ENGINEERING
TOMORROW

Operating Guide

iC7 Series Cooling Modules

76 kW and 152 kW

drives.danfoss.com | iC7

Contents

11 Specifications

1 Introduction

1.1 Purpose of this Operating Guide

This operating guide provides information for safe installation and commissioning of the product. It is intended for use by qualified personnel. To use the drive safely and professionally, read and follow the instructions. Pay particular attention to the safety instructions and general warnings. Always keep this operating guide available with the product.

1.2 Additional Resources

Additional resources are available to help understand the features, and safely install and operate the iC7 products:

- AMFI1256 Cooling Module Application Manual – the parameters and fault codes
- iC7 Series Liquid-cooled System Modules Design Guide
- iC7 Series Liquid-cooled System Modules Installation Guide
- VACON® Ethernet Option Boards Installation Guide – fieldbus installation
- VACON® RS485 and CAN Bus Option Boards Installation Guide – fieldbus installation
- *Facts Worth Knowing about AC Drives*, available for download on www.danfoss.com.
- Other supplemental publications, drawings, and guides are available at www.danfoss.com.

Latest versions of Danfoss product guides are available for download at https://www.danfoss.com/en/service-and-support/documentation/.

1.3 Version History

This guide is regularly reviewed and updated. All suggestions for improvement are welcome.

The original language of this guide is English.

Table 1: Version History

Version	Remarks
172F0589A	The first version of this guide.
172F0589B	Added new chapters on several topics.
172F0589C	Many updates throughout the guide.

1.4 Abbreviations

Table 2: Abbreviations, Acronyms, and Units

Term	Definition
°C	Degrees Celsius
°F	Degrees Fahrenheit
°dH	German degree, hardness
µm	Micrometer
µS/cm	Microsiemens per centimeter, conductivity
A	Ampere
AC	Alternating current

Table 2: Abbreviations, Acronyms, and Units (continued)

Term	Definition
dB	Decibel
DC	Direct current
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
Hz	Hertz
I	Current
IEC	International Electrotechnical Commission
I/O	Input/output
IP	Ingress protection
kHz	Kilohertz
kPA	Kilopascal
kW	Kilowatt
LED	Light-emitting diode
mA	Milliampere
mV	Millivolt
NEMA	National Electrical Manufacturers Association
Nm	Newton meter
PE	Protective earth
ppm	Parts per million
U	Voltage
V	Volt

1.5 Recommended Disposal

When the product reaches the end of its service life, its primary components can be recycled.

Before the materials can be removed, the product must be disassembled. Product parts and materials can be dismantled and separated. Generally, all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, and cardboard can be used in energy recovery. Printed circuit boards and large electrolytic capacitors with a diameter of over 2.5 cm (1 in) need further treatment according to IEC 62635 guidelines. To ease recycling, plastic parts are marked with an appropriate identification code.

Contact your local Danfoss office for further information on environmental aspects and recycling instructions for professional recyclers. End-of-life treatment must follow international and local regulations.

All products are designed and manufactured in accordance with Danfoss company guidelines on prohibited and restricted substances. A list of these substances is available at www.danfoss.com.

This symbol on the product indicates that it must not be disposed of as household waste. Do not dispose of equipment containing electrical components together with domestic waste.

It must be handed over to the applicable take-back scheme for the recycling of electrical and electronic equipment.

- Dispose of the product through channels provided for this purpose.
- Comply with all local and currently applicable laws and regulations.

2 Safety

2.1 Safety Symbols

The following symbols are used in Danfoss documentation.

⚠ DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

The guide also includes ISO warning symbols related to hot surfaces and burn hazard, high voltage and electrical shock, and referring to the instructions.

	ISO warning symbol for hot surfaces and burn hazard
	ISO warning symbol for high voltage and electrical shock
	ISO action symbol for referring to the instructions

2.2 General Safety Considerations

⚠ WARNING

LACK OF SAFETY AWARENESS

This guide provides important information on preventing injury and damage to the equipment or the system. Ignoring this information can lead to death, serious injury, or severe damage to the equipment.

- Make sure to fully understand the dangers and safety measures present in the application.

⚠ WARNING

ELECTRIC SHOCK

Drives contain hazardous voltage when a power source is connected to AC or DC terminals. Failure to disconnect all power sources can result in death or serious injury.

- Before performing any electrical work on the drive, disconnect, lock out, and tag out all power sources to the drive.
- There is more than 1 live circuit. See the relevant wiring diagram in the product guide.

DANGER

DISCHARGE TIME

The drive contains capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the drive.
- Disconnect all input and output power sources of the drive (for example permanent magnet type motors, batteries, or DC-link connections to other drives).
- Wait for the capacitors to discharge fully before performing any service on the equipment. The discharge time is 5 minutes. If the device is broken or fuses have tripped, the discharge time is longer.
- Use a measuring device to make sure that there is no voltage, before opening the drive or performing any work on the cables.

WARNING

UNINTENDED START

When the drive is connected to a power source, the system may start at any time, causing risk of death, serious injury, and equipment or property damage.

- Stop the drive and motor before configuring parameters.
- Make sure that the drive cannot be started by an external switch, a fieldbus command, an input reference signal from the control panel, or after a cleared fault condition.
- Disconnect the drive from the power source whenever safety considerations make it necessary to avoid unintended start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

2.3 Target Group and Necessary Qualifications

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the products. Only qualified personnel are allowed to perform all related activities for these tasks. Qualified personnel are defined as properly trained staff, who are familiar with and authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this guide and other relevant guides. Non-qualified electricians are not allowed to perform any electrical installation or troubleshooting activities.

Only Danfoss authorized, qualified personnel are allowed to repair this equipment. Specialized training is required to perform the activities related to repair.

2.4 Designated Use

Installing and operating a Danfoss product not following the following preconditions is regarded as non-designated use. Danfoss does not take any liability for non-designated use.

Danfoss products are units intended for installation in electrical systems. They comply with the requirements of various directives and certifications. To see all valid certifications for the product, check the product label.

When the product is installed in machinery or system, these have to comply with relevant national regulations.

In any case, the product and its components have to be operated in accordance with all national Occupational Safety & Health regulations and directives.

Operation of Danfoss products is only allowed under observance of the respective EMC regulations.

Operation of Danfoss products is only allowed under observance of the specifications and requirements given on the product label and in the product-specific documentation.

Only use spare parts approved and provided by Danfoss. Using other spare parts can damage the product.

2.5 Safe Operation

Keep all doors and covers closed during operation of the cooling module.

Drive components and accessories can still be live and connected to mains, even after the operation indicators are no longer illuminated.

When working with the cooling module together with the AC drive, also follow the safety instructions in the *iC7 Series System Modules Installation Safety Guide* to prevent any accidents. Retain these operating instructions during the entire life cycle of the cooling module.

3 Product Overview

3.1 Product Variants

The cooling module is available in different variants based on the protection rating, the cooling power, and the number of pumps. The enclosed cooling module has the protection rating IP54, and the standalone cooling module has the protection rating IP23. The available cooling power is 76 kW or 152 kW. The product can have 1 or 2 pumps.

3.2 Description of the Model Code

The model code defines the specifications of the product included in the delivery. It is shown on the package label and the product label. The model code is made of standard codes and plus codes. Each part of the model code corresponds to the data in your order.

Example

The model code can have this format, for example:

iC7-60SLLQ40-0152E54F2+XXXX(+XXXX)

Table 3: Description of the Model Code

Code	Description
iC7-60	Product group
SL	**Product category** SL = system module, liquid-cooled EL = enclosed drive, liquid-cooled
LQ	**Product type** LQ = cooling module
40	**Voltage rating** 40 = 400 V AC (380–415 V AC ±5%) 50/60 Hz 46 = 460 V AC (440–480 V AC ±5%) 60 Hz 50 = 500 V AC (500–525 V AC ±5%) 50 Hz 60 = 600 V AC (575–600 V AC ±5%) 60 Hz 69 = 690 V AC (660–690 V AC ±5%) 50/60 Hz
-0152	**Cooling power** -0076 = 76 kW -0152 = 152 kW
E54	**Protection rating** E23 = IP23 (standalone cooling module) E54 = IP54 (enclosed cooling module)
F2	**EMC category** F2 = C2 Industry environment
+SAP1	**Cooling module configuration** +SAP1 = single-pump +SAP2 = dual-pump
+XXXX	**Options**

3.3 Outer Dimensions and Weights

Table 4: Outer Dimensions and Weights of the Cooling Module

Type	Number of pumps	IP23 Size WxHxD [mm (in)], footprint[1]	IP23 Size WxHxD [mm (in)], total[2]	IP54 Size WxHxD [mm (in)], footprint[1]	IP54 Size WxHxD [mm (in)], total[2]	IP23 Weight [kg (lb)] (standalone, empty)	IP54 Weight [kg (lb)] (Rittal VX25, empty)
iC7-60SLLQxx-0076…	1	300 x 1900 x 550 (11.8 x 74.8 x 21.7)	520 x 1900 x 660 (20.5 x 74.8 x 26.0)	408 x 2060 x 608 (16.1 x 81.1 x 23.9)	520 x 2060 x 660 (20.5 x 81.1 x 26.0)	250 (550)	330 (730)
iC7-60SLLQxx-0076…	2	500 x 1900 x 550 (19.7 x 74.8 x 21.7)	720 x 1900 x 660 (28.3 x 74.8 26.0)	608 x 2060 x 608 (23.9 x 81.1 x 23.9)	720 x 2060 x 660 (28.3 x 81.1 x 26.0)	330 (730)	420 (930)
iC7-60SLLQxx-0152…	1	300 x 1900 x 550 (11.8 x 74.8 x 21.7)	520 x 1900 x 660 (20.5 x 74.8 x 26.0)	408 x 2060 x 608 (16.1 x 81.1 x 23.9)	520 x 2060 x 660 (20.5 x 81.1 x 26.0)	260 (570)	350 (770)
iC7-60SLLQxx-0152…	2	500 x 1900 x 550 (19.7 x 74.8 x 21.7)	720 x 1900 x 660 (28.3 x 74.8 x 26.0)	608 x 2060 x 608 (23.9 x 81.1 x 23.9)	720 x 2060 x 660 (28.3 x 81.1 x 26.0)	350 (770)	440 (970)

1) Footprint = space required on the floor

2) Total = clearance including the protruding pipes

3.4 Product Label

The product label gives information about the product.

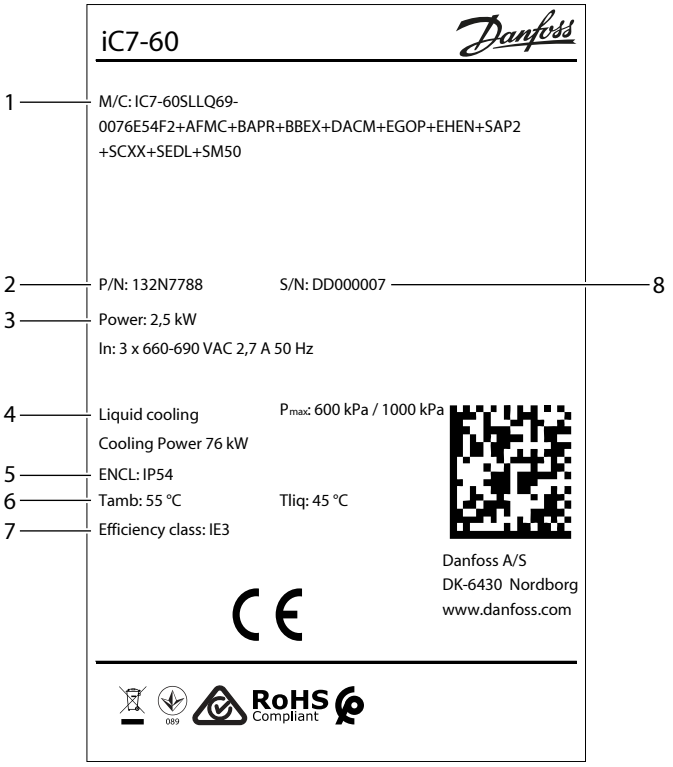

Figure 1: Product Label for the iC7 Series Cooling Module

1	Model code	**2**	Code number
3	Power an input ratings	**4**	Cooling method
5	Protection rating	**6**	Temperature ratings for ambient air and for the coolant
7	Efficiency class	**8**	Serial number

4 Receiving the Product

4.1 Checking the Delivery

1. Examine the packaging and the product for transport damage.
   a. If the product was damaged during transport, contact the cargo insurance company or the carrier.
2. Make sure that the items supplied and the information on the product label correspond to the order confirmation.
   a. If the delivery does not match your order, contact the vendor immediately.

4.2 Storing the Cooling Module

If it is necessary to store the product before installing it, follow these instructions. Keep the equipment sealed in its packaging until installation.

1. Make sure that the ambient conditions are within these guidelines:
   - Temperature: -40...+70 °C (-40...+158 °F)
   - Humidity: 0...96%, condensation must be avoided
2. Make sure that there is no coolant in the cooling module.
3. Plug the inlet and outlet pipes to the cooling module.

4.3 Lifting the Cooling Module

4.3.1 Lifting Safety

The cooling module is delivered horizontally in a plywood package.

⚠ WARNING

LIFTING HEAVY LOAD

Not following the safe lifting instructions can result in death or serious injury and damage to the equipment.

- Follow local safety regulations on lifting.
- Use a lifting device that is in proper working condition and appropriate for the weight of the load.
- Test lift the load to verify the proper center of gravity. Reposition the lifting point if not level.
- Do not walk under, or place any part of your body under a suspended load.

⚠ WARNING

SWINGING HAZARD DURING LIFTING

The swing effect can cause serious injury and damage to the equipment. It occurs when lifting the product into a vertical position, just before the product reaches vertical position, when the center of gravity of the product surpasses the floor support point.

- Make sure that the lifting ropes are properly attached.
- Secure the lifting area.
- Lift the product slowly and carefully.

NOTICE

TRANSPORTATION HAZARD

If there is coolant in the cooling module during transportation, low and high ambient temperatures can damage the cooling module.

- Move the cooling module empty, that is, without coolant in it.

See the dimensions and the weight of the product in 3.3 Outer Dimensions and Weights.

4.3.2 Lifting the Enclosed Cooling Module

1. Remove the plywood package frame and the cooling module fixing brackets.
2. Use a lifting device that is sufficiently strong for the weight of the cooling module.
3. Attach the lifting device in the 4 lifting points of the lifting bars.

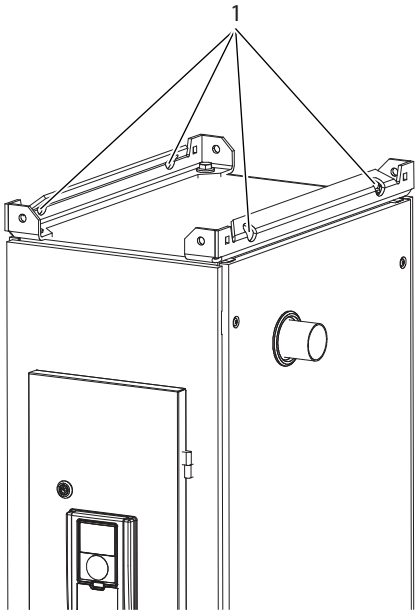

Figure 2: Lifting the Enclosed Cooling Module

1	The lifting points in the lifting bars

4. Lift the cooling module into a vertical position.
5. Lift the cooling module to the required location.

4.3.3 Vertical Lifting of the Standalone Cooling Module

1. Remove the plywood package frame and the cooling module fixing brackets.
2. Use a lifting device that is sufficiently strong for the weight of the cooling module.
3. Attach the lifting device in the 2 lifting points on the sides of the cooling module.

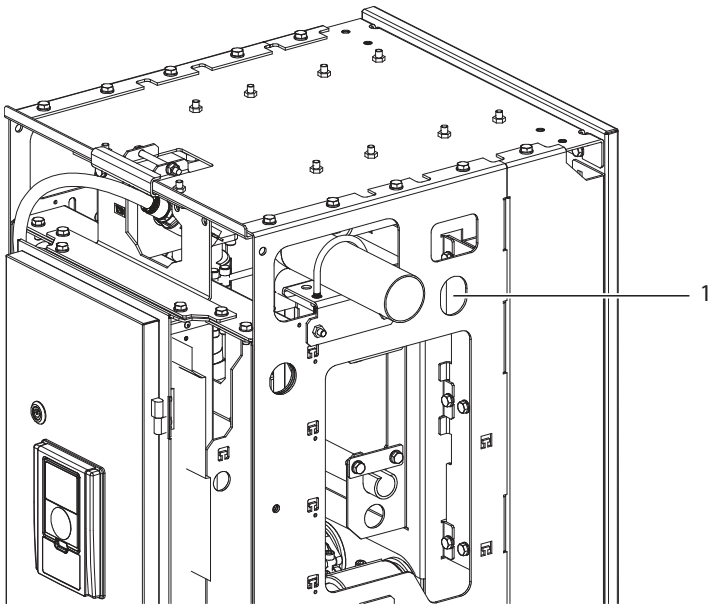

Figure 3: Vertical Lifting of the Standalone Cooling Module

1	Lifting point

4. Lift the cooling module into a vertical position.
5. Lift the cooling module to the required location.

4.3.4 Horizontal Lifting of the Standalone Cooling Module

1. Remove the plywood package frame and the cooling module fixing brackets.
2. Use a lifting device that is sufficiently strong for the weight of the cooling module.
3. Attach the lifting device in the 4 lifting points on the edges of the cooling module.

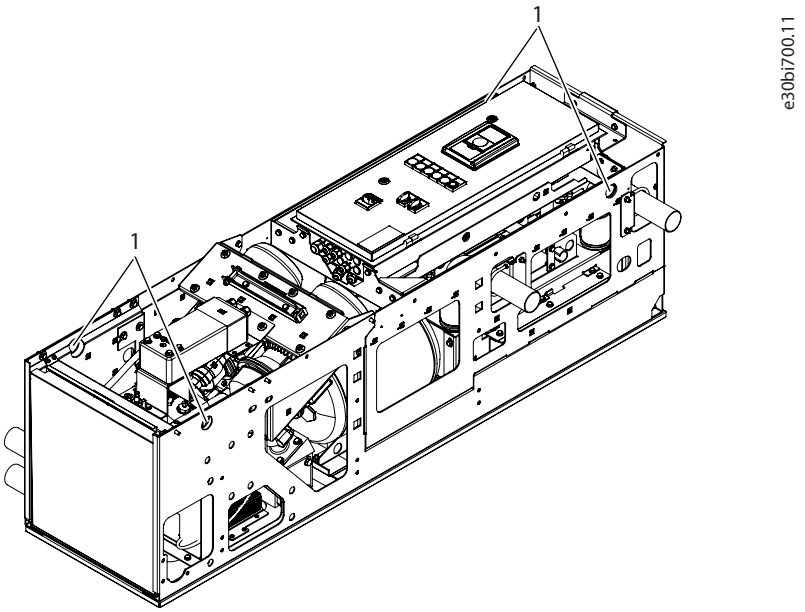

Figure 4: Horizontal Lifting of the Standalone Cooling Module

1	The lifting points

4. Lift the cooling module to the required location.
5. Lift the cooling module into a vertical position.

5 Mechanical Installation

5.1 Required Environmental Conditions

The cooling module is designed to operate within ambient temperatures between -15...+55 °C, or -30...+55 °C with limitations (+5...+131 °F, or -22...+131 °F with limitations). Make sure that the temperature remains within this range during operation. If the cooling module is positioned outside, it must be placed inside a cabinet that is equipped with temperature and humidity control.

If the temperature in the drive room is higher than the temperature of the drive circuit liquid, it can cause condensation on the piping and inside the drive.

Use glycol in temperatures under 0 °C (32 °F). Ice formation is not allowed.

Relative humidity is 5–96%. Dripping water or condensation is not allowed.

Dew-point calculation and condensation prevention are included in the application software.

5.2 Installation Preparations

Do these steps before installing and commissioning the cooling module.

1. Remove the plastic wrappings of the inlet and outlet piping of the drive circuit near the bottom of the cooling module. See 6.12 Pipe Connections.
2. Remove the transportation support screws from the control compartment.
   a. Plug the screw holes with rubber plugs that are in the accessories bag.

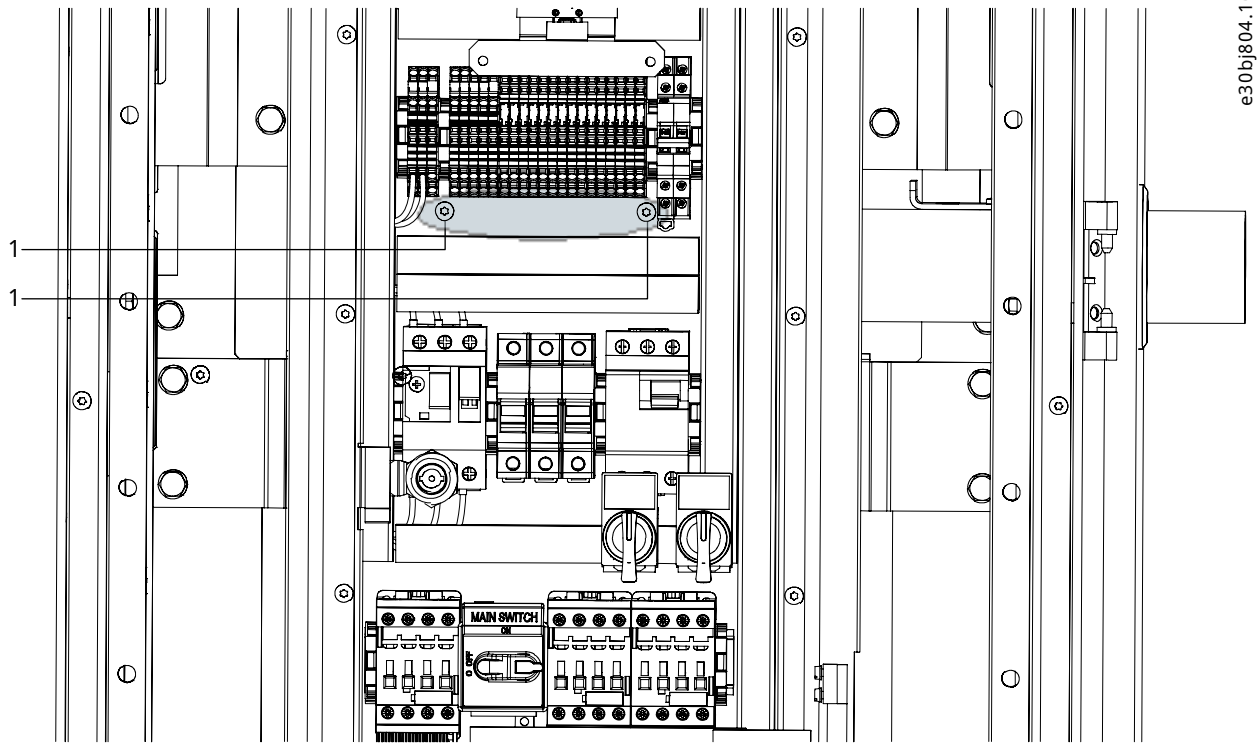

Figure 5: Transportation Screws of the Control Compartment

1	Transportation screws

3. Open the transportation plug of the pressure gauge.

5.3 Installing the Standalone Cooling Module into the Cabinet

The standalone cooling module is designed to be installed into a Rittal cabinet, but it is possible to install it into any cabinet. If another kind of cabinet is used, make sure the standalone cooling module fits inside it.

Table 5: Cabinet Size

Plus code	Cabinet width, depth, and height [mm (in)]
+SAP1	400 x 600 x 2000 (15.7 x 23.6 x 78.7)
+SAP2	600 x 600 x 2000 23.6 x 23.6 x 78.7)

1. To connect the standalone cooling module into the cabinet, design and manufacture special attachment parts.

   The attachment parts must be strong and rigid enough to carry the weight of the product.

   The attachment parts must not disturb the operation of the product or collide with the inlet and outlet piping.

2. Cut the side plates of the cabinet according to the cooling module inlet and outlet piping.
   a. Install seals according to the protection rating.

   See the location of the pipes in 11.2.1 Dimensions of the Single-pump Standalone Cooling Module and 11.2.2 Dimensions of the Dual-pump Standalone Cooling Module.

3. Cut the cabinet door so that the control compartment can be fitted.
   a. Remove the control compartment sleeve. Keep the screws.
   b. Cut the cabinet door according to the cut-out drawing or the removed sleeve.
   c. To make it easier to attach the control compartment into the cabinet door, keep the control compartment attached to the support frame (four M8 screws).
   d. Attach the control compartment into the cabinet door with the screws that were kept in the earlier step.
   e. Remove the four M8 screws, so that the control compartment is only attached into the cabinet door, and moves together with the cabinet door.

   The control compartment has IP54 sealing for both the control compartment base and the control compartment door.

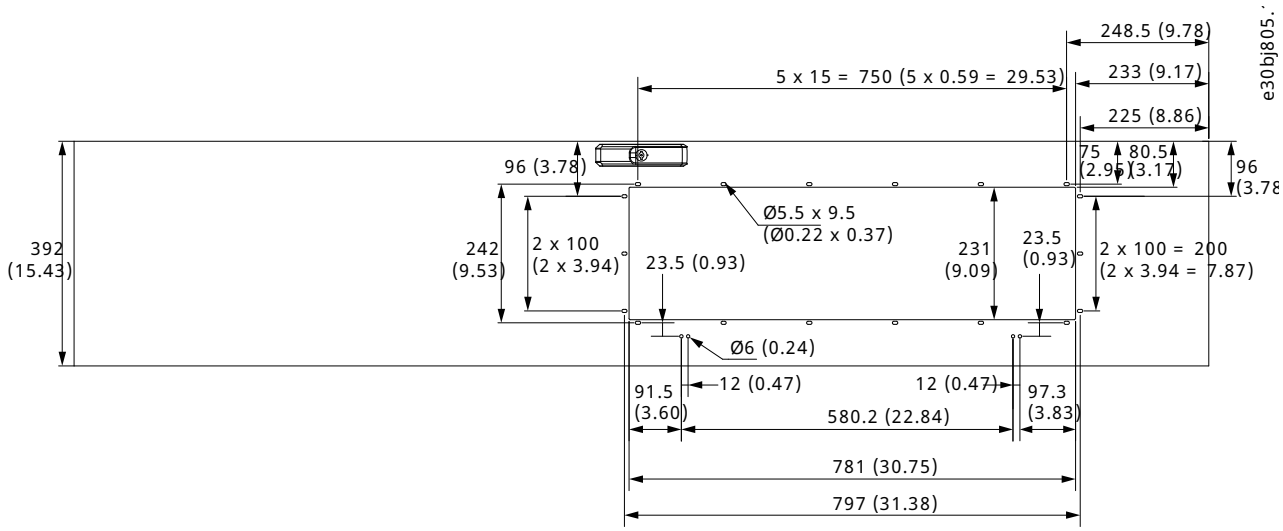

Figure 6: Dimensions for the Cut-out on the Cabinet Door in mm, Single-pump Cabinet

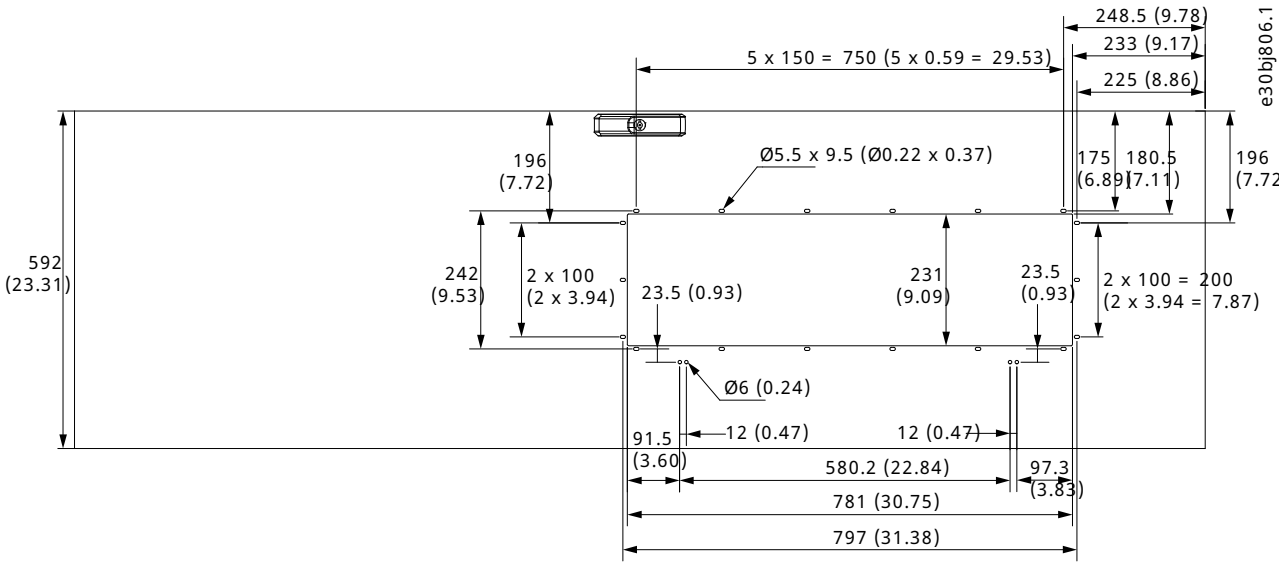

Figure 7: Dimensions for the Cut-out on the Cabinet Door in mm, Dual-pump Cabinet

4. Optional: Install a new leaking pan into the cabinet.
   a. Remove the standard leaking pan of the cooling module.
   b. Detach the leakage sensor LS22 from the standard leaking pan of the cooling module and attach it into the new cabinet leaking pan deep end.
   c. Install seals according to the protection rating.
   d. Install the new leaking pan with an inclination forward.

   More space is gained.

5. If the standard leaking pan of the cooling module is used, the cabinet floor must have sealing that meets the requirements of the protection rating.
6. Attach the cooling module into the cabinet frame using the all the specified mounting holes.

See the location of the mounting holes in 11.2.1 Dimensions of the Single-pump Standalone Cooling Module and 11.2.2 Dimensions of the Dual-pump Standalone Cooling Module.

The installation must be rigid. A good installation prevents the product from moving or being damaged by vibrations.

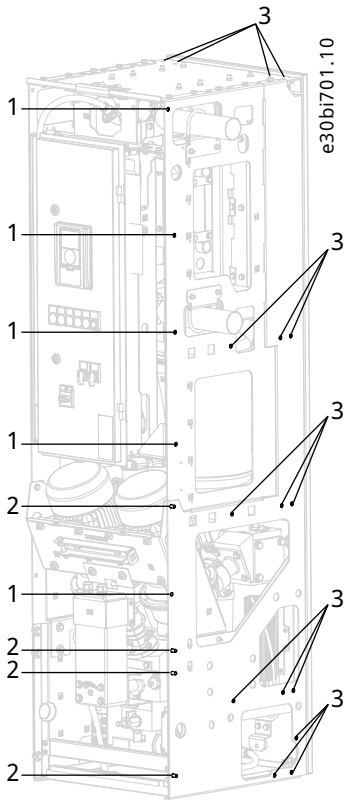

Figure 8: Mounting Holes of the Standalone Cooling Module

1	Through hole, use an M8 screw	**2**	Through hole, use an M8 screw. Pre-attached screw and nut.
3	Thread hole, M8		

7. For the mounting holes that have a screw and a nut pre-attached, remove the nut. When attaching the cooling module, replace the nut with a threaded support part.

   The screw can be reused in the same mounting hole.

8. Attach the enclosed cooling module to the floor and to the wall.
9. If there is another cabinet next to it, attach the cabinets into each other.

   Use fasteners that are strong enough.

5.4 Installing the Standalone Cooling Module without a Cabinet

The standalone cooling module has a self-supporting frame.

⚠ WARNING

INSTALLATION LOCATION HAZARD

If the product is installed without a cabinet, it can become a threat to main systems or persons.

- Install the product in a safe location.
- If it is required, for example, by national regulations, add warning signs in the area and wear protective gear.

1. To attach the standalone cooling module to the floor and/or wall, design and manufacture special attachment parts.

   The attachment parts must be strong and rigid enough to carry the weight of the product.

   The attachment parts must not disturb the operation of the product or collide with the inlet and outlet piping.

2. Attach the cooling module using the all the specified mounting holes.

   See the location of the mounting holes in 11.2.1 Dimensions of the Single-pump Standalone Cooling Module and 11.2.2 Dimensions of the Dual-pump Standalone Cooling Module.

   The installation must be rigid. A good installation prevents the product from moving or being damaged by vibrations.

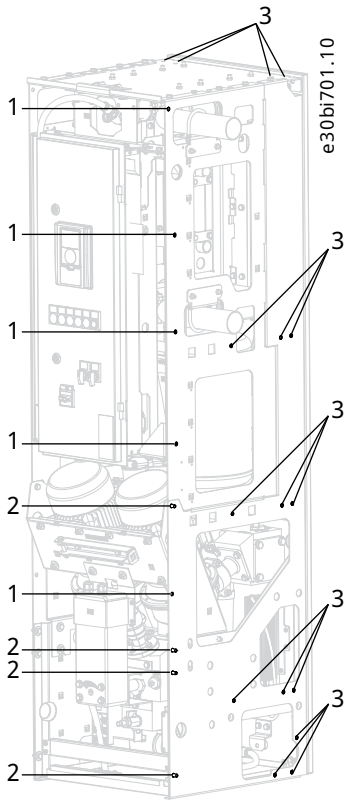

Figure 9: Mounting Holes of the Standalone Cooling Module

1	Through hole, use an M8 screw	**2**	Through hole, use an M8 screw. Pre-attached screw and nut.
3	Thread hole, M8		

3. For the mounting holes that have a screw and a nut pre-attached, remove the nut. When attaching the cooling module, replace the nut with a threaded support part.

   The screw can be reused in the same mounting hole.

5.5 Installing the Enclosed Cooling Module

The enclosed cooling module is delivered installed in a Rittal VX25 cabinet (model code part E54).

1. Attach the enclosed cooling module to the floor (4 fixing points) and to the wall (2 fixing points).

   The floor and the wall must be rigid.

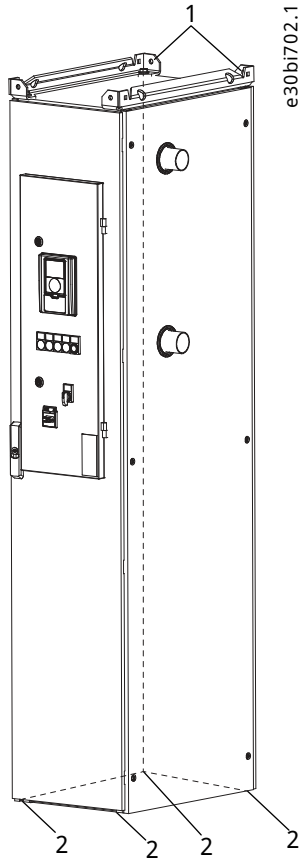

Figure 10: Mounting Holes of the Enclosed Cooling Module

1	The mounting holes at the top	**2**	The mounting holes at the bottom

2. If the enclosed cooling module is right next to the drive cabinet, do these steps.
   a. Remove the side plates of the Rittal cabinets from the sides that are next to each other.
   b. Attach the cabinets into each other.

6 Cooling Installation

6.1 Safety in Liquid-cooling

⚠ WARNING

POISONOUS COOLANTS

Glycols and inhibitors are poisonous. If touched or consumed, they can cause injury.

- Prevent the coolant from getting into the eyes. Do not drink the coolant.

⚠ CAUTION

HOT COOLANT

Hot coolant can cause burns.

- Avoid contact with the hot coolant.

⚠ CAUTION

PRESSURIZED COOLING SYSTEM

Sudden release of pressure from the cooling system can cause injury.

- Be careful when operating the cooling system.

NOTICE

INSUFFICIENT COOLING CAPACITY

Insufficient cooling can cause the product to become too hot and thus become damaged.

- To make sure that the cooling capacity of the cooling system stays sufficient, make sure that the cooling system is vented and that the coolant circulates properly.

NOTICE

DAMAGE TO COOLING SYSTEM

If the coolant circulation is stopped too soon, high-temperature components can cause rapid local increase in the coolant temperature, which can damage the cooling system.

- Do not stop the cooling system when stopping the drive. Keep the coolant circulation flowing for 2 minutes after the drive has been stopped.

6.2 The Operating Principle of the Cooling Module

The operating principle of the cooling module is to transfer heat from the drive circuit into the external circuit.

The heat load is transferred from the drive to the drive circuit. The heat load is then conducted inside the plate heat exchanger from the drive circuit to the external circuit. The external circuit removes the heat load. The removal can be done, for example, with an external condenser, which is a part of your existing cooling system.

If the system has the option +SCXX (no heat exchanger), an external heat exhanger must be used instead of the internal heat exchanger of the cooling module

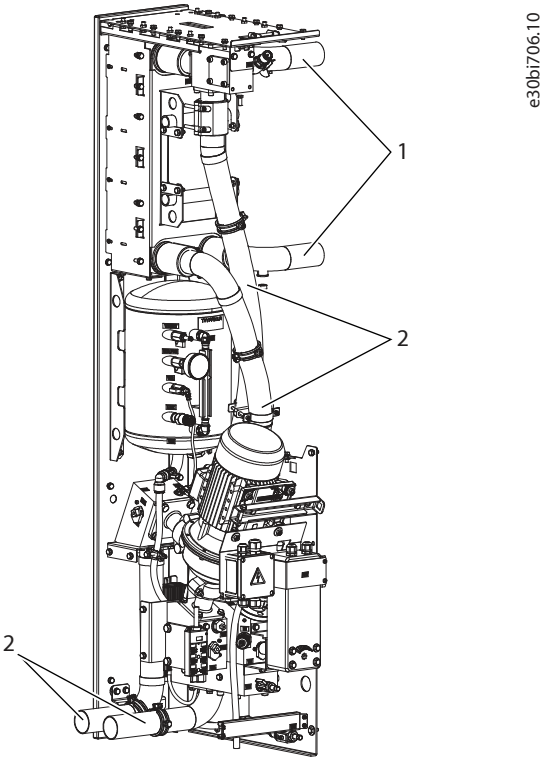

Figure 11: Circulation of Liquid in the 2 Circuits of the Cooling Module

1	Piping of the external circuit	**2**	Piping of the drive circuit

The temperature sensor TE11 monitors the drive circuit temperature. The sensor is in the suction block. The sensor sends an analog signal to the control unit of the cooling module. The application directs the drive circuit flow through the heat exchanger (HX11) or through bypass by turning the 3-way valve actuator (FV11). The position of the 3-way valve actuator is adjusted by using the difference between the temperature sensor and the application reference temperature value. The reference temperature value is set at the commissioning based on the requirement of the AC drive. In addition, the reference temperature value is also adjusted by the dew-point calculation to prevent condensation.

The cooling module has monitoring of the coolant flow, temperature, pressure, coolant level, and coolant leaks. The monitoring is done by sensors together with the application software installed in the control unit of the cooling module. The application software generates alarms and faults from the I/O (input/output) signals, based on the parameter settings. It is possible to access the parameter settings on the control panel of the cooling module. All the monitoring instruments are in the drive circuit, except for the leakage sensor (LS22) and the ambient temperature/humidity sensor (TE21, ME21). The leakage sensor is on the cooling module leaking pan and the ambient temperature/humidity sensor is on the back side of the cooling module control compartment.

See the P & I diagram for more information:

- 11.5.1 Piping and Instrumentation Diagram of the Single-pump Cooling Module with an External Heat Exchanger
- 11.5.2 Piping and Instrumentation Diagram of the Single-pump Cooling Module
- 11.5.3 Piping and Instrumentation Diagram of the Dual-pump Cooling Module

For more information on the parameters and the application software, see the *AMFI1256 Cooling Module Application Manual*.

6.3 Components of the Drive Circuit

The drive circuit is a closed circuit that consists of the cooling module drive side circuit and the AC drive circuit. The drive circuit also includes an expansion tank (EV11) to compensate for the volume fluctuation caused by temperature changes. The drive circuit flow and temperature must match the requirements of the connected drives. These requirements can be calculated by referring to 11.4.1 Determining the Estimated Flow in the System or following the instructions in the relevant drive guide, for example, *iC7 Series Liquid-cooled Systems Modules Design Guide*.

The plate heat exchanger (HX11) connects the drive circuit and the external circuit thermally.

The centrifugal pump (P1) circulates the coolant in the drive circuit. The main function of the pump is to deliver enough flow for the required heat transfer from the drives and into the external circuit. Other important components are the 3-way valve (V111), the relief valve (V231), the pressure transmitters (PT11 and PT12), and the temperature sensor (TE11).

The default reference temperature of the coolant is +45 °C (113 °F). If the temperature increases above the reference, the 3-way valve starts to increase the flow through the heat exchanger and directs less liquid through the bypass. Keeping the temperature as high as possible in the drive circuit lowers the risk of condensation inside the drive cabinet.

See 6.18.2 Filling the Cooling System by Progressive Circulation and 6.18.3 Filling the Cooling System by Forced De-airing.

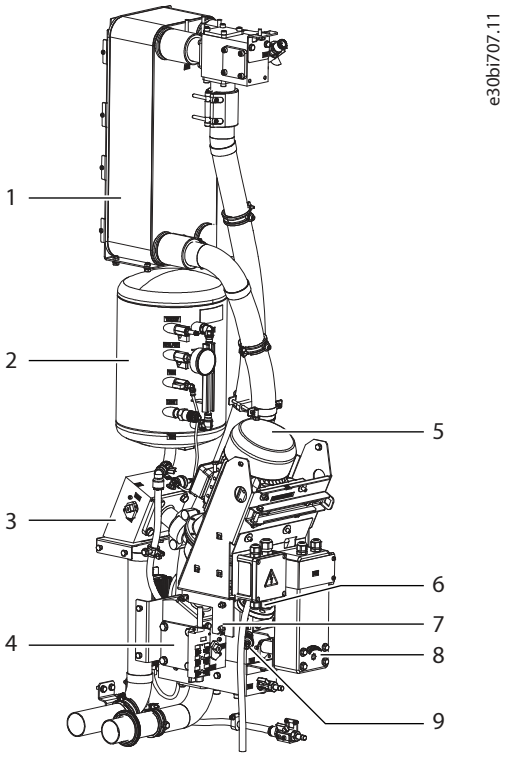

Figure 12: Components of the Drive Circuit

1	Heat exchanger	**2**	Expansion tank
3	Pressure block	**4**	Suction block
5	Pump	**6**	Relief valve
7	Temperature sensor	**8**	3-way valve actuator
9	Pressure transmitter		

6.4 Components of the External Circuit

The external circuit transfers the heat load from the heat exchanger to a customer-specific object. The upper pipe is the outlet, and the lower pipe is the inlet.

NOTICE

LACK OF SUPERVISION IN THE EXTERNAL CIRCUIT

The cooling module does not have a supervision system for the external circuit. If there is no supervision in the external circuit, it is hard to determine the reason for a possible alarm or fault in the cooling module. This can cause damage to the equipment.

- Use suitable devices to control and supervise leaks, flow, and temperature in the piping of the external circuit.
- Use, for example, a leakage sensor, a flow meter, and a temperature sensor.

NOTICE

VIBRATION HAZARD

Vibration shortens the mean time between failure (MTBF) of the cooling module.

- Use suitable devices to control and supervise leaks, flow, and temperature in the piping of the external circuit.
- Prevent all forces or vibrations from entering the cooling module through the pipe connections of the external circuit or through the fixing points of the cooling module.

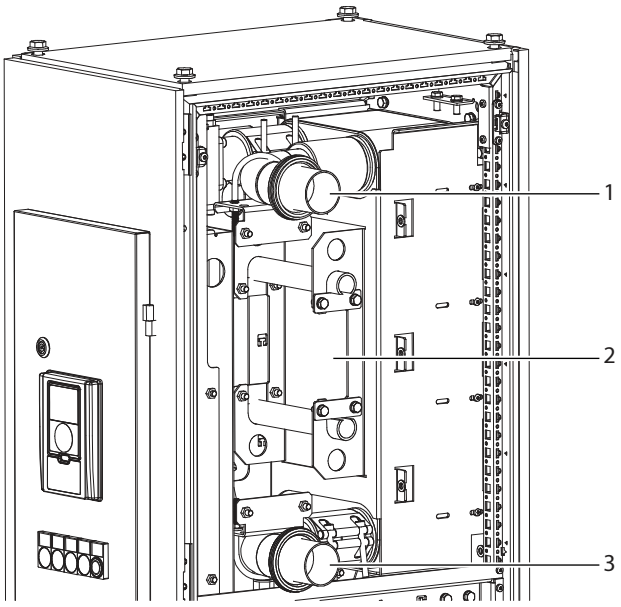

Figure 13: Components of the External Circuit

1	Outlet piping	**2**	Heat exchanger
3	Inlet piping		

6.5 Direction of Coolant Flow

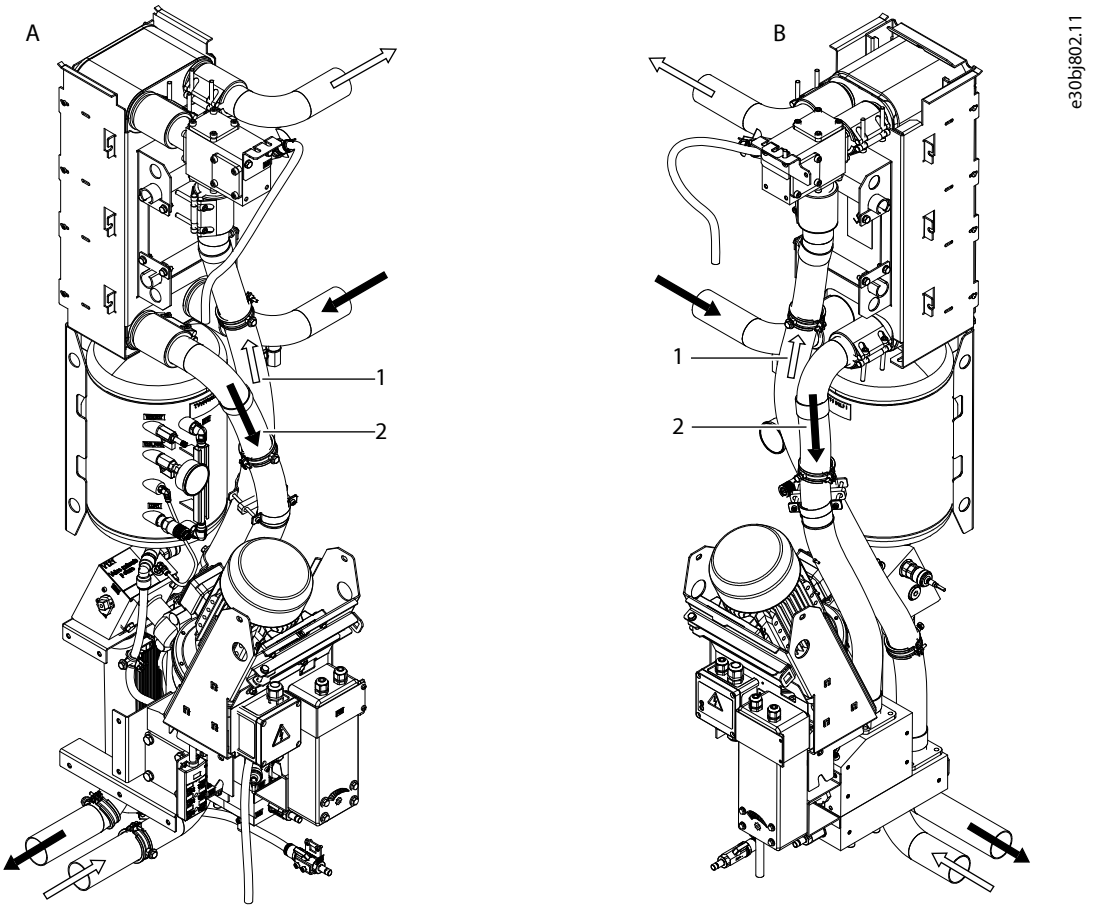

Figure 14: Direction of Coolant Flow

A	Left-handed cooling module	**B**	Right-handed cooling module
1	Hot coolant	**2**	Cold coolant

6.6 Coolant Quality in the Drive Circuit

In the drive circuit, the quality of the liquid has to be as in 6.7 Quality Requirements for the Purified Water.

The coolant must not contain organic sediment or chemically active qualities. The coolant must not contain particles that are larger than 0.05 mm (0.002 in). To filter out large particles, install a filter at the drive circuit inlet.

The used corrosion inhibitors must be suitable for stainless steel, aluminum blocks, EPDM seals, FKM seals, polyurethane hoses, and FEP hoses. To prevent corrosion, add the corrosion inhibitor Cortec VpCI-649 to the drive circuit coolant.

6.7 Quality Requirements for the Purified Water

NOTICE

DAMAGE TO SYSTEM FROM THE USE OF HYDROCARBONS

Hydrocarbons damage the rubber seals of the cooling system.

- Do not use hydrocarbons (for example mineral oil) as coolant. Do not mix hydrocarbons to coolant.

Table 6: Requirements for the Purified Water

Property	Required value
pH	6...8
Chlorides	≤ 25 ppm
Sulphate ions	≤ 25 ppm
Maximum particle size	≤ 50 µm
Total dissolved solids	≤ 200 ppm
Total hardness ($CaCO_3$)	3…4.6 dH° (53…80 ppm)
Hydrogen carbonate	≤ 50 ppm
Electrical conductivity	≤ 500 µS/cm

6.8 Coolant Quality in the External Circuit

The coolant quality in the external circuit does not need to be as good as in the drive circuit. However, a good-quality coolant makes the cleaning interval of the heat exchanger (HX11) longer. Do not use seawater as coolant. Freshwater from lakes or rivers can be used.

The coolant must not contain particles that are larger than 1.5 mm (0.06 in). If there are larger particles in the coolant circulation, the 3-way valve or the heat exchanger can become clogged. To filter out large particles, install a filter (MF21) at the external circuit inlet. The mesh size of the filter must be < 1.5 mm (0.06 in).

The coolant must not include any chemicals, for example, high amounts of chloride, chlorine, or oil. The amount of free chlorine must be < 5 mg/l (< 0.0007 oz/gal). Oil damages the EPDM rubber seals of the cooling module.

A natural source of water can include organic sediment. The organic sediment attaches to the plates inside the heat exchanger. The organic sediment also increases the pressure loss over the heat exchanger and therefore the flow decreases. These factors make the liquid-to-liquid heat transfer between the drive and the external circuit less efficient.

Because of possible organic sediment, install flow measuring or pressure difference measuring equipment. This equipment generates an alarm if the flow is below the requirements. It is also recommended to set leakage sensors in the external circuit.

See 10.3 Cleaning the Heat Exchanger with CIP Equipment or 10.4 Cleaning the Heat Exchanger with Backwashing for the cleaning instructions of the heat exchanger.

NOTICE

CLOGGING OF THE HEAT EXCHANGER

If the coolant quality in the external circuit is not sufficient, the heat exchanger can become clogged. A clogged heat exchanger decreases the flow in the cooling module and makes the cooling module less efficient.

- Use a coolant that meets the requirements.

6.9 Purified Water as Coolant

Purified water can be used as coolant if there is no risk of freezing. Freezing water permanently damages the cooling system. Purified water is demineralized, deionized, or distilled water.

Always use an inhibitor Cortec VpCI-649 with 1.0% of volume with purified water.

NOTICE

CORROSION HAZARD WITH DRINKING WATER

Some components are made of aluminum, which has limited corrosion resistance against high chloride concentrations. Drinking water can have a chloride concentration of 250 ppm, which increases the aluminum corrosion rate. High chloride concentration exposes aluminum especially to pitting corrosion which can damage the system relatively quickly.

- Use purified (demineralized, deionized, or distilled) water with corrosion inhibitors.

6.10 Antifreeze Mix as Coolant

The following antifreeze products are a good general solution for liquid cooling since they provide freeze protection and corrosion protection.

The allowed antifreeze coolants are the following ethylene glycols and propylene glycols.

Ethylene glycols

- DOWCAL 100
- Clariant Antifrogen N

Propylene glycols

- DOWCAL 200
- Clariant Antifrogen L

These glycols already include corrosion inhibitors. Do not add any other inhibitor. Do not mix different glycol qualities because there can be harmful chemical interactions.

The glycol concentration of the coolant must be 25–55% by volume, according to the specified ambient temperature. Higher concentration reduces cooling capacity. Lower concentration results in biological growth and inadequate amount of corrosion inhibitors. Antifreeze must be mixed with purified water according to 6.7 Quality Requirements for the Purified Water.

6.11 Materials

Allowed materials in the cooling system

These materials are allowed in the cooling system if they are compatible with the coolant.

- Aluminum.
- Stainless steel AISI 304/316.
- Plastic.*
- Elastomers (EPDM, NBR, FDM).*

* If plastic or elastomers are used, check material compatibility within the temperature range of the coolant. See 11.8.3 Liquid-cooling Specifications.

Do not use PVC, copper, brass, or other materials not compatible with the heat sink material or coolant.

Recommended material for pipes

- PA11.
- PA12.
- PEX with oxygen barrier.
- PEX-AL-PEX.

6.12 Pipe Connections

Standard connections are DN50 pipe end with Axilock couplings. The Axilock couplings are included in the delivery.

For the external circuit side, there are DIN and ANSI flanges available.

If the cooling module is not installed in the same line-up as the drives, organize transfer piping between the cooling module and the drives. DIN and ANSI flanges are also available as option.

Table 7: Transfer Piping Length

Pipe characteristics	Maximum pipe length [m]
Straight line, DN65 pipe	15
With limitations	25

If the cooling module is delivered as a part of a drive, and is in the same line-up, the connections between the cooling module and the drive are pre-made. In this case, only connect the external circuit piping.

The pressure loss of the transfer piping reduces the coolant flow. It is recommended that the pressure loss of the transfer piping does not exceed 1.0 bar, for the coolant flow to be adequate.

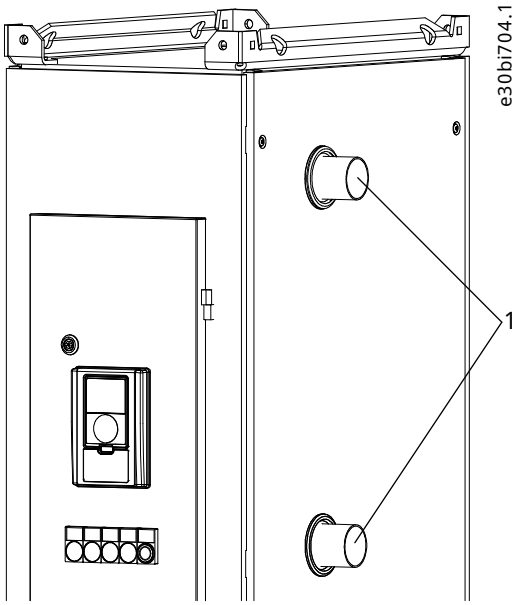

Figure 15: Pipe Connections at the Top

1	The pipe connections of the external circuit

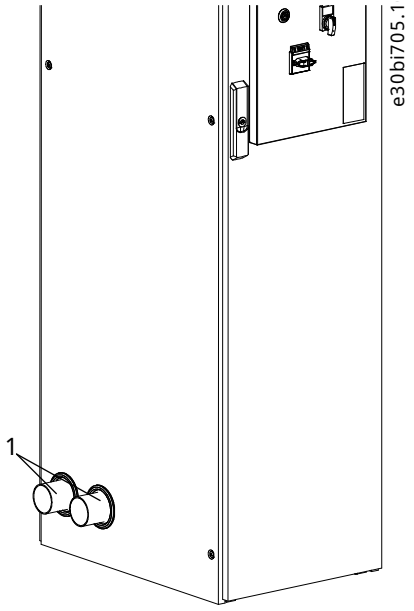

Figure 16: Pipe Connections at the Bottom

1	The pipe connections of the drive circuit

6.13 Connecting Pipes with Axilock Joints

NOTICE

RISK OF LEAKAGE

If not installed correctly, the Axilock joints can leak.

- Follow these instructions carefully when connecting pipes with Axilock joints.

1. Check the ends of the pipes to be connected. To ensure a tight seal, the outside surface of the pipes must be clean and smooth.
2. Place an Axilock around the pipes to be connected.
3. Place the 2 pipes end to end.
   a. Make sure that the pipe ends are facing each other. The maximum angulation is 5°.
4. Make sure that both the pipes are at least 40 mm (1.6 in) inside the Axilock joint.

   All the pipes of the cooling module have a mark at 44 mm (1.7 in) from the end of the pipe. It is half of the length of the Axilock joint.
   The gap between pipe ends must be 0–8 mm (0–0.3 in).

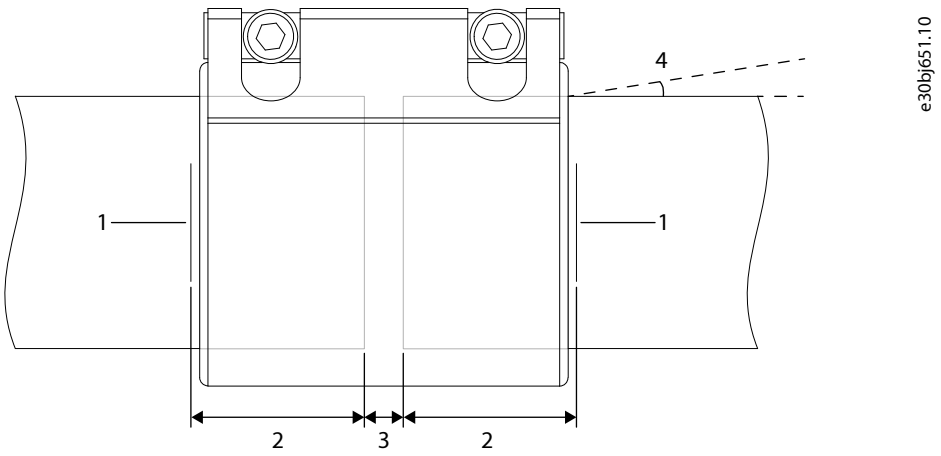

Figure 17: Axilock Joint Installation

1	Marking on the pipe	**2**	Distance between marking and end of pipe: 44 mm (1.7 in)
3	Distance between pipe ends: 0–8 mm (0–0.3 in)	**4**	Maximum angulation: 5°

5. To make the joint durable, tighten the screws carefully in turns little by little, so that both screws are in torque and overtightening does not occur.

a. Use a torque of 15 Nm (133 in-lb). Check the correct torque from the sticker on the Axilock joint.

b. Mark the screws when they are tightened to the correct torque.

When the correct torque is reached, do not retighten the screws. If it is not sure that the screws have been tightened to the correct torque, loosen the screws completely and start the installation of the joint from the beginning.

6.14 Location of Valves and Instrumentation

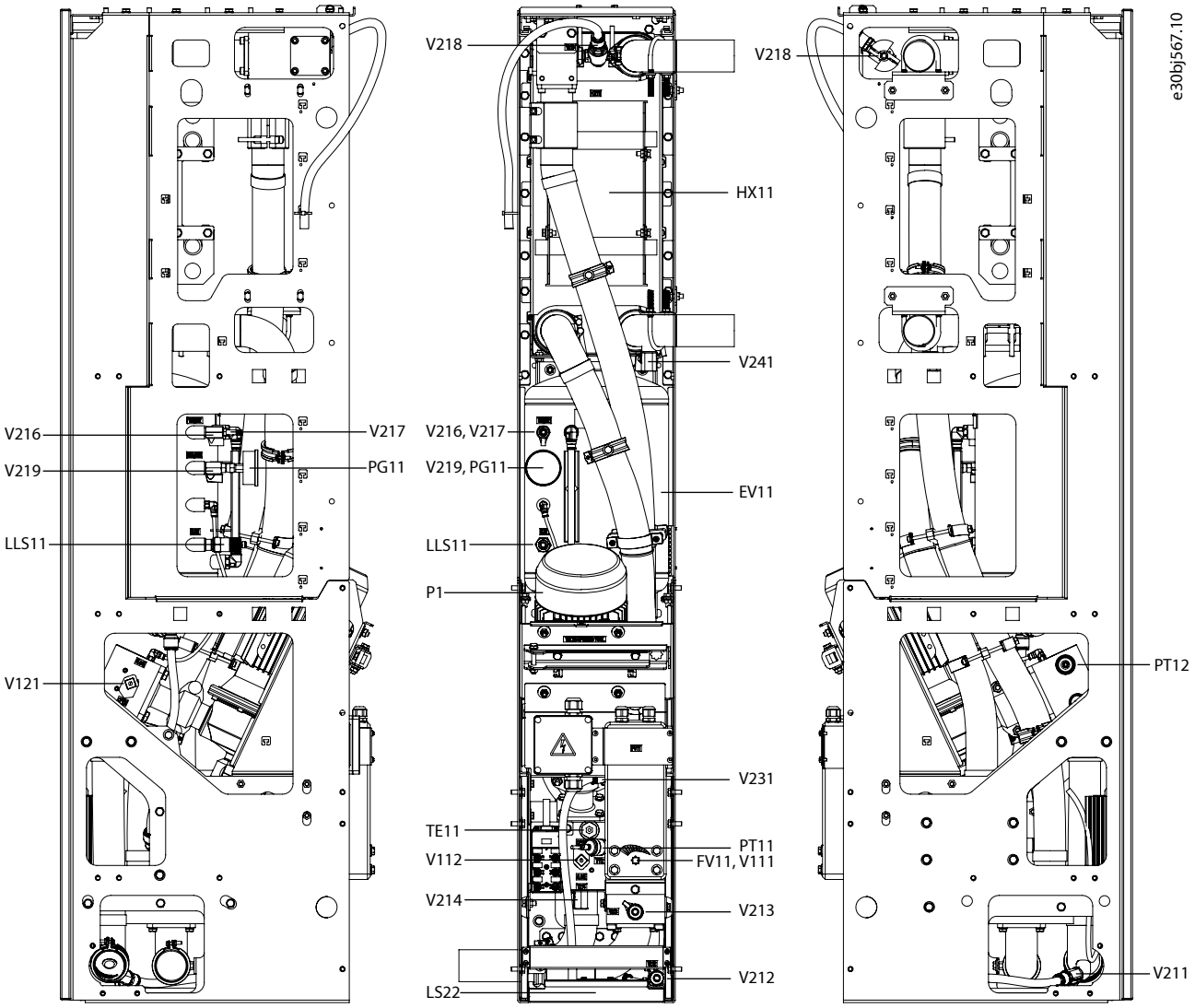

Figure 18: Location of Valves and Instrumentation in Single-pump 76 kW and 152 kW Cooling Module

EV11	Expansion tank	V211	Shut-off valve
FV11	3-way valve actuator	V212	Filling/Draining valve
HX11	Heat exchanger	V213	Filling/Draining valve
LLS11	Liquid level sensor	V214	Draining valve
LS22	Leakage sensor	V216	Pneumatic connection shut-off valve
P1	Pump	V217	Valve for pneumatic connection
PG11	Pump inlet pressure gauge	V218	De-airing valve
PT11	Pump inlet pressure transmitter	V219	Valve for pressure gauge
PT12	Pump outlet pressure transmitter	V221	Expansion tank shut-off valve
TE11	Coolant to drives temperature sensor	V222	Expansion tank shut-off valve
V111	3-way valve	V231	Relief valve

V112	Pump shut-off valve	V241	Draining valve
V121	Pump shut-off valve		

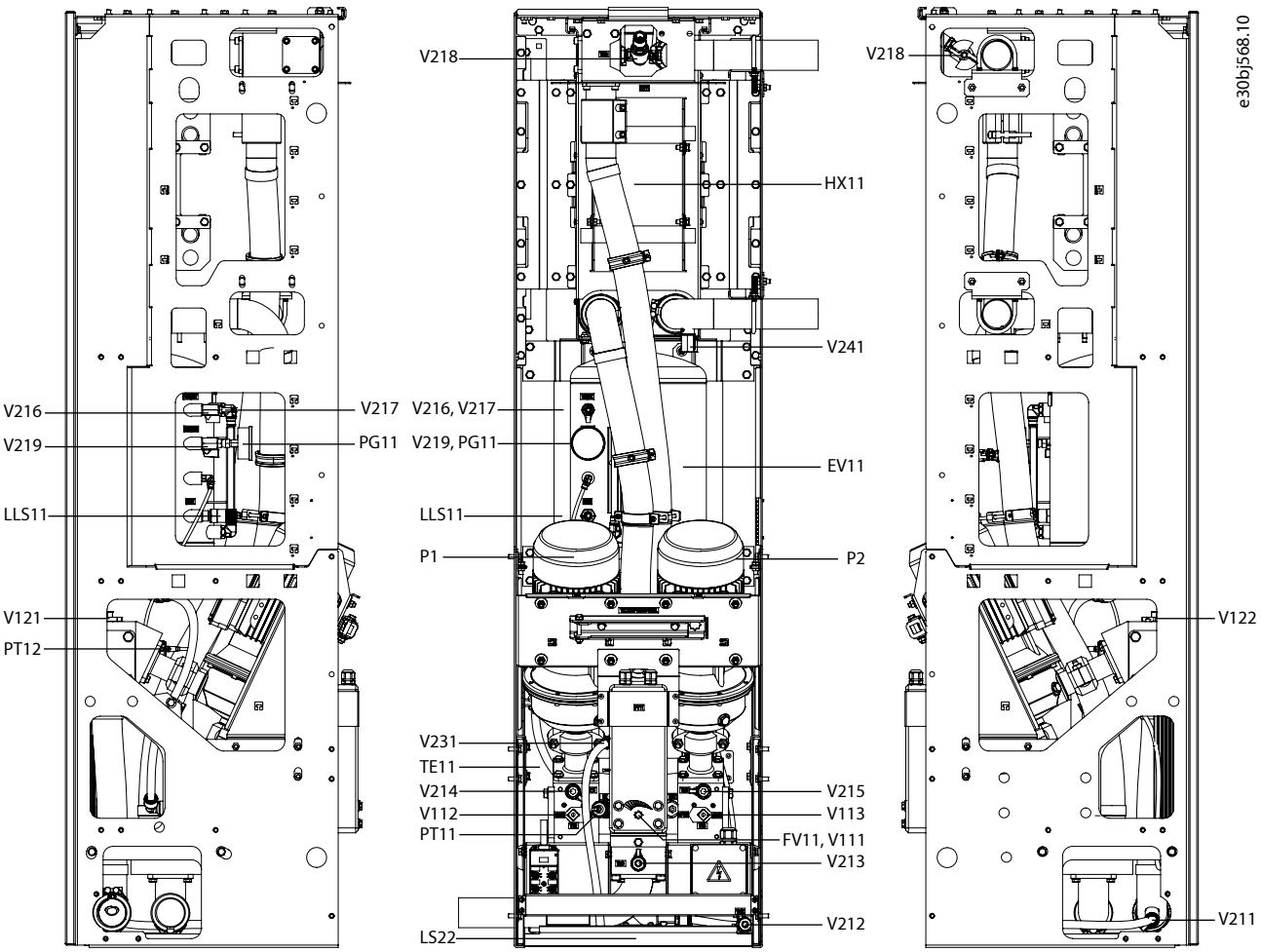

Figure 19: Location of Valves and Instrumentation in Dual-pump 76 kW and 152 kW Cooling Module

EV11	Expansion tank	V122	Pump 2 shut-off valve
FV11	3-way valve actuator	V123	Check valve
HX11	Heat exchanger	V211	Shut-off valve
LLS11	Liquid level sensor	V212	Filling/Draining valve
LS22	Leakage sensor	V213	Filling/Draining valve
P1	Pump 1	V214	Draining valve
P2	Pump 2	V216	Pneumatic connection shut-off valve
PG11	Pump inlet pressure gauge	V217	Valve for pneumatic connection
PT11	Pump inlet pressure transmitter	V218	De-airing valve
PT12	Pump outlet pressure transmitter	V219	Valve for pressure gauge
TE11	Coolant to drives temperature sensor	V221	Expansion tank shut-off valve

V111	3-way valve	V222	Expansion tank shut-off valve
V112	Pump 1 shut-off valve	V231	Relief valve
V113	Pump 2 shut-off valve	V241	Draining valve
V121	Pump 1 shut-off valve		

6.15 Flushing the Cooling System

NOTICE

Any remaining water inside the cooling system is exposed to freezing.

- Temperatures below 0 °C are not allowed.

NOTICE

The system is exposed to corrosion.

- Do not flush the system with water before storage.
- It is not recommended to store the flushed system for a long time without refilling it with proper coolant, which corresponds to the specifications in this guide.

1. Drain the cooling system.

   See 6.19 Draining the Cooling System.

2. Fill the system with purified water. Follow the requirements for purified water.

   See:

   - 6.18.2 Filling the Cooling System by Progressive Circulation
   - 6.18.3 Filling the Cooling System by Forced De-airing
   - 6.9 Purified Water as Coolant

3. Power up the cooling module.
4. Turn on the pump P1 for 10 minutes. If the cooling module has 2 pumps (+SAP2), turn on the pump P1 for 5 minutes, then switch the pump to P2 for another 5 minutes.
5. Turn off the pump.
6. Drain the cooling system.

   See 6.19 Draining the Cooling System.

6.16 Flushing the Pipes after Welding

6.16.1 Flushing the TIG-welded Pipes

If welding is done to the pipes in the drive circuit or the external circuit during installation, commissioning, or maintenance, flush the pipes before connecting them to the cooling module.

1. Flush the pipes by blowing pressurized air through them.

6.16.2 Flushing the Pipes that have been Welded by Other Means than TIG

If welding is done to the pipes in the drive circuit or the external circuit during installation, commissioning, or maintenance, flush the pipes before connecting them to the cooling module.

1. Flush the pipes with water at a minimum flow of 3 m/s.

   Continue flushing for 5 min.

6.17 Doing the Pressure Test

To make sure that every connection made on site is sufficiently tightened, a pressure test is necessary. Use water for the pressure test.

The maximum test pressure of the cooling module is 1.5 x maximum pressure. The lowest maximum pressure connected to the system determines the maximum pressure of the whole system. Therefore, if the cooling module is connected to the drive circuit, the maximum pressure of the drive circuit determines the maximum test pressure.

Table 8: The Maximum Test Pressure of the Cooling Module

Circuit	Maximum pressure [bar]	Maximum test pressure [bar]
Drive circuit	5	7.5(1)
Cooling module	6	9
External circuit	10	15(2)

1) The lowest maximum pressure of the components included in the system determines the maximum pressure of the system.

2) The lowest maximum pressure of the components included in the external circuit determines the maximum pressure of the external circuit.

1. Remove the actuator mounting plate, marked with the text "FV11". The plate is mounted with 4 size M5x10 TX screws.

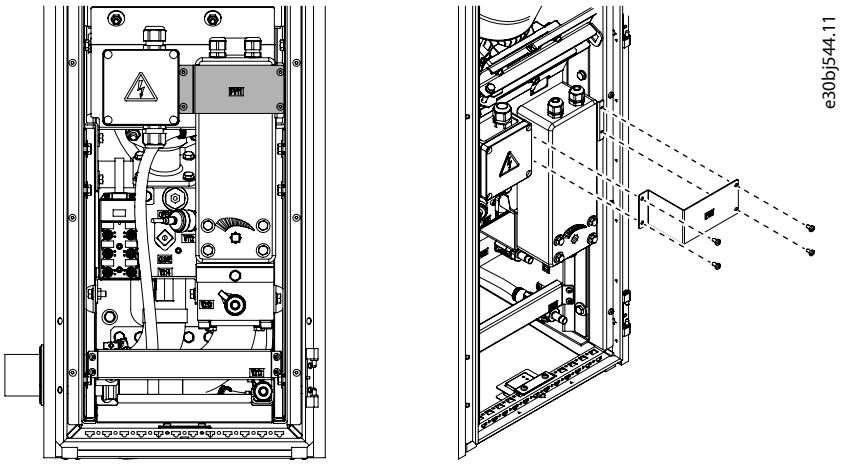

Figure 20: Removing the Mounting Plate of the Valve Actuator

2. Before removing the valve actuator, adjust the valve to one of the extreme positions, 0° (bypass), or 90° (via HEX).
3. Release the valve actuator by removing the 4 size M8x95 hex screws. Do not remove the wires from the actuator. Support the actuator near by, so that the wires are not damaged.

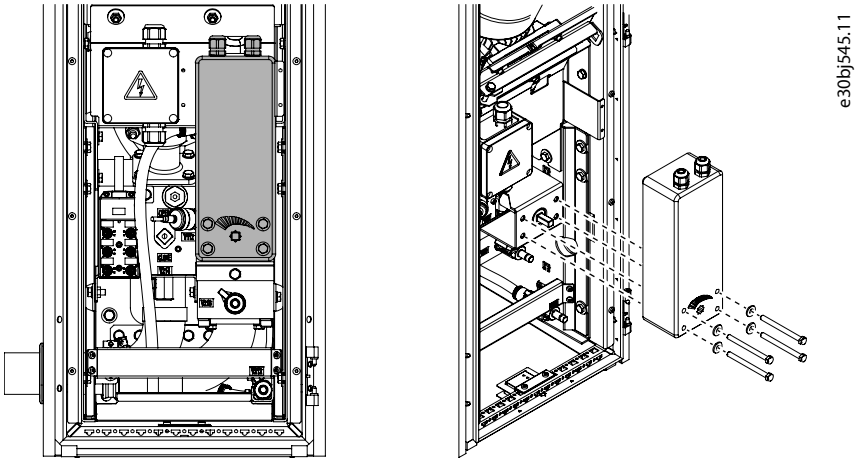

Figure 21: Removing the Valve Actuator

4. Release the relief valve.

a. To make it easier to release the relief valve, remove the pipe and the push-in pipe connector from the valve.

b. To release the relief valve, rotate it counter-clockwise. The tightening torque for the valve is 40 Nm.

Notice that the actuator shaft is now loose.

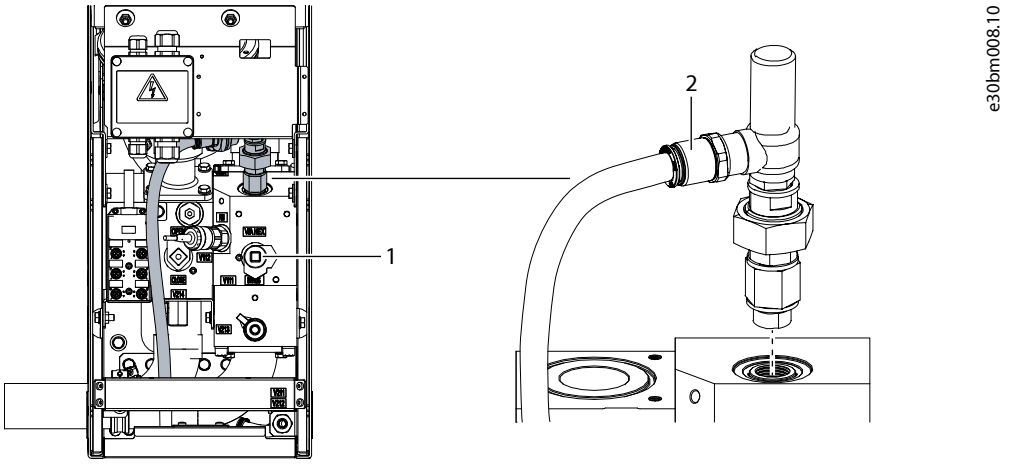

Figure 22: Removing the Relief Valve

1	Actuator shaft	**2**	Push-in pipe connector

5. Place a plug into the threaded hole. The plug is included in the accessories bag.

There is an o-ring seal in the aluminum block groove. It must be in place when reinstalling the relief valve.
If the relief valve is removed after the first commissioning, replace the o-ring seal with a new one.

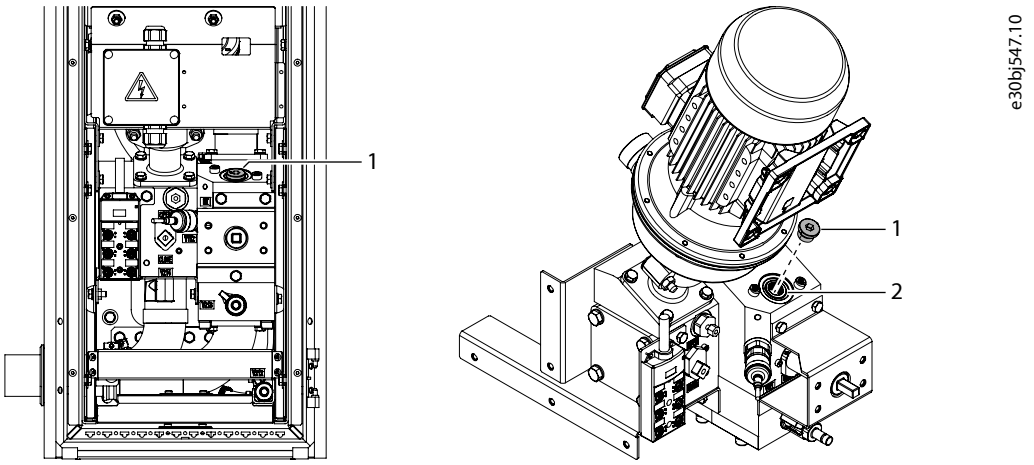

Figure 23: Plugging the Hole of the Relief Valve

1	Plug	**2**	O-ring

6. Fill the cooling system.

   See
   - 6.18.2 Filling the Cooling System by Progressive Circulation
   - 6.18.3 Filling the Cooling System by Forced De-airing

7. Close the valves V219 and V216.
8. Connect the pressurizing pump to valve V212.
9. Open valve V212 and make sure that also V211 is open.
10. To increase the pressure in the system, start the external pressurizing pump.
11. Read the pressure from the pressurizing pump display or a separate pressure gauge/sensor connected between the pressurizing pump and the cooling module.
12. When the pressure reaches the maximum test pressure (1.5 x maximum pressure), close valve V212.
13. Wait for 30 minutes, or the time specified by the national standard.
14. Before doing a close visual examination, decrease the pressure to a safe level (1 bar according to the pressure gauge - PG11).
15. Search visually for any leaks. Check especially all connections made on site.
16. Release the pressure.
17. Open the valves V219 and V216.
18. Drain the cooling system. See 6.19 Draining the Cooling System.
19. Remove the plug from the relief valve connection, and reinstall the relief valve.
20. Reinstall the valve actuator and mounting plate.
    a. Before mounting the actuator, make sure that the actuator and shaft are in the same position. If necessary, turn the manual adjustment screw.

       Turning the screw clockwise turns the valve counterclockwise to 90°.
       Turning the screw counterclockwise turns the valve clockwise to 0°.
       The ratio between the screw and the valve is such that the screw must be turned several revolutions to adjust the valve from one extreme to the other.
       Use a maximum tightening torque of 2 Nm (17.7 in-lb).

b. Make sure that the valve actuator is installed the correct way round.

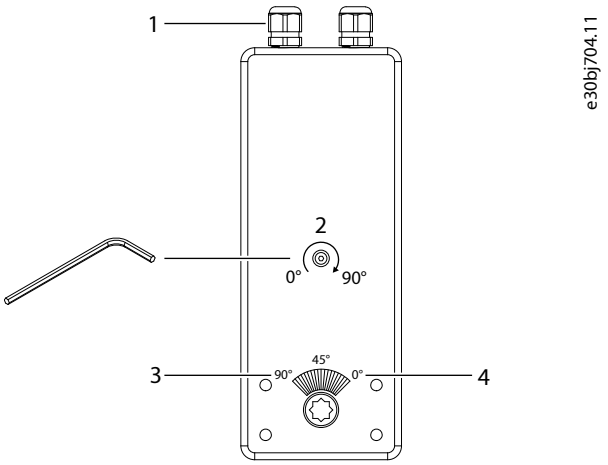

Figure 24: Installation and Manual Adjustment of the 3-way Valve Actuator

1	Connectors at the top	**2**	Manual adjustment screw (3 mm hex)
3	90° on the left	**4**	0° on the right

6.18 Filling the Cooling System

6.18.1 Selecting the Glycol Type

Select the glycol type according to the recommendations in 6.10 Antifreeze Mix as Coolant.

The cooling module is tested with glycol type Clariant Antifrogen L. If a glycol other than Clariant Antifrogen L is used, or if the coolant type is changed during maintenance, flush the system before filling.

1. To flush the cooling system, follow the instructions in 6.15 Flushing the Cooling System.

6.18.2 Filling the Cooling System by Progressive Circulation

Use these instructions to add liquid into the cooling system and to de-air the cooling system.

- Check that all pipes and hoses are connected.
- Check that all the valves are open or closed as they should be. Turn the switch open at the back of the pressure gauge (PG11).

Table 9: Valves Position in +SAP1 & +SAP2

Valves in +SAP1	Valves in +SAP2	Position
V112, V121	V112, V113, V121, V122	Open
V211, V212, V218	V211, V212, V218	Open
V213, V214	V213, V214, V215	Closed
V216, V219	V216, V219	Open

1. Insert liquid supply to V212, and liquid output to V218.
2. Close the pump shut-off valve.

+SAP1: V112 or V121

+SAP2: V112 and V113 or V121 and V122

3. Do the procedure to fill the drive according to the drive specification. See the *iC7 Series Liquid-cooled System Modules Design Guide*.
4. Keep the external filling pump on until the air bubbles no longer come out with the flow.
5. Open the pump shut-off valve.

   +SAP1: V112 or V121

   +SAP2: V112 and V113 or V121 and V122

6. Close the valve V218 and continue the filling so that the system pressure increases.

   The default pressure is 1 bar and 50% expansion tank coolant level.

7. Fill up to about 60% to compensate the de-airing. Use expansion tank pressure gauge.

   Make sure that the shut-off valve for pressure gauge is open.

8. Stop the filling pump after the correct coolant level has been achieved.
9. Close the valves V212 and V211.

   Use a check valve with the filling pump to make the procedure easier.

10. Adjust the pressure to 1 bar by using the pneumatic connection V217.
11. Start the pump P.

    System will be de-airing for a while which leads to coolant level drop.

12. Refill and adjust pressure repeatedly until the coolant level does not drop anymore.

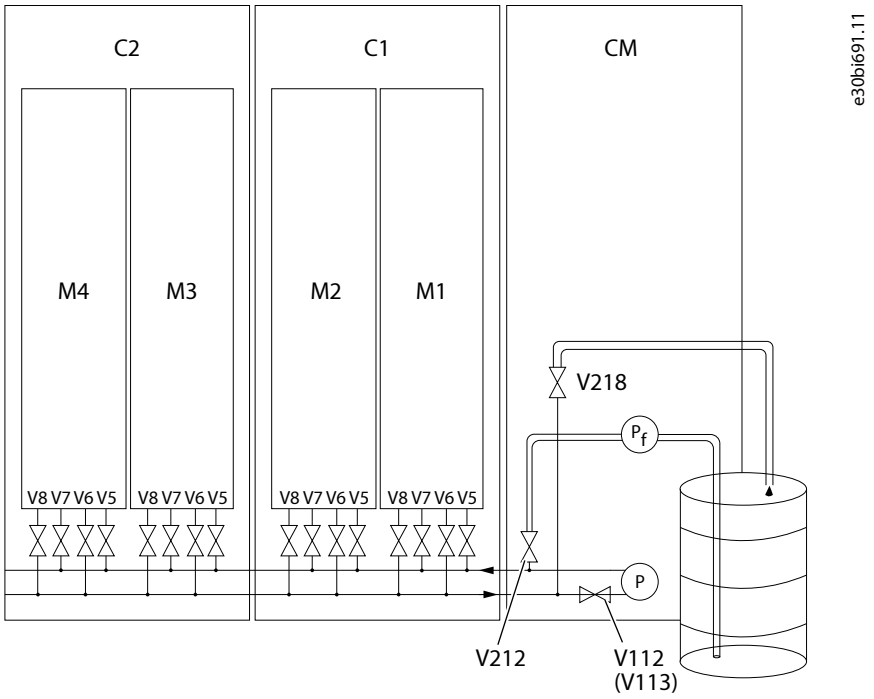

Figure 25: Filling the Cooling System

CM	Cooling module	M1	Drive 1
V212	Filling valve	M2	Drive 2
V112 (V113)	Pump shut-off valve. +SAP1: V112, +SAP2: V112 and V113.	M3	Drive 3
V218	De-airing valve	M4	Drive 4
P_f	Filling pump	V5	Drive valve V5
P	Pump, cooling module	V6	Drive valve V6
C1	First cabinet	V7	Drive valve V7
C2	Second cabinet	V8	Drive valve V8

6.18.3 Filling the Cooling System by Forced De-airing

Use these instructions to add liquid into the cooling system and to de-air the cooling system.

- Check that all pipes and hoses are connected.
- Check that all the valves are open or closed as they should be.

Table 10: Valves Position in +SAP1 & +SAP2

Valves in +SAP1	Valves in +SAP2	Position
V112, V121	V112, V113, V121, V122	Open
V211, V212, V218	V211, V212, V218	Open
V213, V214	V213, V214, V215	Closed
V216, V219	V216, V219	Open

1. Insert liquid supply to V212, and liquid output to V218.
2. Start the external filling pump and run the pump until the air bubbles no longer come out with the flow.
3. To release air, push the needle valve V217 until the surface of the expansion tank EV11 exceeds 60%.
4. Power on the cooling module by turning the mains switch -QB0 to the ON position.
5. Turn the service switch SF3 to the ON position where faults are ignored and the water bypasses the heat exchanger.
6. Check that the pump rotates in the correct direction.

   See 6.20 Checking the Pump Rotation Direction.

7. Start the main pump from switch SF1 for approximately 1.5 s and wait approximately 60 s or until the air bubbles no longer come out with the flow.
   a. Repeat this task approximately 10 times. If there are 2 pumps, use both pumps alternately.
   b. Enable ***P2.13.1 Automatic deairing*** (ID1857) for 10–15 minutes.

      A normal start command is required to start the deairing sequence. The automatic deairing function starts and stops the pumps with 30 s cycles until the start command is removed.

8. Increase the surface of the expansion tank EV11 to 60% of the total volume.

9. Close the valves V218 and V212.
10. Close the external filling pump.
11. Check the system pressure from gauge PG11.

    The pressure must be 1 bar.

12. Adjust the air pressure from the valve V217 if necessary.
13. Turn the service switch SF3 to the OFF position.
14. Start the system by turning the switch SF1 to RUN.
15. Close the valve V216.

    The de-airing is done automatically through the expansion tank piping.

16. Adjust the water level and pressure after a 3 h continued run.

6.19 Draining the Cooling System

1. Power off the cooling module.
2. Connect draining hoses to valves V212 and V213.

   See 6.14 Location of Valves and Instrumentation.

3. Open valves V211, V212, and V213.

   ➲ Coolant starts to flow out through the draining hoses.

4. When the reading of the pressure gauge PG11 drops to 0 bar, open the deairing valve V218.

   ➲ The decreased draining flow increases.

5. Turn the 3-way valve V111 to approximately 45° by using the manual turning screw on the actuator. See Figure 24.
   a. Use a 3 mm hexagon key.
   b. Use a maximum tightening torque of 2 Nm (17.7 in-lb).

   ➲ The decreased draining flow increases.
   Most of the coolant is drained after this step. If it is necessary to drain the system as empty as possible, also do the steps 6–9. If not, skip to step 10.

6. Turn the pump shut-off valves V112 (and V113 in +SAP2 modules) and V121 (and V122 in +SAP2 modules) to the closed position and back to the open position.

   ➲ A small amount of coolant is released.

7. Connect draining hose to valve V214 (and V215 in +SAP2 modules).
8. Valve V214 (and V215 in +SAP2 modules) has a plug by default. Remove the plug.
9. Open valve V214 (and V215 in +SAP2 modules).

   ➲ A small amount of coolant is released.

10. Turn all valves back to their default positions.

11. Dispose of the drained coolant. Follow the currently applicable international and local laws and regulations.

NOTICE

Some coolant remains in the piping under the level of valves V211, V212, and V213.

6.20 Checking the Pump Rotation Direction

NOTICE

DAMAGE TO THE PUMP

If the pump rotation direction is incorrect, it can quickly damage the sealings on the motor shaft.

- After installing the pump, check that the motor rotates in the correct direction.

1. Turn on the pump for a second, and turn it off.
2. Check the rotation direction of the motor fan from the top of the motor.

   The motor cooling fan must rotate clockwise, or to the left when looking from the front of the cabinet (bottom of the motor). There is also a sticker on the motor, which shows the correct rotation direction.

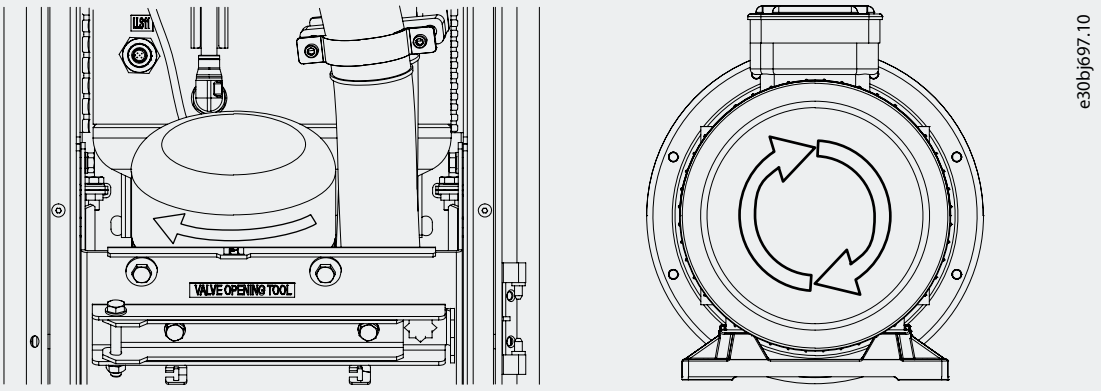

Figure 26: The Correct Rotation Direction of the Pump Motor

3. If the pump rotates in the wrong direction, change 2 mains cable phases (for example, L1 and L2) between each other at the junction box.

7 Electrical Installation

7.1 Electrical Safety

DANGER

SHOCK HAZARD FROM AUXILIARY VOLTAGE

The main switch does not disconnect the auxiliary voltage, if the auxiliary voltage is supplied externally. Contact with this voltage can cause death or serious injury.

- Make sure that the external auxiliary voltage is disconnected before opening the control compartment.
- Use a measuring device to make sure that no voltage is present.

7.2 Electrical Components

7.2.1 Control Unit (-AA1)

The control unit is in the control compartment. The control unit controls and supervises the temperature and flow of the drive circuit. It also controls the pumps. The control unit is programmed to read the I/O signals with dedicated application from:

- The pressure transmitters
- The temperature sensor
- The leakage sensor
- The liquid level sensor
- The humidity/temperature sensor
- The 3-way valve actuator

The iC7 series cooling module uses the VACON® 100 control unit. The interface and connections are described in detail in the VACON® 100 guides.

The I/Os, relays, and option boards are programmed for the cooling module. Modifying them can cause the cooling module to malfunction. By default, 3 option boards are installed:

- OPTB1: Option board with 6 bidirectional terminals.
- OPTB4: I/O expander board with 1 galvanically isolated analog input and 2 galvanically isolated analog outputs (standard signals 0(4)–20 mA).
- OPTBH: Temperature measurement board with 3 individual channels.

The control unit uses the VACON® 100 Cooling Unit application AMFI1256.

7.2.2 Main Switch (-QB0)

The main switch in the control compartment is used to connect and disconnect the mains supply. If the main switch is closed, the control compartment door cannot be opened. To open the control compartment, open the main switch.

If the auxiliary voltage is supplied externally, the main switch does not disconnect the auxiliary voltage.

7.2.3 Fuses (-FC1)

The main circuit is protected against short circuits with fuses. The fuses are installed into a fuse base.

Table 11: Recommended Fuse Types

Region	Fuse type	Current	Catalog number
IEC	Ferrule 10x38 gG	16 A	Mersen type: FR10GG69V16
			Eaton type: C10G16 (up to 500 V AC)

7.2.4 Auxiliary Voltage Transformer (-TA4)

The cooling module is equipped with an auxiliary voltage transformer by default. The auxiliary voltage transformer supplies a 24 V DC power supply that distributes power to the control circuits. The auxiliary voltage transformer is protected by a circuit breaker on the primary side. Do not use the auxiliary voltage transformer to supply power to any other components.

If the cooling module is equipped with a cabinet heater, the auxiliary voltage must be provided externally.

Table 12: Specifications

Specifications	Value
Primary voltage	400/460/500/600/690 V
Secondary voltage	230 V
Frequency	47–63 Hz
Power	50 VA
Maximum ambient temperature	60 °C (140 °F)
Weight	1.7 kg (3.7 lb)

7.2.5 24 V DC Power Supply (-TB7)

The 24 V DC power supply distributes power to the control electronics. Do not use the 24 V DC power supply to supply power to any other components.

Table 13: Specifications

Specifications	Value
Input voltage range	100–240 V AC (-15%...+10%)
Nominal output voltage	24 V DC
Nominal output current	2.5 A
Output power	60 W

7.2.6 Service Switch (-SF3)

⚠ WARNING

SERVICE MODE

The service switch disables all the software protections of the cooling module. High temperatures and pressure can cause serious personal injury.

Running the cooling module in service mode can damage the equipment.

- Only qualified personnel are allowed to use the service mode.

⚠ WARNING

UNEXPECTED PUMP STARTS

In dual-pump cooling modules, if the service mode is activated with the Service switch -SF3 in the AUTO mode, the running pump is selected randomly. This can damage the equipment and cause personal injury.

The pump starts immediately, if the main switch -QB0 is on, -SF1 is in run position, and the overload relay is not tripped.

- Do not activate the service mode in a dual-pump module when the Pump select switch -SF2 is set to AUTO. First select Pump 1 or Pump 2, and then activate the service mode.

The service switch (-SF3) is a toggle switch inside the control compartment. The service switch bypasses the logic control and protections. Only the motor overload protection relays remain in operation. The switch also overrides the temperature-referenced 3-way valve position.

In service mode, the cooling module can be run without the control unit control, and it enables operation in abnormal conditions. Use the service mode in situations where it is necessary to:

- Run the pump regardless of sensor readings.
- Test the operation of the cooling module.
- Allow the commissioning sequence to continue before resolving the faults/alarms.
- Investigate faults that are dependent of the coolant flow.

To activate the service mode, turn the Service switch -SF3 to the ON position. When the control unit receives the feedback signal from the Service switch, it goes to service mode. To show that the service mode is active, the pump signal light starts to blink. To return to normal operation mode, turn the Service switch -SF3 to the OFF position.

NOTICE

Always turn off the service switch when work on the cooling module is completed.

7.2.7 Pump Contactors (-QA5.1/-QA5.2)

The pump contactors are used to switch the pumps on and off.

Auxiliary contact (with +SAP2): ABB CAT4-11U (1SBN010151R1311).

7.2.8 Thermal Overload Relays (-FCX.1/-FCX.2)

The pump contactors are equipped with electronic thermal overload relays to protect the pump motors from overheating. A relay trip causes the pump to stop and a fault appears. The relay settings are adjusted at the factory.

If the relay setting is too low, it can cause unnecessary faults or alarms.

Table 14: Relay Settings

Cooling module	Pump power [kW]	Motor overload relay setting
400 V AC (380–415 V AC ±5%, 50/60 Hz)	1.5	4.75
460 V AC (440–480 V AC ±5%, 60 Hz)	1.5	3.00
500 V AC (500–525 V AC ±5%, 50 Hz)	1.5	3.75
600 V AC (575–600 V AC ±5%, 60 Hz)	1.5	2.25
690 V AC (660–690 V AC ±5%, 50/60 Hz)	1.5	2.75
400 V AC (380–415 V AC ±5%, 50/60 Hz)	3.0	6.50
460 V AC (440–480 V AC ±5%, 60 Hz)	3.0	5.75
500 V AC (500–525 V AC ±5%, 50 Hz)	3.0	5.25
600 V AC (575–600 V AC ±5%, 60 Hz)	3.0	4.50
690 V AC (660–690 V AC ±5%, 50/60 Hz)	3.0	3.75

Relay type: ABB EF19-6.3 (1SAX121001R1104) or ABB EF19-18.9 (1SAX121001R1105).

7.2.9 Auxiliary Relays (-KFJ.11–13 and KFJ.21–23)

The cooling module has 6 contact relays controlled by states FAULT, ALARM, and COOLING OK. The relays -KFJ.11–13 are reserved for the status indicator lights on the cabinet door. The relays -KFJ.21–23 are free to use, for example, to route signals to the external monitoring system. It is possible to route a signal from a relay to the external monitoring system.

Relay contact specifications:

- max. 250 V AC/DC
- min. 5 V (at 100 mA)
- max. 6 A continuous (inrush max. 10 A (4 s))
- min. 10 mA (at 12 V)
- Switching capacity
  - 2 A (at 24 V, DC13)
  - 0.2 A (at 110 V, DC13)
  - 0.1 A (at 220 V, DC13)
  - 3 A (at 24 V, AC15)
  - 3 A (at 120 V, AC15)
  - 3 A (at 230 V, AC15)

Relay type: Phoenix Contact PLC-RSC- 24DC/21 (2966171).

7.2.10 Liquid Heaters (-EBZ.1/-EBZ.2)

The cooling module can be equipped with liquid heater elements (option +SKLH). The control unit controls the liquid heater operation. A contactor (-QAZ) is used to switch the liquid heater option on and off. The liquid heater is protected by a circuit breaker (-FCZ) against short circuits. Other means are used to supervise liquid overheating.

7.2.11 Cabinet Heater (-EB1)

The cooling module can be equipped with a cabinet heater (option +SLEH). The cabinet heater prevents condensation inside the enclosure. The cabinet heater requires external auxiliary power due to its high power consumption. The cabinet heater is controlled with relay -QAM.

Heater type: Eaton R-HEAT-150W (167272)

7.3 Cable and Fuse Requirements

The cooling module uses a 3-phase power supply. Select the mains cable size according to the power requirements. Use a cable with a heat resistance of at least 70 °C (158 °F). To protect the mains cables, install a separate protective device. The cooling module has internal fuses to protect internal equipment. Obey the local regulations when selecting the mains cable and the protective device.

The cabinet heater option requires an external auxiliary power supply. Route the external auxiliary power supply cable into the same junction box as the mains cable through the M20 bushing below the junction box.

Table 15: Cable Requirements for Mains Connection

Characteristic	Value
Cable recommendation	H07RN-F 4 x 2.5 mm^2
Strip length	11–13 mm (0.43–0.51 in)
Cable diameter	13–18 mm (0.51–0.71 in)

7.4 Installing the Mains Cables

NOTICE

Check the pump rotation direction at the commissioning. If the pump rotates in the wrong direction, change 2 mains cable phases (for example, L1 and L2) between each other at the junction box.

1. Find the junction box at the bottom section of the cabinet.

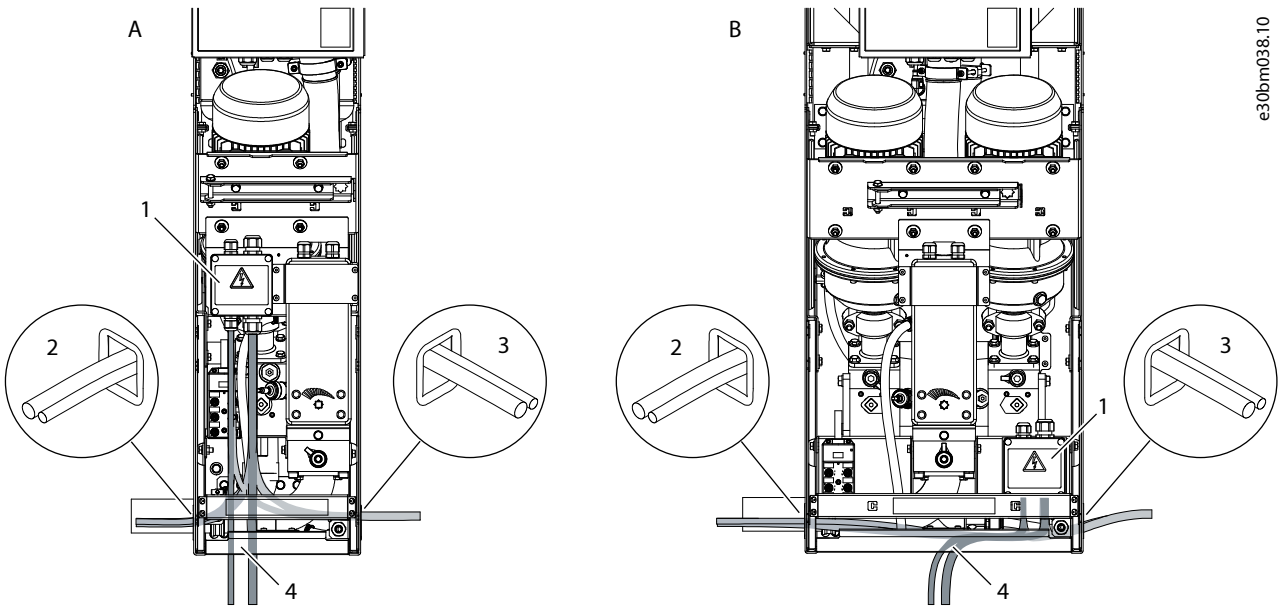

Figure 27: Installing the Mains Cables

A	Cooling module with 1 pump	**B**	Cooling module with 2 pumps
1	Junction box	**2**	Mains cables entering from the left
3	Mains cables entering from the right	**4**	Mains cables entering from the bottom

2. Route the mains cable through the M25 bushing below the junction box.
3. Avoid strain and sharp edges when routing the cable to the junction box.
4. Connect the L1, L2, L3, and grounding conductors into the terminal block.
5. Leave the possible N conductor unconnected.
6. Protect the mains cable from short circuits.

7.5 Mains Connection Data

Table 16: Power Requirement of the Cooling Module

Cooling module	Pump power [kW]	Power requirement (+SKXX) [kW]	Power requirement (+SKLH) [kW]
400 V AC (380–415 V AC ±5%, 50/60 Hz)	3.0	3.5	7.8
460 V AC (440–480 V AC ±5%, 60 Hz)	3.0	3.5	9.2
500 V AC (500–525 V AC ±5%, 50 Hz)	3.0	3.5	10.2
600 V AC (575–600 V AC ±5%, 60 Hz)	3.0	3.5	8.3
690 V AC (660–690 V AC ±5%, 50/60 Hz)	3.0	3.5	9.8
400 V AC (380–415 V AC ±5%, 50/60 Hz)	1.5	2.6	6.9
460 V AC (440–480 V AC ±5%, 60 Hz)	1.5	1.8	7.4
500 V AC (500–525 V AC ±5%, 50 Hz)	1.5	2.6	9.3
600 V AC (575–600 V AC ±5%, 60 Hz)	1.5	1.8	6.6
690 V AC (660–690 V AC ±5%, 50/60 Hz)	1.5	2.6	8.9

Table 17: Short-circuit Current Rating

Characteristic	Current	Fuses
Short-circuit current rating with specified fuses	I_{CC} ≤ 50 kA	• Max. 40 A gG (≤ 415 V) • Max. 25 A gG (≤ 690 V)

7.6 External Auxiliary Voltage Connection

Table 18: Cable Requirements for External Auxiliary Voltage Connection

Characteristic	Value
Voltage	1~, 110–240 V AC, 50/60 Hz
Power requirement	200 W

Table 18: Cable Requirements for External Auxiliary Voltage Connection (continued)

Characteristic	Value
Cable recommendation	H07RN-F 3 x 1.5 mm^2
Strip length	10–12 mm (0.39–0.47 in)
Cable diameter	10–14 mm (0.39–0.55 in)

7.7 Routing Control Wires to the Control Compartment

It is possible to add signal and data connections to the control compartment. It is possible to connect, for example, a data bus cable, a control wire, or an external leakage sensor.

1. Use the recommended wire routing path.

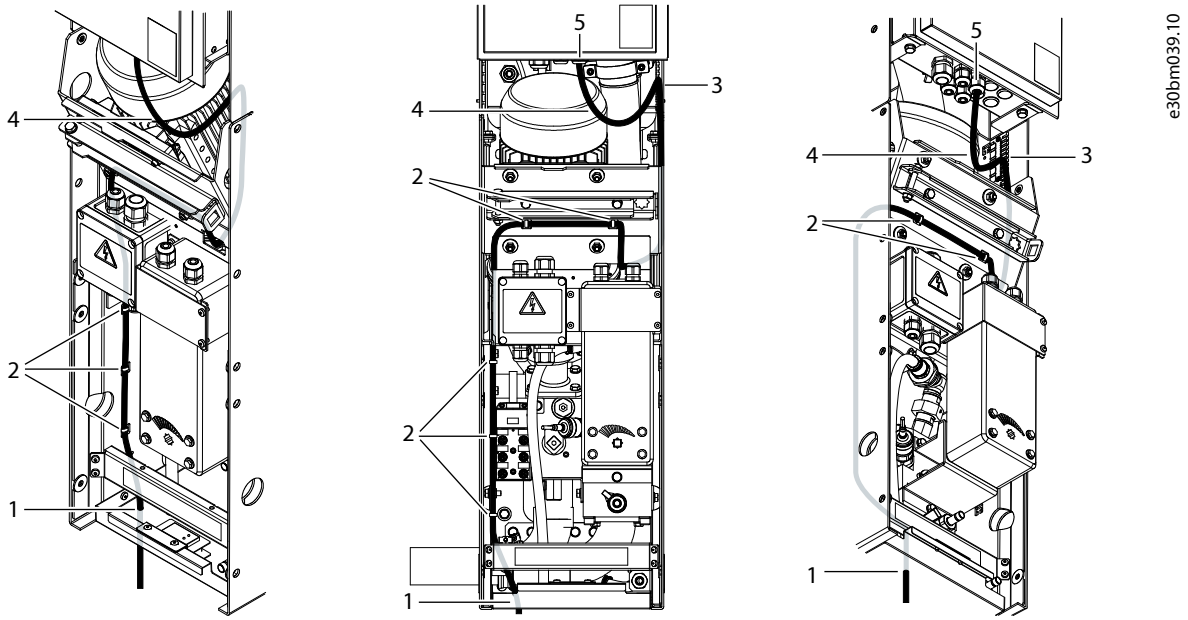

Figure 28: Control Cable Routing of the Cooling Module with 1 Pump

1	Leaking pan lead-through	**2**	Cable tie
3	Strain relief	**4**	Wire loose enough
5	Cable gland to control compartment		

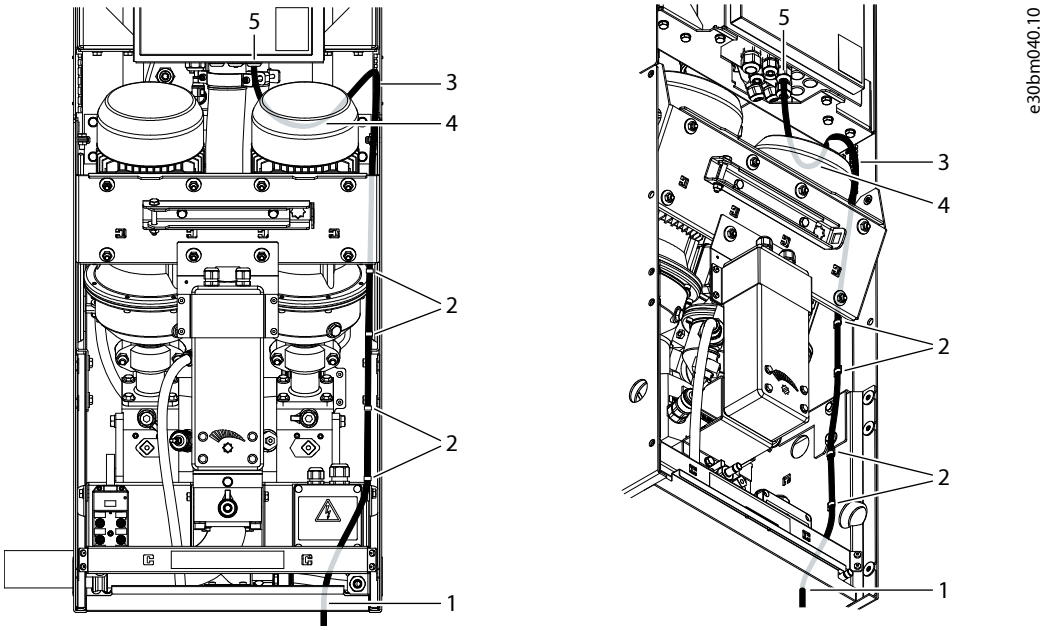

Figure 29: Control Cable Routing of the Cooling Module with 2 Pumps

1	Leaking pan lead-through	**2**	Cable tie
3	Strain relief	**4**	Wire loose enough
5	Cable gland to control compartment		

2. Route the control wires through the leaking pan.

- In an enclosed cooling module, route the control wires through the cable gland on the leaking pan in the bottom of the cooling module.
- In a standalone cooling module, make a cutout in the leaking pan. Add sealing to make the cutout watertight.

3. In an enclosed cooling module, leave extra length for wires between the enclosure frame and door.

4. Ground the shielded cables inside the control compartment near the cable glands with dedicated EMC clamps.

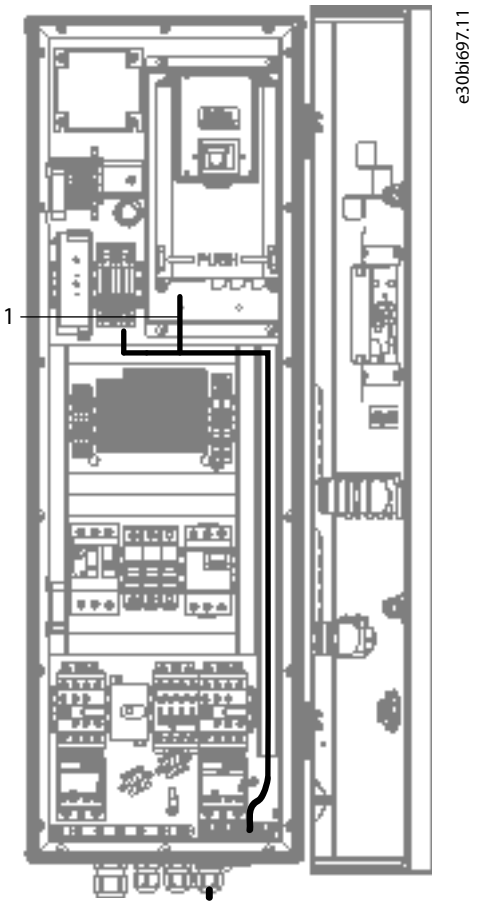

Figure 30: Control Compartment Wiring Route

1	Fieldbus cable

7.8 Instruments and Their Function

7.8.1 Pressure Transmitter (PT11 and PT12)

There are 2 pressure transmitters in the cooling module. One for the pump output (PT11), and the other for the pump inlet (PT12). The transmitter sends a 4–20 mA signal to the control unit. Application software converts the signal into pressure units (bar). Pressure signals are used to measure the flow of the coolant.

7.8.2 Temperature Sensor (TE11)

There is a PT100 type temperature sensor (TE11) to measure the temperature of the liquid coming from the drives. The temperature value is used to control the 3-way valve actuator through the control unit. The temperature signal also generates low- and high-temperature alarms and high-temperature shutoff.

- The high-temperature alarm and shutoff functions protect the main drive from overheating. The shutoff function requires signal wiring from the cooling module control to the control unit of the main drive.
- The low temperature alarm protects the main drive from too low temperatures.

7.8.3 Liquid Level Sensor (LLS11)

The liquid level sensor monitors the liquid level inside the expansion tank. If the liquid level is too low, an alarm appears. Check the liquid level and possible leaks. Check the liquid level regularly.

7.8.4 Leakage Sensor (LS22)

The leakage sensor (LS22) is on the leaking pan at the bottom of the cooling module. The sensor gives a signal to the control unit when there is liquid on the leaking pan. The liquid can be from a leak in one of the circuits, or from condensation on cold pipe surfaces due to high relative humidity of the air. The leakage sensor has a relay contact which is closed when there is no water, and open if there is water or if a connection is broken. More leakage sensors with the same operating principle can be added. Refer to the electrical diagrams for connection.

7.8.5 Ambient Temperature/Humidity Sensor (TE21/ME21)

The ambient temperature/humidity sensor is used to monitor the ambient temperature and the air humidity of the cooling module. The liquid temperature and the cabinet heater option are controlled based on the calculation of the dew point. The ambient temperature/humidity sensor is at the backside of the control compartment.

7.8.6 3-way Valve Actuator (FV11)

The 3-way valve actuator controls the 3-way valve. The 3-way valve actuator is controlled by an analog output signal from the control unit.

8 Control Unit

8.1 Control Compartment Overview

The control compartment contains all the control electronics, protective devices, the auxiliary voltage transformer, and power supply. It is used via the control devices on the control compartment door.

The red-and-yellow main switch (-QB0) connects the main power to the cooling module. The auxiliary power is also connected with the main switch, except when the auxiliary power is supplied externally.

The Run-Stop-Remote switch (-SF1) controls pump operation. In the Run position, power is connected to the pump motor through a contactor and an electronic overload relay. Turning the switch to the Stop position stops the pump. In the Remote position, the start signal can be given remotely. Refer to the electrical diagrams for remote control.

The Pump select switch (-SF2) is used to select which pump is operating in the dual-pump cooling module. The available options are Pump 1, Pump 2, or Auto. In Auto mode, the control unit controls the selection.

The Reset button can be used to reset alarms and faults. An alarm is an unusual operation that does not stop the pump, and a fault is an unusual operation that stops the pump.

Table 19: Control Compartment Indicator Lights

Indicator light	Color	Status
-PF2.1, -PF2.2	White	Indicates pump operation. In the dual-pump cooling module, there are 2 lights, 1 for each pump. In the service mode, the light blinks.
-PF3	Green	Indicates that cooling is OK.
-PF5	Orange	Indicates that there is an active alarm.
-PF4	Red	Indicates that there is an active fault.

There are also changeover relay contacts for the Cooling OK, Fault, and Alarm signals. The relay contacts can have any potential. Refer to the electrical diagrams for connection.

With the control panel, it is possible to modify parameters, monitor the cooling module operation, and clear alarms and faults. Refer to the application manual for more information.

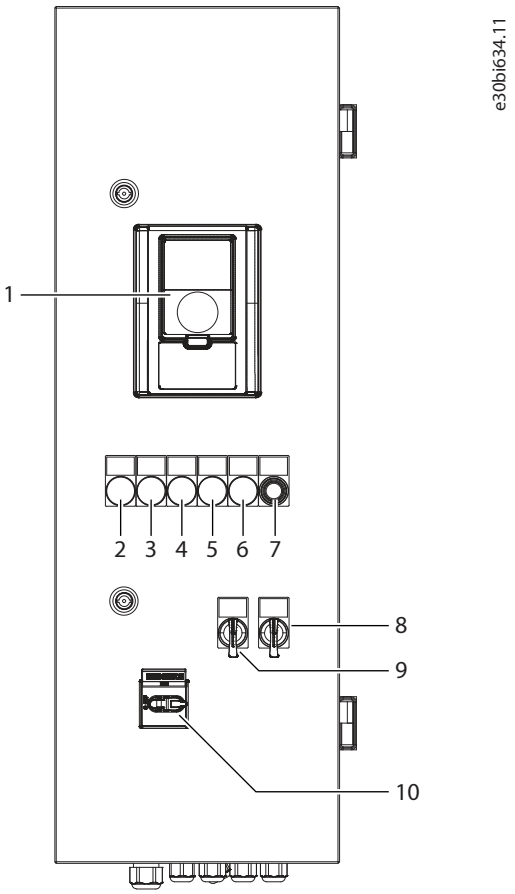

Figure 31: Control Compartment Door

1	Control panel (-PGA)	**2**	Pump 1 indicator light (-PF2.1)
3	Pump 2 indicator light (-PF2.2)	**4**	Cooling OK indicator light (-PF3)
5	Fault indicator light (-PF4)	**6**	Alarm indicator light (-PF5)
7	Reset button (-SF4)	**8**	Pump select switch (-SF2)
9	Run-Stop-Remote switch (-SF1)	**10**	Main switch (-QB0)

8.2 Internal Components of the Control Compartment

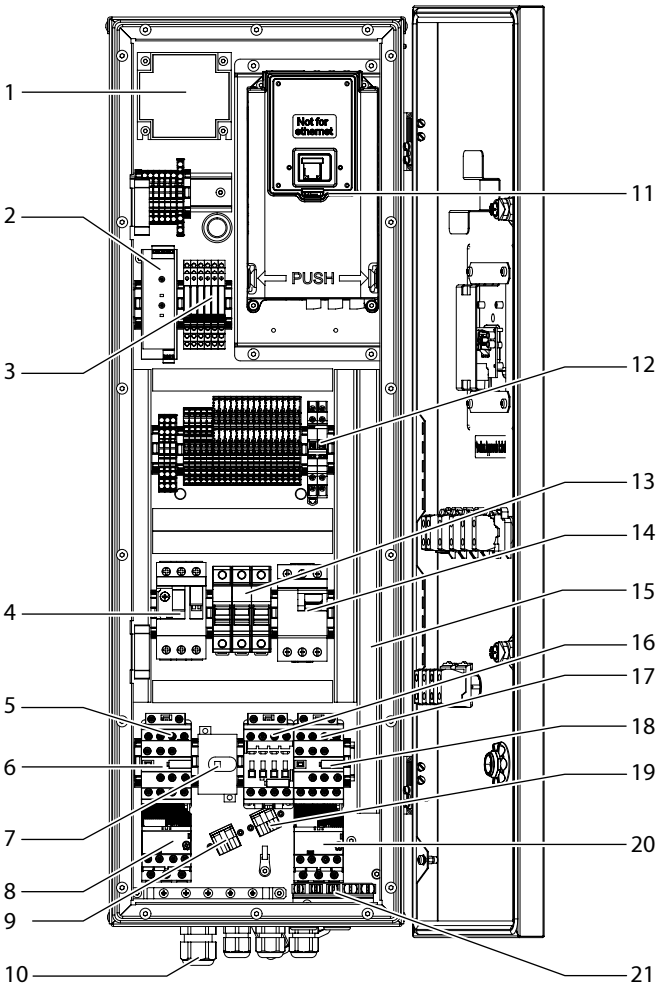

Figure 32: Control Compartment, Door Open

1	Auxiliary voltage transformer (-TA4)	**2**	+24 V DC power supply (-TB7)
3	Auxiliary relays (-KFJ.11...13 and -KFJ.21...23)	**4**	Auxiliary voltage transformer primary protection device (-FC4)[1]
5	Pump 1 contactor (QA5.1)	**6**	Pump 1 auxiliary contact terminals
7	Main switch (-QB0)	**8**	Pump 1 overload relay (-FCX.1)
9	Pump 1 power terminal (-XD7.1)	**10**	Cable glands for I/O cabling
11	Control unit (-AA1)	**12**	Service switch (-SF3)
13	Main fuses (-FC1)	**14**	Liquid heater protection device (-FCZ)
15	Wire ducts	**16**	Liquid heater contactor (-QAZ)
17	Pump 2 contactor (-QA5.2)	**18**	Pump 2 auxiliary contact terminals
19	Pump 2 power terminal (-XD7.2)	**20**	Pump 2 overload relay (-FCX.2)
21	Grounding clamps for I/O cabling		

1) If auxiliary voltage is supplied externally, the Auxiliary voltage supply protective device (-FC4) is installed instead of the Auxiliary voltage transformer primary protection device (-FC4).

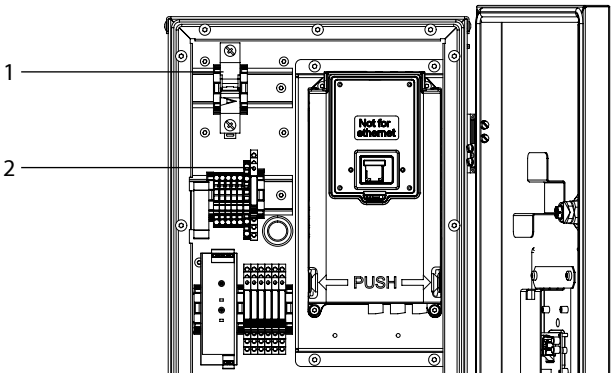

Figure 33: Control Compartment, with External AC Supply and Option +SLEH

1	Cabinet heater protective device (-FC5)	**2**	Cabinet heater relay (-QAM)

8.3 Fieldbus Protocols

The available Ethernet fieldbus protocols:

- Modbus TCP/UDP
- BACnet/IP
- PROFINET IO
- EtherNet/IP

The available RS485 fieldbus protocols:

- Modbus RTU
- BACnet MSTP
- Metasys N2

The cooling module can be connected to a fieldbus with an RS485 or an Ethernet cable. If an RS485 cable is used, connect it to terminals A and B of the standard I/O board. If an Ethernet cable is used, connect it to the Ethernet terminal.

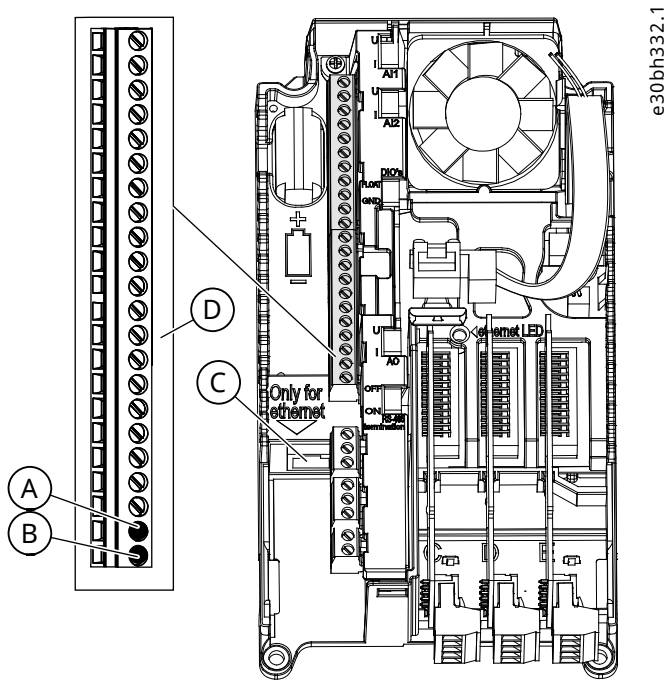

Figure 34: Ethernet and RS485 Connections in the Control Unit

A	RS485 terminal A = Data -	**B**	RS485 terminal B = Data +
C	Ethernet terminal	**D**	Control terminals

9 Starting the Cooling Module

9.1 Commissioning the Cooling Module

Follow these instructions to commission the cooling module.

Read the safety instructions in 6.1 Safety in Liquid-cooling and 2.5 Safe Operation and obey them.

1. Make sure that the cooling module is installed correctly and rigidly.

   - For the enclosed cooling module, see 5.5 Installing the Enclosed Cooling Module.
   - For the standalone cooling module, see 5.3 Installing the Standalone Cooling Module into the Cabinet.
   - For installation without a cabinet, see 5.4 Installing the Standalone Cooling Module without a Cabinet.

2. Make sure that the pipe connections into the drive circuit (2 pcs) and the external circuit (2 pcs) are made.

   See 6.12 Pipe Connections.

3. Do the pressure test for both the circuits.

   See 6.17 Doing the Pressure Test.

   The pressure test can also be made with coolant, but only after the cooling system has been filled.

   Make sure that the relief valve is removed before the pressure test and reattached after the pressure test.

4. Connect the mains cable into the junction box.

   See 7.4 Installing the Mains Cables.

5. Turn on the power from the main switch.
6. Fill the cooling system with coolant using one of the two methods.

   See 6.18.2 Filling the Cooling System by Progressive Circulation and 6.18.3 Filling the Cooling System by Forced De-airing.

7. Check the pump rotation direction.

   a. If the pump rotates in the wrong direction, change 2 mains cable phases (for example, L1 and L2) between each other at the junction box. See 6.20 Checking the Pump Rotation Direction.

   The cooling module is ready to be used.

10 Maintenance

10.1 Preventive Maintenance Recommendations

Generally, all technical equipment, including iC7 Series Cooling Modules, need a minimum level of preventive maintenance. Regular maintenance is recommended to ensure trouble-free operation and long life of the cooling module. It is also recommended, as a good service practice, to record a maintenance log with counter values, date, and time describing the maintenance and service actions.

Danfoss recommends the following inspections and service intervals for the cooling module.

NOTICE

The service schedule for part replacements can vary depending on operation conditions. Under specific conditions, the combination of stressful operating and environment conditions work together to reduce the lifetime of the components significantly. These conditions can include, for example, extreme temperature, dust, high humidity, hours of use, corrosive environment, and loading.

For operation in stressful conditions, Danfoss offers the DrivePro® Preventive Maintenance service. DrivePro® services extend the lifetime and increase the performance of the product with scheduled maintenance including customized part replacements. DrivePro® services are tailored to your application and operating conditions.

Table 20: Maintenance Schedule for iC7 Series Cooling Modules

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Installation			
Visual inspection	1 year	–	Check for the unusual, for example, for signs of overheating, aging, corrosion, and for dusty and damaged components.
Auxiliary equipment	1 year	According to manufacturer recommendations	Inspect equipment, switchgear, relays, disconnects, or fuses/circuit breakers. Examine the operation and condition for possible causes of operational faults or defects. The continuity check on fuses must be performed by trained service personnel.
EMC consideration	1 year	–	Inspect the installation wiring regarding the electromagnetic capability and the separation distance between control wiring and power cables.
Cable routing	1 year	–	Check for parallel routing of motor cables, mains wiring, and signal wiring. Parallel routing must be avoided. Avoid routing cables through free air without support. Check for aging and wearing of the cable insulation.
Control wiring	1 year	–	Check for tightness, damaged or crimped wires or ribbon wires. The connections must be terminated correctly with solid crimped ends. The use of shielded cables and grounded EMC plate, or a twisted pair is recommended.
Proper clearances	1 year	–	Check that the required external clearances for proper airflow for cooling are followed. For clearances, refer to the local design regulations.

Table 20: Maintenance Schedule for iC7 Series Cooling Modules (continued)

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Seals condition	1 year	–	Check that the seals of the enclosure, the covers, and the cabinet doors are in good condition.
Corrosive environments	1 year	–	Conductive dust and aggressive gases, such as sulphide, chloride, and salt mist, can damage the electrical and mechanical components. Air filters do not remove air-borne corrosive chemicals. Act based on these findings.
Cooling module			
Programming	1 year	–	Check that the parameter settings are correct according to the motor, and I/O configuration. Only trained service personnel can perform this action.
Control panel	1 year	–	Check that the display pixels are intact. Check the event log for warnings and faults. Repetitive events are a sign of potential issues. Contact your local service center.
Cooling capacity	1 year	–	Check for blockages or constrictions in the coolant passages of the cooling channel. The heat exchanger must be free of particles and sediment.
Cleaning	1 year	–	The interior of the enclosure must be cleaned annually, and more frequently if necessary. The level of dust inside the enclosure is an indicator for when the next cleaning is required.
Grounding	1 year	–	The cooling module requires a dedicated ground wire connecting the module, and other components to the building ground. Check that the ground connections are tight and free of paint or oxidation. Daisy-chain connections are not allowed. Braided straps are recommended if applicable.
Power cables and wiring	1 year	–	Check for loose connections, aging, insulation condition, and proper torque to the connections. Check for proper rating of fuses and continuity check. Observe if there are any signs of operation in a demanding environment. For example, discoloration of the fuse housing can be a sign of condensation or high temperatures.
Vibration	1 year	–	Check for abnormal vibration or noise coming from the cooling module to ensure that the environment is stable for electronic components.
Insulator gaskets	1 year	10–15 years	Inspect the insulators for signs of degradation due to high temperature and aging. Replacement is based on findings. Only trained service personnel can perform this action.
Batteries	1 year	7–10 years	Batteries must be replaced according to manufacturer recommendation. Replace the RTC battery in the control unit every 7–10 years.

Table 20: Maintenance Schedule for iC7 Series Cooling Modules (continued)

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Service products			
Spare parts	1 year	2 years	Stock spares in their original boxes in a dry and clean environment. Avoid hot storage areas.
Exchange units and units stored for long periods before commissioning	1 year	2 years	Visually inspect for signs of damage, water, high humidity, corrosion, and dust within the visual field of view without disassembly.
Coolant (drive circuit)			
Log	Commissioning/startup, or at the time of replacing liquid coolant	–	To create a baseline for future reference before and after adding inhibitor and glycol, record the water quality specification values. Also record the system pressure, coolant flow rate, temperature range, and create a baseline for future reference. The cooling module is tested with glycol type Clariant Antifrogen L. If using a different glycol type or if the coolant type is changed during maintenance, flush the system before filling.
Glycols	1 year	Based on findings	When replacing the coolant in the drive circuit of the cooling system, measure and record the level of glycol. The glycol concentration depends on the ambient temperature. The minimum concentration level is 75/25% demineralized water/glycol.
Corrosive inhibitors	1 year	Based on findings	When replacing the coolant in the drive circuit of the cooling system, measure and record the level of Danfoss recommended corrosive inhibitor (Cortec-VpCI-649, see specification). If the inhibitor is below the 1% recommended level, practice caution before adding more inhibitor not to exceed the level of electrical conductivity.
Pre-mixed glycol and inhibitor coolant	1 year	Based on findings	The pre-mixed coolants contain specific percentages of glycol and inhibitor for antifreeze and corrosion protection. The advantage of using a pre-mixed coolant is that the chemical composition is within Danfoss specifications, and there is no need for analyzing the coolant.
Demineralized water	1 year	Based on findings	Only use demineralized, deionized, or distilled water in the coolant solution. Record and compare the chemical composition values when replacing or adding coolant.
Cooling system			
Pipes, hoses, valves, and connections	1 year	–	Check for external signs of moisture, corrosion, and coolant leaks. Check the tightness of the cooling pipe connections. Check the heat exchanger and host pipes in the cooling system. Check that metallic hoses are not pressed against sharp edges. Turn the internal shut-off valves from "open" to "closed" position 2-3 times.
Leak detector	1 year	10 years	Test the functioning of the leak detector.

Table 20: Maintenance Schedule for iC7 Series Cooling Modules (continued)

Component	Inspection interval[1]	Service schedule[2]	Preventive maintenance actions
Auxiliary equipment	1 year	According to manufacturer recommendations	Check that the sensors, gauges, and indicators are functioning correctly. Act based on findings.
System cooling capacity	1 year	Based on findings	Test the cooling capacity and the thermal transfer of the system. Record the coolant system flow, pressure, and input and output temperature, and compare to the previous measurements. Act based on these findings.
Cooling system (external circuit)			
Pipes, hoses, valves, and connections	1 year	–	Check for external signs of moisture, corrosion, and coolant leaks. Check the tightness of the cooling pipe connections. Replacement interval for components depends on the water quality and ambient conditions.
Water quality	1 year	–	Check the water quality on the external circuit side (particle size). If the water quality is not sufficient, the heat exchanger can become clogged.
Coolant flow	1 year	–	Monitor the flow/pressure of the coolant. Organic sediment increases the pressure loss over the heat exchanger and decreases the flow.

1) Defined as the time after the commissioning/startup or the time from the previous inspection.

2) Defined as the time after the commissioning/startup or the time from the previous service schedule actions.

10.2 Maintenance Log for Cooling System

During the commissioning phase of the product and during each inspection refer to the maintenance schedule. Record values such as the ambient air temperature, system pressure, flow, and input/output cooling liquid temperature during run condition. Record the water chemical analysis values and the type and percentages of glycol and inhibitor or pre-mixed solutions of the liquid coolant.

The initial values create a base-line value to compare versus future values measured during preventive maintenance intervals. Record the chemical analysis values each time the liquid coolant is replaced. Record all the maintenance tasks and service tasks with counter values, date, and time.

10.3 Cleaning the Heat Exchanger with CIP Equipment

⚠ CAUTION

USAGE OF PERSONAL PROTECTIVE EQUIPMENT

Cleaning agents can irritate the eyes and skin.

- When using cleaning agents, always use personal protective equipment (PPE).

If the heat exchanger cannot be cleaned by using backwashing, use CIP (clean-in-place) equipment.

1. Select a suitable cleaning agent according to the type of contamination in the heat exchanger.

   Make sure that the cleaning agent does not damage the materials of the heat exchanger (stainless steel).

2. Follow the instructions in the user guide of the CIP equipment and the cleaning agent.

   The Axilock joints used to connect the pipes to the heat exchanger have EPDM sealings, which are sensitive to some cleaning agents. Do not use the Axilock joints when connecting the CIP equipment to the heat exchanger.

3. Clean the heat exchanger with the CIP equipment.
4. To remove chemicals after the cleaning, flush the heat exchanger with fresh water.

10.4 Cleaning the Heat Exchanger with Backwashing

⚠ CAUTION

USAGE OF PERSONAL PROTECTIVE EQUIPMENT

Cleaning agents can irritate the eyes and skin.

- When using cleaning agents, always use personal protective equipment (PPE).

Use these instructions to remove light adhesive particles from the heat exchanger.

1. To clean the heat exchanger, use backwashing.
   a. Direct the high-speed water flow in the opposite direction to the flow in normal operation.

11 Specifications

11.1 Tightening Torques

ISO standard threads

All regular ISO standard threads are tightened according to Table 21. The table is also valid with aluminum threads. Self-tapping screws and special couplings are excluded.

Table 21: Tightening Torques for ISO Standard Threads

Thread	Torque [Nm (in-lb)]
M3 × 0.5	1.0 (8.9)
M4 × 0.7	2.2 (19.5)
M5 × 0.8	4.5 (39.8)
M6 × 1	8 (71)
M8 × 1.25	20 (177)
M10 × 1.5	40 (354)
M12 × 1.75	70 (620)
M16 × 2	170 (1505)

Self-tapping screws

Tighten the self-tapping screws until the screw seats and no longer turns easily. There is no specific torque for self-tapping screws.

Hydraulic connections

Tighten all aluminum block 1/2" connections to 40 Nm (354 in-lb). The only exception is the elbow valve of the inlet blocks, which is tightened to 20 Nm (177 in-lb), or until the pressure flattens the seal correctly.

Tighten the pressure sensor (1/4") to 20 Nm (177 in-lb).

Tighten the screws in 1/8" aluminum threads to 12 Nm (106 in-lb).

Victaulic coupling

Tighten the nuts evenly by alternating sides until metal-to-metal contact occurs.

Axilock coupling

Tighten the Axilock coupling to 15 Nm (133 in-lb). Tighten the screws carefully in turns little by little, so that both screws are in torque and overtightening does not occur. A special tool can be used to turn both screws at the same time.

Expansion tank connections

Pressurizing valve

- Pneumatic connection shut-off valve, V216, Schwer 1/8" valve: 15 Nm (133 in-lb)
- Valve for pneumatic connection, V217, Schrader 1/8" valve: 12 Nm (106 in-lb)

Pressure gauge

- Valve for pressure gauge, V219, Schwer 1/4" valve: 20 Nm (177 in-lb)
- Pump inlet pressure gauge, PG11, Schwer coupling: 20 Nm (177 in-lb)

- Pressure meter: 12 Nm (106 in-lb)

Expansion tank inlet hose

- Schwer 1/8" valve: 15 Nm (133 in-lb)
- Parker elbow fitting: 12 Nm (106 in-lb)

Level indicator

- Liquid level sensor, LLS11: 20 Nm (177 in-lb)

Sensor connections

- M12 connector: 0.4 Nm (3.5 in-lb)

11.2 Dimensions

11.2.1 Dimensions of the Single-pump Standalone Cooling Module

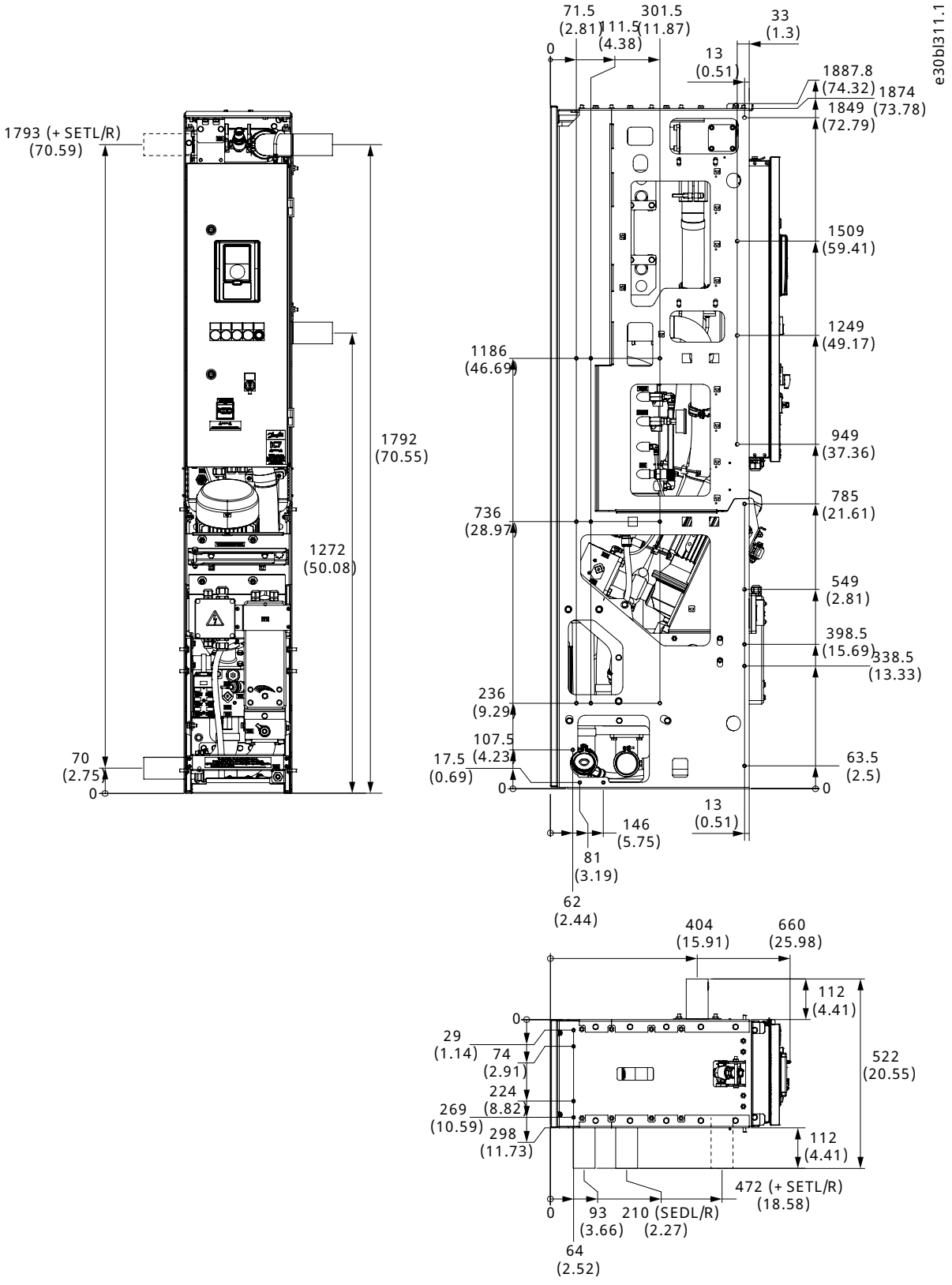

Figure 35: Dimensions of the Single-pump Standalone Cooling Module in mm (in)

11.2.2 **Dimensions of the Dual-pump Standalone Cooling Module**

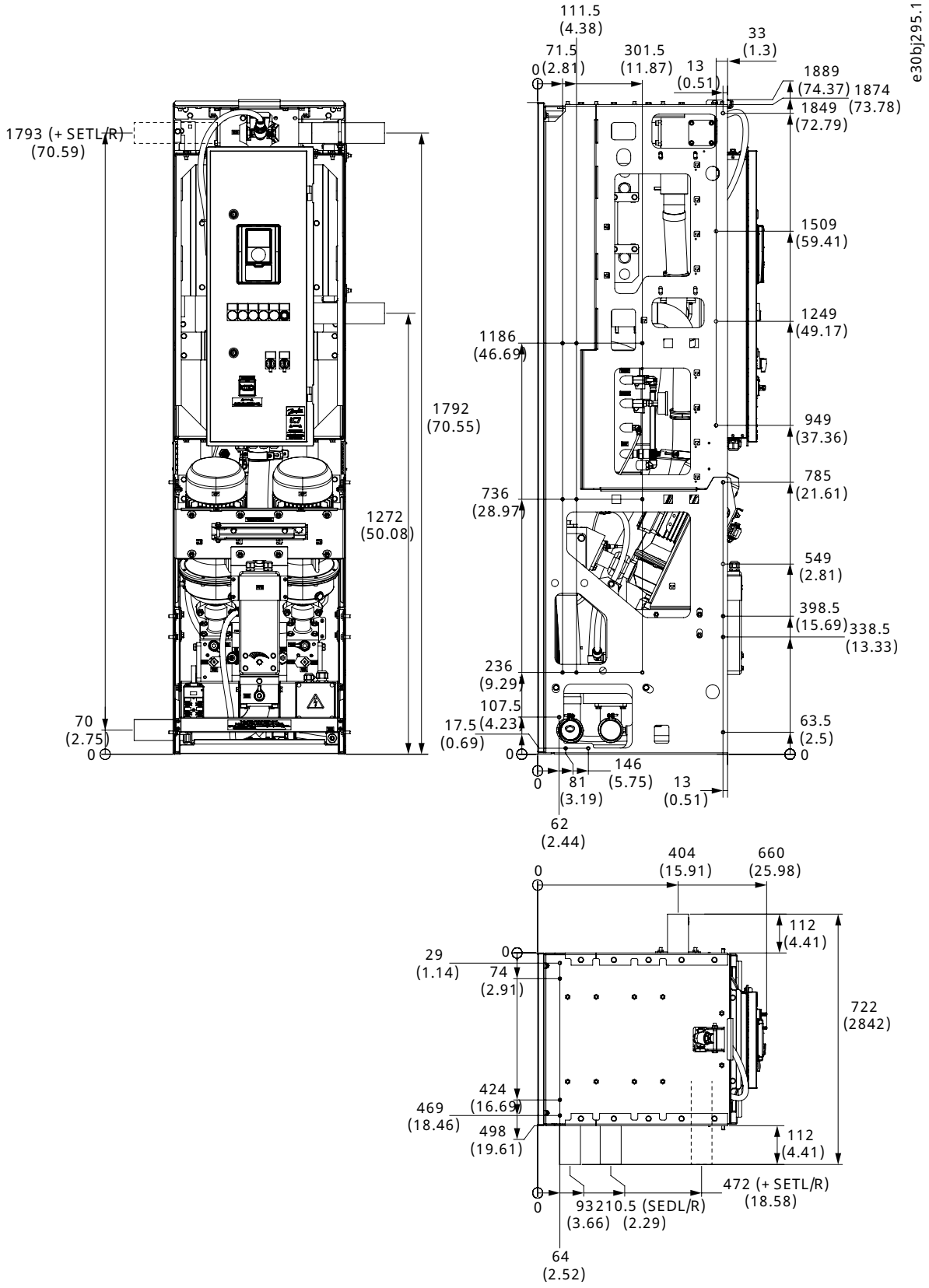

Figure 36: Dimensions of the Dual-pump Standalone Cooling Module in mm (in)

11.2.3 Dimensions of the Single-pump Enclosed Cooling Module, Drive Circuit Pipes on the Left

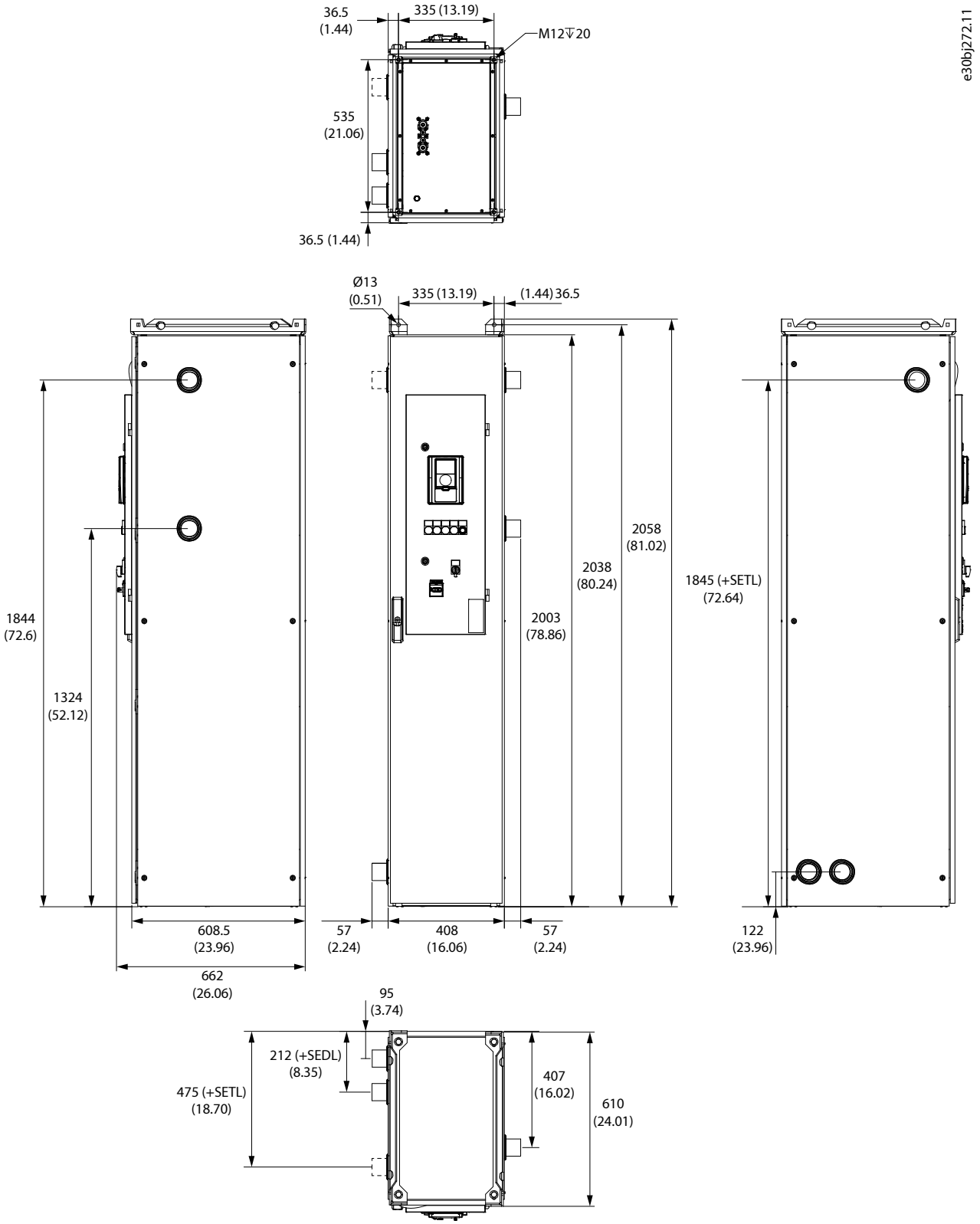

Figure 37: Dimensions of the Single-pump Enclosed Cooling Module in mm (in), Drive Circuit Pipes on the Left

11.2.4 Dimensions of the Dual-pump Enclosed Cooling Module, Drive Circuit Pipes on the Left

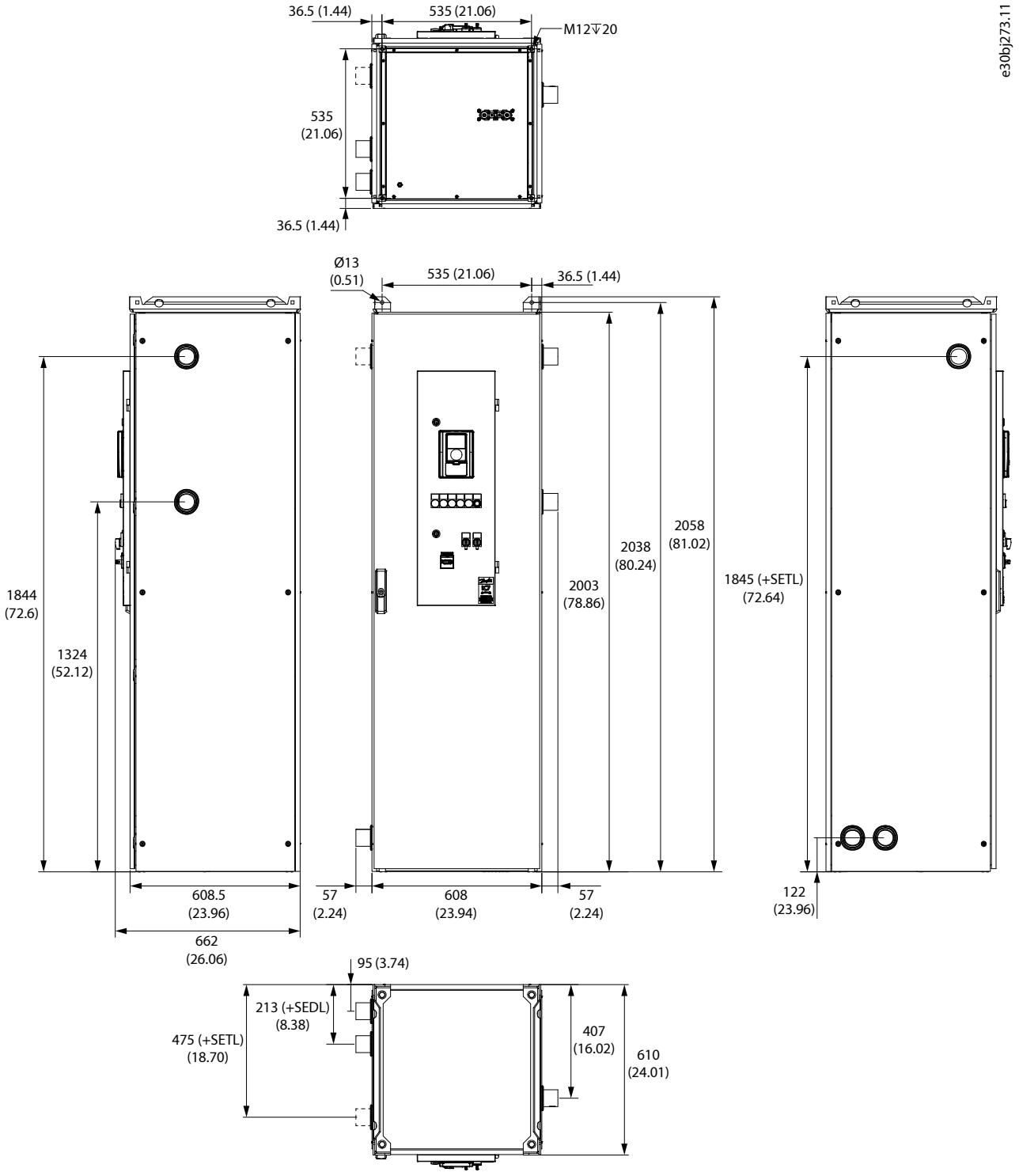

Figure 38: Dimensions of the Dual-pump Enclosed Cooling Module in mm (in), Drive Circuit Pipes on the Left

11.2.5 Dimensions of the Single-pump Enclosed Cooling Module, Drive Circuit Pipes on the Right

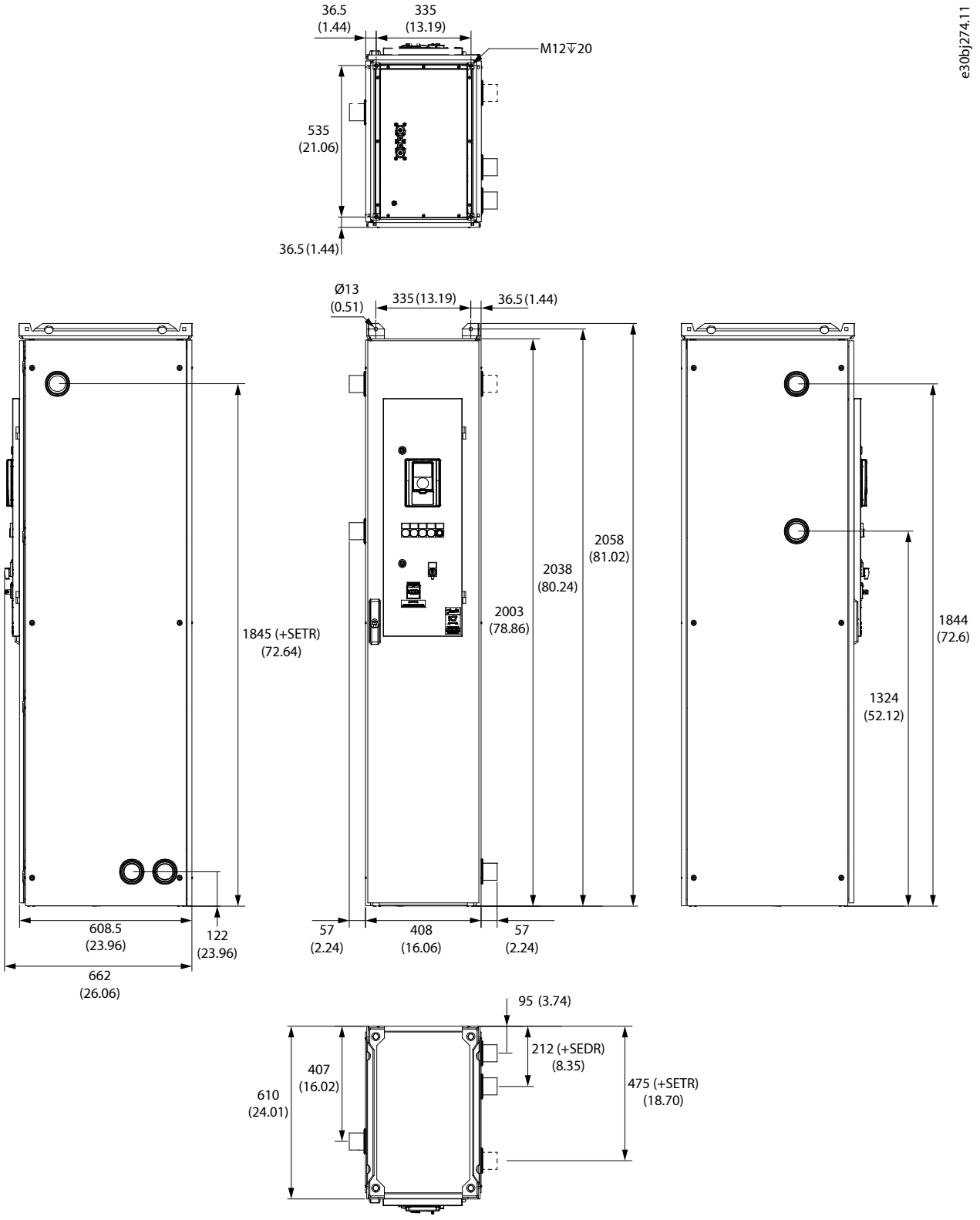

Figure 39: Dimensions of the Single-pump Enclosed Cooling Module in mm (in), Drive Circuit Pipes on the Right

11.2.6 Dimensions of the Dual-pump Enclosed Cooling Module, Drive Circuit Pipes on the Right

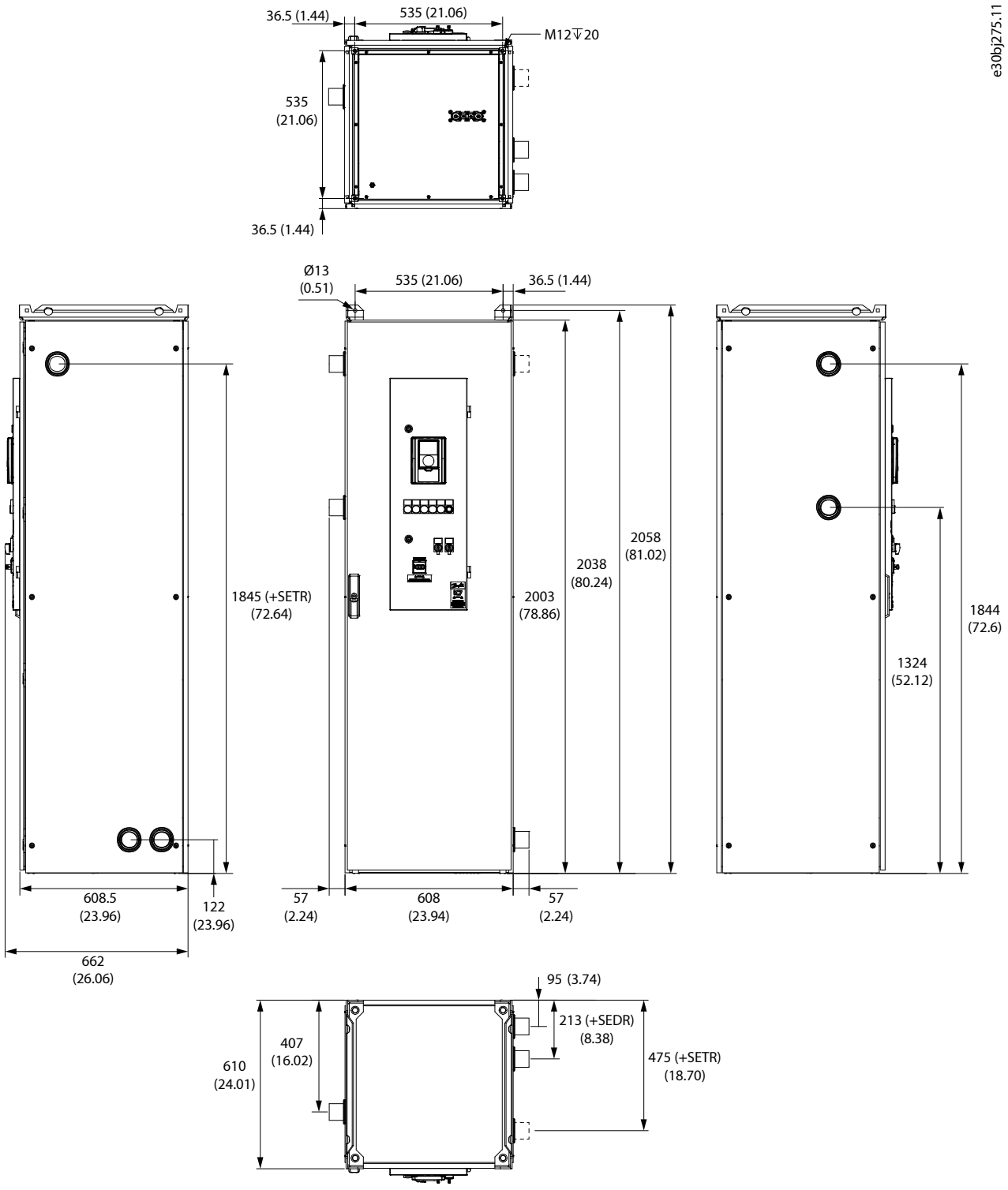

Figure 40: Dimensions of the Dual-pump Enclosed Cooling Module in mm (in), Drive Circuit Pipes on the Right

11.2.7 **Dimensions of the Optional DIN Flanges**

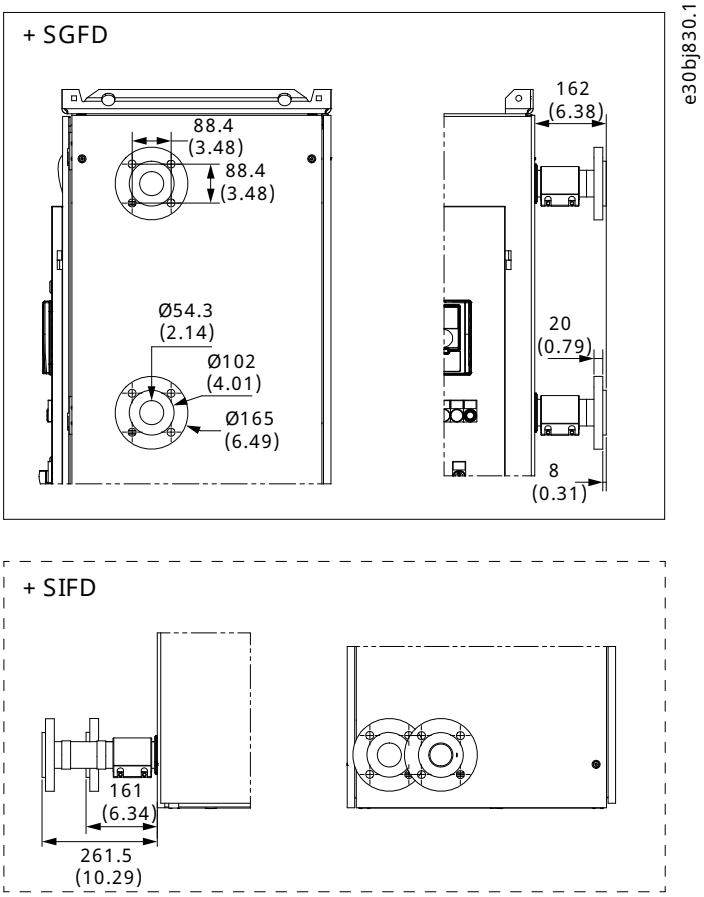

Figure 41: Dimensions of the Optional DIN Flanges, +SGFD and +SIFD, in mm (in)

11.2.8 **Dimensions of the Optional ANSI Flanges**

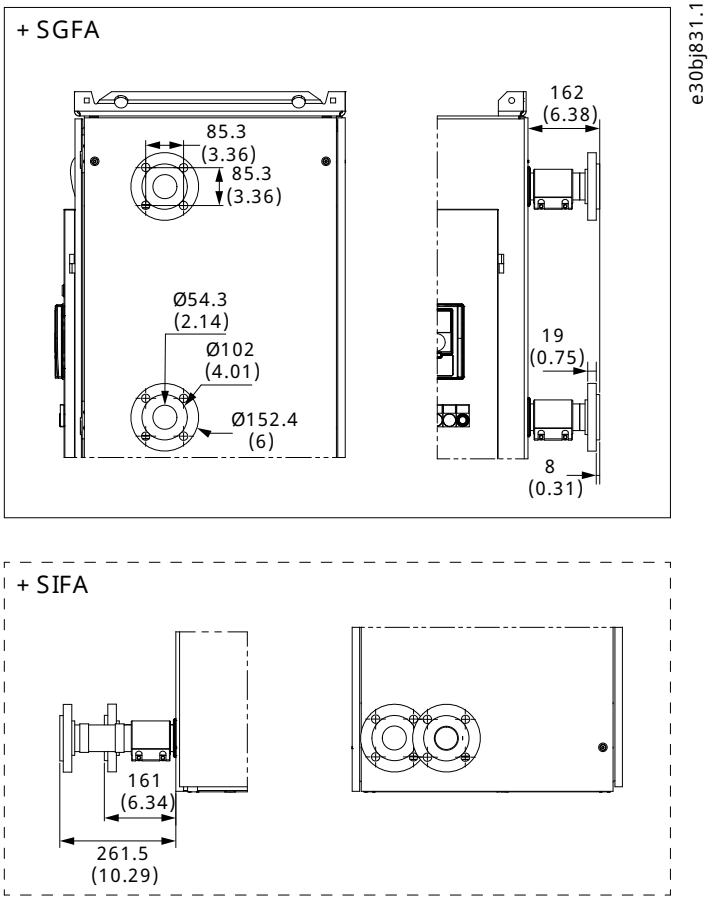

Figure 42: Dimensions of the Optional ANSI Flanges, +SGFA and +SIFA, in mm (in)

11.3 **Options**

Table 22: Options for the Cooling Module

Option group	Plus code	Description
Communication interface	+BAEL	Ethernet – no protocol
	+XXXX	PROFINET IO
	+BAIP	EtherNet/IP
	+BAMT	Modbus TCP
	+MABR	Modbus RTU
	+BABN	BACnet MSTP
	+BAMS	Metasys N2
Control panel	+BF20	Control panel
Product series	+DACM	Cooling module application
Technical documentation	+EGOP	Operating guide
Documentation language	+EHEN	English

Table 22: Options for the Cooling Module (continued)

Option group	Plus code	Description
Cooling module configuration	+SAP1	Single-pump
	+SAP2	Dual-pump, redundant
Heat exchanger	+SCXX	None
	+SCLE	Liquid-to-liquid
Cooling connection location	+SEDL	Drive connect, left base
	+SEDR	Drive connect, right base
	+SETL	Drive connect, left base/top
	+SETR	Drive connect, right base/top
External pipe coupling type	+SGPC	Standard coupling
	+SGFD	Flange coupling (DIN)
	+SGFA	Flange coupling (ANSI)
Drive pipe coupling type	+SIPC	Standard coupling
	+SIFD	Flange coupling (DIN)
	+SIFA	Flange coupling (ANSI)
Liquid heater	+SKXX	No
	+SKLH	Yes
Cabinet heater	+SLXX	No
	+SLEH	Yes
Frequency range	+SM50	Input frequency 50 Hz
	+SM60	Input frequency 60 Hz
Marine construction	+AFXX	None
	+AFMC	Yes

Table 22: Options for the Cooling Module (continued)

Option group	Plus code	Description
Product specific marine cert.	+VBXX	None
	+VBAB	American Bureau of Shipping
	+VBBV	Bureau Veritas
	+VBDN	DNV
	+VBLR	Lloyd's Register
	+VBIN	Registro Italiano Navale
	+VBMA	Marine appr details by case
	+VBKR	Korean Register of Shipping
	+VBCN	China Classification Society
	+VBRU	Russian Maritime Register
	+VBNP	Nippon Kaiji Kyokai

11.4 Supply Pressure

11.4.1 Determining the Estimated Flow in the System

The cooling module has a fixed-speed pump, and flow reduction is not included. For determining the estimated flow in the system, do the following steps.

- Calculate the pressure loss in the drive system (cooling module excluded) and form a graph of the data.
- Select the most suitable cooling module for the application and pick the equivalent supply pressure graph.
- Fit the two graphs together. The flow in the system is at the intersection of the curves.

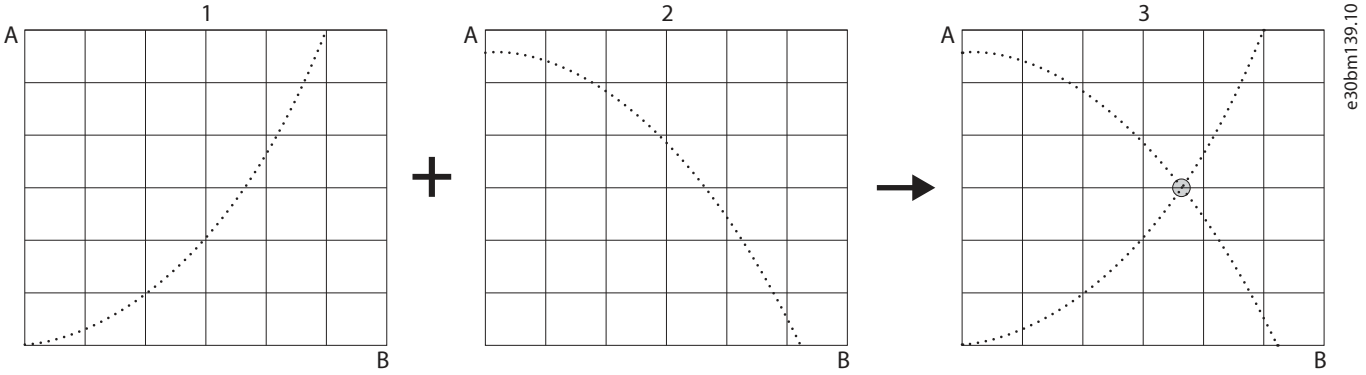

Figure 43: Determining the Estimated Flow in the System

A	Pressure	**B**	Flow
1	Estimated pressure loss in the drive circuit	**2**	Supply pressure of the cooling module
3	Flow in the system		

Install a choke valve into the system, if the flow is too high even with the most suitable cooling module. Add the effect of a choke valve (or any other component that increases pressure loss) into the pressure loss graph and check the system flow again. Keep the prevailing flow inside the pump limits. The limits are:

- 152kW cooling module: 180–450 l/min
- 76kW cooling module: 120–280 l/min

NOTICE

FLOW IS TOO HIGH

There is a risk of damage to the equipment.

- Keep the prevailing flow within the pump limits.

If the system has the option +SCXX (no heat exchanger), the graphs in 11.4.2 Supply Pressure of the 152 kW Single-pump Cooling Module, 11.4.3 Supply Pressure of the 152 kW Dual-pump Cooling Module, and 11.4.4 Supply Pressure of the 76 kW Cooling Module are not valid. The flow of the cooling module with an external heat exchanger depends on the intended heat exchanger and piping pressure losses. It is recommended to use heat exchangers with the following pressure losses. In case of higher pressure loss or complicated piping, the nominal supply pressure of the cooling module will be decreased.

- 76kW cooling module: 0.4 bar at 190 l/min
- 152kW cooling module: 0.6 bar at 360 l/min

11.4.2 Supply Pressure of the 152 kW Single-pump Cooling Module

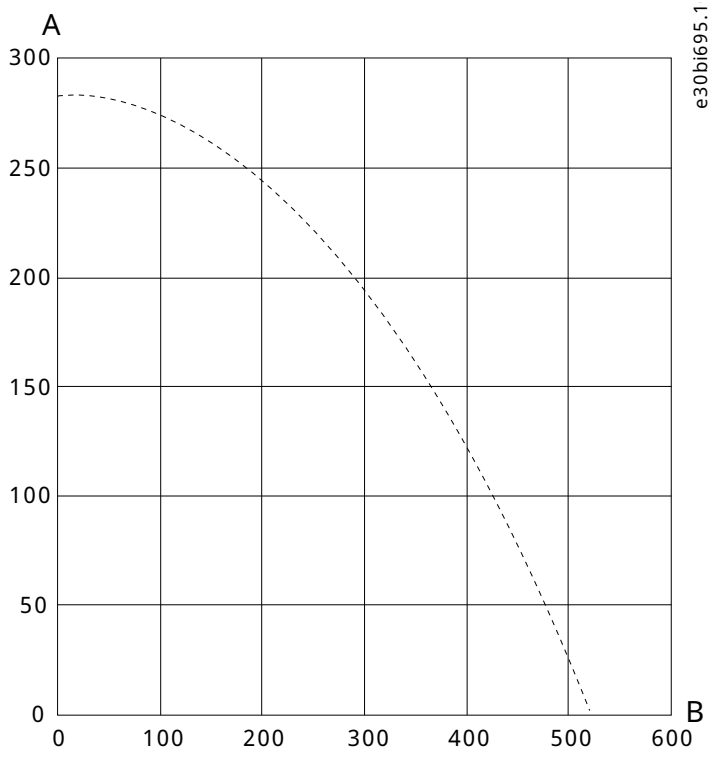

Figure 44: Supply Pressure of the 152 kW Single-pump Cooling Module

A	kPa	**B**	l/min

11.4.3 Supply Pressure of the 152 kW Dual-pump Cooling Module

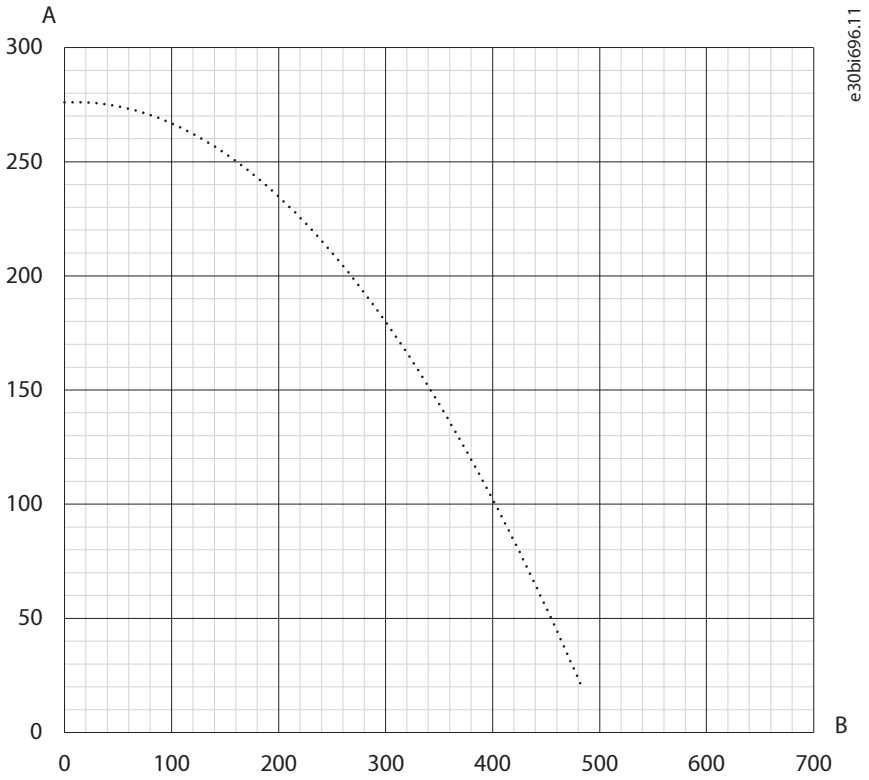

Figure 45: Supply Pressure of the 152 kW Dual-pump Cooling Module

A	kPa	**B**	l/min

11.4.4 Supply Pressure of the 76 kW Cooling Module

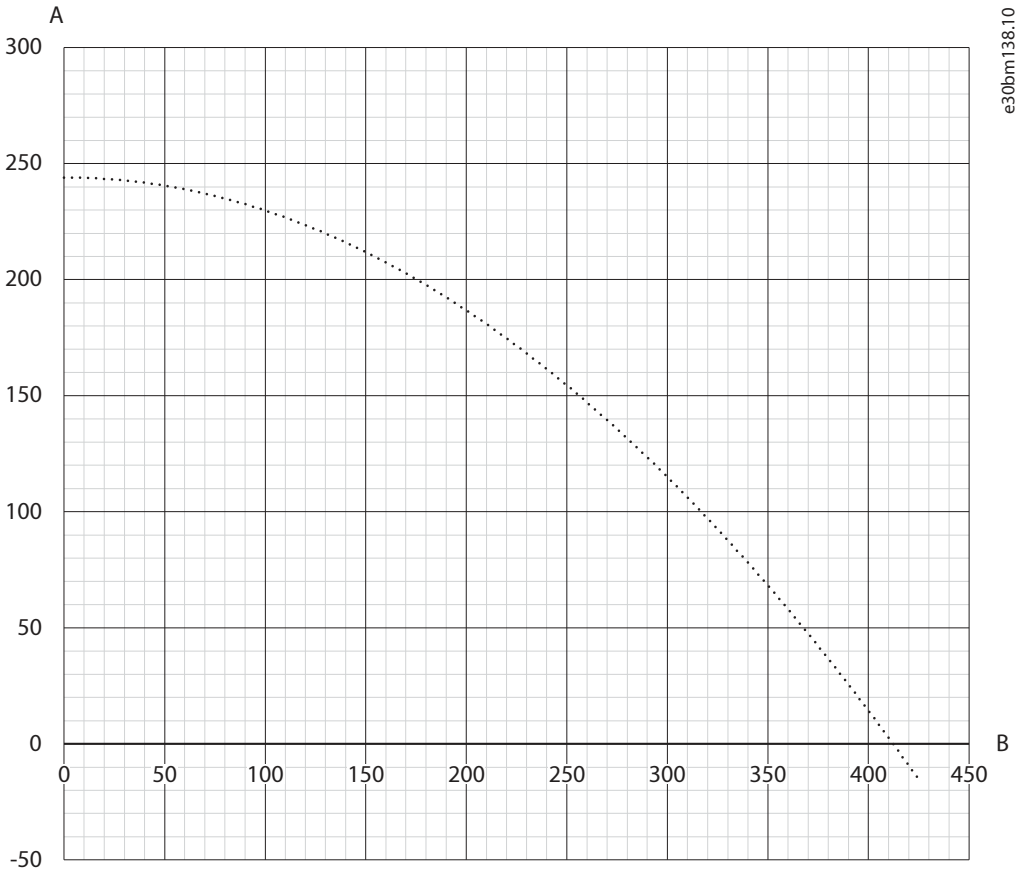

Figure 46: Supply Pressure of the 76 kW Single-pump or Dual-pump Cooling Module

A	kPa	**B**	l/min

11.5 P & I Diagrams

11.5.1 Piping and Instrumentation Diagram of the Single-pump Cooling Module with an External Heat Exchanger

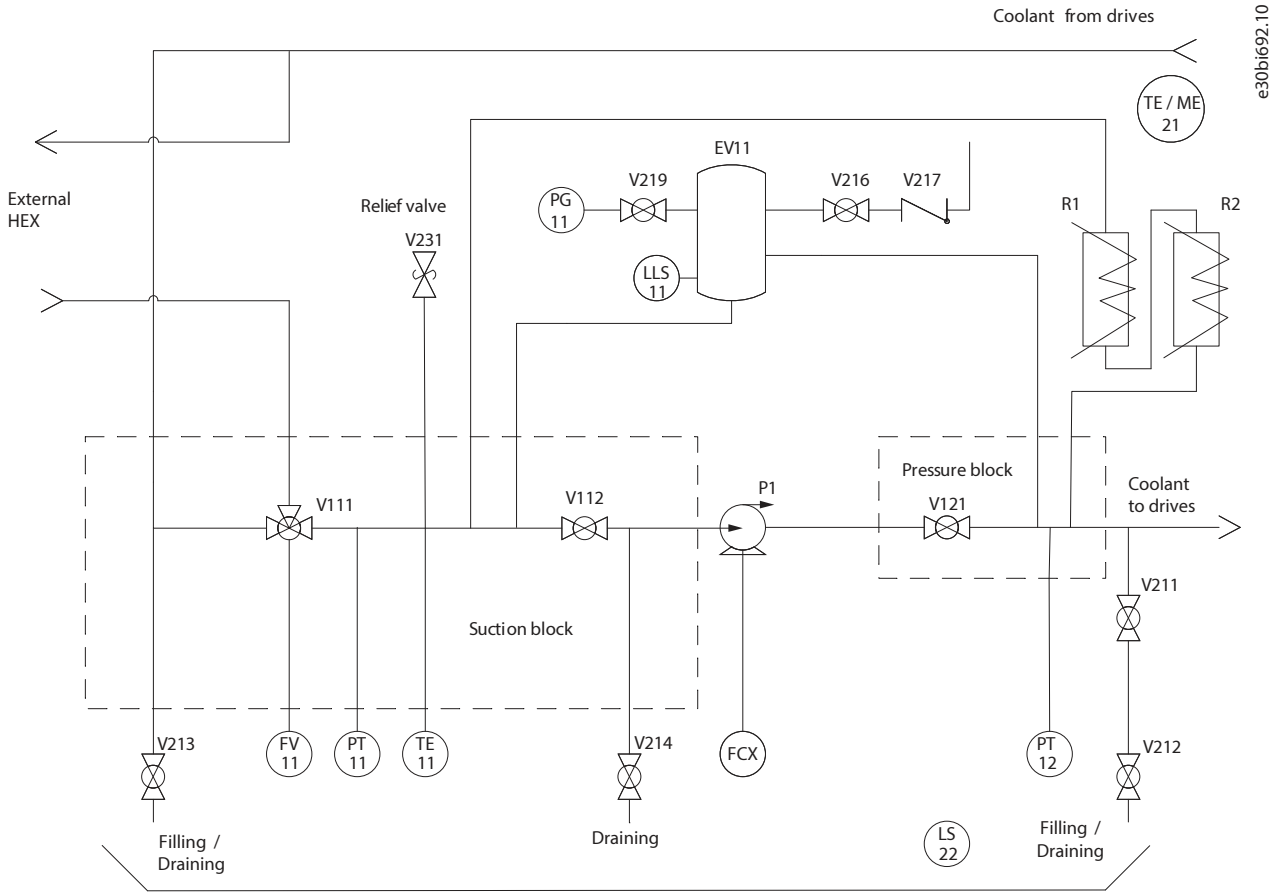

Figure 47: Piping and Instrumentation Diagram of the Single-pump Cooling Module with an External Heat Exchanger

EV11	Expansion tank	TE11	Ambient temperature sensor
FCX	Motor over temperature switch	V111	3-way valve
FV11	3-way valve actuator	V112	Pump shut-off valve
LLS11	Liquid level sensor	V121	Pump shut-off valve
LS22	Leakage sensor	V211	Shut-off valve
ME21	Ambient humidity sensor	V212	Filling/Draining valve
P1	Pump	V213	Filling/Draining valve
PG11	Pump inlet pressure gauge	V214	Draining valve
PT11	Pump inlet pressure transmitter	V216	Pneumatic connection shut-off valve
PT12	Pump outlet pressure transmitter	V217	Valve for pneumatic connection
R1	Liquid heater 1	V218	De-airing valve

R2	Liquid heater 2	V219	Valve for pressure gauge
TE21	Coolant to drives temperature sensor	V231	Relief valve

11.5.2 Piping and Instrumentation Diagram of the Single-pump Cooling Module

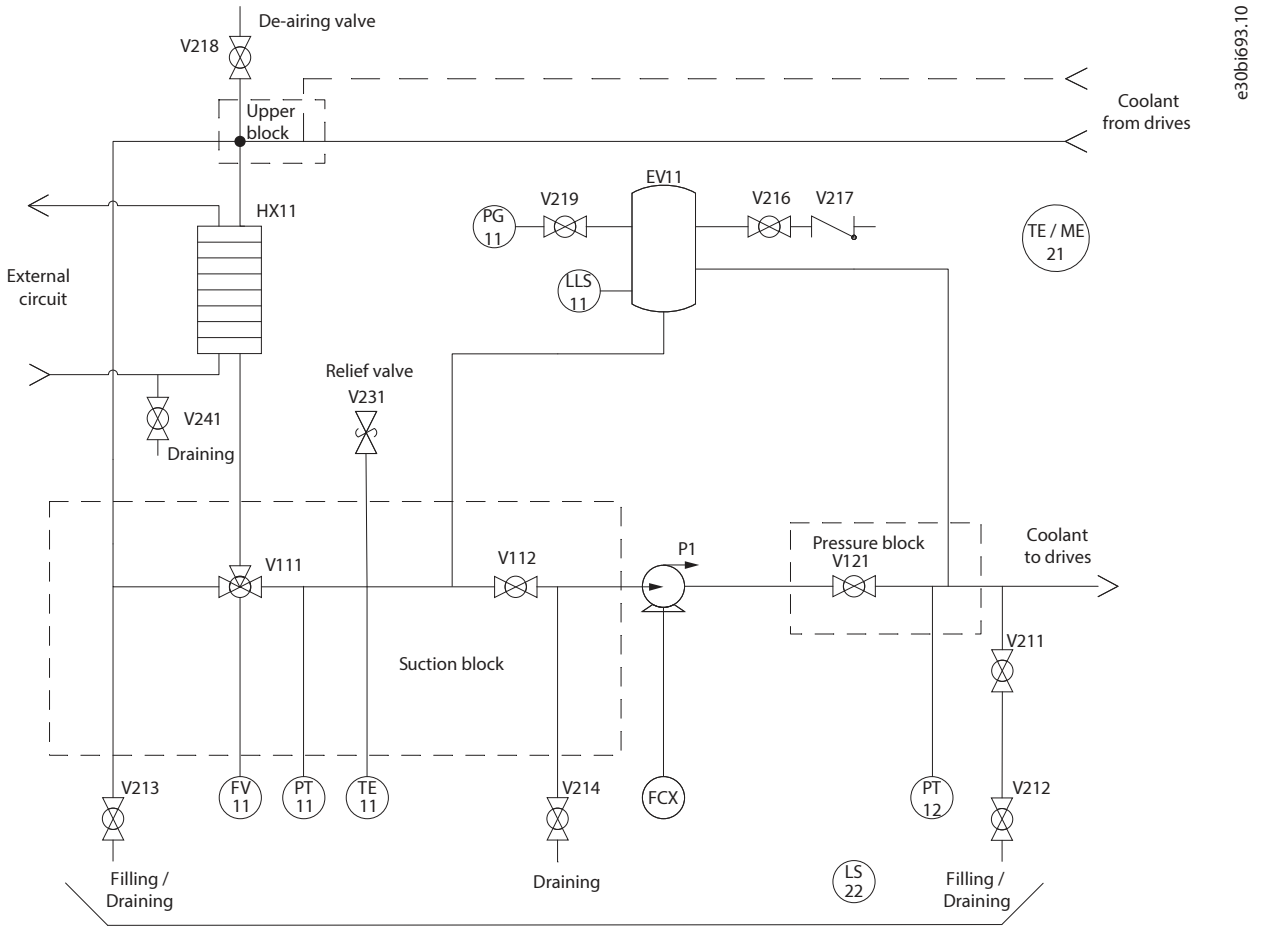

Figure 48: Piping and Instrumentation Diagram of the Single-pump 76 kW and 152 kW Cooling Module

EV11	Expansion tank	V111	3-way valve
FCX	Motor over temperature switch	V112	Pump shut-off valve
FV11	3-way valve actuator	V121	Pump shut-off valve
HX11	Heat exchanger	V211	Shut-off valve
LLS11	Liquid level sensor	V212	Filling/Draining valve
LS22	Leakage sensor	V213	Filling/Draining valve
ME21	Ambient humidity sensor	V214	Draining valve
P1	Pump	V216	Pneumatic connection shut-off valve
PG11	Pump inlet pressure gauge	V217	Valve for pneumatic connection
PT11	Pump inlet pressure transmitter	V218	De-airing valve

PT12	Pump outlet pressure transmitter	V219	Valve for pressure gauge
TE11	Coolant to drives temperature sensor	V231	Relief valve
TE21	Ambient temperature sensor	V241	Draining valve

11.5.3 Piping and Instrumentation Diagram of the Dual-pump Cooling Module

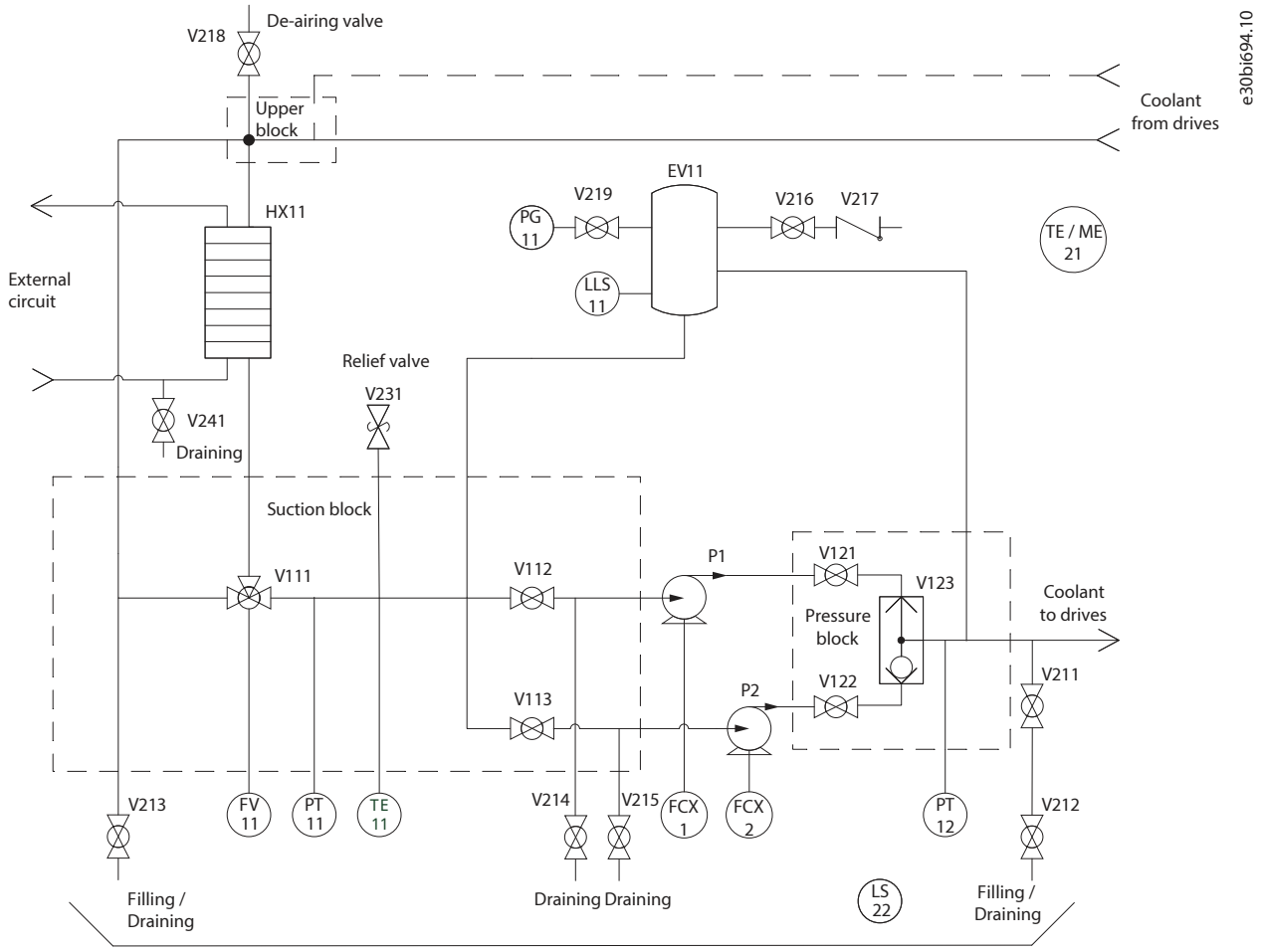

Figure 49: Piping and Instrumentation Diagram of the Dual-pump 76 kW and 152 kW Cooling Module

EV11	Expansion tank	V112	Pump 1 shut-off valve
FCX 1	Motor over temperature switch	V113	Pump 2 shut-off valve
FCX 2	Motor over temperature switch	V121	Pump 1 shut-off valve
FV11	3-way valve actuator	V122	Pump 2 shut-off valve
HX11	Heat exchanger	V123	Check valve
LLS11	Liquid level sensor	V211	Shut-off valve
LS22	Leakage sensor	V212	Filling/Draining valve
ME21	Ambient humidity sensor	V213	Filling/Draining valve
P1	Pump 1	V214	Draining valve

P2	Pump 2	V215	Draining valve
PG11	Pump inlet pressure gauge	V216	Pneumatic connection shut-off valve
PT11	Pump inlet pressure transmitter	V217	Valve for pneumatic connection
PT12	Pump outlet pressure transmitter	V218	De-airing valve
TE11	Coolant to drives temperature sensor	V219	Valve for pressure gauge
TE21	Ambient temperature sensor	V231	Relief valve
V111	3-way valve	V241	Draining valve

11.6 Wiring Diagrams

11.6.1 Wiring Diagrams

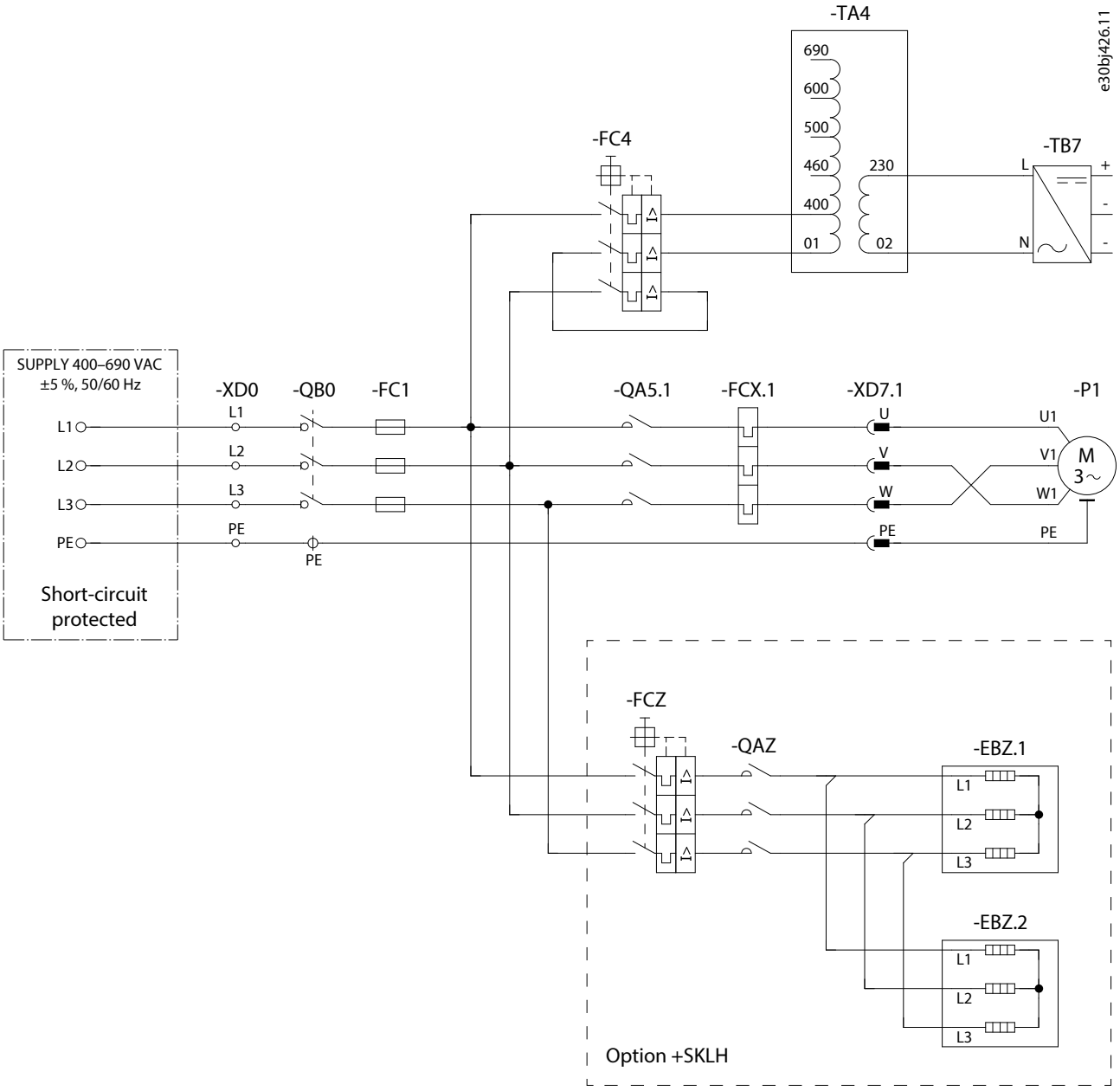

Figure 50: Wiring Diagram for Single-pump Cooling Module with Auxiliary Transformer

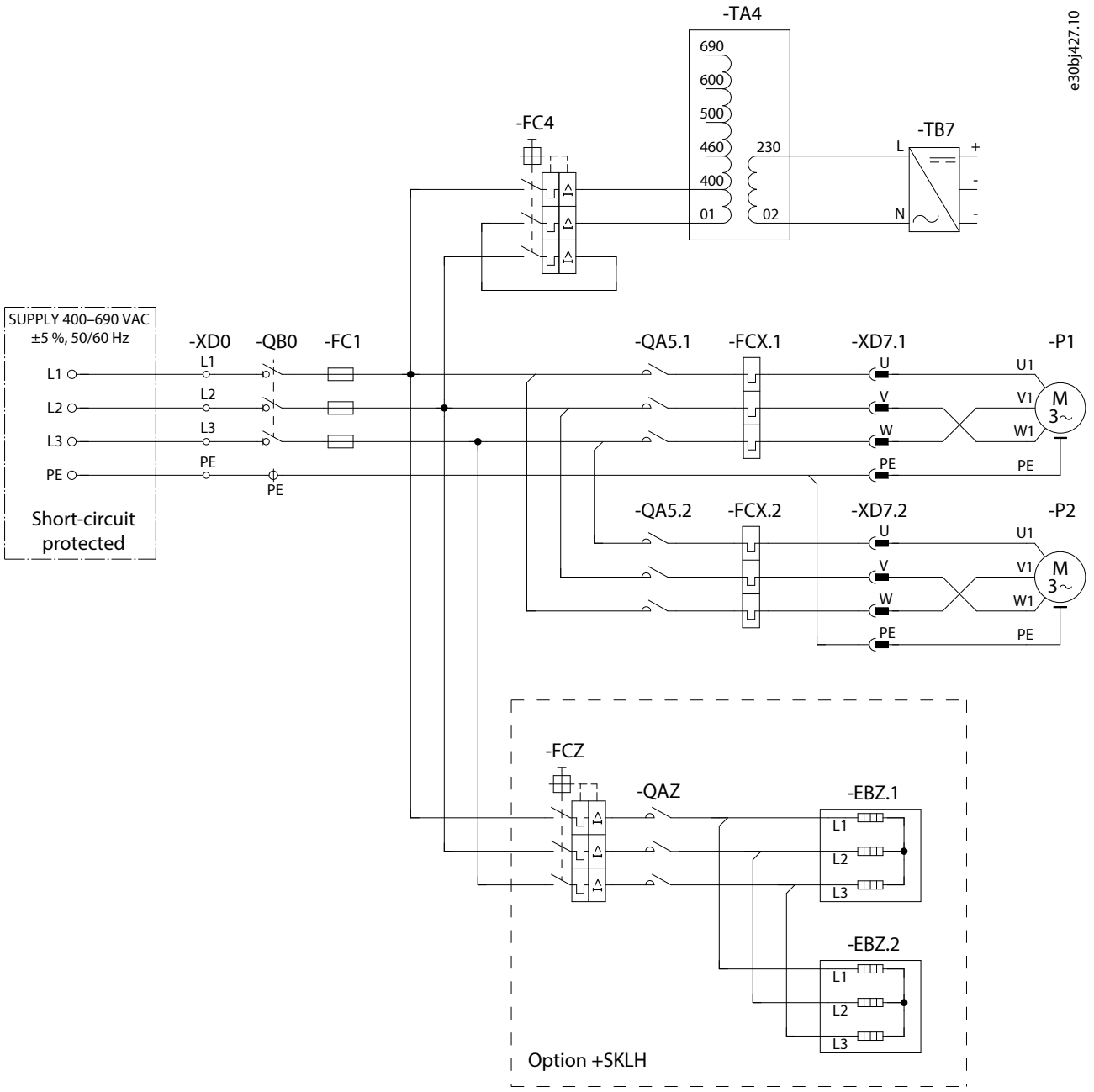

Figure 51: Wiring Diagram for Dual-pump Cooling Module with Auxiliary Transformer

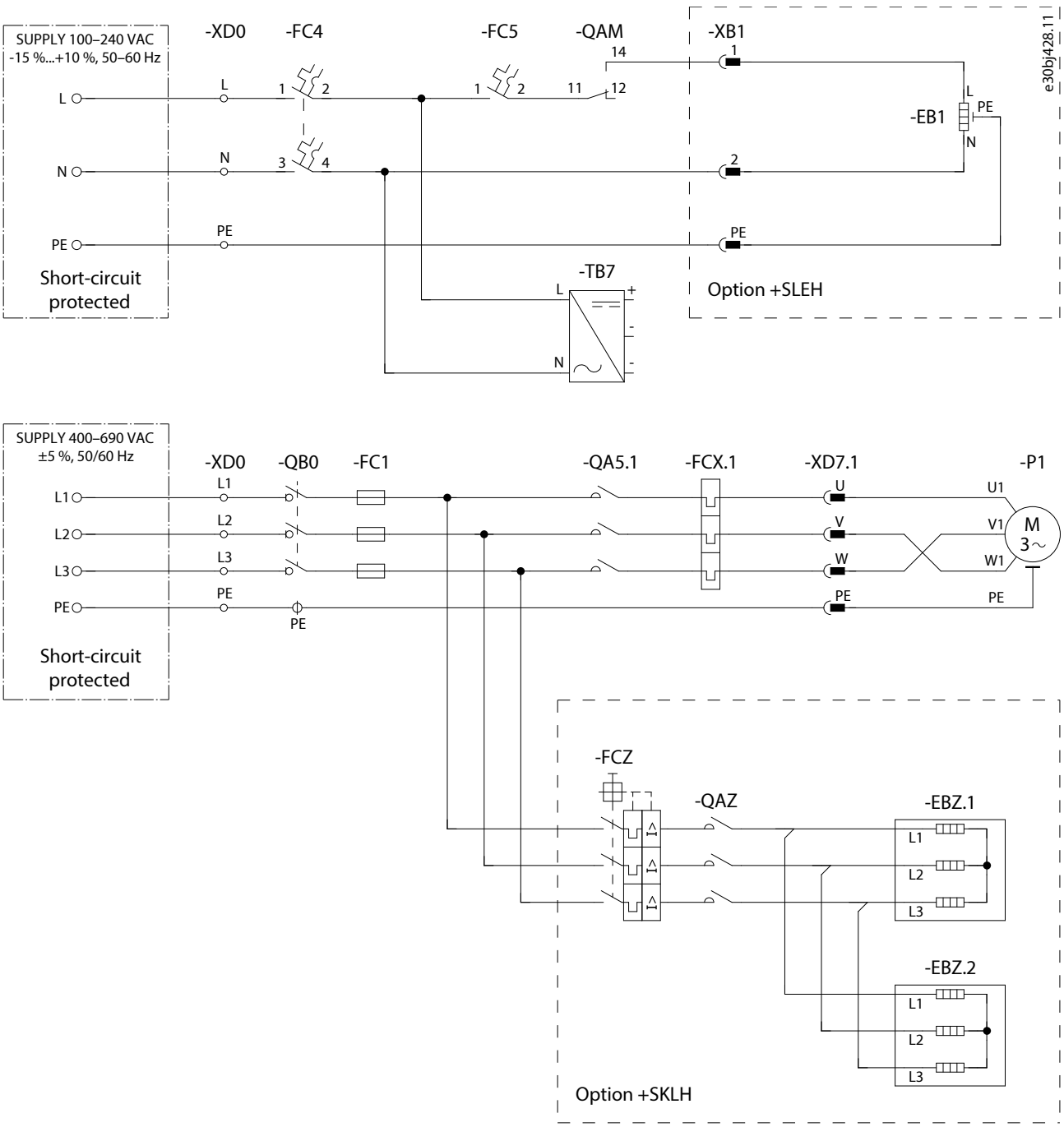

Figure 52: Wiring Diagram for Single-pump Cooling Module with External Auxiliary Supply

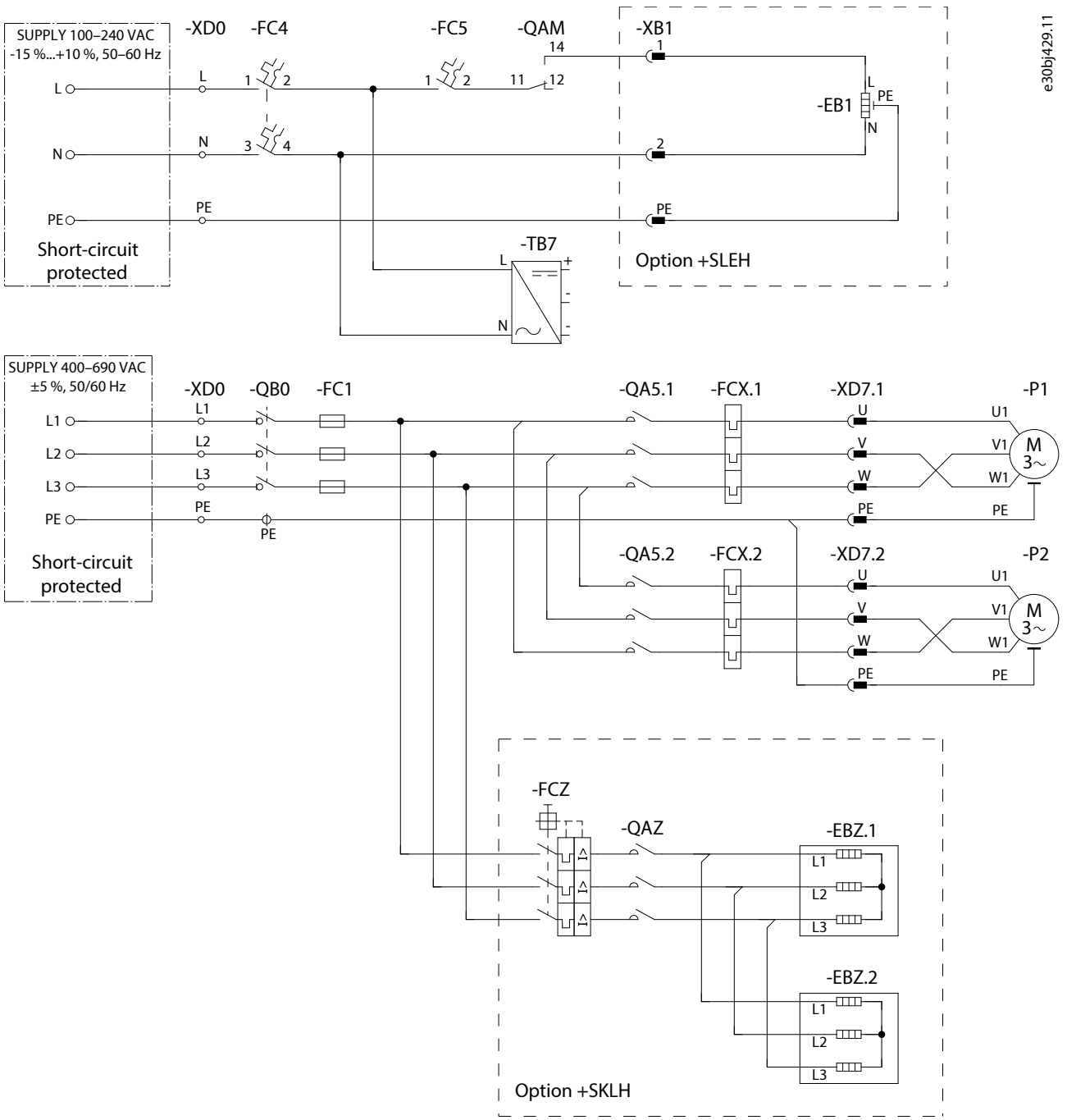

Figure 53: Wiring Diagram for Dual-pump Cooling Module with External Auxiliary Supply

11.6.2 **Wiring Diagram, Dual-pump Cooling Module with Auxiliary Transformer**

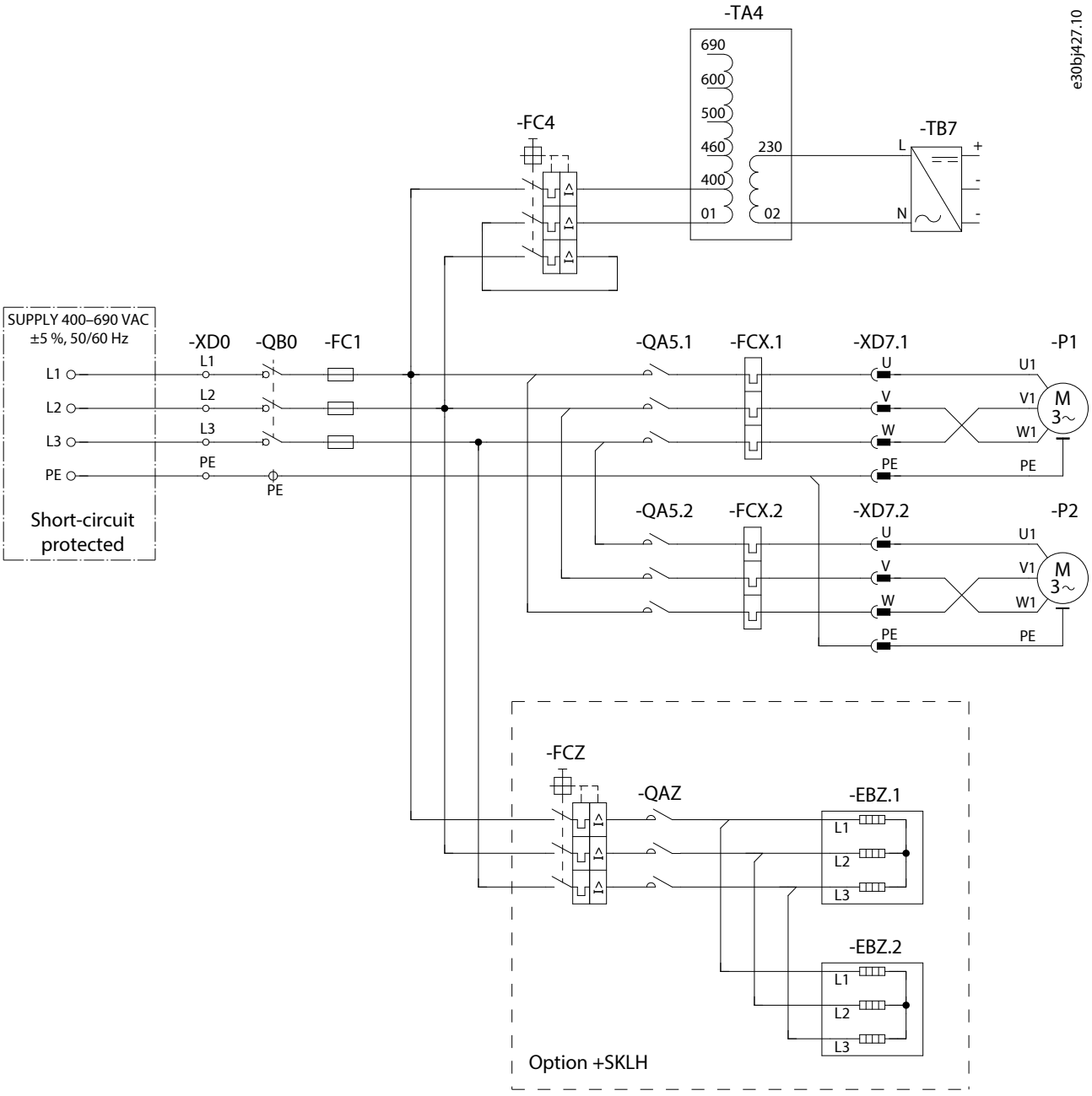

Figure 54: Wiring Diagram for Dual-pump Cooling Module with Auxiliary Transformer

11.6.3 **Wiring Diagram, Single-pump Cooling Module with External Auxiliary Supply**

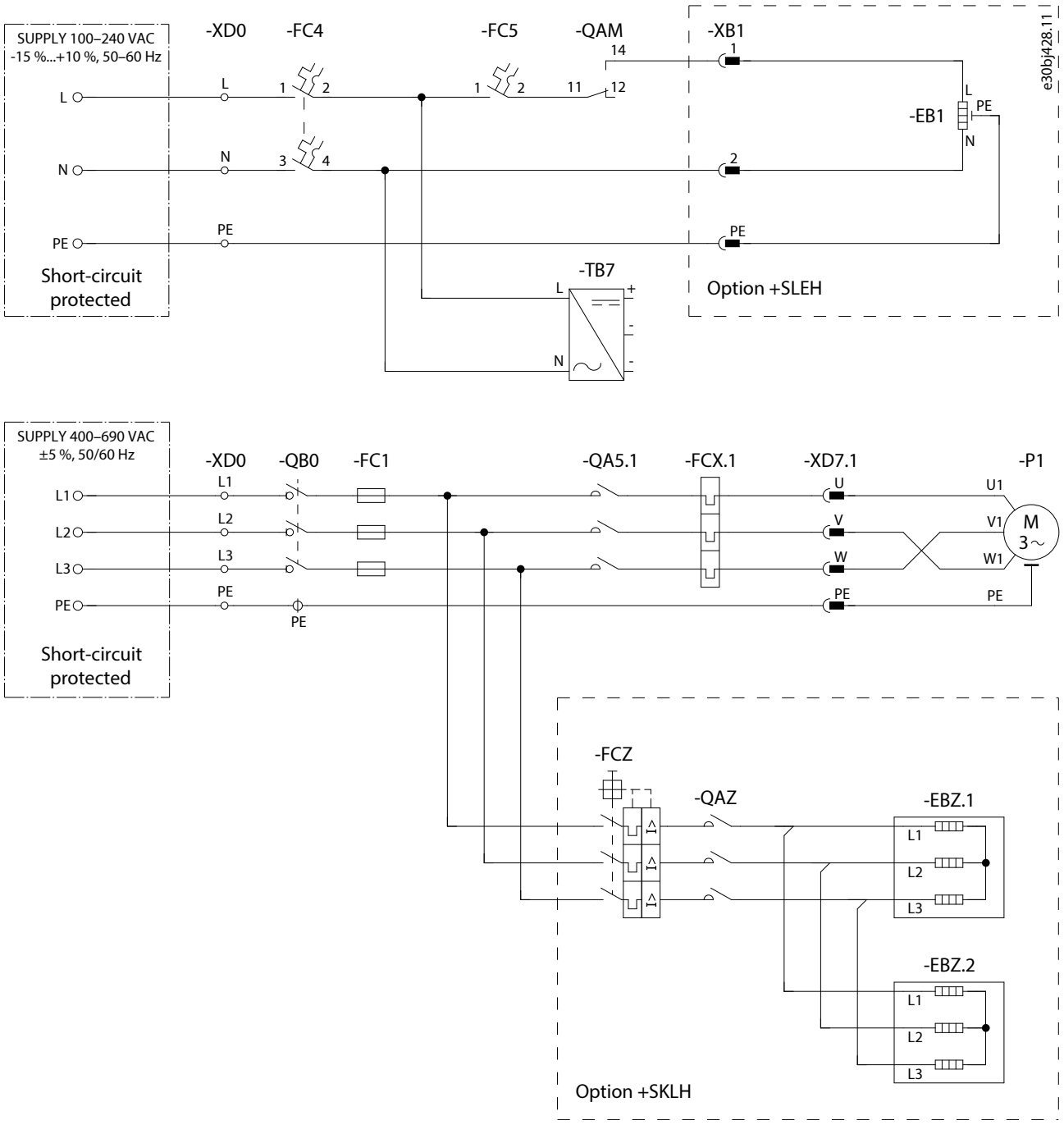

Figure 55: Wiring Diagram for Single-pump Cooling Module with External Auxiliary Supply

11.6.4 Wiring Diagram, Dual-pump Cooling Module with External Auxiliary Supply

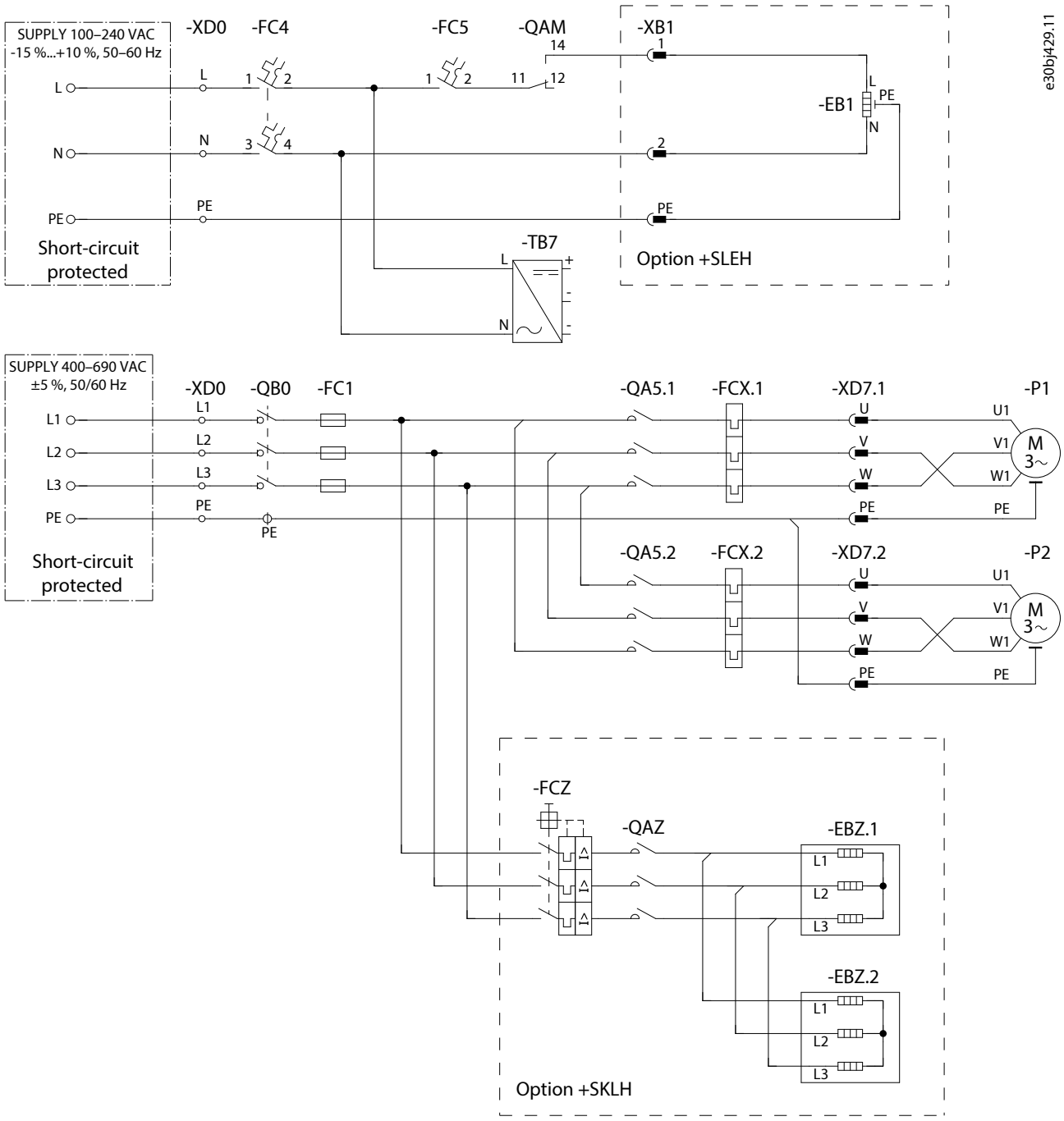

Figure 56: Wiring Diagram for Dual-pump Cooling Module with External Auxiliary Supply

11.7 Signal and Power Block Diagrams

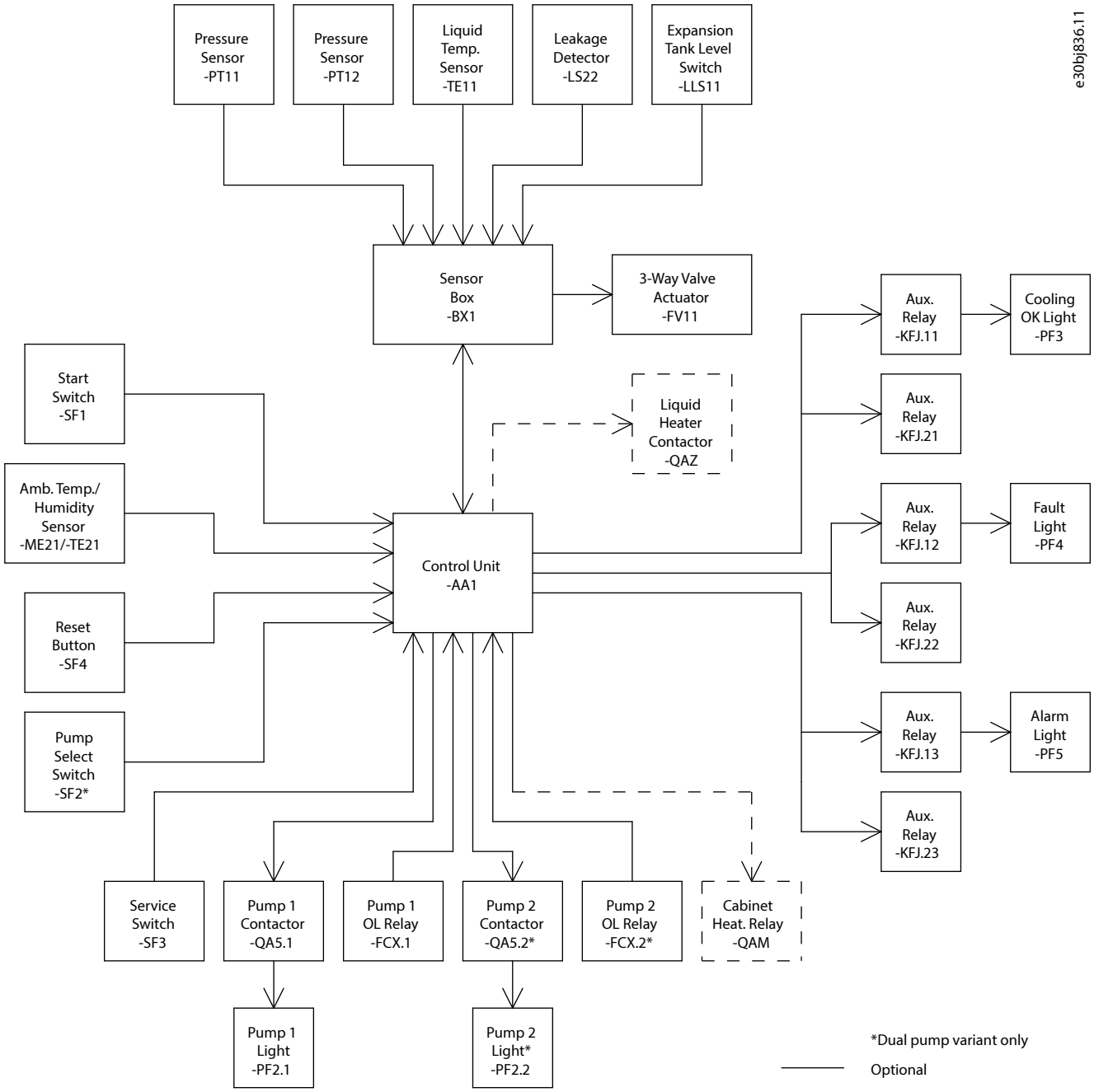

Figure 57: Signal Block Diagram

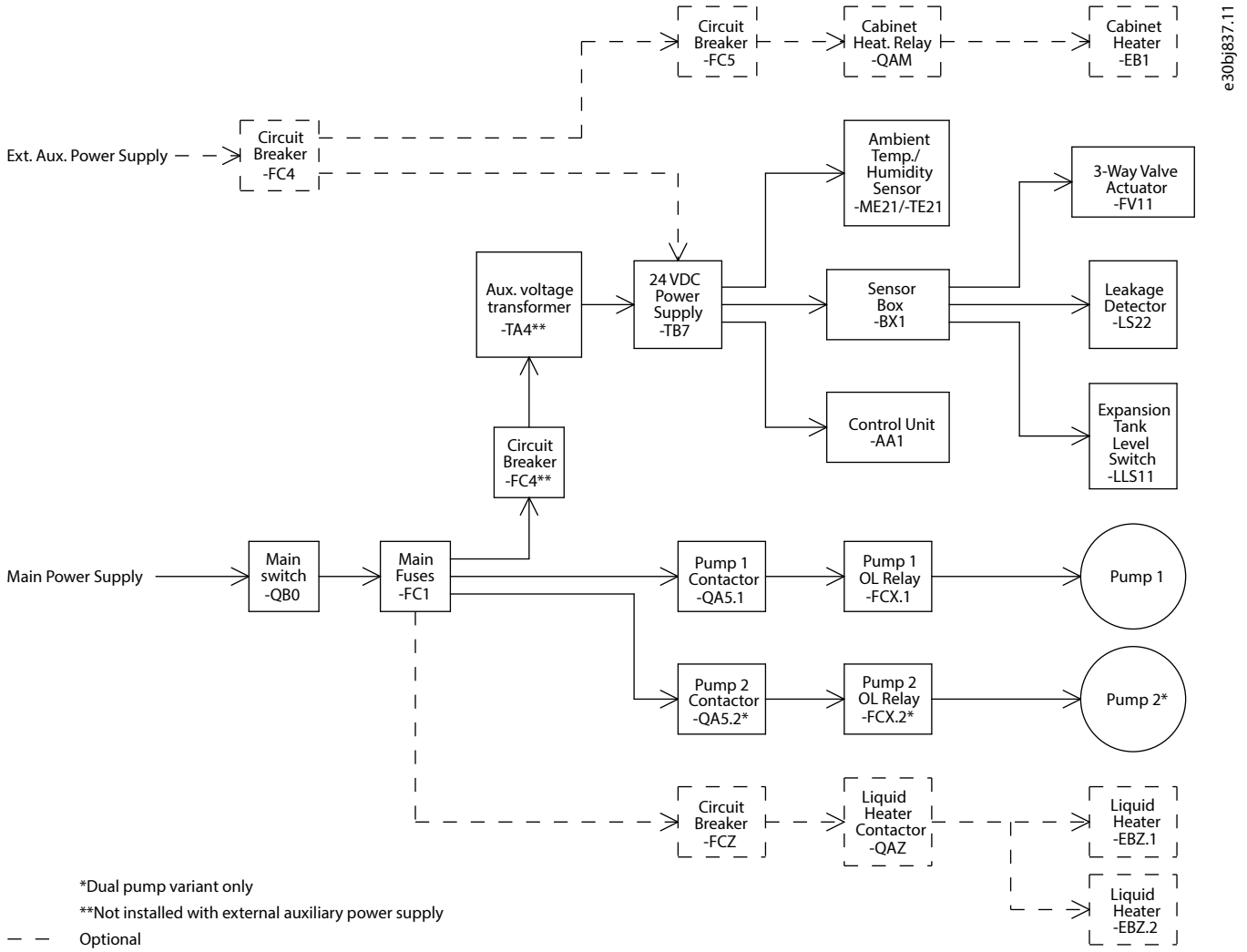

Figure 58: Power Block Diagram

11.8 Technical Data

11.8.1 Mains Connections

Table 23: Mains Connections

Item/function	Data
Input voltage U_{in}	3 x 380–415 V AC ±5%
	3 x 440–480 V AC ±5%
	3 x 500–525 V AC ±5%
	3 x 575–600 V AC ±5%
	3 x 660–690 V AC ±5%
Auxiliary input voltage U_{in}	1 x 110–240 V AC ±5% (required only with the option +SLEH cabinet heater)
Input frequency	50/60 Hz
Supply network	TN-S, TN-C, IT and TT

Table 23: Mains Connections (continued)

Item/function	Data
Maximum input power	9.1 kW
Short-circuit current (conditional)	50 kA (max gG fuse: 400 V/40 A, 690 V/25 A)
Overvoltage category	Class III according to IEC/EN 61800-5-1

11.8.2 Cooling Characteristics

Table 24: Cooling Characteristics

Type	Number of pumps	Cooling power [kW]	Drive circuit coolant flow [l/min]	External circuit minimum coolant flow [l/min](1)	Drive circuit coolant volume [l]	External circuit coolant volume [l]
iC7-60SLLQxx-0076…	1	76	190	190	42	6
iC7-60SLLQxx-0076…	2	76	190	190	47	7
iC7-60SLLQxx-0152…	1	152	360	360	45	10
iC7-60SLLQxx-0152…	2	152	360	360	50	10

1) When the coolant temperature is a maximum of 38°C (100°F)

11.8.3 Liquid-cooling Specifications

Table 25: Liquid-cooling Specifications

Item/function	Data
Temperature of coolant Nominal (allowable)	External circuit: < +38 °C (-30...+55 °C) < 100 °F (-22...+131 °F)
	Drive circuit: +45 °C (-30...+55 °C) 113 °F (-22...+131 °F)
	Glycol to be used in coolant below 0 °C (+32 °F) Ice formation is not allowed.
System maximum pressure	External circuit: 1000 kPa
	Drive circuit: 600 kPa
Maximum supply pressure AC drive side	150 kPa at 360 l/min (152 kW single-pump), see 11.4.2 Supply Pressure of the 152 kW Single-pump Cooling Module. 150 kPa at 360 l/min (152 kW dual-pump), see 11.4.3 Supply Pressure of the 152 kW Dual-pump Cooling Module.
External circuit pressure drop	76 kW cooling module: 20 kPa at 190 l/min 152 kW cooling module: 25 kPa at 360 l/min

Table 25: Liquid-cooling Specifications (continued)

Item/function	Data
Allowed coolant	External circuit: purified water or good quality pure water, with inhibitor and glycol, according to 6.8 Coolant Quality in the External Circuit
	Drive circuit: purified (demineralized, deionized, or distilled) water with corrosion inhibitors, or a mixture of this type of water and glycol with corrosion inhibitors, according to 6.6 Coolant Quality in the Drive Circuit
Corrosion inhibitor	Drive circuit: Corrosion inhibitor required for long lifetime
Allowed materials in the AC drive cooling system	Aluminum. Stainless steel AISI316. Plastic (PVC not allowed). Elastomers (EPDM, NBR, FDM).
Pipe connections	External circuit: DN50 pipe with Axilock-S coupling, DIN/ANSI flanges[1]
	Drive circuit: DN50 pipe with Axilock-S coupling, DIN/ANSI flanges[1]

1) Axilock-S couplings are included in the delivery.

11.8.4 Environmental Conditions

Table 26: Environmental Conditions

Item/function	Data
Protection rating	IP23/IP54
Ambient operating temperature (limited performance)	Ambient temperature: –15 °C (–30 °C) (no frost) … +55 °C Ambient temperature: 5 °F (–22 °F) (no frost) … +131 °F Surrounding temperature: –30 °C (no frost) … +60 °C Surrounding temperature: –22 °F (no frost) … +140 °F
Storage and transportation temperature	–40…+70 °C (-40...+158 °F), glycol to be used in liquid under 0 °C (32 °F) and no ice formation
Relative humidity	5–96% RH, no dripping water or condensation
Pollution degree	PD3
Altitude	–
	–
Vibration (IEC60068-2-6)	Displacement amplitude 1 mm (0.04 in) (peak) at 2…13.2 Hz Maximum acceleration amplitude 0.7 G at 13.2…100 Hz with maximum amplification of 5
Shock (IEC60068-2-27)	Maximum 15 G, 11 ms
Sound pressure level	55 dB(A)

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