failure (software)	BB FW App version is not recognized by CB MCU.	
0x6121	24865	Drive failure (software)	CB FW Boot version is not recognized by CB MCU.	
0x6122	24866	Drive failure (software)	CAN communication fault.	Check the CAN cable connection between the controller and the converter. Check the position of the CAN termination switch at both sides of the CAN cable. Both should be OFF.
0x6123	24867	Drive failure (software)	V/F profile not correct.	Re-download the parameters to Neos. If the error returns, contact your supplier.
0x6124	24868	Drive failure (software)	Error in read/write from/into BB EEPROM.	Reboot the system or turn off the unit and then turn it on again. If the error returns, contact your supplier.
0x6125	24869	Drive failure (software)	Error in read/write from/into CB	
0x6126	24870	Drive failure (software)	No reliable values obtained during inductance identification procedure.	Reset the error and repeat the procedure. If the error returns, contact your supplier.

Fault code (Hexa decimal)	Fault code (Decimal)	Fault description	Cause	Actions
0x6129	24873	Drive failure (software)	First ADC regular acquisition sequence not executed in time.	Try to reset the error. If the error returns, contact your supplier.
0x612A	24874	Drive failure (software)	Foreground part 1 not executed.	
0x612B	24875	Drive failure (software)	Voltage saturation during the inductance identification procedure (more Vbus needed to conclude the procedure).	Reset the error and repeat the procedure. If the error returns, contact your supplier.
0x612C	24876	Drive failure (software)	No reliable values obtained by the ADC's during the Vbus oversampling.	Try to reset the error. If the error returns, contact your supplier.
0x612D	24877	Drive failure (software)	Error in read diagnostic from BB EEPROM.	Reboot the system or turn off the unit and then turn it on again. If the error returns, contact your supplier.
0x612E	24878	Drive failure (software)	Failure at initial position detection.	Reset and try again. If the problem stil persists, try to reduce the vessel pressure. If the error returns, contact your supplier.
0x612A	24879	Drive failure (software)	Foreground part 1 runs out of time (not concluded before the next foreground part 2 update event).	Try to reset the error. If the error returns, contact your supplier.
0x6130	24880	Drive failure (software)	Induction motor not magnetized.	
0x6135	24885	Drive failure (software)	Negative value obtained for the rotor time during IM parameters identification procedure.	Reset the error and repeat the procedure. If the error returns, contact your supplier.
0x6136	24886	Drive failure (software)	The identification procedure was not completed within the time limit (5 minutes).	
0x6137	24887	Drive failure (software)	The reference current (P431) used for the identification procedure is not big enough.	Reset the error, increase P431 and repeat the procedure. If the error returns, contact your supplier.
0x6138	24888	Drive failure (software)	Foreground runs out of time (not concluded before the next foreground interrupt update event).	Try to reset the error. If the error returns, contact your supplier.

Fault code (Hexa decimal)	Fault code (Decimal)	Fault description	Cause	Actions
0x7130	28976	Motor over temperature	Motor over temperature detected	Let the motor cool. Make sure that the main fan and air flow in and out of the pump is not blocked. Make sure that there is a flow of cool air in the area of the pump. Make sure that there are no loose connectors at the control unit of the converter.
0x8101	33025	Drive failure (software)	CAN communication fault.	Check the CAN cable connection between the controller and the converter. Check the position of the CAN termination switch at both sides of the CAN cable. Both should be OFF.
0x8111	33041	Drive failure (software)		
0x8112	33042	Drive failure (software)		
0x8121	33057	Drive failure (software)		
0x8122	33058	Drive failure (software)		
0x8131	33073	Drive failure (software)		
0x8141	33089	Drive failure (software)		
0x8401	33793	Over voltage	Motor maximum speed exceeded	Try to reset the fault. If the fault still shows, contact us.
0x8402	33794	Over voltage	Motor startup failed, requested speed not reached	Do not reset the fault immediately. Wait until the pump de-pressurizes (by blow off). If the fault code still shows, contact us.
0x8403	33795	Negative speed	Electrical connection incorrect. Wrong rotation direction of the main motor.	Try again after reducing the pressure in the vessel. Swap two power cables.
0x9002	36866	Hardware run enable missing	Hardware enable signal for fan inverter missing.	Reset and try again.
0xA010	40976	Overload on digital outputs	Overload on digital outputs.	Check the wiring and connected devices to 24VDC AUX PSU.
0xA011	40977	Overload on digital outputs		
0xA012	40978	Overload on digital outputs		Check the wiring and connected devices to 24 VDC digital outputs.
0xA013	40979	Overload on digital outputs		
0xB000	45056	I/O disabled	Emergency stop circuit opened or "ALL_DEVICES" fault occurred.	Check the emergency stop button. Reset and try again.

13. Storage

WARNING: STORAGE SAFETY

Risk of injury or damage to equipment. If the pump is going to be stored without operating from time to time, protective steps must be taken. Contact your supplier.

Operate the pump regularly (for example, twice a week until warm).

14. Disposal

DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL and UK DIRECTIVE 2013 – S.I. 2013/3113 on waste electrical and electronic equipment (WEEE)

This equipment comes under the provisions of the European Directive 2012/19/EU and UK Directive 2013 – S.I. 2013/3113 on waste electrical and electronic appliances (WEEE) and cannot be disposed as unsorted waste.

The equipment is labelled in accordance with the European Directive 2012/19/EU and UK directive 2013 – S.I. 2013/3113 with the crossed-out wheelie bin symbol.

At the end of life-time of the electric and electronic equipment (EEE) it must be taken to separate collection.

For more information contact your local waste authority, customer centre or the distributor.

Note:

Obey all the local and national safety and environmental regulations when you discard service liquid and all other used materials (for example, dirty rags and machine parts).

15. Guidelines for inspection

On the Declaration of Conformity/Declaration by the manufacturer, the harmonised and other standards that have been used for the design are shown or referred to.

The Declaration of Conformity/Declaration by the manufacturer is part of the documentation that is supplied with the pump.

Local legal requirements, use outside the limits and conditions as specified by the manufacturer can require other inspection periods as mentioned on the declaration.

16. Service

16.1. Return the equipment or components for service

Before you send your equipment to us for service or for any other reason, you must complete a Declaration of Contamination Form. The form tells us if any substances found in the equipment are hazardous, which is important for the safety of our employees and all other people involved in the service of your equipment. The hazard information also lets us select the correct procedures to service your equipment.

If you are returning equipment note the following:

- If the equipment is configured to suit the application, make a record of the configuration before returning it. All replacement equipment will be supplied with default factory settings.
- Do not return equipment with accessories fitted. Remove all accessories and retain them for future use.
- The instruction in the returns procedure to drain all fluids does not apply to the lubricant in pump oil reservoirs.

Download the latest documents from *https://www.beaconmedaes.com/*, follow the procedure in HS1, fill in the electronic HS2 form, print it, sign it, and return the signed copy to us.

NOTICE:

If we do not receive a completed form, your equipment cannot be serviced.

P20050125A

EU Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer:

Atlas Copco Vacuum Belgium n.v.
Industrielaan 40
B-3730 Hoeselt
Belgium

Documentation Officer
Jana Sigmunda 300
Lutín , 78349
Czech Republic
T: +42(0) 580 582 728
documentation@atlascopco.com

The product specified and listed below

Product: Oil Injected Screw Vacuum pump, with motor
Models: GHS1202VSD+**,** GHS1402VSD+, GHS1602VSD+, GHS2002VSD+
Pump family numbers: 8153690XXX

Is in conformity with the relevant Union harmonisation legislation:

2006/42/EC	Machinery directive *Note: The safety objectives of the Low Voltage Directive 2014/35/EU were complied with in accordance with Annex 1 No. 1.5.1 of this directive.*
2014/30/EU	Electromagnetic compatibility (EMC) directive Class A Emissions, Industrial Immunity
2011/65/EU	Restriction of certain hazardous substances (RoHS) directive as amended by Delegated Directive (EU) 2015/863

Based on the requirements of relevant harmonised standards and technical documentation:

EN ISO 12100:2010	Safety of machinery. General principles for design. Risk assessment and risk reduction
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps. Safety requirements. Vacuum pumps
EN 60204-1:2018	Safety of machinery. Electrical equipment of machines. General requirements
EN 61000-6-2:2005	Electromagnetic Compatibility (EMC) - Part 6-2: Generic Industrial Immunity Standard
EN 61000-6-4:2007 A1:2011	Electromagnetic Compatibility (EMC) - Part 6-4: Generic Industrial Emission Standard
EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

This declaration, based on the requirements of the listed Directives and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2024-06-29*

You must retain the signed legal declaration for future reference
This declaration becomes invalid if modifications are made to the product without prior agreement.

This is a sample legal declaration

For CE marked equipment, find the signed legal declaration in the product packaging.
You must retain the official signed legal declaration for future reference.

Form **5009 0514 07**
ed. 00, 2022-10-07

This product has been manufactured under a quality management system certified to ISO 9001:2015

P20050125B

Declaration of Conformity

Atlas Copco Vacuum Belgium n.v.
Industrielaan 40
B-3730 Hoeselt
Belgium

Documentation Officer
Innovation Drive
Burgess Hill
West Sussex
RH15 9TW
documentation@atlascopco.com

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Product:	Oil Injected Screw Vacuum pump, with motor
Models:	GHS1202VSD+, GHS1402VSD+, GHS1602VSD+, GHS2002VSD+
Pump family numbers:	8153690XXX

The object of the declaration described above is in conformity with relevant statutory requirements:

Supply of Machinery (Safety) Regulations 2008
The objectives of the Electrical Equipment (Safety) Regulations 2016 are governed by Annex 1 1.5.1 of this regulation.

Electromagnetic Compatibility Regulations 2016
Class A Emissions, Industrial Immunity

Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Relevant designated standards or technical specifications are as follows:

EN ISO 12100:2010	Safety of machinery. General principles for design. Risk assessment and risk reduction
EN 1012-2:1996 +A1:2009	Compressors and vacuum pumps. Safety requirements. Vacuum pumps
EN 60204-1:2018	Safety of machinery. Electrical equipment of machines. General requirements
EN 61000-6-2:2005	Electromagnetic Compatibility (EMC) - Part 6-2: Generic Industrial Immunity Standard
EN 61000-6-4:2007 A1:2011	Electromagnetic Compatibility (EMC) - Part 6-4: Generic Industrial Emission Standard
EN IEC 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

This declaration, based on the requirements of the listed Statutory Instruments and EN ISO/IEC 17050-1, covers all product serial numbers from this date on: *2024-06-29*

You must retain the signed legal declaration for future reference
This declaration becomes invalid if modifications are made to the product without prior agreement.

This is a sample legal declaration

For UKCA marked equipment, find the signed legal declaration in the product packaging.
You must retain the official signed legal declaration for future reference.

Form **5009 0514 07**
ed. 00, 2022-10-07

ADDITIONAL LEGISLATION AND COMPLIANCE INFORMATION

EMC (EU, UK): Industrial equipment

Caution: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

RoHS (EU, UK): Material Exemption Information

This product is compliant with the following Exemptions
Annex III:

- 6(b) **Lead** as an alloying element in aluminium containing up to 0.4% by weight
- 6(c) Copper alloy containing up to 4% **lead** by weight
- 7(c) I Electrical and electronic components containing **lead** in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound
- 7(c) II **Lead** in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher

REACH (EU, UK)

This product is a complex article which is not designed for intentional substance release. To the best of our knowledge the materials used comply with the requirements of REACH. The product manual provides information and instruction to ensure the safe storage, use, maintenance and disposal of the product including any substance-based requirements.

Article 33.1 Declaration (EU, UK)

This product contains Candidate List Substances of Very High Concern above 0.1%ww by article as clarified under the 2015 European Court of Justice ruling in case C-106/14.

- Lead (Pb)
  This substance is present in certain aluminium / brass / electrical or electronic components.

TSCA PBTs (US)

Regulation of Persistent, Bioaccumulative, and Toxic Chemicals Under TSCA Section 6(h)
The product does not knowingly or intentionally contain substances in contravention with the above requirements.

Compliance Information – incorporated products and assemblies

Fans	2009/125/EC Ecodesign directive requirements for energy-related products Regulation (EU) No 327/2011: Industrial fans driven by motors

Additional Applicable Requirements

The product is in scope for and complies with the requirements of the following:

2012/19/EU	Directive on waste electrical and electronic equipment (WEEE)

材料成分声明
China Material Content Declaration

	有害物质 Hazardous Substances					
部件名称 Part name 	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr VI)	多溴联苯 Polybrominated biphenyls (PBB)	多溴二苯醚 Polybrominated diphenyl ethers (PBDE)
铸铝及铝合金制品 Aluminium alloys	X	○	○	○	○	○
铜管管件 Brass pipe fitting	X	○	○	○	○	○
铜接头 Brass connectors	X	○	○	○	○	○
电机（泵和机械增压泵） Motors (pump and mechanical booster)	X	○	○	○	○	○
电子元件和控件 Electronics and Controls	X	○	○	○	○	○

O: 表示该有害物质在该部件的所有均质材料中的含量低于 GB/T 26572 标准规定的限量要求。
O: Indicates that the hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572.

X: 表示该有害物质在该部件的至少一种均质材料中的含量超出 GB/T26572 标准规定的限量要求。
X: Indicates that the hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T26572.