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POWERPACK

Instruction manual

PowerPack series 30-110

PATENTED

www.heatrecovery.pro

1. Purpose of the manual

This manual is addressed to all ASFI customers who have purchased the PowerPack external heat recovery system. The manual will help you to use the unit without any specific theoretical background, familiarise you with the application possibilities and allow you to understand its operation.

Reading this manual can help eliminate risks, save maintenance and downtime expenses, and extend the reliability and life of your system. It provides help in case of problems, key information on necessary maintenance and details of accessories for the unit.

Operational staff on site should have the manual available at all times.

Once you have read the manual, the PowerPack is ready to go. The manual provides a useful supplement to the domestic standards for environmental protection and accident prevention. The heat recovery system is partly shown in the drawings without any protective covers or devices to provide a better overview of the unit. However, operation without them is prohibited.

The compressor manual contains all safety-related information for each specific compressor to which the PowerPack system may be connected.

2. Safety

Proper use, inspection and maintenance increase the life and utility of the PowerPack. Anyone involved in the maintenance of the unit must be physically able to perform the necessary tasks and be familiar with the procedures for servicing the units. No person may proceed with the installation and maintenance of the heat recovery system until they are familiar with this manual. Persons familiar with the manual must be able to use both normal mechanical hand tools and specialised instruments in a proper and safe manner.

The heat recovery system may only be used as per this manual and in compliance with its intended application. The user is responsible for ensuring that only authorised and duly trained persons operate the heat recovery system and that operating, maintenance and

service personnel are familiar with and strictly adhere to all safety measures. The user must ensure that only duly qualified and authorised persons operate the heat recovery system, and that no person with a slow response time operates the heat recovery system.

When operating the heat recovery system, any working technique that compromises the safety of the system is not permitted. Use the recommended personal protective equipment to shield yourself from sharp edges and corners when operating the heat recovery system. The work area must be kept clean and organised to prevent hazards from dirt and misplaced parts. It is not permitted to operate the heat recovery system without the necessary protective equipment. It is not permitted to dismantle safety and protective equipment.

All safety covers must be closed before starting the system; they must not be opened while the system is in operation. The compressor to which the heat recovery system is or will be connected must be shut down before the covers are removed or secured for repair or maintenance. Refer to the relevant sections of the compressor manual and this manual for this purpose. Once the connection or maintenance work has been completed, the housing and protections must be reinstalled.

Any alterations or modifications to the heat recovery system may only be carried out with the approval of ASFI and in compliance with all applicable safety regulations. Unauthorised alterations waive the manufacturer's liability for any damage caused.

Do not start the heat recovery system if one or more components are damaged, if the system cannot be started, or if the damage is visible or foreseeable.

Before carrying out any work on the heat recovery system, ensure that the electrical supply has been disconnected, locked, and marked, and that the hydraulic system of the PowerPack has been completely drained of oil and water. Make sure the unit has been disconnected from the electrical supply for at least 15 minutes before carrying out any repairs.

Certain maintenance tasks are technically complex and require specific tools, equipment, training, and knowledge to perform them correctly. Under such circumstances, only ASFI

certified technicians may be allowed to maintain the PowerPack. Maintenance personnel may not undertake any maintenance or inspection tasks outside the scope of the instructions in this manual. For further details, please contact ASFI or your device supplier.

ASFI cannot provide all possible repair methods or be aware of all potential risks and/or accidents. Make sure that safety is not compromised by the operations performed if maintenance procedures are carried out that are not explicitly suggested by the manufacturer. Secure the PowerPack in a safe place before seeking technical assistance if you are unsure of the maintenance process. Both this manual and other materials supplied with the unit, when used as intended, contain information for qualified technical personnel only. The use of non-original spare parts may invalidate any warranties and create safety risks and performance and handling problems. For further details, please contact ASFI or your device supplier.

3. Transport and storage

3.1. Receipt

Review the delivery note for any damage or missing items before signing the receipt. Make a note of any damage or missing items before signing the receipt. To inspect the goods, speak to the carrier straight away about your desire to check the delivery. Leave all materials in place until the carrier has checked the consigment.

Receipts that have been signed but do not contain any comments are deemed to have been delivered *without reservation*. Subsequent complaints shall constitute claims for latent defects. For claims due to damage to the consignment, please contact the transport company directly.

If damage (latent defect) is found upon receipt of the consignment, please make a phone call to the transport company. The phone call to the carrier should be made within 15 days of receipt of the consignment, followed by an inspection and written confirmation. In the event of a claim for a latent defect, the onus is on the recipient to prove that the damage occurred during transport.

Check on the rating plate that the model supplied is as ordered and that it is suitable for the customer's electrical installation.

All electrical components and the unit housing must comply with the requirements of the installation environment.

3.2. Unpacking and handling

The PowerPack is supplied in polyethylene or other material packaging. Should it be necessary to cut through the packaging with a knife, use caution so as not to damage the top layer of paint of the unit housing and controller.

To move the compressor with a forklift, use the holes in the PowerPack base to allow the forks of the forklift to slide in. The forks on both sides must be fully inserted into the holes of the unit. Before moving the unit, check where the centre of gravity is (the side with the heat exchanger fitted is heavier). Neither ASFI nor any other supplier is responsible for damage to the unit during improper unpacking and handling.

3.3. Long-term storage

Unless the product is used immediately after delivery, it should be prepared for long-term storage and protected as follows:

- place on a flat, stationary surface,
- protect all edges and walls of the housing from damage,
- do not store directly on the ground (e.g. earth or concrete),
- do not store in direct contact with chemicals,
- protect the control panel and the four pipes protruding from the housing from damage and live creatures entering the hydraulic system,
- protect the unit from dust and moisture.

In the event of improper storage, the company supplying the device is not responsible for any damage caused. Please contact the service department of the distributing company for detailed information on long-term storage.

4. Before installing the heat recovery system

4.1. On-site location

Use any location with a level, stable surface to install the heat recovery system. The floor on which the PowerPack will be placed must not be made of flammable materials. It is recommended to place the PowerPack system in a clean, dry, dust-free and well-ventilated area.

To ensure proper operation and maintenance, a clearance of approximately 1 metre must be maintained around the PowerPack. The room must not contain any flammable objects or liquids. High ambient humidity and temperatures exceeding 45˚C should be avoided. Due to the water content of the unit, the lowest ambient temperature that can occur in the room is 5˚C.

4.2. Maximum values for water in the heat recovery system

Table 1. Maximum value for water in the heat recovery system.

No.	Material	Element/chemical compound	Limit value	Unit
1	Total calcium (Ca + Mg)	Ca + Mg	< 0.01	mmol/litre
			< 0.0562	˚dH
2	Manganese	Mn	< 0.1	mg/l
3	Iron	Fe	< 0.2	mg/l
4	Free chlorine	Cl	< 0.5	mg/l
5	Ammonia	NH_3	< 2	mg/l
6	Oxygen	O_2	< 2	mg/l
7	Non-carbonate hardness	-	< 6	˚dH
8	Silicon oxide	SiO_2	< 8	mg/l
9	Carbonate hardness	$CaCO_3$	< 16	˚dH
10	Free aggressive carbon dioxide	CO_2	< 20	mg/l
11	Total hardness	-	< 22	˚dH
12	Sulphates	SO_4	< 60	mg/l
13	Nitrate	NO_3	< 100	mg/l
14	Chlorides <70˚C	Cl	< 100	mg/l
15	Chlorides <50˚C	Cl	< 200	mg/l
16	Total dissolved substances	TDS	< 600	mg/l
17	Electrical conductivity	-	< 1500	µS/cm
18	pH of water	-	7-9	

Table 1 shows the maximum values that may occur in the water circuit inside the heat recovery system. These are suggested parameters that may change depending on the operating environment. The operating temperature and overall composition are the determining elements in each situation. No warranty claims will be considered on this

basis. Adherence to the above water properties will allow the heat recovery unit to operate for a long time without failure.

5. Intended use/technical data/structure

The heat recovery system shall be considered as an accessory for oil-injected compressors. A closed oil circuit is factory-built into the compressors to ensure sufficient lubrication and cooling of the screw stage. When the screw stage cools down, the oil absorbs the high temperatures by heating up. Connecting the PowerPack system to the compressor's cooling oil system enables heat recovery in the form of hot water.

The system is based on a plate heat exchanger with an oil circuit from the compressor and a water circuit from the heating system connected to it. The flow in the circuit is forced by a variable speed circulating pump, controlled by an analogue signal, to maintain a constant water temperature measured downstream of the heat exchanger. Heat recovery from the oil does not take place immediately. It must first be ensured that the compressor cooling oil has reached a sufficient temperature. When the oil has not reached the required temperature, the water circulation pump does not pump water, as this would cause the oil to cool down. When the oil has reached a sufficient temperature, the water circulation pump starts and begins to pump water to the heat exchanger.

The way the heat recovery system works protects the system from overheating (expected in summer) by regulating the flow of water through the circulation pump to the heat exchanger in the PowerPack. If the temperature rises above the setpoint, the circulating pump will increase its speed, and if there is no take-up and the maximum temperature value is exceeded, the pump will stop and recovery will be halted. The oil is then cooled in an oil cooler in the compressor.

Water and oil temperatures are monitored using three temperature sensors. The two sensors measuring the water temperature are located upstream of the pump and downstream of the heat exchanger. By reading the two temperature values of the water entering and leaving the recovery circuit, the automation system automatically adjusts the flow rate to the oil temperature so that the oil does not overcool.

On the oil side, there is one temperature sensor mounted on the oil return pipe after the heat exchanger. The temperature values can be displayed on the control panel in the PowerPack.

The PowerPack heat recovery system is available in three series. These differ in the internal fittings used and are tailored to the compressor power from which the heat will be extracted. However, the principle of operation of each is the same.

Table 2. Series with operating point specifications.

PowerPack series							
Model	Maximum compressor power	Quantity of heat recovered	ΔT = 20K Inflow 40˚C Outflow 60˚C		Dimensions (L x W x H) mm	Disposable pressure - water side	Electrical power
PowerPack 30	30	21.00	0.98	m^3/h	920 x 480 x 730	60 kPa	<300W
PowerPack 75	75	52.50	2.46	m^3/h	920 x 480 x 730	50 kPa	<300W
PowerPack 110	110	77.00	3.60	m^3/h	920 x 480 x 730	50 kPa	<300W

The table above shows the series with operating point specifications. The fittings are designed for a working pressure of 6 bar.

5.1. Process flow diagrams

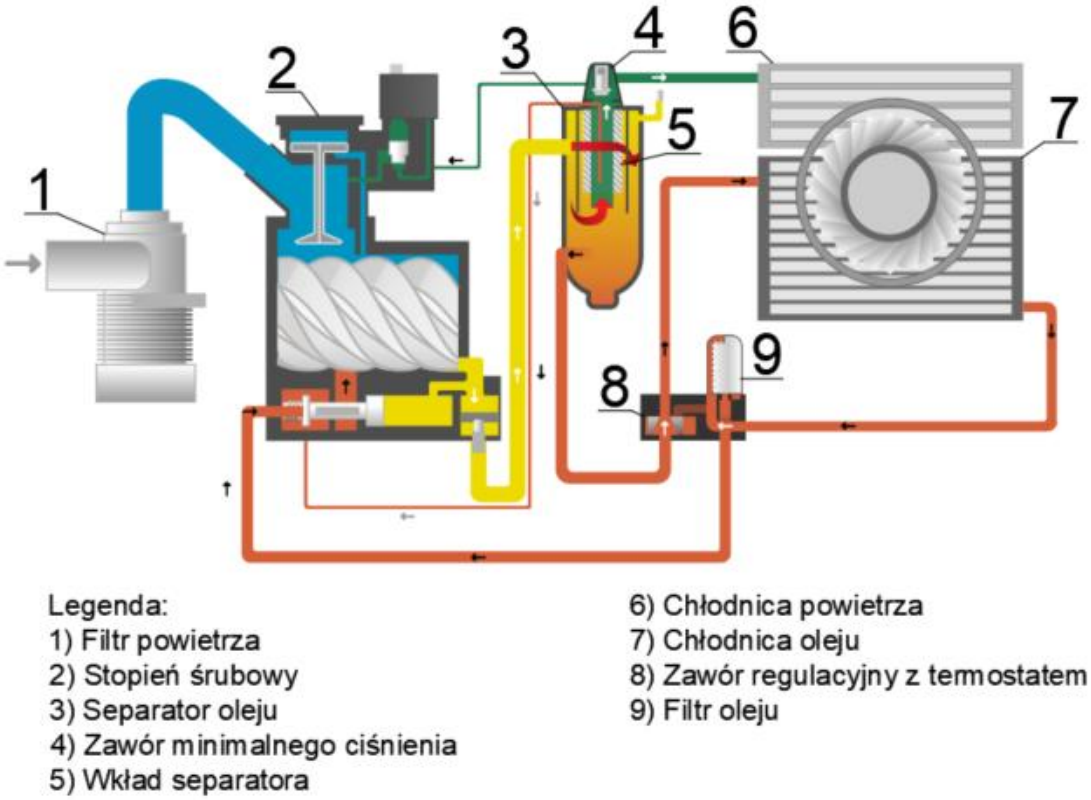

Figure 1. Compressor process diagram.

Figure 1 shows the process diagram of the compressor. Ambient air is drawn in through the filter (1), then directed through the suction valve. Oil, previously cleaned in the filter (9), is injected into the compressed air in the screw stage (2). The oil injection ensures adequate lubrication, sealing and cooling of the screw stage (2). The oil/air mixture is compressed in the spaces between the screw rotors and then directed into the oil separator tank (3), where most of the contained oil is precipitated. From the oil separator, the air flows through the separator cartridge (5) and the minimum pressure valve (4) to the air cooler (6). The oil accumulating in the oil separator (3) flows through a thermostatic control valve (8). When the oil temperature is high, it is cooled in the oil cooler (7) and further pumped to the screw stage. During the start-up phase, the thermostatic valve (8) bypasses the cooler by feeding the oil in a short circuit to the injection bypassing the cooler.

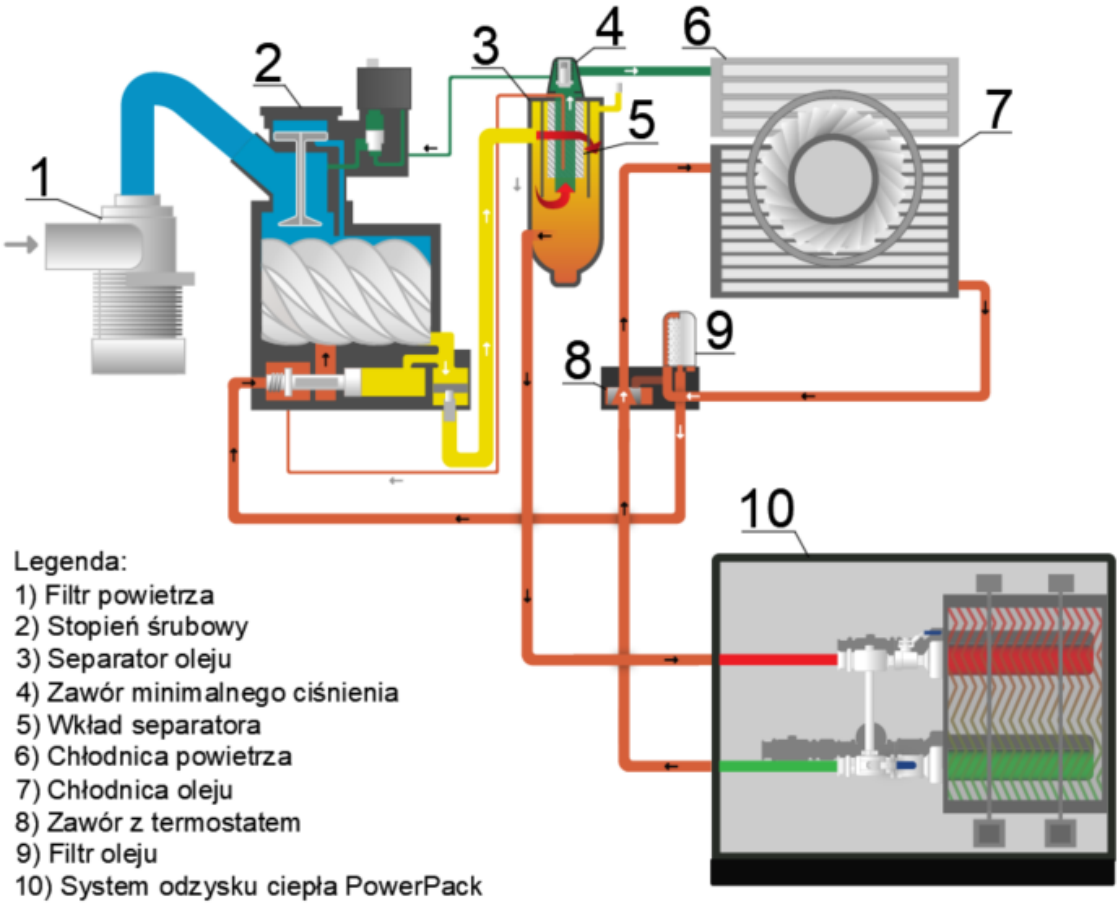

Figure 2. Process diagram for compressor with PowerPack heat recovery system.

Figure 2 shows the process diagram with the PowerPack heat recovery system. The compressor principle remains the same as in the previous diagram. A significant change is the direct connection of the PowerPack with the oil separator (3) and the valve with thermostat (8). Plugging the PowerPack in at the locations shown in the diagram will allow the temperature of the oil returning to the valve (8) to be read. Heat energy is extracted from the oil in a heat exchanger inside the PowerPack. A variable-speed water circulation pump adjusts to the temperature of the returning oil at valve (8). The purpose of the PowerPack is to extract as much heat energy as possible from the oil, while preventing it from overcooling or being diverted to the oil cooler (7). It is then possible to claim complete heat extraction from the oil.

6. Initial start-up of recovery / installation

Installation of the heat recovery system should not be carried out until the conditions described in Section 4 - *Before installing the heat recovery system* - have been read and met.

Prior to initial start-up of the heat recovery system, ensure that all supplied components are complete and that no transport damage is visible on the outer housing. The scope of delivery depends on the product ordered. The scope of the supplied components includes:
- PowerPack heat recovery unit,
- instruction manual.

The installation for connecting the PowerPack system to the compressor must be carried out by authorised service technicians. This is essential as connecting the heat recovery requires interference with the compressor's oil system.

Before proceeding with hydraulic operations, remove all protective materials from the PowerPack and level the unit with supports. All supports should be adjacent to the ground. The compressor should also be switched off with the mains disconnect and protected against accidental reconnection and all systems inside depressurised. In addition, the tightness of the system, the correctness of the hydraulic connections and the accuracy and correctness of the electrical connections should be checked. In addition, the setting values should be noted, and technical documentation kept with the unit.

Once the above steps have been completed, installation can begin.

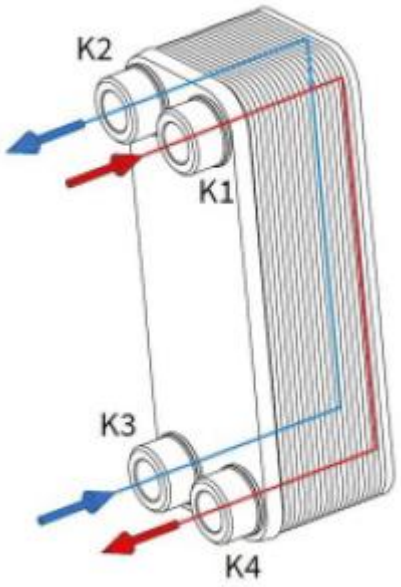

Figure 3. Oil/water plate heat exchanger. Connection method: K1 - hot oil input, K4 - cooled oil output, K2 - heated water output, K3 - heated water input.

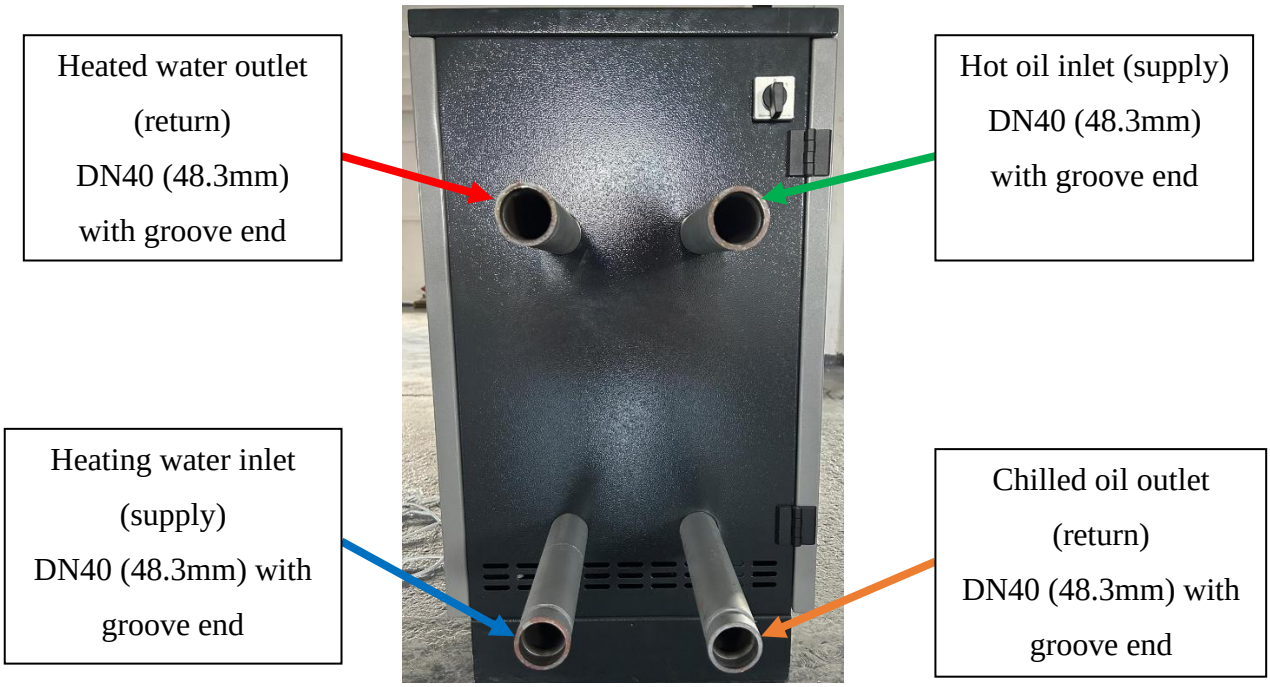

Figure 4. Oil and water hose connections on the side of the system.

The oil hose connection is located on the right-hand side. The top connection is the inlet (supply) of hot oil to the heat recovery system and the bottom connection is the outlet (return) of cooled oil to the compressor.

The water side is located on the left. The lower spigot is the inlet of the water to be heated (supply) and the upper spigot is the outlet of the heated water (return).

The pipes coming out of the PowerPack on the water and oil sides end with DN40 48.3 mm pipe with groove for Victaulic connection.

When connecting hoses, do not confuse the oil side with the water side. Doing so may cause irreparable damage to the compressor and may necessitate flushing the entire water system.

The hoses connecting the PowerPack to the compressor and the heating circuit should be certified to operate under the conditions generated by the compressor (pressure temperature).

Hoses should be installed in such a way that they do not transmit any stresses or vibrations. The use of vibration stabilisers is recommended.

The mesh filter has not been fitted to the PowerPack heat recovery system. Its use is necessary because it acts as a water filter and its main purpose is to protect the pipework, pump, exchanger, and plant on the receiving side from contamination.

After the connection of the heat recovery system to the compressor and the heating circuit, a leak test is mandatory. This will prevent leakages and spills. If a heat recovery leak occurs, it must be found. If the leak occurs in a moving part, e.g. a screw, it must be tightened until it is leak-free. If a leak occurs in a clamp connecting two components, immediately shut down the heat recovery and contact the service department.

Once the heat recovery system has been connected and tested successfully, the PowerPack system can be started.

6.1 Shutdown of heat recovery during compressor operation

The heat recovery system is adapted and allows the heat exchanger inside the unit to be shut off, so that the oil flows directly to the thermostat valve bypassing the exchanger. To do this, two valves must be closed and one opened in the correct order. The valves are located on the supply pipe (valve No. 3), on the return pipe (valve No. 2) and on the bypass vertical pipe (valve No. 1).

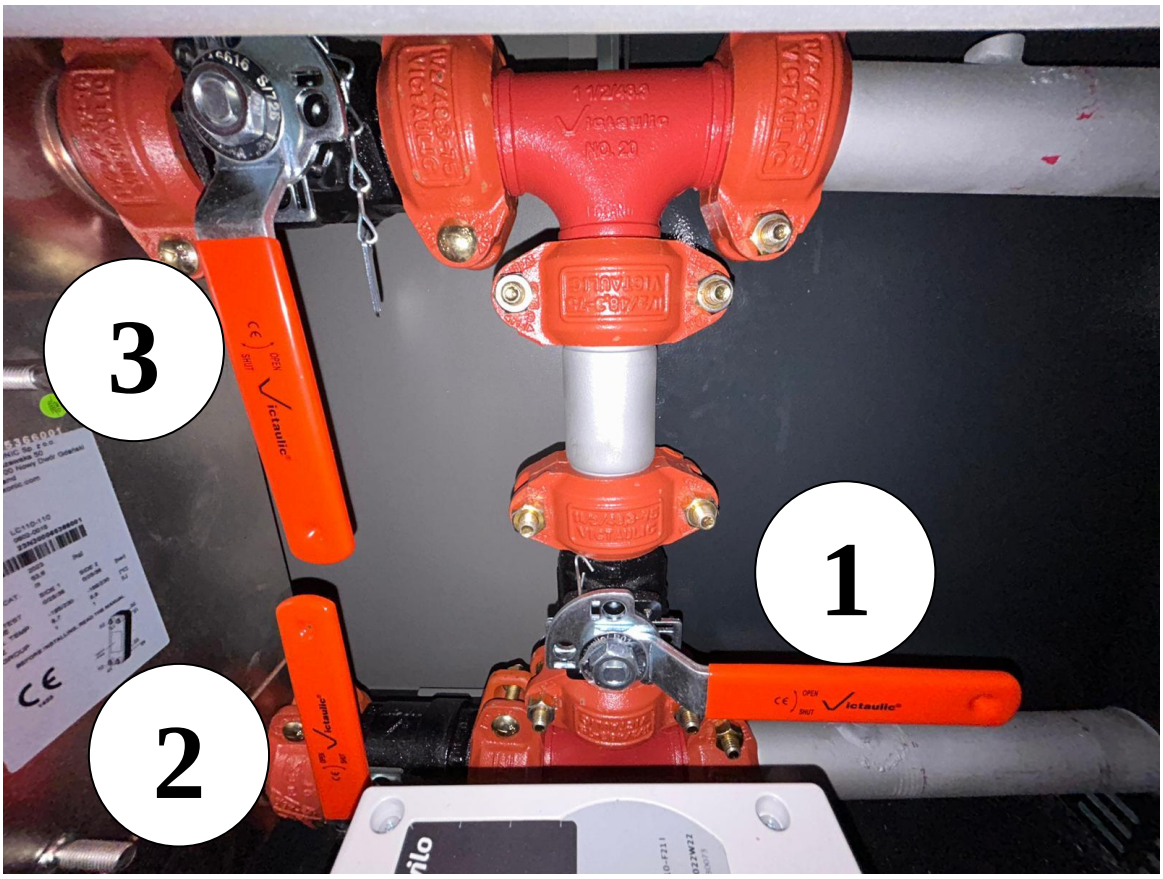

Figure 5. Illustration of oil-side ball valves inside the PowerPack.

The illustration above shows the oil side inside the PowerPack. It shows three two-way through valves bearing numbers 1, 2 and 3.

IMPORTANT!

The sequence of closing and opening of the valves described above is of utmost importance. Failure to comply with the guidelines may result in damage to the compressor.

Table 3. PowerPack recovery exchanger shutdown.

PowerPack recovery exchanger shutdown			
Action	Two-way valve No. 1 - bypass	Two-way valve No. 2 - oil return	Two-way valve No. 3 - oil supply
Valve position in operating or shutdown mode	OPEN	CLOSED	CLOSED
Execution sequence	FIRST	SECOND	THIRD

The table above provides information on the steps to be taken to shut down the heat recovery system.

The PowerPack heat exchanger can be switched off by turning the lever of the two-way valve (1) on the vertical pipe so that the lever position is parallel to the vertical pipe, and then closing the two two-way valves (2, 3) in sequence 2 and 3 so that their lever position is perpendicular to the horizontal pipe.

Table 4. Activation of the PowerPack recovery exchanger.

Activation of the PowerPack recovery exchanger			
Action	Two-way valve No. 1 - bypass	Two-way valve No. 2 - oil return	Two-way valve No. 3 - oil supply
Valve position in operating or shutdown mode	CLOSED	OPEN	OPEN
Execution sequence	THIRD	SECOND	FIRST

The table above provides information on the steps to be taken to activate the heat recovery system.

Activation of the PowerPack heat exchanger with the compressor running can be done by opening the two two-way valves (2, 3) in sequence 3 and 2 so that the position of their

levers is parallel to the horizontal pipe, and then closing the two-way valve (1) on the vertical pipe so that the position of the levers is perpendicular to the vertical pipe.

7. Errors and failures

This chapter provides basic troubleshooting information. Thorough inspections by trained personnel in the safety, use and maintenance of this equipment is the most effective way to accurately identify the source of problems.

Table 5. General failures.

Symptom	Failure	Solution
Unable to start	No power	Check the power switch - setting the switch to the 'I' position indicates the correct setting. If the problem persists, contact a qualified electrician.
	Controller failure	Check power supply to the unit. Repair/replace the unit.
No reading or temperature rise on the water and oil side	Temperature sensor failure	Check that the temperature sensor is connected properly. If so, it will need to be repaired/replaced by the service department.
	Heat exchanger failure	Replace with new heat exchanger by the service department.
	Circulation pump failure	Check the power supply to the circulation pump. If the problem persists, repair/replacement by the service department will be required.
Zbliżony odczyt temperatury zasilającej i powrotnej	Circulation pump failure	Check the speed at which the circulation pump is pumping water to the heat exchanger. If the value deviates from the setpoint, the circulation pump will require adjustment or repair/replacement by the service department.
	Low oil flow	Contact the service department to check the patency of the oil system.

The table above summarises information on typical symptoms, probable causes and repair methods. Do not attempt to repair the unit yourself; contact a qualified service technician to do so. Any tampering with a malfunctioning component by an untrained person may lead to a safety hazard for that person or permanent damage to the unit.

8. Maintenance

Maintenance work on the PowerPack may only be carried out by trained service personnel. Non-trained personnel may not interfere in any way with the PowerPack system.

Before carrying out maintenance work, ensure that the compressor has been shut down using the mains disconnect switch, protect against accidental reconnection, and depressurise all systems inside. As there is hot oil and water in the pipes of the heat recovery system, wait a few hours after stopping the compressor before disconnecting the connections.

Regular cleaning and maintenance are essential for a long and properly functioning heat recovery system. Failure to carry out maintenance can lead to failure, e.g. of the circulation pump.

8.1. Maintenance alerts

Depending on the service level selected, the unit will alert the user to the need for component maintenance by periodically displaying a service message together with a flashing LED.

- Maintenance chart.

As suggested below, maintenance should be carried out as follows:

1. When specified by the controller,
2. After a specified number of hours or according to the unit's maintenance schedule.

Table 6. Maintenance chart.

Frequency	Action	Component undergoing maintenance
Every day	Check	Tightness of fittings and hose connections
	Check	Controller - service indicators
	Check	Mesh filter - is it clogged?
	Check	Oil and water pressure in the system
Every month	Calibrate temperature sensors	Temperature sensor
	Pump feedback control	Circulation pump
	Close and open the two-way valve	Oil-side two-way valve - see section 6.1 for correct valve closing and opening.
	Inspection of PowerPack control and power supply cables	Controller
Every 6 months	Check	Pump rate control
Every 4,000 hours or 6 months	Servicing	Full-service inspection - carried out by an authorised service technician
	Cleaning	Cleaning the exchanger on the water and oil side

9. Controller

PowerPack is responsible for controlling the heat recovery system. Its task is to control the water circulation pump P1 (supply to the recovery system), to measure the temperature on the oil and water side and to control and protect the heat recovery system. The HMI panel on the front of the PowerPack is responsible for the ongoing presentation of the operation of the recovery system. The presentation of the operating status and other functions is available via the six screens shown and described below.

9.1. Home screen

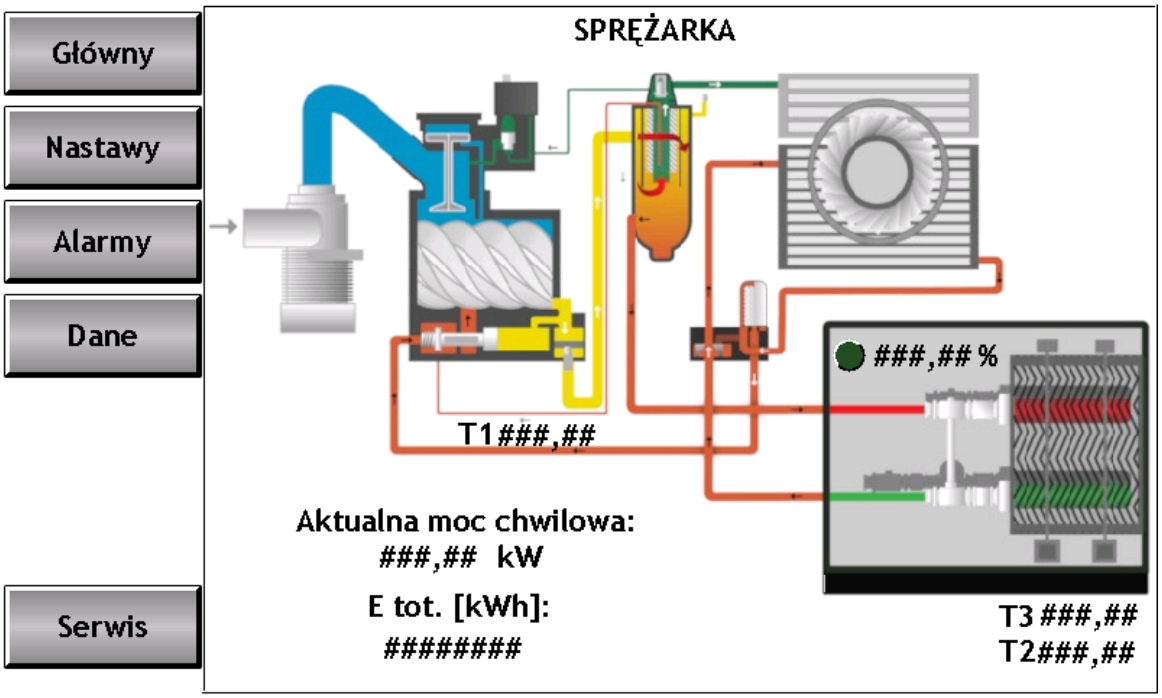

Figure 6. HMI home screen.

The home screen serves as a real-time view of the operation of the PowerPack heat recovery system's actuators.

T1 – temperature of the oil return from the PowerPack (downstream of the heat exchanger),

T2 – temperature of water entering the heat exchanger in the PowerPack (supply),

T3 – temperature of water leaving the heat exchanger in the PowerPack (return),

Pump Start / Stop - the operating status of the pump is indicated by a circular light (green - running, red - stop). The percentage next to it represents the current setpoint (control),

Aktualna moc chwilowa – moc chwilowa odzyskana przez PowerControl w danym momencie swojej pracy,

E tot. [kWh] - the total amount of energy recovered from the system, expressed in kWh.

The percentage next to the visualised unit represents the current setpoint (control),
The percentage next to the green LED represents the current setpoint (control).

9.2. Settings

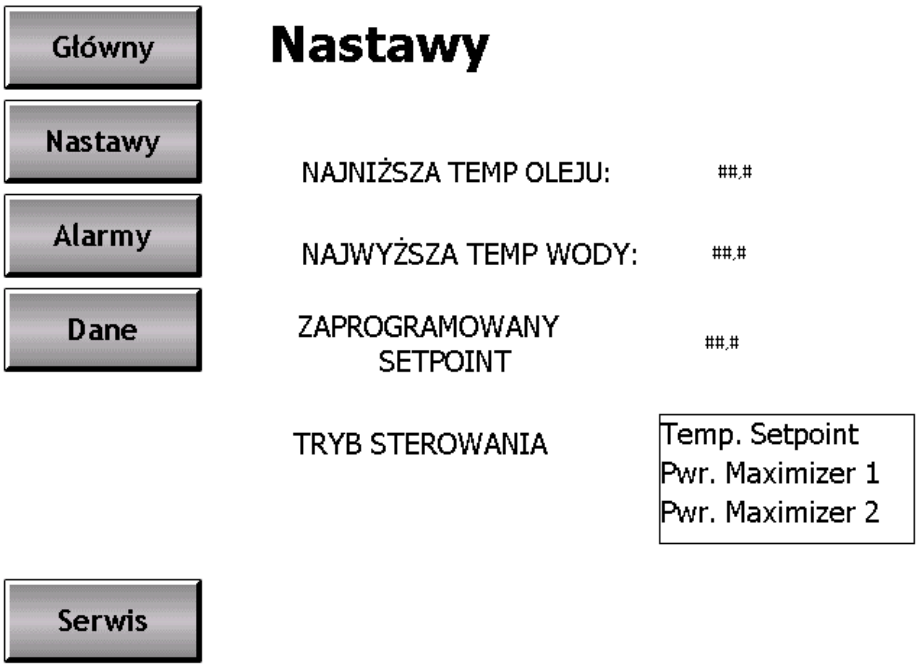

Figure 7. HMI setting window.

In the settings window, we make changes to the settings of the temperature parameters involved in the logical structure of the control algorithm.

Lowest oil temperature - the lowest temperature to which the compressor oil in the recovery exchanger can be cooled.

Highest water temperature - the maximum value of the heated water temperature at which recovery will be disconnected. In practice, this means no heat extraction by the circuits.

SETPOINT preset - the value that overrides when one of the three PowerPack control modes is selected.

Control mode - three possible control modes to select the operation of the PowerPack:

1) 1) Temp. Setpoint – a mode in which pump operation depends on the flow temperature of the hydraulic coupling / buffer. Example: The setpoint water temperature is 60˚C. The pump will adjust its speed to maintain a constant temperature of 60˚C at the water outlet of the exchanger.
2) Pwr. Maximizer 1 and 2 – a mode designed to achieve maximum energy recovery. It adjusts the recovery operation independently of the temperature values on the return and feed water pipes.

NOTE!

Unauthorised changes to the default values may damage the installation and compressors.

9.3. Alerts

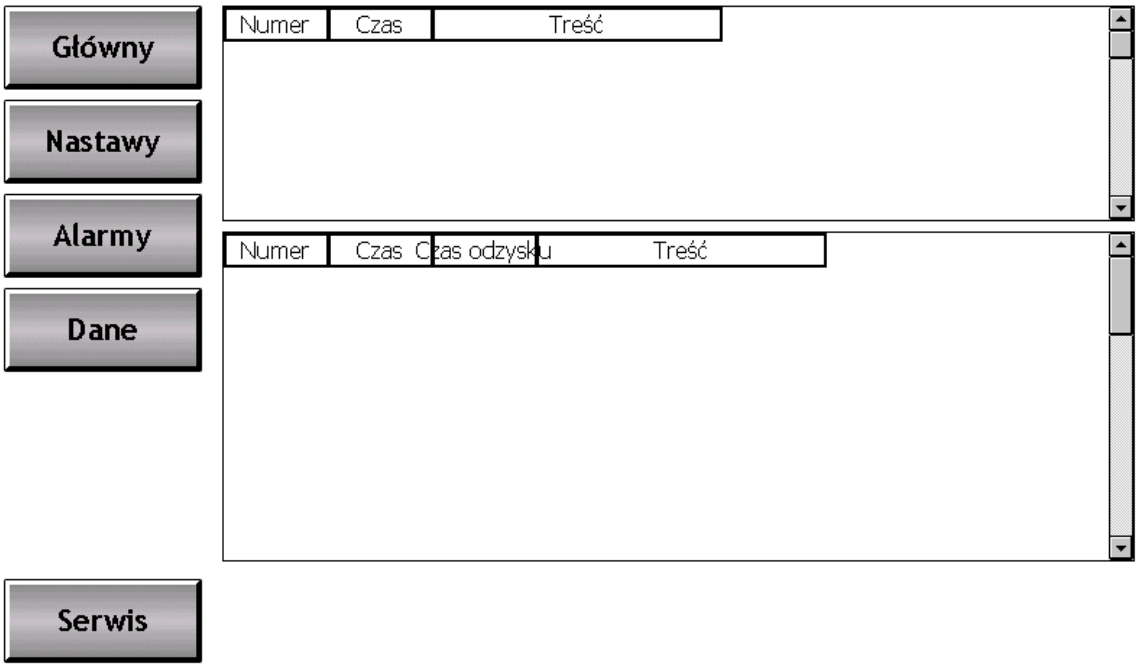

Figure 8. HMI alert window.

The alert window displays any communication errors that occur, pump overheating messages, compressor and receiver-side over-temperature warnings.

Pump alerts are permanently triggered - they require a reset. Other alerts appear and disappear automatically when they cease (e.g. overtemperature).

9.4. Data

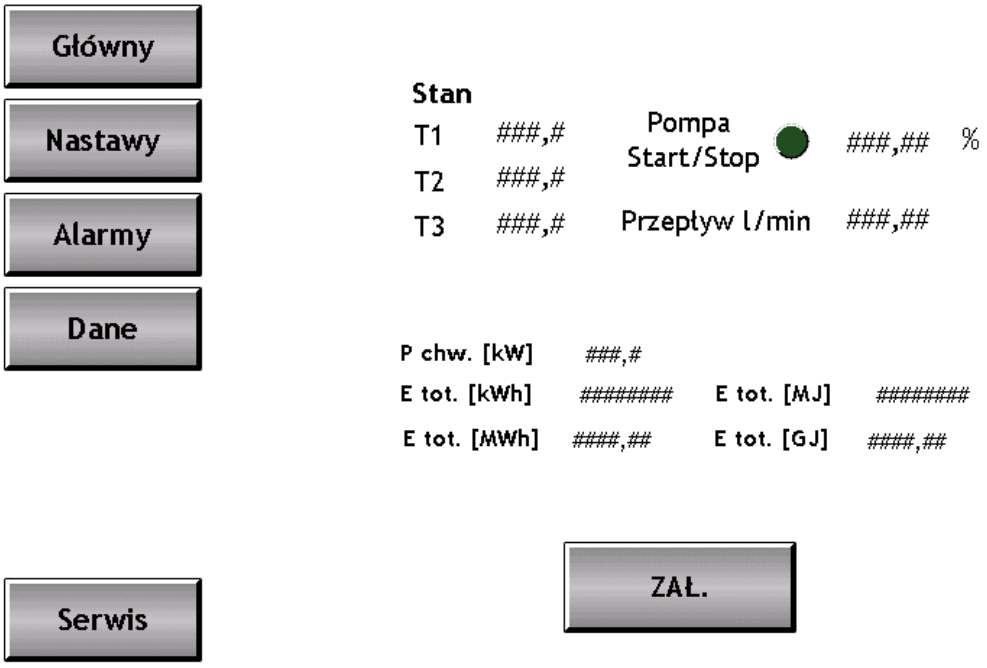

Figure 9. HMI data window.

The status window provides a quick and clear overview of all plant operating parameters in real time. It is also possible to switch heat recovery on or off by pressing the ON/OFF button in the centre of the window below the heat recovery data.

T1 – temperature of compressor oil return (downstream of the heat exchanger),

T2 – temperature of water entering the heat exchanger,

T3 – temperature of water leaving the heat exchanger,

Pump Start / Stop - the operating status of the pump is indicated by a circular light (green - running, red - stop). The percentage next to it represents the current setpoint (control),

Flow l/min - the rate at which the pump pumps water in litres per minute,

P chw. [kW] - the instantaneous power recovered by the PowerControl at a given point in its operation,

E tot. [kWh] – total amount of energy recovered from the system, expressed in kWh,

E tot. [MWh] – total amount of energy recovered from the system, expressed in MWh,

E tot. [MJ] – total amount of energy recovered from the system, expressed in MJ,

E tot. [GJ] – total amount of energy recovered from the system, expressed in GJ.

Figure 10. HMI service window.

The service window allows the controller's language to be changed and Modbus communication to be previewed. The available languages include Polish, English and French.

9.5.1. Modbus communication

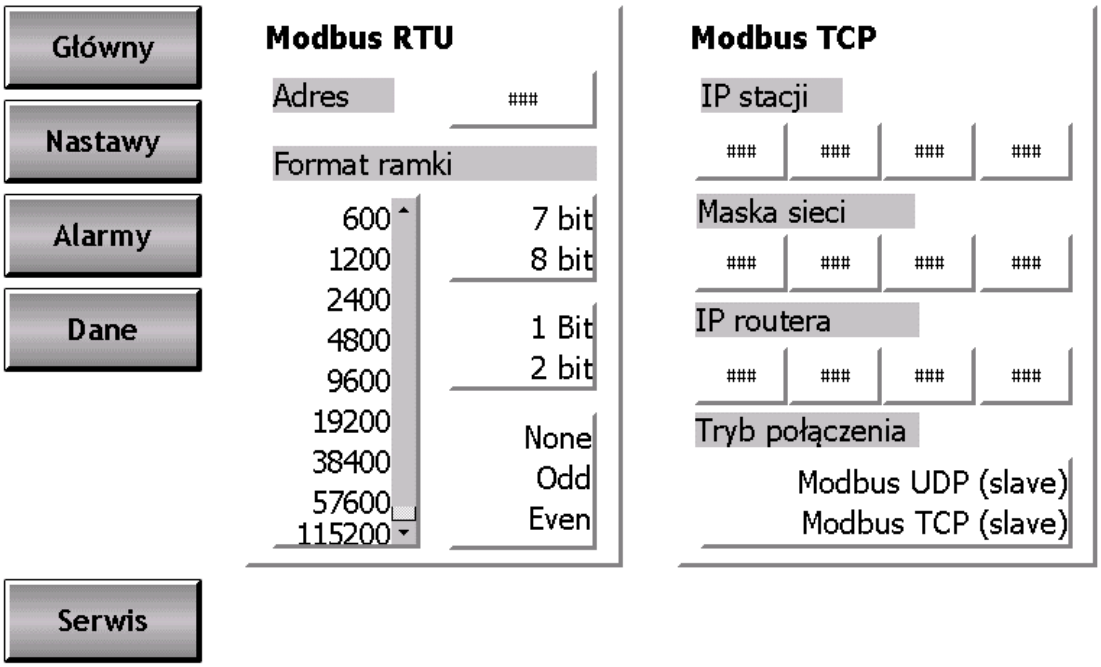

Figure 11. HMI communication - Modbus window.

Modbus RTU is based on the RS232 or RS485 asynchronous serial transmission standard. Data is transmitted in binary form and a 2-byte CRC code is used to check the correctness of the frames. This guarantees the correctness of the transmitted data. One Modbus RTU request consists of the slave address (1 byte), function code (1 byte), up to 256 bytes of data and CRC (2 bytes), the maximum request length is 255 bytes. There is a pause (no transmission) between Modbus RTU messages, which lasts at least 3.5 x the time required to transmit one byte.

Modbus TCP/IP is based on the ETHERNET TCP/IP communication standard. It is equivalent to Modbus RTU, but uses the TCP protocol on port 502 for communication. There is no checksum calculation as the higher TCP layer already does this. The ID field is not always used because the IP address used in the TCP/IP protocol is the device identifier.

10. Dimensional drawing of the PowerPack

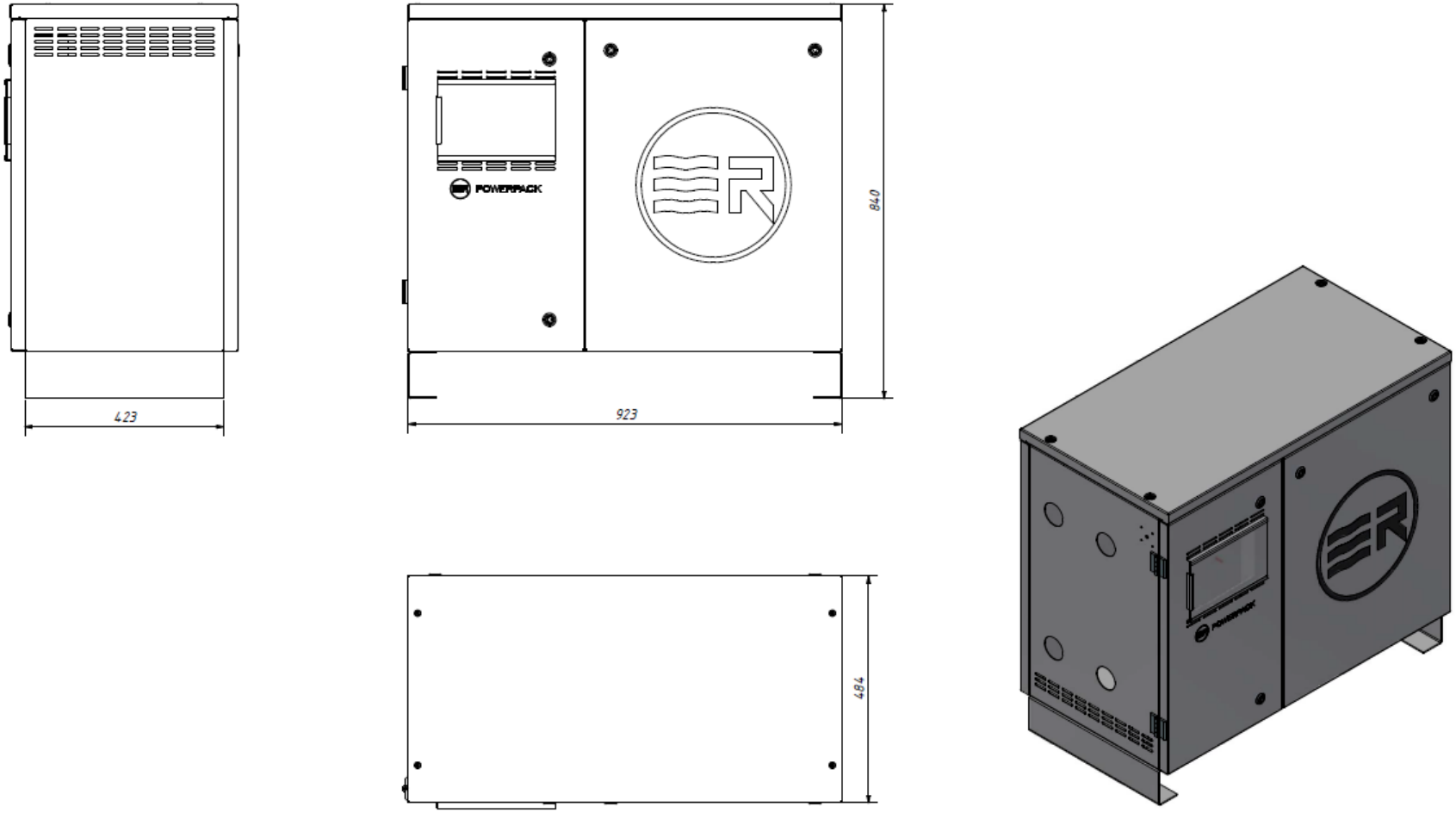

Figure 12. Dimensional PowerPack housing.

11. Electrical diagram

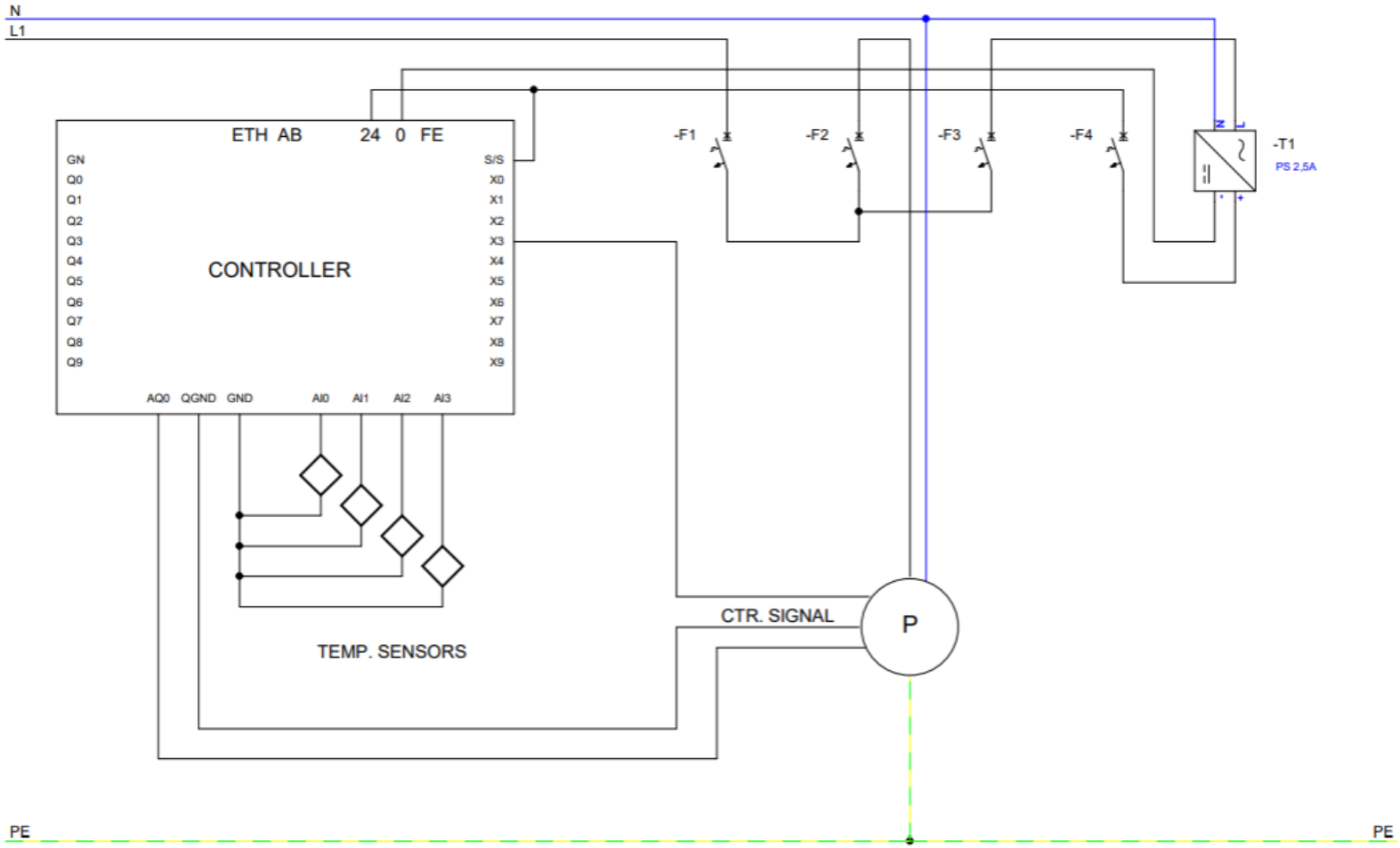

Figure 13. Electrical diagram – 230V/24V power supply.

12. Final remarks

The heat recovery system models described in this manual can be used in many countries. Heat recovery units purchased and shipped to European Union member states must be CE marked and comply with all relevant directives. In such cases, an EC certificate of conformity is included in the unit's design documentation. Any modification of the PowerPack heat recovery system is strictly prohibited, as it may render the EC certificates and markings useless.

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The design of the PowerPack heat recovery system and its solutions are exclusively patented by ASFI.

13. Warranty

ASFI contractually warrants that the equipment it manufactures and supplies will be free from defects in material and workmanship for a period of 18 months from the date of delivery or 12 months from the start-up of the PowerPack heat recovery system, whichever comes first. All cases of non-compliance with this warranty must be notified to the company in writing by the purchaser within the aforementioned period. ASFI will, at its discretion, rectify the problem by repairing the faulty equipment or supplying replacement parts, provided that the purchaser has stored, maintained and used the equipment in accordance with the guidelines specified in this manual. Any manufacturer's warranties on internal and external fittings supplied by ASFI but made by others will be transferred to ASFI to the extent that they can be transferred to the vendor of the heat recovery system. The vendor will not be obliged to make any alterations, replacements or repairs to the equipment, nor will the vendor be obliged to pay for any work carried out by the purchaser or others without the prior written consent of ASFI.

The warranty conditions do not cover cases of corrosion, erosion or normal material wear. Workmanship warranties are limited exclusively to the items specified in ASFI's offer. ASFI is obliged to perform its obligations in the manner and within the timeframe specified above.

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14. List of figures and tables