Emotron FDU/VFX 2.1

Liquid Cooling

Instruction manual

English

Valid from software version V5.12

emotron
DEDICATED DRIVE
A CG Product

Emotron FDU/VFX 2.1 Liquid Cooling

Valid from Software version V5.12

INSTRUCTION MANUAL - ENGLISH
Original instructions

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Safety instructions

Before you begin with the installation, commissioning or powering up the unit for the first time it is very important that you carefully study this instruction manual.
The following symbols can appear in this manual or on the product itself. Always read these first before continuing.

NOTE: Additional information as an aid to avoid problems.

CAUTION!
Failure to follow these instructions can result in malfunction or damage to the DCU.

WARNING!
Failure to follow these instructions can result in serious injury to the user in addition to serious damage to the DCU.

Installation

- The device must be installed by trained personnel.
- Disconnect all power sources before servicing.
- Always use appropriate DC-fuses to protect the wiring and prevent short-circuiting. To protect the IGBTs against short circuit currents, superfast semiconductor fuses are preferred.

Operating and maintenance personnel

Technically qualified personnel

Installation, commissioning, demounting, making measurements, etc. may only be carried out by personnel technically qualified and trained for the task.

1. Read the whole instruction manual before installing and putting the equipment into operation.
2. During all work (operation, maintenance, repairs, etc.) observe the switch-off procedures given in this instruction as well as any other operating instruction for the driven machine or system.
3. The operator must avoid any working methods which reduce the safety of the device.
4. The operator must do what he can to ensure that no unauthorised person is working on the device.
5. The operator must immediately report any changes to the device which reduce its safety to the user.
6. The user must undertake all necessary measures to operate the device in recommended condition only.

Installation of spare parts

We expressly point out that any spare parts and accessories not supplied by us have also not been tested or approved by us.

Installing and/or using such products can have a negative effect on the characteristics designed for your unit. The manufacturer is not liable for damage arising as a result of using non-original parts and accessories.

General warnings

WARNING!
Make sure that all safety measures have been taken before switching on the power supply.

WARNING!
Make sure that all safety measures have been taken before starting the motor in order to avoid personal injury.

WARNING!
Never operate the DCU with the front cover removed.

WARNING!
The cooling system may contain hot pressurised liquid. Contact with hot liquid or sudden release of pressure can cause serious burns. Allow the system to cool and depressurise the cooling circuit before performing service, maintenance, or disconnecting any hoses.

Alarms

Never disregard an alarm. Always check and remedy the cause of an alarm.

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1. General information

1.1 Liquid Cooling Option

The liquid cooling option uses a closed-loop circuit to remove heat from the power electronic building blocks (PEBBs) in variable speed drives (VSDs).

The cooling liquid is distributed either directly or via a dividing unit and is connected to an external cooling system, such as a plate heat exchanger. The heat exchanger is not included in the liquid cooling option.

The external cooling system and the heat exchanger are not covered in this manual.

1.2 System Schematic Overview

Fig. 1 shows a simplified example of a closed-loop cooling system, including the external cooling system.

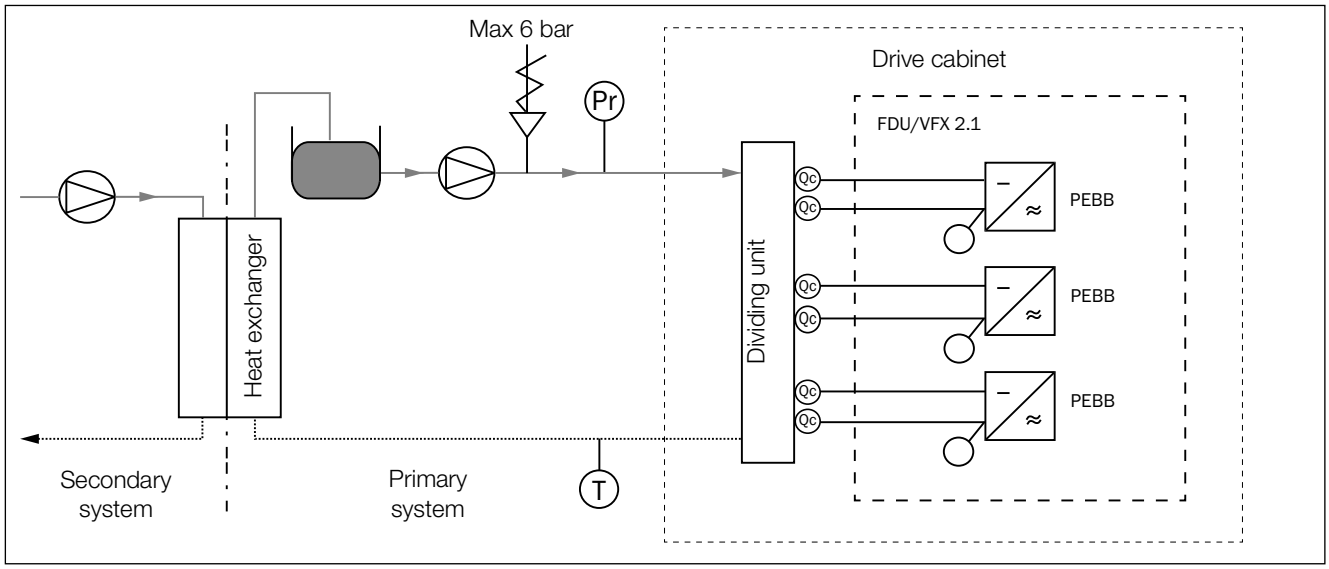

Fig. 1 Schematic example of a closed-loop system

Table 1 Symbols and definitions

Pr	Pressure Indicator
T	Temperature indicator
⊳	Pump
PEBB	Power Electronic Building Block
Qc	Quick coupling

The liquid temperature is indirectly controlled by the VSD´s internal temperature circuit. The VSD will switch off if the internal temperature becomes too high.

2. Installation

2.1 General

The liquid cooling option consists of a factory-mounted PEBB frame for liquid cooling and dividing units.

The system materials consist of aluminium, galvanised copper, stainless steel, and ethylene propylene diene monomer rubber (EPDM).

The allowed cooling media are:

- Water-glycol mixture
- Demineralised water
- Technical water
- Non-potable water
- Drinking water

See Chapter 6. for drinking water quality specifications.

The liquid must be free from organic deposits or chemically active substances. When filling the system, it is recommended to use a filter to prevent particles larger than 0.1 mm from entering the circuit.

At low temperatures, the system must be protected against freezing. Use a water-glycol mixture (20–30%, depending on the ambient temperature) for freeze protection, or consult your supplier for further advice.

To prevent electrolytic corrosion, add an inhibitor to the cooling medium. See Chapter 5. "Technical Specification", for more information.

2.2 Connections

To minimise pressure drops in the liquid circuit, ensure that the piping is as straight as possible.

Clean the pipes and connections, preferably with water. Otherwise, use pressurised air. A suitable filter is recommended to prevent dirt particles from clogging the piping, hoses, and coupling fittings, thereby reducing cooling efficiency.

To enable easy disconnection of the liquid supply, it is recommended to install manually operated valves at both the inlet and outlet. Furthermore, it is recommended to use instruments for measuring the pressure, flow, and temperature of the liquid in the system.

To minimise the risk of galvanic corrosion, it is recommended to use stainless steel for the fittings and piping, the same material as the dividing unit.

If stainless steel is not used, the following main line hoses are permitted:

- Plastic (PVC)
- Rubber (EPDM only)
- Copper (avoid uninsulated contact with stainless steel)
- Other stainless and acid-resistant materials

2.2.1 Dividing Unit

Connect the wall-mounted IP54 VSDs equipped with a single PEBB (sizes E, F, and FA) directly to the external cooling system. To connect VSDs with multiple PEBBs to the external cooling system, use the dividing units included in the option.

The PEBB frame for liquid cooling is provided with rubber hoses equipped with drip-free quick couplers. These couplers allow easy connection of the hoses to the dividing units without loss of liquid. See Fig. 1

The dividing unit distributes the flow equally to the PEBBs. To ensure equal liquid flow, use identical hoses and fittings for all connected PEBBs.

The mounting of the liquid cooling system is described in Chapter 4.

2.3 Fan

Some heat producing components are not thermally coupled to the liquid cooled heat sink. The drive's internal cooling fan cools these components and is factory set to a predefined speed to ensure sufficient cooling.

Typically, 2% of the energy used is lost as heat. Most of these power losses (80–90%) are dissipated into the liquid and removed from the cabinet. For the remaining losses, sufficient measures must be taken to keep the internal cabinet temperature below 40 °C. Furthermore, the ambient temperature outside the cabinet must be below 40 °C, see Chapter 5.

2.4 Flow Conditions

To guarantee sufficient cooling, it is advised to use a water flow according to Table 4 and Table 5 in Chapter 5. "Technical Specification".

The approximate pressure drop for different flow rates (100% drinking water) is shown in Table 2. See also the corresponding graph in Fig. 2.

Flow rate [l/min]	Δ P [bar]
2,0	0,20
3,0 *	0,30
4,0 *	0,45
5,0 *	0,65
6,0 *	0,90
7,0	1,20
8,0	1,50

* Adviced flow rate 3 - 6 l/min

Table 2 Pressure drop Δ P for different flow rates

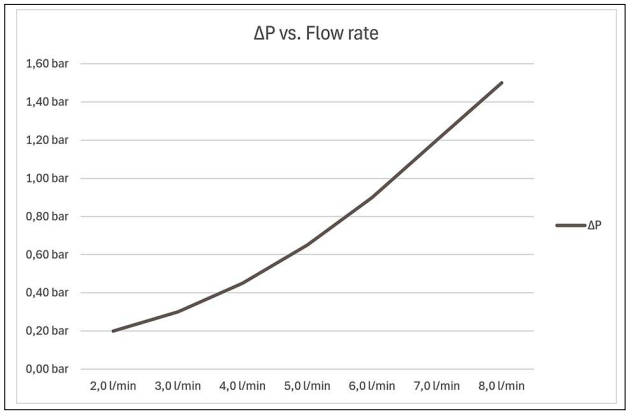

Fig. 2 Graphic overview of the pressure drop

2.4.1 Ethylene Glycol/Water Mixture

The specific heat capacity of an ethylene glycol/water mixture is lower than that of pure water. Therefore, the circulating flow rate in the heat transfer system must be increased. When using a 30% ethylene glycol mixture, the heat capacity may decrease by up to 20%.

The higher viscosity of ethylene glycol compared to water also results in an increased pressure drop, which must be compensated for. The combined compensation required for the reduced specific heat capacity and the increased pressure drop may be up to 100% for a 30% mixture.

WARNING: Propylene glycol is NOT allowed.

Note: The system pressure required to achieve the specified flow rates depends on several variables.

2.5 Condensation

Actions must be taken to prevent condensation. When the VSD is off or idle, the liquid temperature must be maintained above the dew point of the ambient air around the VSD. If this condition is not met, act by lowering the room temperature and/or the relative humidity, or by increasing the cooling liquid temperature.

Note: Increasing the cooling liquid temperature may reduce the performance of the VSD.

Note: The liquid temperature leaving the VSD must not exceed 65 °C.

3. Maintenance

3.1 Checking the Liquid

Over time, the liquid can become contaminated with floating particles from the system, which reduces its conductivity. Lower conductivity increases the risk of electrochemical reactions between different alloys in the primary system.

Contamination levels are typically lower in closed systems than in open systems.

For both open and closed systems, the use of inhibitors is recommended. Regular inspection of the cooling liquid is an important part of maintenance. See Section 3.2, "Maintenance Schedule". Refer to cooling liquid supplier information on checking and replacing schedule for the cooling liquid.

WARNING!
Improper connection may cause water leakage. Water in contact with electrical equipment can result in serious injury to the user in addition to serious damage to the DCU.

WARNING!
The cooling system may contain hot pressurised liquid. Contact with hot liquid or sudden release of pressure can cause serious burns. Allow the system to cool and depressurise the cooling circuit before performing service, maintenance, or disconnecting any hoses.

WARNING!
Changing the glycol:
- mixing is not permitted
- when antifreeze is going to be replacedby different one,the cooling circuit must first be flushed with water and it must be ensured that no residue of the original coolant remains.

3.2 Maintenance Schedule

To ensure optimal operation of the liquid cooling unit, several systematic maintenance tasks must be performed. See Table 3.

Table 3 Maintenance schedule

	Every 6 months	Once a year
Checking quick couplers		√
Checking filter		√
Inspection*	√	
Checking cooling liquid	√	

* See detailed instructions below.

The 6-monthly inspections include the following tasks:

- Check the system for possible leaks. It is dangerous to use the VSD while it is leaking.
- This check has only to be done for a closed system. Check the system pressure for abnormal variations. Rising pressure can indicate flow obstruction.
- Check the flow in the primary circuit at the flow indicator. The flow must be at least as high as in the initial setup.
- Check the heat sink temperature in menu [71A]. A higher value than normal can indicate cooling problems. The nominal value must not exceed 70 °C.
- Check the quick couplings for leakage. Please report any abnormalities to Emotron.

The 1-year inspection includes the following tasks:

- Disconnect the quick couplers and check for visible residue. Report any abnormalities to Emotron.
- Check the filters for leakage or other visible residue.
- Review the checklist from the 6-monthly inspections.

4. Mounting

The liquid cooled PEBB frame is mounted at the upper part of the cabinet, see Fig. 3, (A). Each PEBB is equipped with two hoses, one blue-marked for inlet flow, the other red-marked for outlet flow. These hoses must be connected to an external liquid supply, either directly for frame sizes with a single PEBB or through dividing units for larger sizes with multiple PEBBs.

The dividing units are mounted in the lower section (the plinth) of the cabinet, see Fig. 3, (B), and Section 4.1.

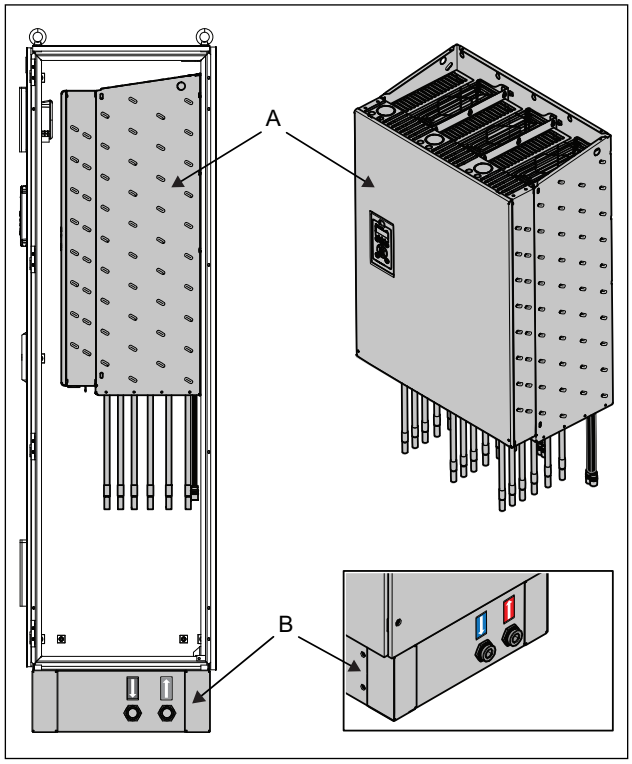

Fig. 3 Overview of the liquid cooling system components inside the cabinet

4.1 Dividing Units

Fig. 4 shows the dividing units mounted in the lower section (the plinth) of the cabinet. One of the units distributes the inlet flow from the external liquid supply to the PEBBs, with all connections marked by blue-coloured labels. The other unit collects the outlet flow back to the external heat system, with all connections marked by red-coloured labels.

Connect the hoses from each PEBB to the dividing units using a quick coupler as shown in Fig. 4. Make sure each labelled hose is connected to the correct dividing unit.

If the cabinets are equipped with two or more liquid-cooled PEBB frames, connect each pair of dividing units as shown in Fig. 5. All PEBBs are then included in the same flow circuit to minimise flow differences in the system. Apply thread sealant to all threads before connection.

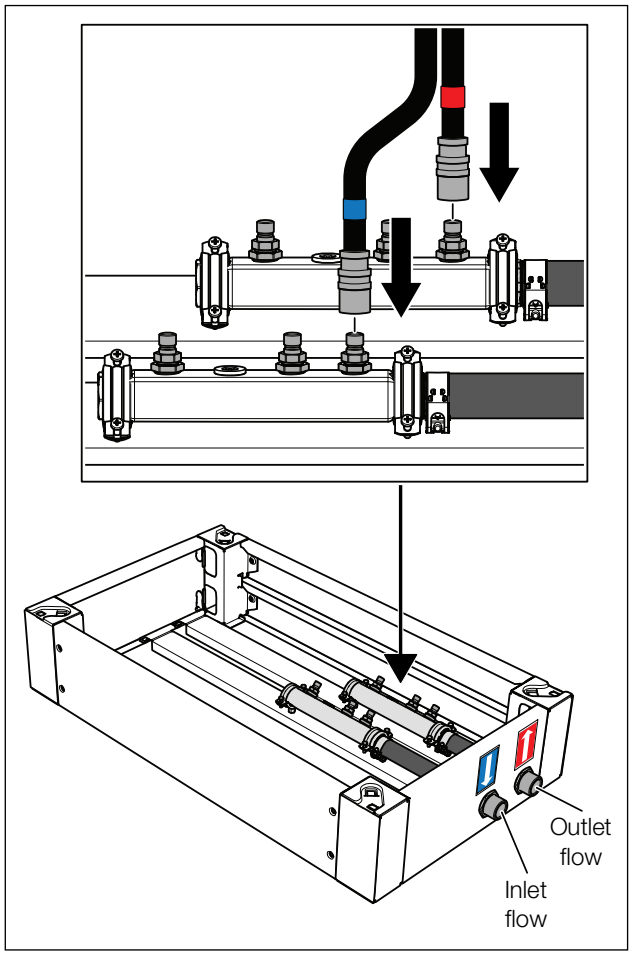

Fig. 4 Connecting the hoses to the dividing units

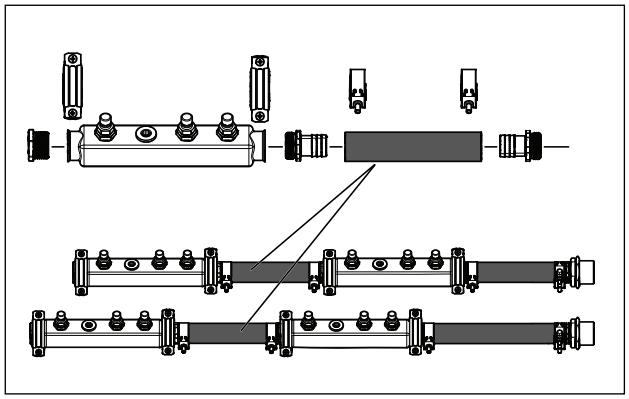

Fig. 5 Connecting dividing units for equal flow distribution when two or more PEBB frames are included in one circuit.

5. Technical Specification

Main liquid connections dividing unit
- BSPT (British Standard Tapered Pipe) thread 1” - Male quick coupling 3/8” *

* Applies only for frame size E, F or FA.

Ambient conditions
- Temp: 0 – 40 °C

Pressure ratings primary circuit
- Maximum working pressure 6 bar - Operating pressure range 4-6 bar

Temperature ratings cooling liquid
- Maximum outlet temperature 65 °C - Delta temperature from inlet to outlet is +10°C at 3 l/min per PEBB - Advise: input cooling liquid temperature should be between 15°C and 35°C - The inlet temperature of the liquid must be high enough to avoid condensation – typically above the dew point of the ambient air

Required flow of cooling liquid
- Typically 3 l/min per PEBB - Recommended flow range 3 - 6 l/min

Corrosion inhibitor
Open-loop system: - Cortec VpCI-647 - Ferrofos 8500 Closed-loop system: - Cortec VpCI-649 - Ferrolix 335 Water/inhibitor mixture: - Depending on the glycol/water mixture and type of system (open/closed), it is recommended to check with the inhibitor supplier for the exact values.

Freeze protection
Antifreeze with glycol as an active substance. Mixture of water/antifreeze: - The ratio between antifreeze and water depends on the type of inhibitor and type of system. It is recommended to follow the instructions from the antifreeze supplier for the correct ratio between water and antifreeze.

Required Water Flow

Pressure drop: Approximately 0,30 bar at a flow rate of 3,0 l/min using 100% drinking water.

Table 4 Required water flow for each frame size, *480 V*

Rated current [A]	Frame size	Number of PEBB	Water flow [l/min]
90-175	E	1	3
210-295	F	1	3
365	FA	1	3
430-500	H	2	6
590	G2	2	6
660-730	H2	2	6
810-885	G3	3	9
1010-1100	H3	3	9
1300-1460	H4	4	12
1710-1820	H5	5	15
2190	H6	6	18

Table 5 Required water flow for each frame size, *690 V*

Rated current [A]	Frame size	Number of PEBB	Water flow [l/min]
82-200	F69	1	3
250-400	H69	2	6
430-595	I69	3	9
650-800	J69	4	12
905-995	KA69	5	15
1K2	K69	6	18

Note: Possibilities in our drive software to use:
- Digital Input for detection of cooling Liquid level in tank (LC Level)
- Digital Output for starting Liquid Cooling pump (LC Pump)
- Digital Output for starting Heat Exchanger Pump (LC HE Pump)
See Fig. 1.

6. Cooling Water Quality Specification

The specifications in Table 6 apply to technical water, non-potable water and drinking water.

Table 6

Quality	Unit	Value
pH		6….8
Hardness of liquid	°dH	3….8
Free carbon dioxide	mg/dm^3	8….15
Associated carbon dioxide	mg/dm^3	8….16
Aggressive carbon dioxide	mg/dm^3	0
Sulphides free		free
Oxygen	mg/dm^3	<10
Chlorides ions	ppm	<40
Sulphate ions	ppm	<50
Nitrates and nitrites	mg/dm^3	<10
COD	mg/dm^3	<7
Ammonia	mg/dm^3	<5
Iron, Fe	mg/dm^3	0.2
Manganese	mg/dm^3	0.2
Conductivity	µS/cm	<400
Solid residue from evaporation	mg/dm^3	<500
Potassium permanganate consumption	mg/dm^3	<25
Suspended matter	mg/dm^3	<3
Maximum particle size	µm	<100
Dissolved substances	ppm	<340

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