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MD880LC-80 Series Integrated DC Chopper Kit

Hardware Guide

Industrial Automation | Intelligent Elevator | New Energy Vehicle | Industrial Robot | Rail Transit

Data code PS00011014A00

Preface

Introduction

The MD880LC-80 series from Inovance is a liquid-cooled integrated DC chopper kit designed for high power density, compact structure, and reliability. It offers wide voltage regulation range, high accuracy, fast dynamic response, and programmable power output. Operating at 690 V and a power range of 600 kW to 1140 kW, it is often used in battery charging/discharging controllers, power conversion systems, DC test power supplies and other applications.

This guide describes the system composition, technical specifications, installation dimensions, space requirements, wiring, routine maintenance, and parts replacement.

More Information

Name	Data code	Description
MD880-80 Series Integrated DC Chopper Kit Software Guide	PS00011015	It includes information on commissioning tools, quick commissioning guide, function module description, parameter description, connectors, and troubleshooting.

Revision History

Date	Version	Description
December 2023	A00	First release

Access to the Guide

This guide is not delivered with the product. You can obtain the PDF version in the following ways:

- Visit *www.inovance.com*, go to Support > Download, search by keyword, and then download the PDF file.
- Scan the QR code on the product with your smart phone.

Warranty

Inovance provides warranty service within the warranty period (as specified in your order) for any fault or damage that is not caused by improper operation of the user. You will be charged for any repair work after the warranty period expires.

Within the warranty period,maintenance fee will be charged for the following damage:

- Damage caused by operations not following the instructions in the user guide
- Damage caused by fire, flood, or abnormal voltage
- Damage caused by unintended use of the product

- Damage caused by use beyond the specified scope of application of the product
- Damage or secondary damage caused by force majeure (natural disaster, earthquake, and lightning strike)

The maintenance fee is charged according to the latest Price List of Inovance. If otherwise agreed upon, the terms and conditions in the agreement shall prevail.

For details, see the Product Warranty Card.

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Safety Instructions

Safety Disclaimer

- This chapter presents essential safety instructions for a proper use of the equipment. Before operating the equipment, read through the guide and comprehend all the safety instructions. Failure to comply with the safety instructions may result in death, severe personal injuries, or equipment damage.
- "CAUTION", "WARNING", and "DANGER" items in the guide only indicate some of the precautions that need to be followed; they just supplement the safety precautions.
- Use this equipment according to the designated environment requirements. Damage caused by improper use is not covered by warranty.
- Inovance shall take no responsibility for any personal injuries or property damage caused by improper use.

Safety Levels and Definitions



Indicates that failure to comply with the notice will result in death or severe personal injuries.



Indicates that failure to comply with the notice may result in death or severe personal injuries.



Indicates that failure to comply with the notice may result in minor or moderate personal injuries or equipment damage.

Safety Precautions

- Product illustrations in the user guide are sometimes shown without covers or protective guards. Remember to install the covers or protective guards as specified first, and then perform operations in accordance with the instructions.
- Product illustrations in this guide are for reference only. Actual products may vary.

Unpacking
 • Do not install the equipment if you find damage, rust, or signs of use on the equipment or accessories upon unpacking. • Do not install the equipment if you find water seepage or missing or damaged components upon unpacking. • Do not install the equipment if you find the packing list does not conform to the equipment you received.



- Check whether the packing is intact and whether there is damage, water seepage, damp, and deformation.
- Unpack the package by following the unpacking sequence. Do not strike the package violently.
- Check whether there is damage, rust, or injuries on the surface of the equipment and equipment accessories before unpacking.
- Check whether the package contents are consistent with the packing list before unpacking.

Storage and Transportation



- Use professional loading and unloading equipment to carry large-scale or heavy equipment. Failure to comply may result in personal injuries or equipment damage.
- Before hoisting the equipment, ensure the equipment components such as the front cover and terminal blocks are secured firmly with screws. Loosely-connected components may fall off and result in personal injuries or equipment damage.
- Never stand or stay below the equipment when the equipment is being hoisted by the hoisting equipment.
- When hoisting the equipment with a steel rope, ensure the equipment is hoisted at a constant speed without suffering from vibration or shock. Do not turn the equipment over or let the equipment stay hanging in the air. Failure to comply may result in personal injuries or equipment damage.



- Handle the equipment with care during transportation and mind your steps to prevent personal injuries or equipment damage.
- When carrying the equipment with bare hands, hold the equipment casing firmly with care to prevent parts from falling. Failure to comply may result in personal injuries.
- Store and transport the equipment based on the storage and transportation requirements. Failure to comply will result in equipment damage.
- Avoid storing or transporting the equipment in environments with water splash, rain, direct sunlight, strong electric field, strong magnetic field, and strong vibration.
- Avoid storing the equipment for more than three months. Long-term storage requires stricter protection and necessary inspections.
- Pack the equipment strictly before transportation. Use a sealed box for long-distance transportation.
- Never transport the equipment with other equipment or materials that may harm or have negative impacts on this equipment.

Installation



- Installation must be performed by only experienced personnel who have been trained with necessary electrical information.



- Read through the guide and safety instructions before installation.
- Do not install this equipment in places with strong electric or magnetic fields.
- Before installation, check that the mechanical strength of the installation site can bear the weight of the equipment. Failure to comply will result in mechanical hazards.
- Do not wear loose clothes or accessories during installation. Failure to comply may result in an electric shock.
- When installing the equipment in a closed environment (such as a cabinet or casing), use a cooling device (such as a fan or air conditioner) to cool the environment down to the required temperature. Failure to comply may result in equipment over-temperature or a fire.
- Do not retrofit the equipment.
- Do not fiddle with the bolts used to fix equipment components or the bolts marked in red.
- When the equipment is installed in a cabinet or final assembly, a fireproof enclosure providing both electrical and mechanical protections must be provided. The IP rating must meet IEC standards and local laws and regulations.
- Before installing equipments with strong electromagnetic interference, such as a transformer, install a shielding equipment for the equipment to prevent malfunction.
- Install the equipment onto an incombustible object such as a metal. Keep the equipment away from combustible objects. Failure to comply will result in a fire.



- Cover the top of the equipment with a piece of cloth or paper during installation. This is to prevent unwanted objects such as metal chippings, oil, and water from falling into the equipment and causing faults. After installation, remove the cloth or paper on the top of the equipment to prevent over-temperature caused by poor ventilation due to blocked ventilation holes.
- Resonance may occur when the equipment operating at a constant speed executes variable speed operations. In this case, install the vibration-proof rubber under the motor frame or use the vibration suppression function to reduce resonance.

Wiring



- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Before wiring, cut off all the power supplies of the equipment. and wait for at least the time designated on the equipment warning label before further operations because residual voltage still exists after power-off. After waiting for the designated time, measure the DC voltage in the main circuit to ensure the DC voltage is within the safe voltage range. Failure to comply will result in an electric shock.
- Do not perform wiring, remove the equipment cover, or touch the circuit board with power ON. Failure to comply will result in an electric shock.
- Check that the equipment is grounded properly. Failure to comply can result in electric shock.



- Do not connect the input power supply to the output end of the equipment. Failure to comply can result in equipment damage or even a fire.
- When connecting a drive to the motor, check that the phase sequences of the drive and motor terminals are consistent to prevent reverse motor rotation.
- Cables used for wiring must meet cross sectional area and shielding requirements. The shield of the cable must be reliably grounded at one end.
- Fix the terminal screws with the tightening torque specified in the user guide. Improper tightening torque may overheat or damage the connecting part, resulting in a fire.
- After wiring is done, check that all cables are connected properly and no screws, washers or exposed cables are left inside the equipment. Failure to comply may result in an electric shock or equipment damage.



- Follow the proper electrostatic discharge (ESD) procedure and wear an anti-static wrist strap to perform wiring. Failure to comply may result in damage to the equipment or to the internal circuit of the product.
- Use shielded twisted pairs for the control circuit. Connect the shield to the grounding terminal of the equipment for grounding purpose. Failure to comply will result in equipment malfunction.

Power-on



- Before power-on, check that the equipment is installed and wired properly and the motor can be restarted.
- Before power-on, make sure that the power supply meets product requirements to prevent product damage or even a fire.
- After power-on, do not open the cabinet door or protective cover of the equipment, touch any terminal, or disassemble any unit or component of the equipment. Failure to comply will result in an electric shock.



- After wiring and parameter setting, perform a test run to confirm that the equipment can operate safely. Otherwise it may cause personal injury or equipment damage.
- Before power-on, check that the rated voltage of the equipment is consistent with that of the power supply. Failure to comply may result in a fire.
- Before power-on, check that no one is near the equipment, motor, or machine. Failure to comply may result in death or personal injuries.

Operation



- The equipment must be operated only by professionals. Failure to comply will result in personal injuries or even death.
- Do not touch any connecting terminals or disassemble any unit or component of the equipment during operation. Failure to comply will result in an electric shock.



- Do not touch the equipment casing, fan, or resistor with bare hands to feel the temperature. Failure to comply may result in personal injuries.
- Prevent metal or other objects from falling into the equipment during operation. Failure to comply may result in a fire or equipment damage.

Maintenance



- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not maintain the equipment with power ON. Failure to comply will result in an electric shock.
- Before maintenance, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.
- In case of a permanent magnet motor, do not touch the motor terminals immediately after power-off because the motor terminals will generate induced voltage during rotation even after the equipment power supply is off. Failure to comply will result in an electric shock.



- Perform routine and periodic inspection and maintenance on the equipment according to maintenance requirements and keep a maintenance record.

Repair



- Equipment installation, wiring, maintenance, inspection, or parts replacement must be performed only by professionals.
- Do not repair the equipment with power ON. Failure to comply will result in an electric shock.
- Before inspection and repair, cut off all the power supplies of the equipment and wait for at least the time designated on the equipment warning label.



- Submit the repair request according to the warranty agreement.
- When the fuse is blown or the circuit breaker or earth leakage current breaker (ELCB) trips, wait for at least the time designated on the equipment warning label before power-on or further operations. Failure to comply may result in death, personal injuries or equipment damage.
- When the equipment is faulty or damaged, the troubleshooting and repair work must be performed by professionals that follow the repair instructions, with repair records kept properly.
- Replace quick-wear parts of the equipment according to the replacement instructions.
- Do not use damaged equipment. Failure to comply may result in death, personal injuries, or severe equipment damage.
- After the equipment is replaced, check the wiring and set parameters again.

Disposal
WARNING • Dispose of retired equipment in accordance with local regulations and standards. Failure to comply may result in property damage, personal injuries, or even death. • Recycle retired equipment by observing industry waste disposal standards to avoid environmental pollution.

Safety label

For safe equipment operation and maintenance, comply with the safety labels on the equipment. Do not damage or remove the safety labels. The following table describes the meaning of the safety labels.

Safety label	Description
	• Read through the safety instructions before operating the equipment. Failure to comply may result in death, personal injuries, or equipment damage. • Do not touch the terminals or remove the cover with power ON or within 10 min after power-off. Failure to comply will result in an electric shock.

1 Product Information

1.1 Model and Nameplate

MD880LC - 80M - 0600 - 7
① ② ③ ④

Figure 1-1 Model description

① **Product platform** MD880LC: MD880 series liquid-cooled AC drive	③ **Rated current** 0600: 600 A
② **Product type** 80M: DC-DC module	④ **Voltage class** 7: 690 VAC

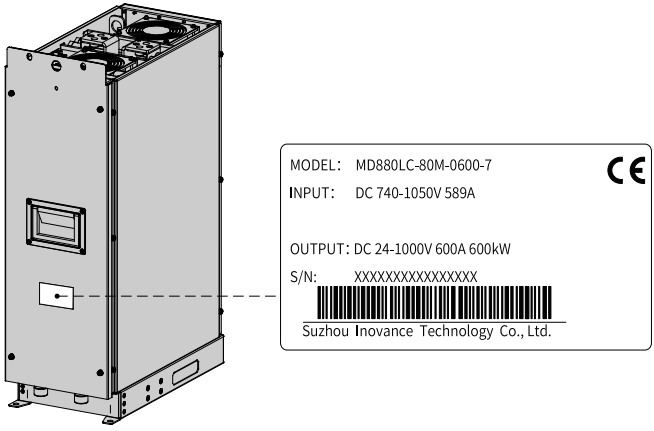


Figure 1-2 Nameplate

1.2 Technical Data

Table 1–1 Technical data

Item		Technical data
Basics	Voltage at the high-voltage side	690 V system: 740 VDC to 1050 VDC
	Voltage at the low-voltage side	690 V system: 24 VDC to 1000 VDC
	Overload capacity	Heavy overload: 150% for 1 minute every 5 minutes Fast overload: 200% for 10s every 1 minute
	Operating efficiency	⩾ 97%
	Response time	⩽ 5 ms (when the power supply voltage varies within the range of 10% to 90% of its rated voltage)
	Switching time	⩽ 10ms (when the power supply voltage drops to –90% or rises to +90% of the rated voltage)
	Regenerative power	100%
	Voltage accuracy	⩽ 0.1%Fs at the low-voltage side ⩽ 1%Fs at the high-voltage side
	Ripple of voltage (Vrms)	⩽ 0.2%Fs at the low-voltage side ⩽ 0.5%Fs at the high-voltage side
	Current accuracy	⩽ 1%Fs
Liquid-cooled system	Coolant	Pure water or mixture of pure water and ethylene glycol combined with preservative. For use in ambient temperature below 5°C, antifreeze must be added
	Maximum working pressure (Bar)	6 bar
	System circulated volume and flow rate	100% water: ⩾ 16 L/min 80% water and 20% ethylene glycol: ⩾ 18 L/min 60% water and 40% ethylene glycol: ⩾ 21 L/min
Mechanical data	Vibration resistance	In compliance with GB/T4798.3- Mechanical conditions Frequency range: 2 Hz to 9 Hz; Displacement: 3 mm Frequency range: 9 Hz to 200 Hz; Acceleration rate: 9.8 m/s^2 (1 g) Shock resistance of 100 m/s^2, 11 ms
	Safety performance	In compliance with EN 61800-5-1
	Cooling mode	Liquid
Protective functions	Protective functions	Short circuit, overcurrent, overvoltage, undervoltage, overtemperature, and so on

Item		Technical data
Environment	Place of service	Indoors and free from direct sunlight, dusts, corrosive gases, combustible gases, oil mists, vapors, water drips, and salty elements
	Altitude	Below 1000 m; derated by 1% per 100 m increase when the altitude is above 1000 m; Maximum altitude: 4000 m
	Operating temperature	–10°C to +50°C; derated by 2% for every additional 1°C when the temperature is over 40°C; Maximum temperature: 50°C
	Module noise	⩽ 60 dB
	Ambient humidity	5% to 95% (without condensation)
	Storage temperature	–40°C to +70°C
	Storage humidity	5% to 95% (without condensation)
	Pollution degree	PD2
	Overvoltage level	OVCIII
	IP rating	IP00

Note

- Due to its basic topology characteristics, the voltage at the high-voltage side of the chopper must be at least 50 V higher than the voltage at the low-voltage side.
- Heavy overload and fast overload conditions are based on an appropriate reference current. For details, see *"1.10 Overload Capacity" on page 25*.
- For the ultra-capacitor and battery charging and discharging applications, the chopper unit requires no additional configuration.
- For use with the test bench, the chopper unit requires the additional capacitor box to deliver the desired performance.

1.3 Specifications of the DC Chopper Module

Table 1–2 Specifications of the DC chopper module

Structure	Model	Rated current at high-voltage side (A)	Output current at low-voltage side (rated voltage 1000 V)					
			No overload use		Fast overload use		Heavy-duty use	
			Current (A)	Power (kW)	Current (A)	Power (kW)	Current (A)	Power (kW)
H7	MD880LC-80M-0600-7	589	600	600	450	450	510	510
H7 x 2	MD880LC-80M-1140-7	1140	1140	1140	855	855	969	969

1.4 Hardware Description

1.4.1 Working Principle

The integrated DC chopper kit is a DC-DC converter system, mainly composed of the power module and filter module, and combined with necessary voltage and current detection loop, main controller (HCU) and card accessory. The DC chopper converts fixed DC input voltage into adjustable DC output voltage to power various loads such as DC chopper, battery, super capacitor and other loads. It can also feed back the energy generated at the load side to the DC bus.

Regulating the output voltage within a specific range, the integrated DC chopper kit provides stable and adjustable DC voltage to the load.

The integrated DC chopper kit can be used in different power distribution systems, including TN, TT, and IT.

1.4.2 Basic Topology

The following figure shows the basic topology of the MD880LC-80D integrated DC chopper kit.

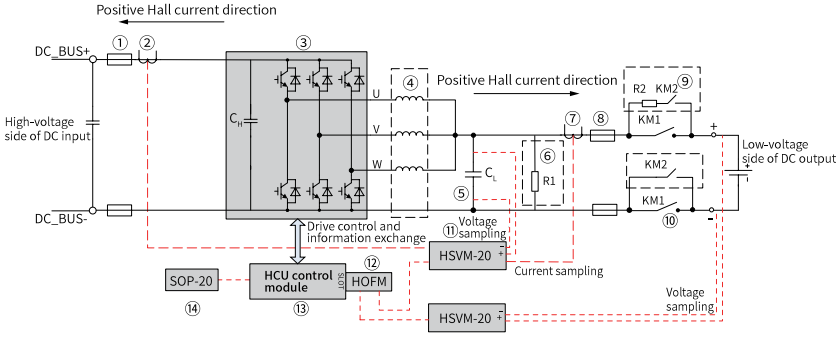


Figure 1-3 Basic topology of the integrated MD880LC-80D DC chopper kit

No.	Description	Quantity	Type	Description
①	DC fuse at the high-voltage side	-	User-defined	Short circuit protection
②	High-voltage side current sampling Hall	1	Standard	Enabling load current feedforward at the high-voltage side to improve dynamic response performance, configurable by the user
③	MD880LC-80M DC chopper module	1	Standard	MD880LC-80D chopper power module
④	DC reactor	3	Standard	-

No.	Description	Quantity	Type	Description
⑤	Metal film capacitor	2	Standard	-
⑥	Discharge resistor	-	User-defined	Releasing the energy stored in the capacitor in the stop state
⑦	Low-voltage side current sampling Hall	1	Standard	Enabling load current feedforward at the low-voltage side to improve dynamic response performance, configurable by the user
⑧	DC fuse at the low-voltage side	-	User-defined	Short circuit protection
⑨	Pre-charge circuit	-	Standard	Pre-charge (including pre-charge contactor and pre-charge resistor) for device switch-on, configurable by the user
⑩	Output main contactor	1	User-defined	Configurable by the user
⑪	HSVM-20 voltage and current detection module	2	Standard	An additional HSVM-20 module is needed when the load is a battery to ensure safe switch-on. The HSVM-20 detects the low-voltage side during pre-charge.
⑫	HOFM-30 optical fiber expansion module	1	Standard	Inserted in the SLOT of HCU and communicating with the HSVM-20 module through optical fiber
⑬	HCU-80	1	Standard	Controller of the DC chopper device
⑭	SOP-20-880 + SOP-20-MP-IP54	1	Standard	Smart operating panel and dock, connected to HCU through network cable

Note

- Avoid frequent start/stop of the load pre-charge circuit to prevent damage to the pre-charge resistor. Wait at least 3 minutes between pre-charges.
- Add a discharge resistor when the load's withstand voltage is low to protect the device. Choose the resistance value and power rating carefully to avoid burning out the resistor.
- The topological characteristics of a DC chopper result in the DC input voltage being naturally higher than the output voltage. Therefore, the DC input is typically defined as the high-voltage side and the DC output as the low-voltage side.
- The DC chopper device is a two-way system, and the direction of positive and negative currents must be specified. Current from high voltage input to low voltage output is defined as positive (represented by positive numbers), while current from low voltage output to high voltage input is defined as negative (represented by negative numbers). This helps prevent confusion and accidents.
- "User-defined" means that the device needs to be selected by the user based on specific requirements, while "Standard" means it comes with the DC chopper (The 80D DC chopper kit is composed of "Standard" devices). For no special requirements, select the basic DC-DC system composed of standard parts. However, for special needs, see the additional function description in the preceding table to determine which user-defined options are required.
- When two parallel chopper modules are used, you need to select an additional HPCU module.

1.4.3 Output Current Feature

The MD880LC-80 series DC chopper module is capable of delivering its maximum rated current continuously across the entire output voltage range, without derating.

1.4.4 Filter

The LC filter is used and the following figure shows details.

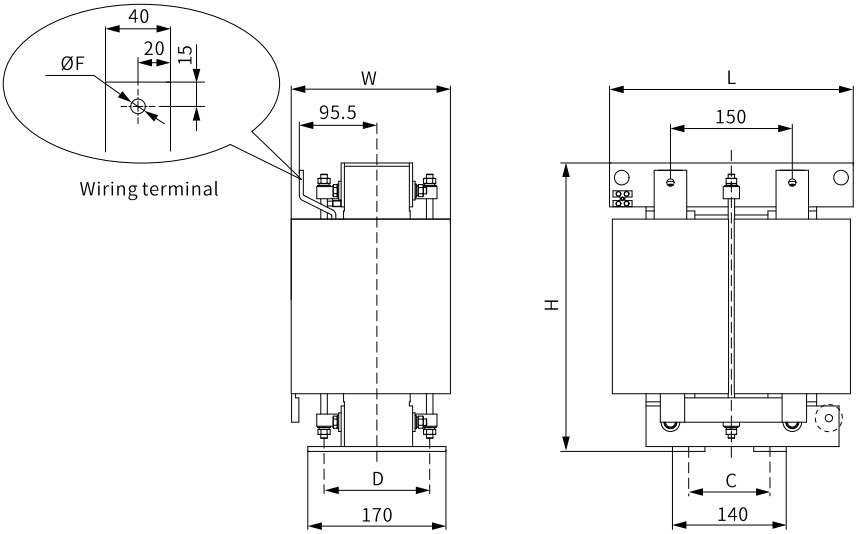


Figure 1-4 Filter reactor (unit: mm)

The following table shows specifications of standard chopper filters.

Table 1–3 Specifications of filter reactors

Model	Single-phase reactor rated current (A)	Heat dissipation	Max. reactor size L x W x H (mm)	Reactor mounting hole-C x D (mm)	Reactor wiring terminal hole ØF	Product weight (kg)	Loss (W)
MD880LC-80D-0600-7	200	Natural ventilation	300 x 195 x 355	4-Ø12-100 x 130	Ø11	52	⩽ 1500

Note

- The MD880LC-80D DC chopper comes with three DC reactors as standard.
- At the ambient temperature of 50°C, the reactor still meets the thermal requirement of a temperature rise of no more than 110K.
- The preceding table lists the DC reactor dimensions and weight and provides the total losses of the three reactors.

Table 1–4 Specifications of filter capacitors

Model	Capacitor diameter (mm)	Capacitor height (mm)	Capacitor quantity	Wiring method	Connection
MD880LC-80D-0600-7	116	228.5	2	M6x8 bolt	Parallel

Note

The filter capacitor has an M12 screw at its bottom for securing it in position. If the equipment will be operating in a vibration-prone environment, it is essential to incorporate a capacitor clamp or bracket for added support when designing the cabinet.

1.5 Structural Layout and Outline Dimensions

Overview

The handle on the front panel allows easy push-in and withdrawal of the module. The control room is inside the module covered by the blanking plate on the right side, the AC output bus terminal at the bottom, and the positive and negative bus terminals at the top.

External Power Supply

The external 24 VDC/2 A power supply can be used to power the control system for commissioning. After the main power is established, the chopper module relies on the internal auxiliary power supply, and the 24 V power becomes redundant.

Structural Layout

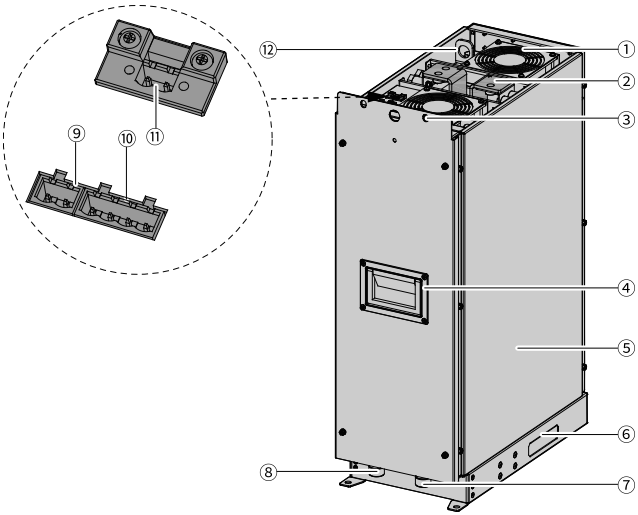


Figure 1-5 Layout 1 of the DC chopper module

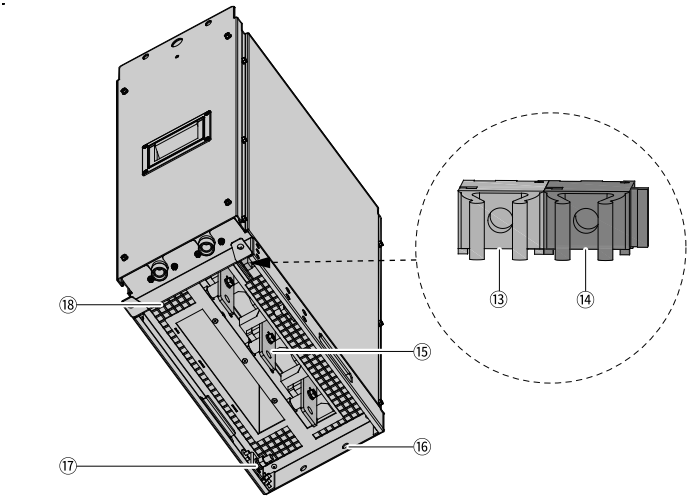


Figure 1-6 Layout 2 of the DC chopper module

No.	Description	No.	Description
①	Auxiliary fan	⑩	STO terminal
②	DC bus terminal	⑪	HCU redundant power output terminals
③	Upper fixed hole	⑫	Eye bolt

No.	Description	No.	Description
④	Front handle	⑬	VR optical fiber receiving terminal
⑤	Blanking plate covering control room	⑭	VT optical fiber transmitting terminal
⑥	Bottom handle	⑮	Positive electrode terminals U, V, W at the low-voltage side
⑦	Coolant outlet joint, M26 × 1.5 metric external thread, 24° cone	⑯	Back fixed hole (optional)
⑧	Coolant inlet joint, M26 × 1.5 metric external thread, 24° cone	⑰	Grounding terminal
⑨	Input terminal for 24 VDC external power supply	⑱	Bottom fixed hole

Outline Dimensions

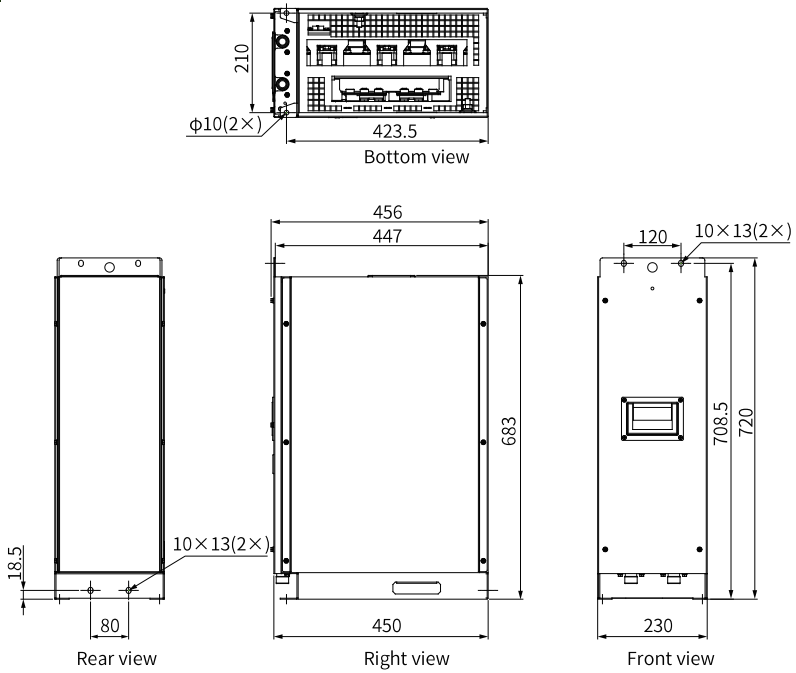


Figure 1-7 Outline dimensions of the DC chopper module (mm)

1.6 Outline Dimensions of the Hall Sensor Assembly

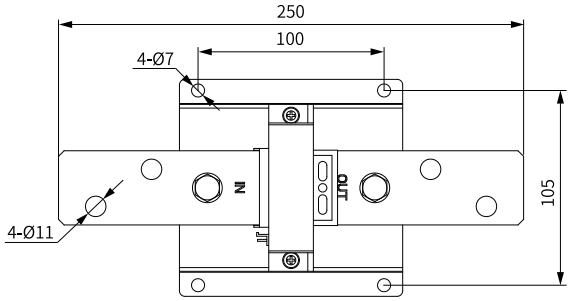


Figure 1-8 Outline dimensions of the Hall sensor HA2 assembly (unit: mm)

Table 1–5 Hall sensor specification

Single-phase reactor Hall sensor	Model
HA2	MD880LC-80D-0600-7

Note

At the high-voltage side, if the Hall current flows out in the direction of the high-voltage side, it is considered positive. At the low-voltage side, if the Hall current flows out in the direction of the low-voltage side, it is also considered positive. See *"Figure 1–3 " on page 15*

1.7 Outline Dimensions of the Pre-charge Resistor

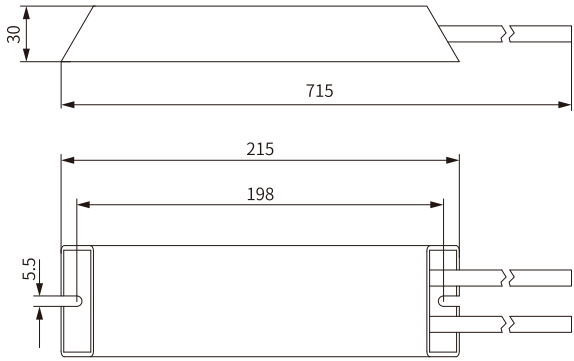


Figure 1-9 Outline dimensions of the pre-charge resistor (unit: mm)

Table 1–6 Recommended pre-charge resistor for different bus capacitances

Category	Capacitance (high-voltage side)	Quantity of resistors	Connection mode	Connection details	Equivalent resistance	Contactor
1 x Capacitance	8000	2	Series	Series	20.0	38 A
2 x Capacitance	16000	2	Series	Series	20.0	38 A
4 x Capacitance	32000	4	Series/parallel	Two in series, two in parallel	10.0	38 A
6 x Capacitance	48000	4	Series/parallel	Two in series, two in parallel	10.0	38 A
8 x Capacitance	64000	4	Series/parallel	Two in series, two in parallel	10.0	38 A
10 x Capacitance	80000	8	Series/parallel	Two in series, four in parallel	5.0	38 A
12 x Capacitance	96000	8	Series/parallel	Two in series, four in parallel	5.0	38 A

Note

- The pre-charge resistor is of 10 Ω, 300 W.
- The pre-charge contactor and pre-charge resistor are connected in parallel at the two terminals of the low-voltage DC output switch KM1. The feedback contact of the pre-charge contactor is connected to the HCU controller.

1.8 Outline Dimensions of the Air-to-Liquid Heat Exchanger

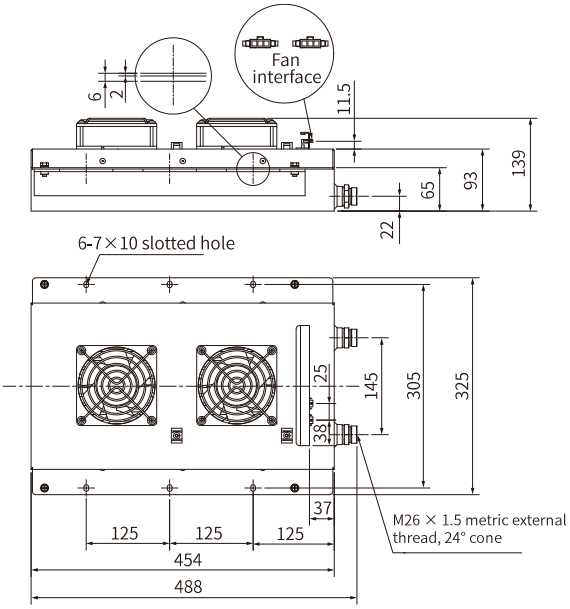


Figure 1-10 Outline dimensions of the air-to-liquid heat exchanger (unit: mm)

1.9 Derating

Ambient Temperature Derating

When the temperature is +45°C to +55°C, the rated output current must be derated by 0.5% for every 1°C increase. The output current can be calculated by multiplying the current value given in the rating table by the derating factor (k):

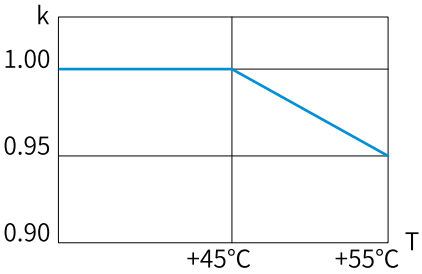


Figure 1-11 Ambient temperature derating

Coolant Derating

When the temperature is 40°C to 50°C, the rated output current must be derated by 2% for every 1°C increase. The output current can be calculated by multiplying the current value given in the rating table by the derating factor (k):

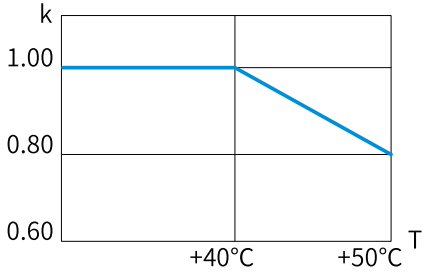


Figure 1-12 Coolant temperature derating

Altitude Derating

In altitudes 1000 m to 4000 m above sea level, the output current must be derated by 1% for every additional 100 m.

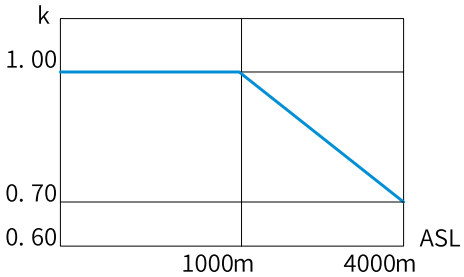


Figure 1-13 Altitude derating

1.10 Overload Capacity

For systems where overload may occur, a proper base load current is necessary for the MD880LC series DC chopper modules. The criterion for overload is that the drive is operated with its base load current before and after the overload occurs.

Curve in Fast Overload Mode

The fast overload (I_{fast}) is based on 200% base load current for 10s/60s.

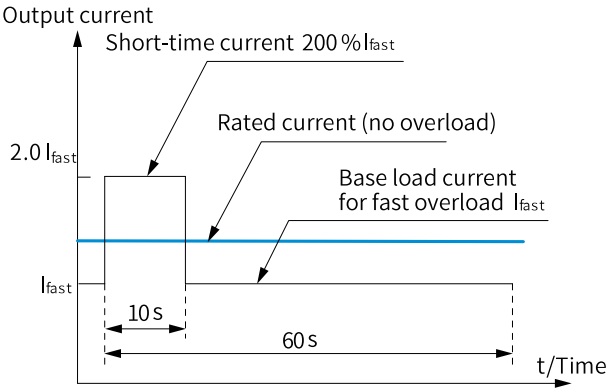


Figure 1-14 Curve in fast overload mode

Curve in Heavy Overload Mode

Heavy overload duty (I_H) is based on 150% base load current for 60s/300s.

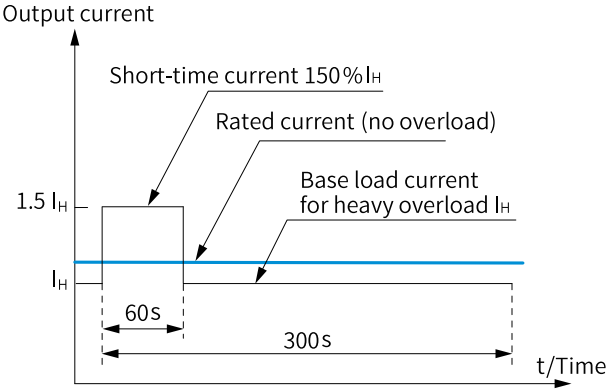


Figure 1-15 Curve in heavy overload mode

2 Mechanical Installation

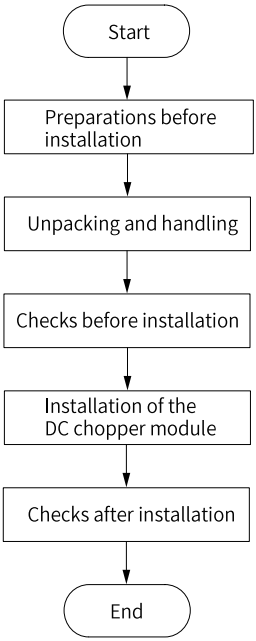


Figure 2-1 Mechanical installation flowchart

2.1 Safety Precautions

Danger

To ensure the DC chopper module is reliable and safe to use, it must be properly installed and operated by qualified personnel in accordance with all the warning notices and safety instructions. Personal injury or even death or material damage can result if these factors are not taken into account.

2.2 Mounting Hole Dimensions of the DC Chopper Module

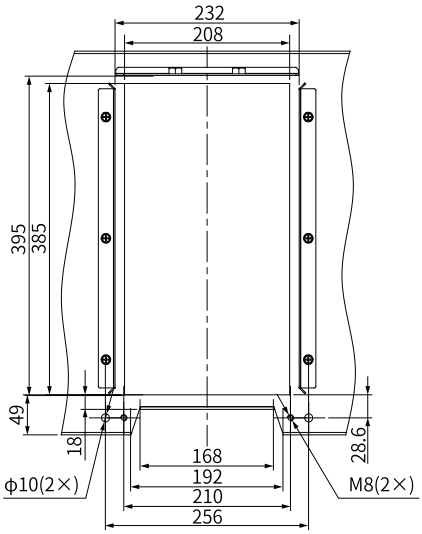


Figure 2-2 Mounting base hole dimensions of the DC chopper module (unit: mm)

2.3 Cabinet Design Instructions

2.3.1 Cabinet Design Precautions



- Ensure that the module is grounded properly through the fixing points on the mounting baseplate.
- Care should be taken when installing coolant pipes. Check for correct pipe installation and ensure no leaks occur.
- The cabinet must protect the module against contact and meet the requirements for dust and humidity.
- The cabinet frame must be sturdy enough to carry the weight of the drive components, control circuitry and other equipment installed in it.
- Make sure any cross-members or shelves on which components are mounted are properly grounded and the connecting surfaces left unpainted. Ensure that the module is grounded properly through the fixing points on the mounting baseplate.
- To facilitate installation and maintenance, it is recommended to leave enough space around the equipment to allow adequate cooling air flow, necessary clearance, and space required for holding cables and cable supports. Do not install the control board near the main circuit or high-temperature parts.
- If there is a risk of condensation in the cabinet, use a cabinet heater. Although the heater is mainly used to keep the air dry, it can also be used for heating in low temperatures. When placing the heater, follow the instructions provided by the manufacturer.

2.3.2 Cabinet EMC Requirements

- Use of only conductive EMC shield gaskets is not enough to achieve protective grounding. To ensure electrical safety of the parts, a low-frequency grounding structure is required. Follow local regulations to design protective grounding.
- The fewer and smaller the holes in the cabinet, the better the anti-interference and anti-attenuation performance. The maximum diameter of a hole in galvanic metal contact in the covering cabinet structure is 100 mm. Pay special attention to the cooling air inlet and outlet grids.
- Ensure high-frequency multi-point grounding in the cabinet to avoid voltage differences and to form structures that can shield against radiation. Use short and flat low-inductance copper braids to improve the performance of high-frequency grounding system. High-frequency one-point grounding cannot be used due to the long distances in the cabinet.

- The best galvanic connection between the steel panels is achieved by welding them together as no holes are necessary. If welding is not possible, do not paint the gap between panels and install special conductive EMC bars to realize galvanic connection. Generally, reliable conductive bars are made of flexible silicon with the surface covered by a metal mesh. Additional conductive gaskets are needed between metal surfaces to enhance the contact between them. The maximum distance between assembly screws is 100 mm.

2.3.3 Recommended Cabinet Layout

The following figure shows the structural details.

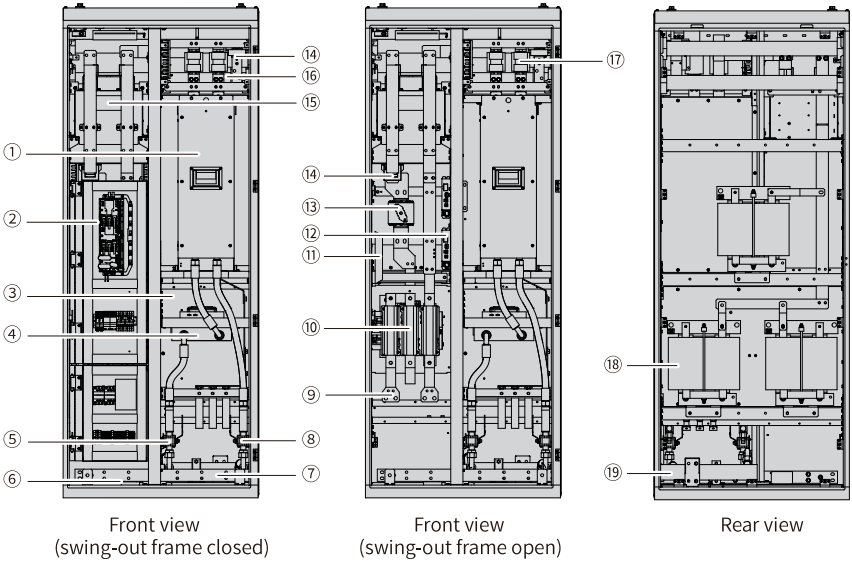


Figure 2-3 Structural layout of the DC chopper module

No.	Description	No.	Description
①	DC chopper module	⑪	Pre-charge resistor
②	Swing-out frame	⑫	HSVM-20
③	Air inlet duct	⑬	DC fuse at the low-voltage side
④	Air-to-liquid heat exchanger	⑭	Hall sensor assembly
⑤	Inlet valve	⑮	Capacitor
⑥	Heater	⑯	Busbar
⑦	PE busbar	⑰	DC fuse at the high-voltage side
⑧	Outlet valve	⑱	Filter reactor

No.	Description	No.	Description
⑨	Terminal block	⑲	Main pipe
⑩	Contactor	-	-

- At the upper part are installed DC bus and DC fuse.
- The control board is positioned near the front in the middle part of the cabinet, which can be switched on/off.
- The outlet reactor is installed near the back at the lower part of the cabinet. And the front part of the reactor is the copper busbar for wire connection.
- An air-to-liquid heat exchanger and a closed air duct are placed between the reactor and the chopper module to cool the air entering the chopper module.
- At the bottom near the back of the cabinet is the main coolant pipe.
- The main coolant inlet and outlet manifolds are placed on the left and right sides of the lower part of the cabinet.

2.4 Pre-Installation Preparation

2.4.1 Installation Environment Requirements

Item	Requirement
Installation location	Install the drive module in a place that meets the following requirements: • No direct sunlight • No oil dirt and dust • No water drops and humidity lower than 95% • No corrosive, inflammable, or explosive gas
Vibration	Install the equipment in a place not prone to vibration. For vibration isolation performance, see *"1.2 Technical Data" on page 13*.
Ambient temperature	Make sure the temperature is within the allowable range. See *"1.9 Derating" on page 24* for the derating coefficient.
Heat dissipation and ventilation	Install the chopper module on flame retardant materials with enough space around it to dissipate the heat generated during operation. Screw the module on the mounting support.
Protective enclosure	The product is intended for cabinet assembly for systems operating in the end-user environment. The end-user system shall provide enclosures for fireproof and electrical and mechanical protection in line with local laws and regulations and relevant IEC standards.

2.4.2 Mounting Clearance

The following figure shows the mounting space and clearance of the H7 DC chopper.

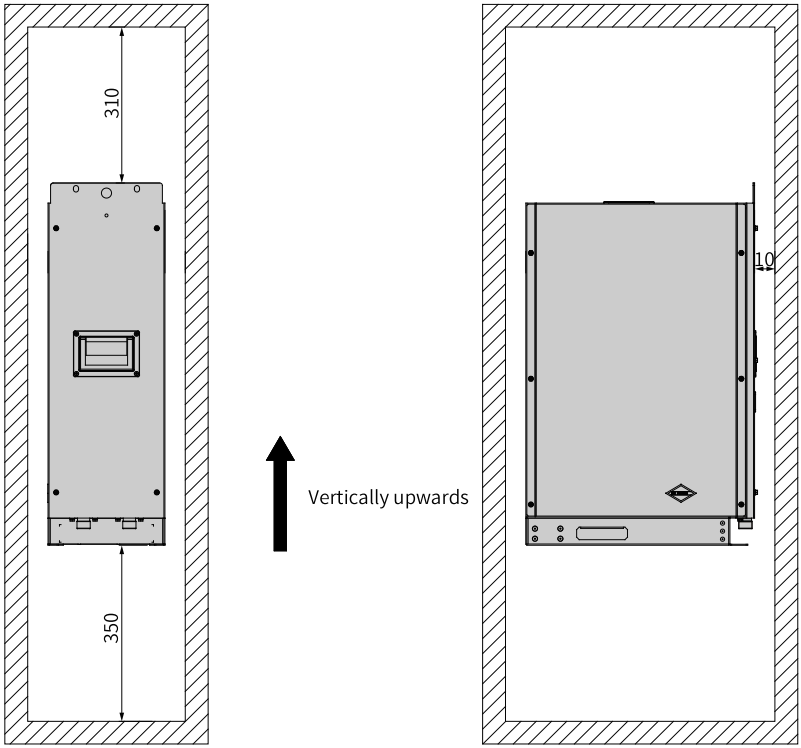


Figure 2-4 Clearance (unit: mm)

Note

The preceding dimensions are minimum dimensions.

2.4.3 Installation Tools

The following tools are used for moving, attaching and fastening the module.

- The slotted screw for signal wire connection.
- The open-end torque wrench with width across flats 32 for pipe connection.
- The crane, forklift, pallet truck and roller for moving the module around.
- The wrench or socket wrench with width across flats 16&18 for cable connection.
- The wrench or socket wrench with width across flats 13 for attaching the DC chopper module.

2.5 Unpacking and Handling

2.5.1 Unpacking

Unpacking Precautions

Caution

- Check the items carefully upon reception.
- Check that you have received all the items specified on the delivery note. Notify the shipping company of any missing components or damage. If necessary, contact Inovance office or the local agent for support.

Unpacking Steps

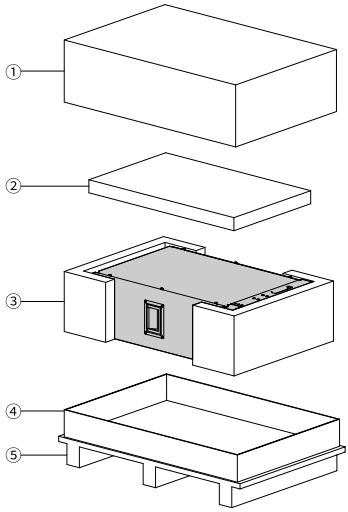


Figure 2-5 Transport package layout

No.	Description	No.	Description
①	Box cover	④	Plywood support
②	Wrapping sheet	⑤	Wooden pallet
③	DC chopper module	-	-

1. Cut off the plastic straps and lift off the box cover.
2. Remove all wrapping materials of the module.
3. Lift off the module and accessories.

4. Cut open the plastic wrapping of the module.
5. Check that there are no signs of damage.
6. Dispose of or recycle the packaging according to local regulations.

Unpacking Checklist

Check the following items after unpacking.

Table 2–1 Unpacking Checklist

No.	Item	Checked
1	Outside surface shall be free from scratches, dents or any sign of damage.	☐
2	All optional parts are included in the delivery.	☐
3	The nameplate is consistent with your order.	☐
4	The warning label is free from blurs, scratches or any sign of damage.	☐

2.5.2 Storage



- Try to store in the original Inovance packing crate.
- Do not expose the product to moisture, high temperature, or direct sunlight for a long time.
- If the storage temperature is lower than 0°C, drain the internal coolant.
- For long-term storage, appropriate measures (cover the product, for example) shall be taken to ensure the module is free from contamination and environmental factors.
- Store in a clean and dry place with a temperature kept between –40°C and +70°C and variation less than 1°C/min.

2.5.3 Handling

Handling Precautions

Caution

- All handling equipment must have a load capacity that is greater than the combined weight of the module.
- Lifting equipment needs to be sufficiently strong, stable and suitable for the MD880 series product.
- Move the transport package by a forklift to the installation site. Fix the chopper module to a wooden pallet when handling with a forklift. When lifting the crate with a crane, use a wooden pallet.

Handling Before Unpacking

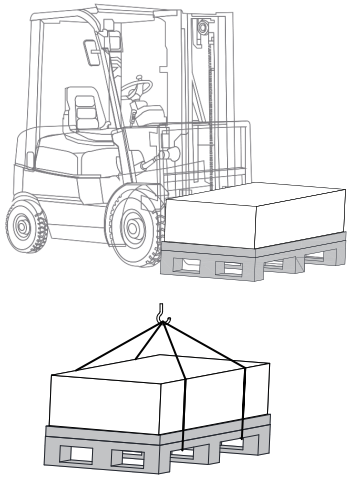


Figure 2-6 Handling before unpacking

Note

- The equipment overturns easily because it is heavy and has a high center of gravity. Never place it on the inclined plane with a tilt of over 5°.
- Place the equipment on a flat and firm ground that can bear its weight.
- Transport the equipment in the upright position as indicated on the packing box.

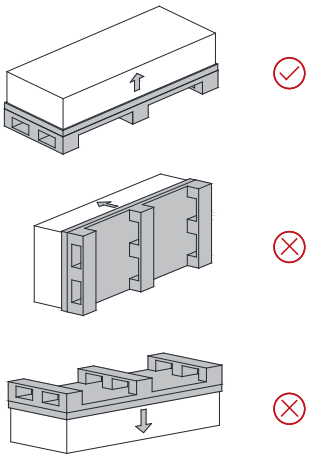


Figure 2-7 Transport mode

Handling After Unpacking

- The load-carrying capacity of the crane must be greater than the weight of the drive.
- Straighten the flat-lying equipment before further handling.
- Use eyelets on the top of the load for lifting and handling, with the lift height not higher than 0.3 m.

2.6 Checklist Before Installation

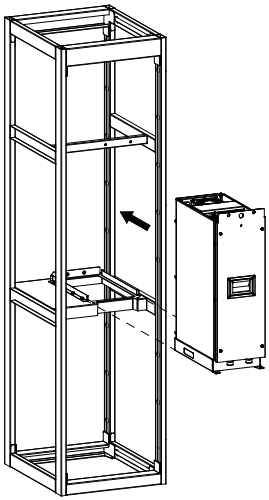
Check the items in the following table and confirm with a tick of the boxes.

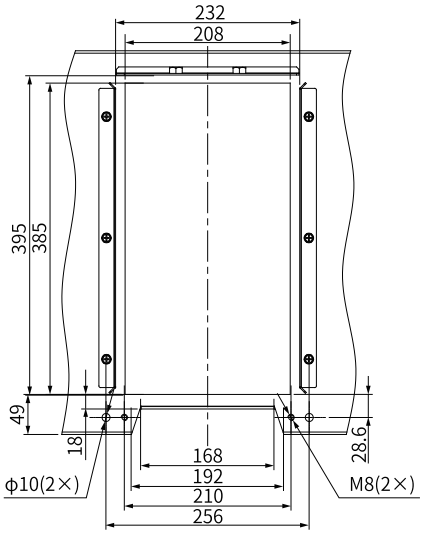
Table 2–2 Checklist before installation

No.	Item	Checked
1	The packing box is intact and dry.	☐
2	All the accessories are delivered.	☐
3	The module enclosure is free from peculiarities, such as deformation, flaking paint, cracks and signs of damp.	☐
4	The space around the module shall meet the minimum requirements for ventilation at both the inlet and outlet.	☐

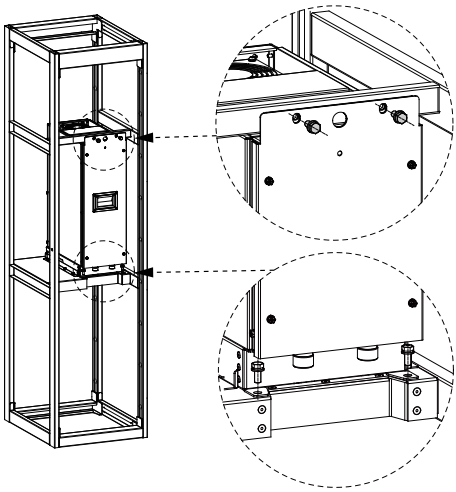
2.7 Installation of the DC Chopper Module

1. Push the module into the cabinet along the metal rail. See the right figure for the size (unit: mm) of the mounting baseplate.

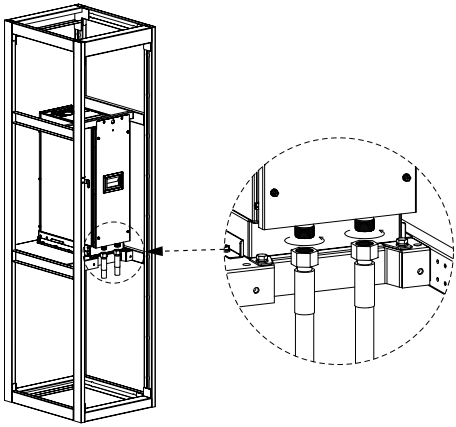




2. After putting the chopper in place, fasten the four anchor bolts (M8×20) at the top and bottom of the module.



3. It is recommended to install the incoming and outgoing pipes after the main circuit is electrically connected. The coolant outlet joint is of M26 x 1.5 metric external thread, 24° cone and an installation torque of 35 N·m.



2.8 Checklist After Installation

After installation, you must go through the following items to avoid equipment damage or property loss.

Table 2–3 Checklist after installation

No.	Item	Checked
1	Cabinet shrouds are in place and doors are closed.	☐
2	The chopper module is fastened properly to the cabinet.	☐
3	The coolant connections between cubicles (if any) and to the cooling circuit are tight.	☐

No.	Item	Checked
4	There are no tools, foreign objects or dust from drilling inside the cabinet.	☐
5	The drive cabinet is attached to the floor. For vibration and other considerations, it can be fastened to the wall or roof if necessary.	☐

3 Electrical Installation

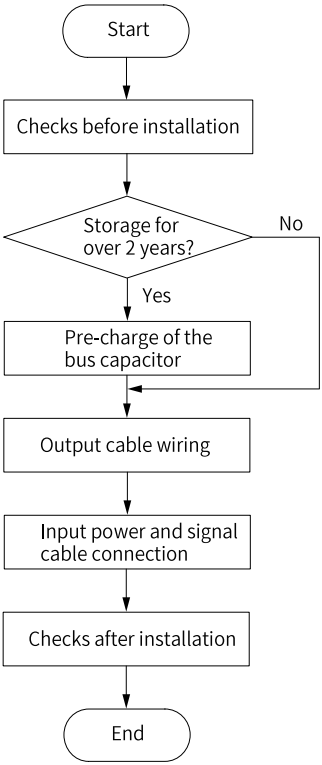


Figure 3-1 Electrical installation flowchart

3.1 Safety Precautions



- This product is often used in industrial applications involving high voltage. It contains live and rotating components. Therefore, there is a risk of severe injury or significant property damage if covers are removed without authorization during operation, if it is used or operated incorrectly, or if it has not been properly maintained.
- Only professional technicians are allowed to perform operations and they must read and comply with safety information provided in this guide.
- When carrying out any kind of work on electrical devices, the following "five safety rules" must always be observed:
  - The power supply is cut off.
  - Make sure that reconnection is not possible.
  - Make sure that the equipment is de-energized.
  - Make sure that the equipment is properly grounded.
  - Cover adjacent live parts or isolate them before starting work.

3.2 System Composition

The following figure shows the typical drive system of the common DC busbar.

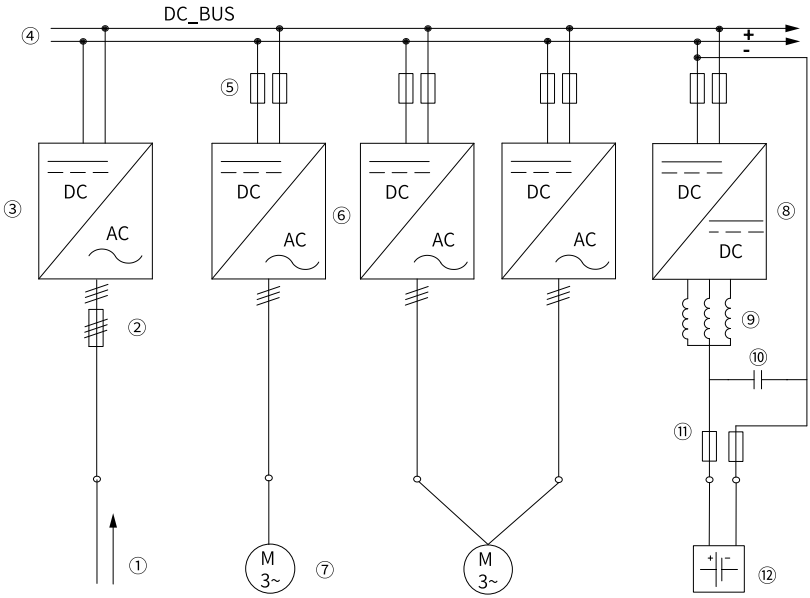


Figure 3-2 Drive system

No.	Description	No.	Description
①	AC power supply	⑦	Motor
②	Three-phase fuse	⑧	DC chopper module
③	Rectifier module	⑨	DC reactor
④	Common DC busbar	⑩	Metal film capacitor
⑤	DC fuse	⑪	Output DC fuse
⑥	Inverter module	⑫	Load (such as battery)

The AC power supply system is connected to the rectifier module through an AC fuse to convert the AC voltage to DC voltage, which is distributed to all modules through the DC bus. The DC chopper module converts the DC voltage into an adjustable DC voltage that can be supplied to the battery and other loads. It is recommended to install external DC fuses for each module that is connected to the DC bus.

The MD880LC-80 series integrated DC chopper kit is often used in battery charging/ discharging controllers, power conversion systems, DC test power supplies and other applications.

3.3 Electrical Terminal Dimensions of the DC Chopper Module

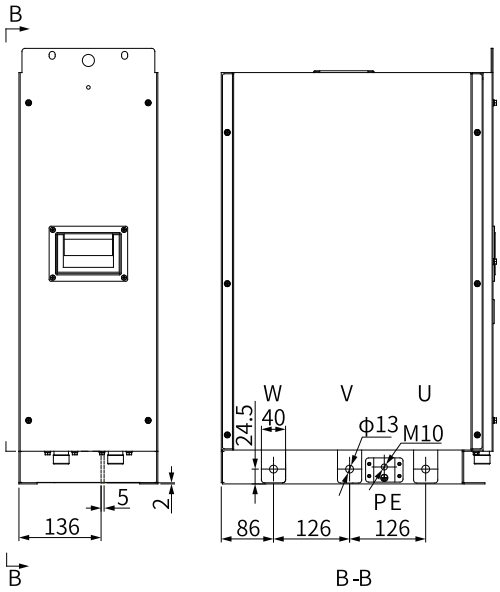


Figure 3-3 AC terminal dimensions of the DC chopper module (unit: mm)

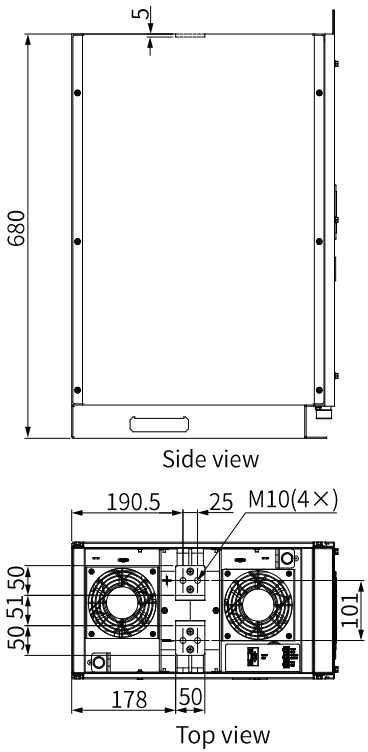


Figure 3-4 DC terminal dimensions of the DC chopper module (unit: mm)

3.4 Inspection Before Wiring

Take necessary measures when performing electrical installation to ensure safety. Comply with the following rules during electrical installation.

- Only qualified professionals are allowed to operate the equipment.
- The equipment runs with high voltage. All connection work must be carried out when the cabinet unit is de-energized.
- High voltage levels can remain in the device even 15 minutes after power disconnection due to DC bus capacitors. Wait until voltage is below 36 VDC before opening the device.
- Work on a disconnected device must be carried out with extreme caution because external supply voltages may be present. The power terminals and control terminals may still be live even when the equipment is stopped.
- The user is responsible for ensuring that the motor, cabinet units, and other components are installed and connected in accordance with the recognized technical rules in the country of installation and with other applicable regional

regulations. Special attention must be paid to regulations concerning cable dimensions, fuses, grounding, shutdown, isolation, and overcurrent protection.

- If a fuse in a branch circuit trips, the fault current may have been cut off. To reduce the risk of fire or an electric shock, the current-conducting parts and other components in the unit should be inspected and damaged parts replaced. If any fuse trips, figure out the cause and rectify the fault.

3.5 Pre-charge of the DC Bus Capacitor

The DC side of the chopper module contains several electrolytic capacitors. Their service life depends on working time, load and ambient temperature. The service life can be extended by lowering the ambient temperature.

Capacitor failures are often accompanied by device damage and input fuse failure or fault trip. If you suspect a capacitor failure, contact Inovance. Do not use spare parts not specified by Inovance.



The unit must not be stored for more than two years. If it is kept in storage for over two years, the DC-link capacitors inside need to be recharged before commissioning. The storage period is calculated from the date of manufacture rather than the date of delivery.

For the charging procedure, see the following:

Charging requirements:

Apply the rated voltage to the DC bus capacitor without load for at least 30 minutes; during this period, no charging module control is allowed to be enabled.

Recommended components for the charing circuit:

①: One 10 A/690 V three-phase fuse switch

②: Six 100 W/220 V incandescent lamps for the chopper module of a 690 V system with two connected in series in every power phase

③: Various small components, such as lamp holder and 1.5 mm^2 cable.

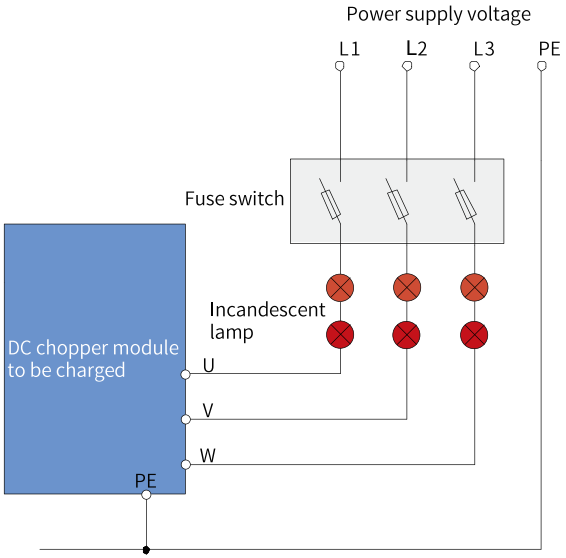


Figure 3-5 Charging connection

3.6 Routing Specifications

3.6.1 Anti-interference Measures

Take the following measures to suppress interference:

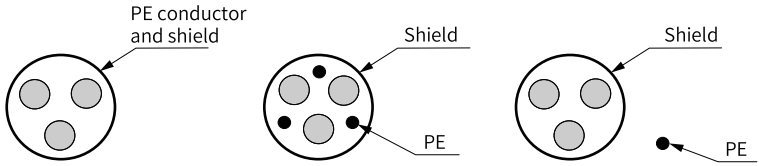
- Use cables as short as possible for reference inputs and encoders.
- Use a thick cable (above 2.0 mm^2) as the grounding cable.
  - D class (or higher class) grounding is recommended (grounding resistance below 100 Ω).
  - Use single-point grounding.
- Use a noise filter to prevent radio frequency interference. Installing a noise filter on the input side of the power cable can be helpful in reducing electrical noise and interference in residential or noisy environments.
- To prevent malfunction due to electromagnetic interference, take the following measures:
  - Install the host controller and noise filter near the cabinet.
  - Install a surge protection device on the relay, solenoid and electromagnetic contactor coils.
  - The distance between a strong-current cable and a weak-current cable must be at least 30 cm. Do not put these cables in the same duct or bundle them together.

- Do not share the power supply with an electric welder or an electric discharge machining device. Install a noise filter on the input side of the power cable when there is a high-frequency generator nearby.

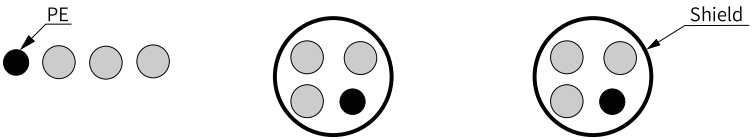
3.6.2 Requirements on Shielded Cables

Use shielded twisted pair cables. Shielded cables are classified into three-conductor cable and four-conductor cable. If the conductivity of the shield of the shielded three-conductor cable is insufficient, add an extra PE cable or use a four-conductor shielded cable, with one conductor being PE cable. To suppress radio frequency interference, the shield of the shielded cable must be made of coaxial copper braid. To enhance the shielding performance and conductivity, the braided density of the shield must be higher than 90%.

- Power cables recommended (symmetrical shielded cables):



- Power cables not recommended:



3.6.3 Cable Routing Requirements

- Keep the motor cable and PE shielded leads (twisted) as short as possible to reduce the electromagnetic radiation and external stray current and capacitive current. For the motor cable longer than 100 m, install an output filter or dv/dt reactor.
- It is recommended that all control cables be shielded.
- Route the motor cables away from other cables. Several motor cables can be laid in parallel.
- It is recommended that motor cables, power input cables and control cables be laid in different ducts. Do not route motor cables and other cables in parallel over long distances. This is to avoid electromagnetic interference caused by rapid changes of the output voltage from the control cabinet.
- If the control cable must run across the power cable, make sure they are arranged at an angle of close to 90°. Other cables must not run across the control cabinet.

- The power input and output cables of the control cabinet and weak-current signal cables (such as control cable) should be laid vertically (if possible) rather than in parallel.
- Cable ducts must be connected and grounded properly. Aluminum duct can be used to improve equipotentiality.
- Connect the filter, control cabinet, and motor to the system (machines or devices) properly. Protect all connections with spray coating and ensure good contact between conductive metal parts.

3.6.4 Precautions for Use of Cables

- Do not bend or apply stress to cables. The diameter of the conductor in a signal cable is typically very small, measuring only 0.2 mm or 0.3 mm. As a result, it is important to handle these cables with care to prevent fracture or damage.
- In scenarios where cables need to be moved, use flexible cables. Ordinary cables are easily damaged after being bent for a long time. Cables of low-power motors cannot be used for movement.
- If the cable drag chain is used, ensure the following requirements are met.
  - the bending radius of the cable must be at least 10 times the diameter of the cable.
  - do not fix or bundle the cables inside the cable drag chain. Rather, you can secure the cables at both ends of the chain.
  - cables must not be wound or warped.
  - space factor inside the cable drag chain must not exceed 60%.
  - do not mix cables of significantly different sizes together as thicker cables may crush thinner cables. If you need to use them together, place a spacer plate to separate them.

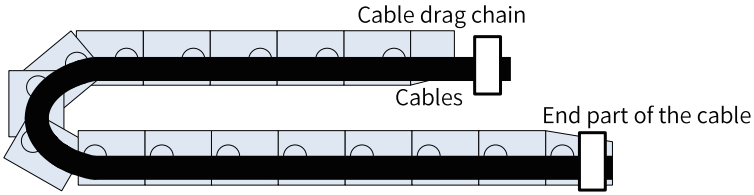


Figure 3-6 Cable drag chain

Requirements

- Route signal cables and power cables separately: Separate signal cables from high-voltage circuits (power supply input, rectifier output, and braking resistor connection cables) by a distance of at least 30 cm. This can reduce interference from other equipment on analog signals. This requirement must be met even inside the control cabinet.

- Use the twisted-pair shielded cables as the analog control signal cables. When stripping the sheathing back of the cable, the stripped part must be as short as possible (5 mm to 7 mm), and wrap the stripped shield with insulating tape to prevent it from coming into contact with other cables, eliminating interference.
- Use the shielded cables as the power cables, or shield all cables with cable ducts.
- When control cables must cross power cables, make sure they are at an angle as near to 90° as possible.

Signal Cable Routing

- Cables transmitting different signals shall be routed separately. Maintain a proper distance (preferably 30 cm if space permits) between cables that cause interference and sensitive ones. When such cables must cross, make sure they are at an angle as near to 90° as possible to prevent interference.

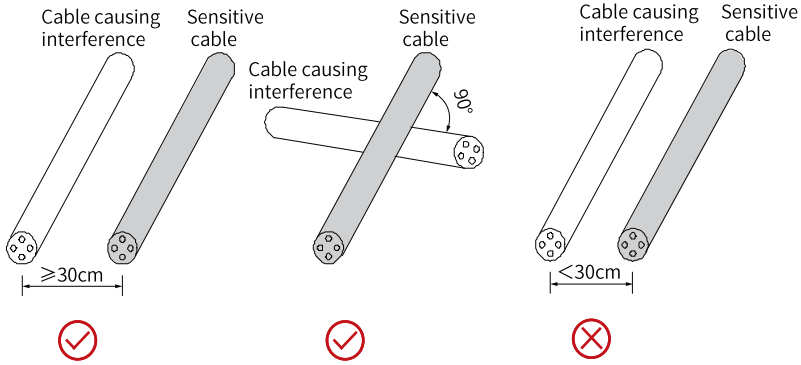


Figure 3-7 Routing of cables that cause interference and sensitive ones

- Route different types of signal cables through different routes and separate them with equipotential signals. When routing signal cables of the same type, keep the equipotential signal cable in the outer layer and the equipotential signals in the middle if possible. The following figure shows details.

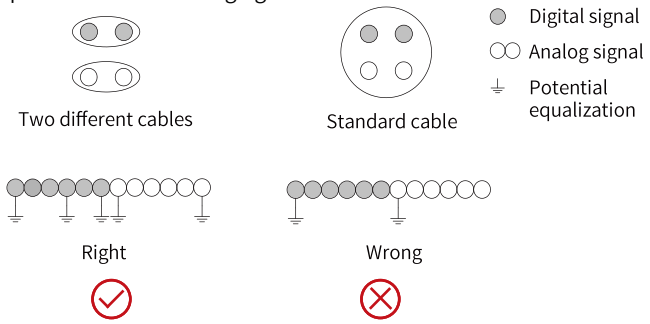


Figure 3-8 Routing of different types of signal cables

- For the multi-core cables, it is recommended that a cable only transmits the same type of signals. If different types of signals are to be transmitted, use shielded conducting cores, as shown in the following figure:

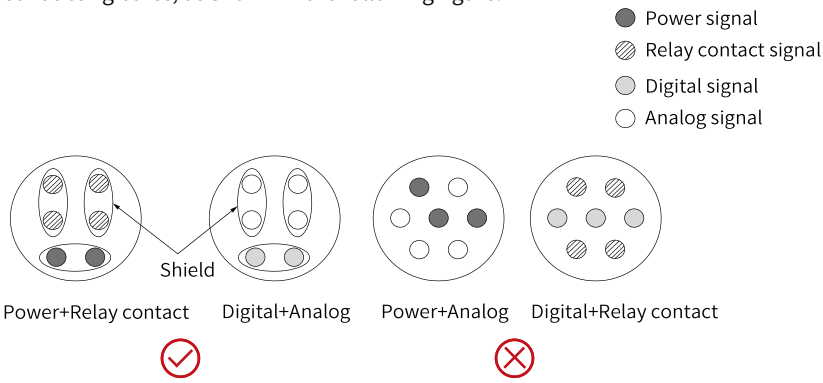


Figure 3-9 Routing of multi-core cables

- For unused conducting cores in a multi-core cable, connect them to the equipotential bonding conductors.

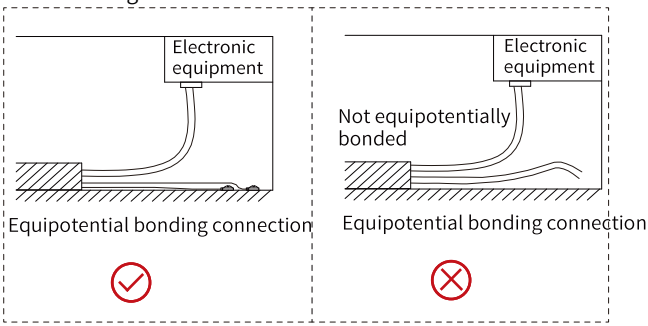


Figure 3-10 Handling of unused cores in a multi-core cable

- For the cables transmitting low-level sensor signals and relay signals, lay the two cable types close to each other for a not too large loop area. Make sure to use twisted-pair cables for the analog signals. Route the digital signal cables close to each other.

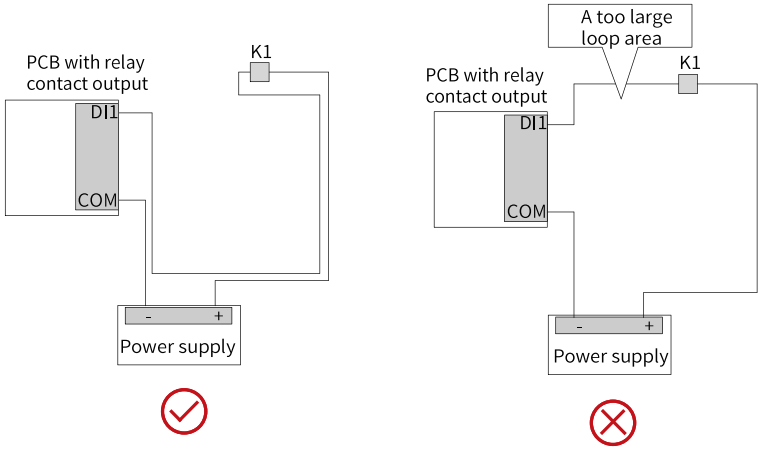


Figure 3-11 Routing for a not too large loop area

- Lay multiple types of cables along the equipotentially bonded metal parts and separate them to improve EMC performance. Metallic enclosures (zinc iron or stainless steel) isolated with sheet metal will deliver even better EMC performance.

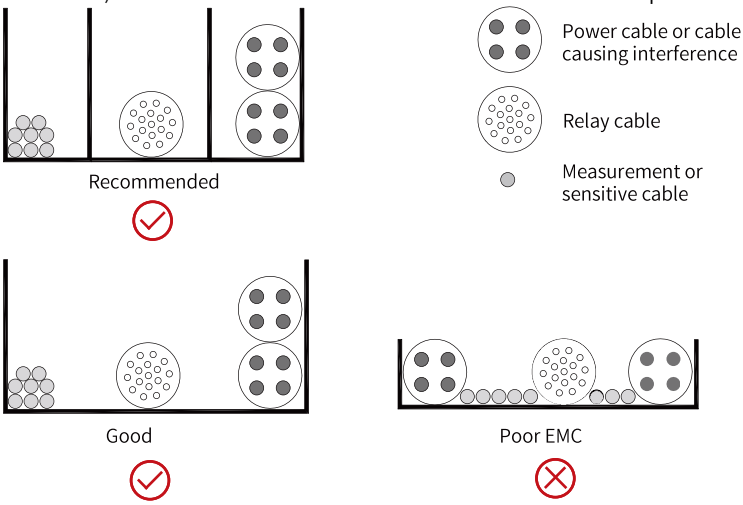


Figure 3-12 Routing of multiple types of cables

- Keep the length of the unshielded cable part as short as possible, and the shield braid is tied to the nearest PE terminal. Too long a stripped part will make the cable susceptible to interference. It is especially true for encoder signals.

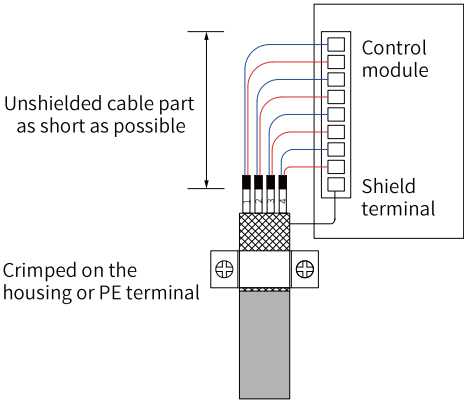


Figure 3-13 Requirements on shielded cables

Connection of Shielded Power Cables

The input power cable and shield must be in large-area contact with the shield plate in the cabinet modules to achieve good EMC effect. See the figure below for the connection diagram.

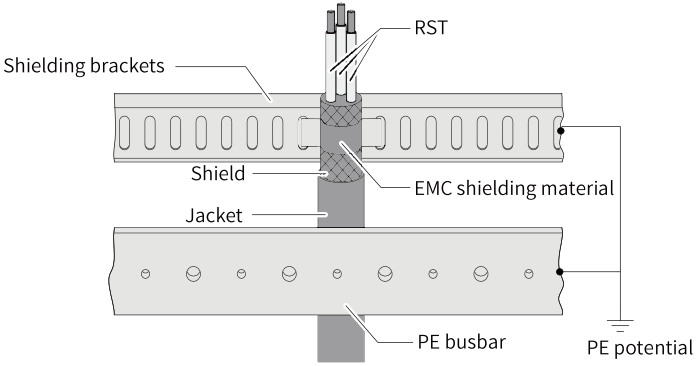


Figure 3-14 Connection of shielded power cables

3.7 Main Circuit

3.7.1 Description of Main Circuit Terminals

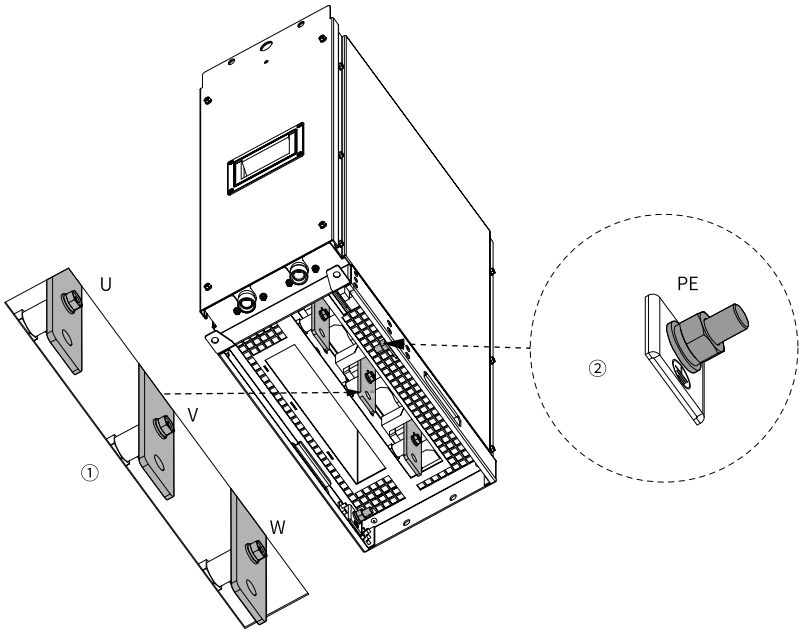


Figure 3-15 Terminals at the DC chopper bottom

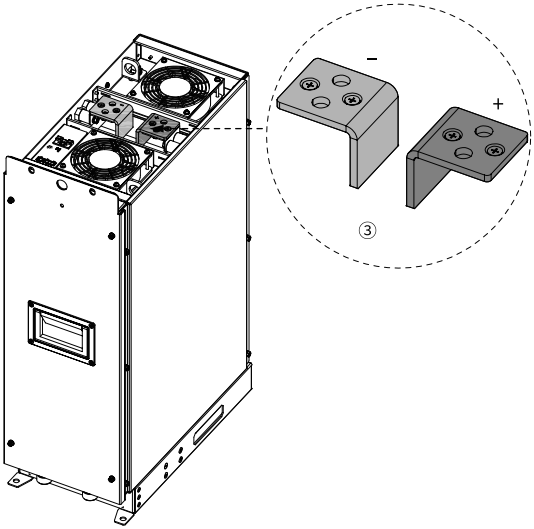


Figure 3-16 Terminals at the DC chopper top

Table 3–1 Terminal connection parameters of the DC chopper

No.	Terminal	Description
①	Positive electrode terminals U, V, W at the low-voltage side	See *"3.7.2 Main Circuit Wiring Cable Selection" on page 54* for proper cable selection.
②	PE terminal	See *"3.7.2 Main Circuit Wiring Cable Selection" on page 54* for proper cable selection.
③	+ and – wiring terminals at the high-voltage side	See *"3.7.2 Main Circuit Wiring Cable Selection" on page 54* for proper copper busbar.

3.7.2 Main Circuit Wiring Cable Selection

Table 3–2 Wiring cable selection

Module model	Rated output current	Copper bar size (high-voltage side)	Copper busbar hole size	Cable quantity and gauge for the positive pole (low-voltage side)	Wiring terminal
UN: DC voltage range of 740 VDC to 1050 VDC					
MD880LC-80M-0600–7	600 A	50 x 5 mm^2	M10-2	1 x 95 mm^2	OT/95-10

Note

- The PE cable must be connected separately, with the cross-sectional area being at least one half of the power phase line.
- Note: 1 x 95 mm^2 indicates that each phase requires one cable with a cross-sectional area of 95 mm^2.
- Note: OT/95-10 indicates a crimping OT-type terminal that is designed for use with a cable with a cross-sectional area of 95 mm^2 and has an M10 screw hole.
- The dimensions of the wiring terminals cannot exceed those marked in the table. Otherwise, the stability and specified electrical clearance may be affected.
- The cable configuration of negative bus at the DC low-voltage side is consistent with that at the DC high-voltage side.
- Derating is required when multiple cables of the same specifications are connected in parallel.

3.7.3 Main Circuit Wiring Requirements

- Do not solder the twisted conductors.
- Prevent foreign matters from entering the wiring part of the terminal block.
- To protect the main circuit, separate and cover the surface that may come into contact with the main circuit.
- The specifications and installation method of main circuit cables must comply with local regulations and related IEC requirements. Use copper lead cables with appropriate dimensions according to the recommended main circuit cables.
- If the motor cable is too long, electrical resonance will be generated due to the impact of distributed capacitance. This will damage the motor insulation or generate higher leakage current, causing the equipment to trip overcurrent protection. When the motor cable length is greater than 150 m, install an AC output reactor close to the unit.
- The tightening torque may vary with terminals. Tighten terminal screws with the specified tightening torque. You can use the torque screwdriver, ratchet, or wrench. If you use an electric tool, make sure it is in the low speed setting. Otherwise, the screws may be damaged. Do not tighten the terminal screws at an angle in the specified range (not above 5 degrees) to prevent damage.

3.8 Control Circuit

3.8.1 Description of Control Circuit Terminals

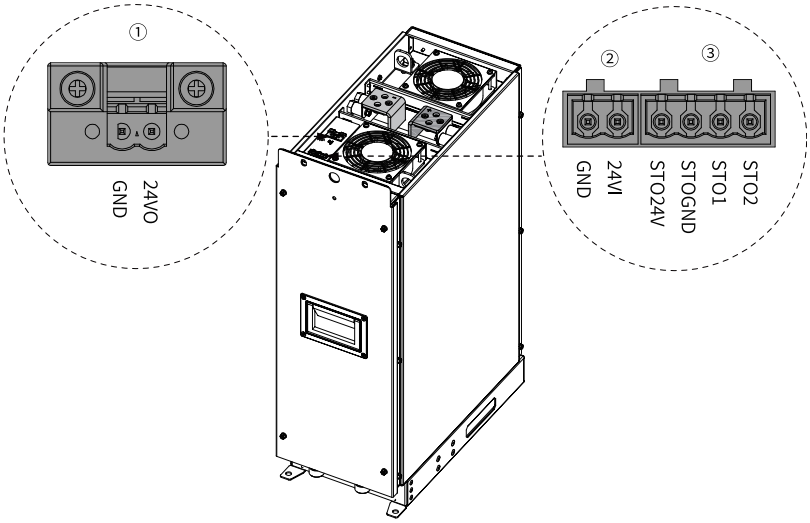


Figure 3-17 Layout of control circuit terminals 1

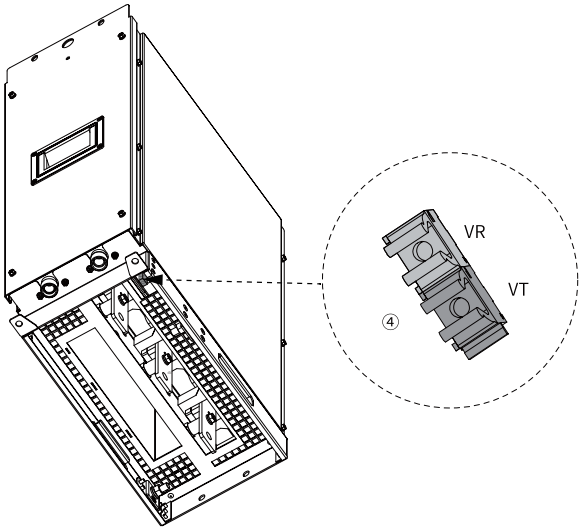


Figure 3-18 Layout of control circuit terminals 2

Table 3–3 Description of control terminals

No.	Terminal	Description
①	2-pin power terminal	HCU redundant power output terminals.
②	2-pin power terminal	Input terminal for 24 VDC external power supply, 2-core twisted pair, single-core cable, cross-sectional area of 0.5 mm^2 to 2.5 mm^2.
③	4-pin STO terminal	STO terminal, 4-core shielded cable, cross-sectional area of 0.5 mm^2 to 2.5 mm^2.
④	VR optical fiber receiving terminal/VT optical fiber transmitting terminal	Optical fiber connection with HCU or HPCU.

Note

If you need to use the STO terminal, unplug the shorting stub.

To connect the NC temperature switch of reactor/braking resistor to HCU contact HDI1 for overtemperature detection, refer to the connection mode in *HCU Control Module User Guide*. See the following table.

Step	Parameter	Value	Action
①	B6-04	9	Setting
②	F4-04	Ones (position) 1	Setting
③	A2-51	4668	Setting
④	A2-52	1	Checking. Otherwise, repeat step ③
⑤	A2-51	52568	Setting
⑥	A2-54	1	Checking. Otherwise, repeat steps ③ to ⑥

3.8.2 Selection of Control Circuit Cables

To ensure that the control circuit is free from strong external interference, use shielded signal cables and install shielding brackets to offer large-area 360° shielding. Use separate shielded cables for different analog signals. It is recommended to use shielded twisted pair (STP) cables for digital signals.

Module model	Terminal type	IEC cable (mm^2)	NEC cable (AWG)	Lug specification
MD880LC-80M-0600-7	STO terminal (optional)	0.5	20	Cord end terminal

3.8.3 Control Circuit Wiring Requirements

Note

Cable connection of the control circuit shall be carried out according to EN 60204-1.

Requirements on cabling I/O signal cables:

- To avoid malfunction, separate the cable connecting the relay output terminal at least 30 cm away from other I/O signal cables.
- Keep a distance of at least 30 cm from the main circuit and other power lines to avoid interference with I/O signals.
- I/O signals include analog input (AI), analog output (AO), digital input (DI), digital output (DO), and relay output signals. Before wiring the I/O terminal, disconnect the main power supply and ensure that the danger indicator on the AC drive is off.

3.9 Grounding

3.9.1 Main Circuit Grounding



- When multiple devices are used, ground all the devices. Incorrect grounding will lead to faulty operation.
- To prevent electric shock, connect the grounding wire to the grounding terminal properly. Follow the relevant electrical regulations of specific countries or regions on the grounding method.
- To prevent electric shock, make sure that the PE conductor meets the technical specifications and local safety standards. The grounding wire should be as short as possible. As the leakage current of the device typically exceeds 3.5 mA, proper PE conductor is required according to IEC 61800-5-1. Use copper wire for the conductor with a cross-sectional area of at least 10mm^2 or use two conductors of the same gauge.

Main circuit grounding requirements:

- Do not connect the grounding terminal to the N terminal of the neutral wire of the power supply.
- Connect the grounding wire to the grounding terminal. Otherwise, the device may be abnormal or damaged.
- It is recommended that the device be installed on the conductive metal surface. Ensure the entire conductive bottom is in good contact with the metal surface.
- Use a yellow-green cable with copper conductors for the protective grounding conductor. Do not connect the protective grounding conductor to switching devices such as circuit breakers in series.
- Tighten the grounding screws to the correct tightening torque so that the PE conductor will not come loose or too tight.

3.9.2 Module Grounding

The chopper module needs to be properly grounded. When used in the system, it should be connected to the grounding copper busbar through a star connection along with other components such as the rectifier, input reactor, and filter module. And the output side of the module is connected to the motor.

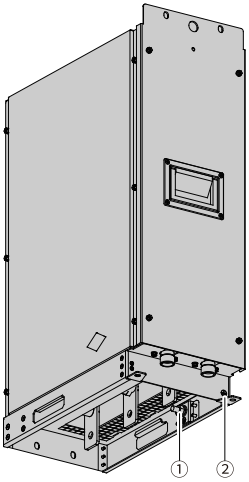


Figure 3-19 Module grounding

Table 3–4 Grounding terminal description

No.	Description
①	Connect the motor output grounding cable of the chopper to the grounding screw.
②	Ground the chopper enclosure through connecting with the cabinet sheet metal.

3.9.3 Recommended Cabinet Grounding

The most cost-effective measure to suppress interference in the cabinet during installation is to ensure that the interference source is isolated from the equipment that may be disturbed. It is necessary to divide the cabinet into multiple parts for EMC resistance based on interference intensity differences of sources. Install devices in the corresponding areas and wire according to the following table.

Table 3–5 Recommended grounding of cabinet system

No.	Wiring requirements
1	All grounding points in the cabinet should be well coated for protection.
2	Devices in different parts of the cabinet should be equipotentially connected.
3	In a cabinet, establish different parts based on interference intensity differences of sources.
4	Install the power supply input filter inside the cabinet to a place near the input interface of the cabinet.
5	Shield all the communication (such as RS485) cables and signal cables routed out from the control cabinet.
6	In the case of multiple cabinets, use grounding cables for connection to achieve equipotentiality.

3.10 Cable Connection of the Module

Terminal Layout

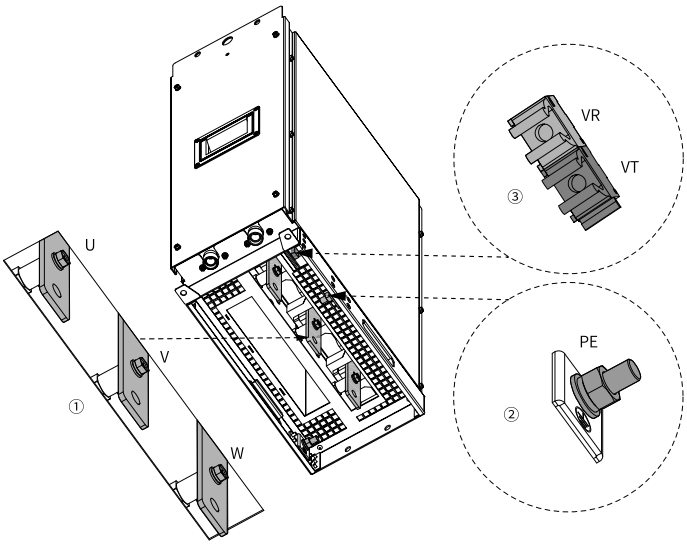


Figure 3-20 Terminals at the DC chopper bottom

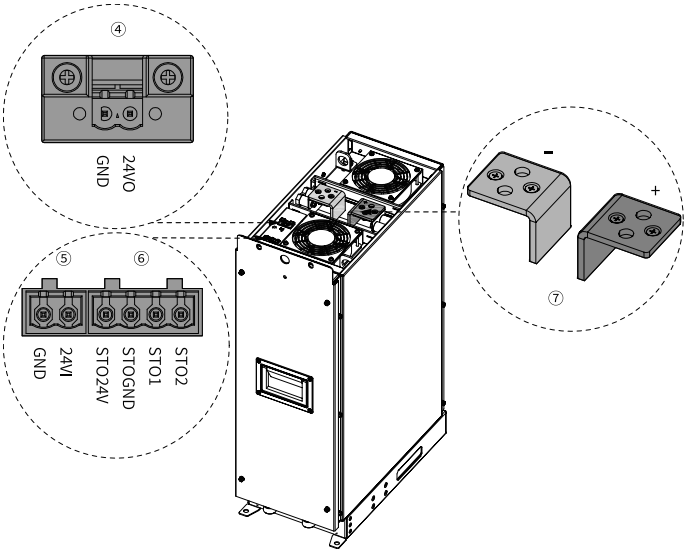


Figure 3-21 Terminals at the DC chopper top

Table 3–6 Terminal connection parameters of the DC chopper

No.	Terminal	Description
①	Positive electrode terminals U, V, W at the low-voltage side	See *"3.7.2 Main Circuit Wiring Cable Selection" on page 54* for proper cable selection.
②	PE terminal	See *"3.7.2 Main Circuit Wiring Cable Selection" on page 54* for proper cable selection.
③	VR optical fiber receiving terminal/VT optical fiber transmitting terminal	Optical fiber connection with HCU or HPCU.
④	2-pin power terminal	HCU redundant power output terminals.
⑤	2-pin power terminal	Input terminal for 24 VDC external power supply, 2-core twisted pair, single-core cable, cross-sectional area of 0.5 mm^2 to 2.5 mm^2.
⑥	4-pin STO terminal	STO terminal, 4-core shielded cable, cross-sectional area of 0.5 mm^2 to 2.5 mm^2.
⑦	+ and – wiring terminals at the high-voltage side	See *"3.7.2 Main Circuit Wiring Cable Selection" on page 54* for proper copper busbar.

Note

If you need to use the STO terminal, unplug the shorting wire.

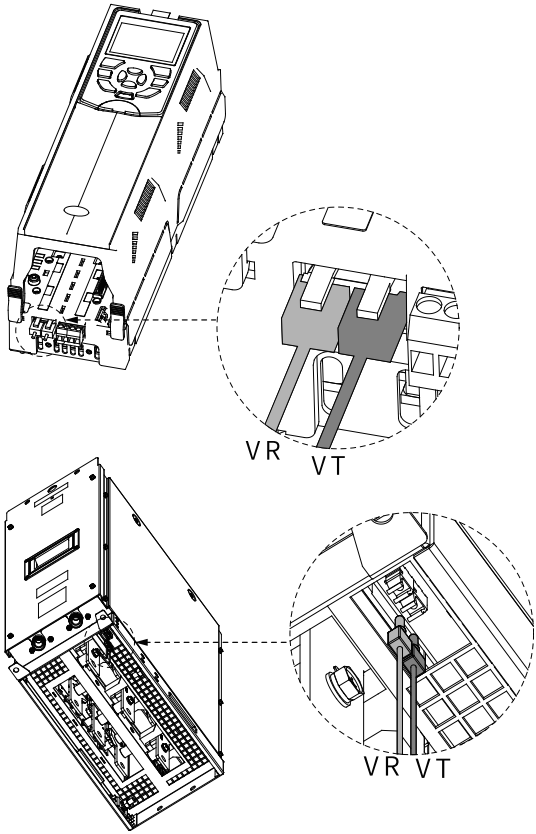


Figure 3-22 Optical fiber terminals

Wiring Steps

1. Remove the protective cover of the terminals and make sure that the inputs and outputs are connected properly.
2. Connect cables to output terminals based on the following sequence: U, V, and W, or (+) and (-).
3. Secure the power cables on the cable rack to avoid mechanical strain on the terminals.
4. For shielded power cables, fix the shield to the shielding plate according to EMC requirements.

3.11 Inspection After Wiring

No.	Item	Checked
1	The auxiliary power supply provides the correct voltage.	☐
2	The input power supply is connected to the motor cable properly, with correct voltage supplied.	☐
3	Cables are connected with specified torque to the connectors provided.	☐
4	The input/output power cables are fixed to the fixing bracket to reduce tension.	☐
5	For the DC chopper module in parallel output connection with the motor, ensure that the connection is correct.	☐
6	The control cables must be shielded and connected properly. To prevent interference, the control cables must be laid separately from the power cables. Make sure to comply with the relevant EMC directives.	☐
7	When EMC-shielded cables are used, screwed glands that connect the shield to ground with greatest possible surface area must be provided on the motor terminal box. The cable shield is secured to the shielding plate in the DC chopper module to ensure EMC compliance.	☐
8	The date of manufacture can be found on the nameplate of the chopper. If it is less than 2 years from the initial commissioning or the downtime of power components is less than 2 years, then there is no need to pre-charge the DC bus capacitors. Pre-charge it when the downtime is over 2 years.	☐

4 Internal Cooling Circuit

4.1 Recommended Liquid-cooled System Design

Each cubicle has an inlet and outlet manifold, fitted with a stop valve and a drain valve. The stop valves can be closed to isolate all modules in the cubicle from the main cooling circuit.

The following figure shows the coolant pipe connections in a drive system consisting of a rectifier unit and a DC-DC unit.

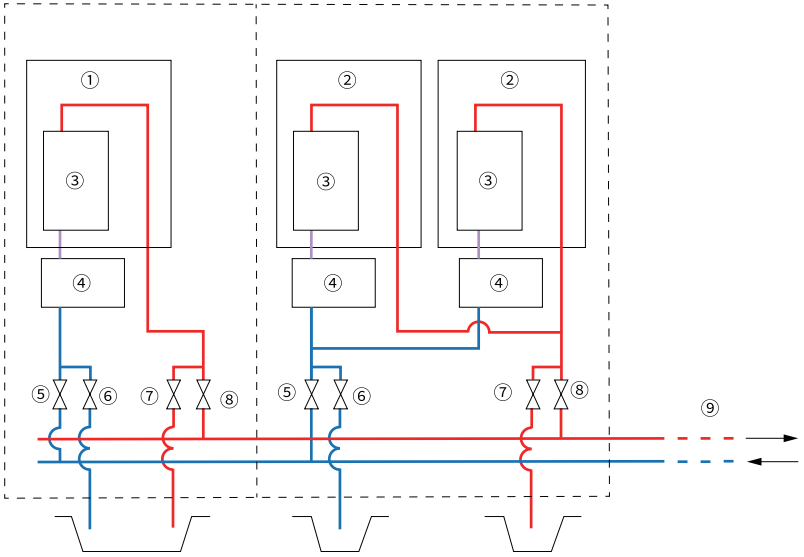


Figure 4-1 Internal cooling system

Table 4–1 Description of the internal cooling system

No.	Description	No.	Description
①	Power supply unit	⑥	Inlet-side drain valve
②	DC-DC unit	⑦	Outlet-side drain valve
③	Heatsink	⑧	Outlet valve
④	Air-to-liquid heat exchanger	⑨	Coolant main pipe
⑤	Inlet valve	-	-

Note

The coolant used with MD880 liquid-cooled DCDC system is pure water or ethylene glycol mixed with pure water.

4.2 Technical Data of the Cooling Circuit

4.2.1 Installation Requirements

Install the bleed valve at the highest point in the system and drain valve at the lowest point. See the following figure.

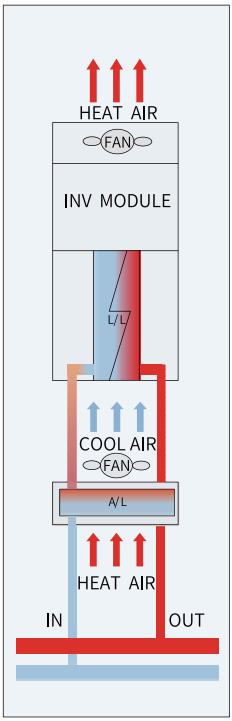


Figure 4-2 Cooling circuit in the cabinet

Table 4–2 Internal cooling circuit parameters

Module model	Air inlet temperature (°C)	Air volume (CFM)	Coolant flow rate (L/min)			Water inlet temperature (°C)	Water inlet pressure (bar)
			100% water	Water/ ethylene glycol ratio 80:20	Water/ ethylene glycol ratio 60:40		
MD880LC-80M-0600-7	< 50	360	⩾ 16	⩾ 18	⩾ 21	< 40	< 6

4.2.2 Coolant Temperature Control

The temperature of the coolant in the internal cooling circuit must be kept within the following specified limits.

- Additional ethylene glycol solution is needed at 0°C to 5°C.
- 20% ethylene glycol mixture is usable in storage temperatures down to –10°C.
- 40% ethylene glycol mixture is usable in storage temperatures down to –25°C.
- Note that operation below 0°C (32°F) is not allowed regardless of the freezing point of the coolant.

Note

The minimum coolant temperature is dependent on ambient temperature and relative humidity.

4.2.3 Temperature Limits

Freeze protection: The freezing point of the coolant is determined by the concentration of heat transfer fluid in the mixture.

The higher the concentration of heat transfer fluid, the higher the viscosity of the coolant. This results in a higher pressure loss in the system. For details, see section *"4.2.4 Pressure Limits" on page 68*.

Coolant inlet temperature:

- 0°C to 40°C (32°F to 104°F): no drive output current derating required.
- 40°C to 45°C (104°F to 113°F): drive output current must be derated by 2% per 1°C (1.8°F) temperature increase.
- 45°C to 50°C (113°F to 122°F):
  - If components with a maximum operating temperature of 55°C (131°F) are installed in the same space as the drive modules, drive output current must be derated by 6% per 1°C (1.8°F) temperature increase.

- If there are no components with a maximum operating temperature of 55°C (131°F) installed in the same space as the drive modules, drive output current must be derated by 2% per 1°C (1.8°F) temperature increase.

Condensation is not allowed. The minimum coolant temperature to avoid concentration (at an atmospheric pressure of 1bar) is shown below as a function of the relative humidity (RH) and the ambient temperature (T_{air}).

T_{air} (°C)	Min. $T_{Coolant}$ (°C)				
	RH = 95%	RH = 80%	RH = 65%	RH = 50%	RH = 40%
5	4.3	1.9	-0.9	-4.5	-7.4
10	9.2	6.7	3.7	-0.1	-3.0
15	14.2	11.5	8.4	4.6	1.5
20	19.2	16.5	13.2	9.4	6.0
25	24.1	21.4	17.9	13.8	10.5
30	29.1	26.2	22.7	18.4	15.0
35	34.1	31.1	27.4	23.0	19.4
40	39.0	35.9	32.2	27.6	23.8
45	44.0	40.8	36.8	32.1	28.2
50	49.0	45.6	41.6	36.7	32.8
55	53.9	50.4	46.3	42.2	37.1

Note

The coolant temperature must be 0°C (32°F) or above under all conditions. For example, at an air temperature of 5°C and relative humidity of 50%, the coolant temperature may not be below 0°C. At an air temperature of 45°C and relative humidity of 65%, the coolant temperature may not be below 36.8°C.

Maximum temperature rise: Depends on heat losses and mass flow. Typically 10°C (18°F) with nominal losses and flow.

4.2.4 Pressure Limits

Base pressure: 100 kPa to 150 kPa (recommended); 200 kPa (maximum). “Base pressure” denotes the pressure of the system compared with the atmospheric pressure when the cooling circuit is filled with coolant.

Design pressure (PS): 600 kPa

Air counterpressure in the expansion tank: 40 kPa

Maximum pressure difference (between main in/out lines): 200 kPa

Nominal pressure difference (between main in/out lines): 120 kPa with 25/75% (volume) coolant solution, 150 kPa with 50/50% (volume) coolant solution. This must be taken into account when determining the size of the liquid cooling circuit.

4.2.5 Coolant Flow Rate Limits

The maximum coolant flow rate for all drive equipment is 1.3 times the nominal values. For nominal values, see *"Table 4–2 " on page 67*.

4.2.6 Cooling Circuit Materials

Materials used in the internal cooling circuit are listed below. These are also the only materials that can be used in the external cooling circuit.

- Heavy gauge aluminum
- Rubber gasketing NBR (nitrile rubber)
- Plastic materials, such as PA, PEX and PTFE
- Stainless steel AISI 316L (UNS 31603)

Note

PVC hoses are not suitable for use with antifreeze.



If connecting external piping to the internal cooling circuit, use only materials that are specified above. Copper, brass or bronze must not be used under any circumstances. Even minor dissolution of copper can cause copper precipitation on aluminum and subsequent galvanic corrosion. The liquid cooling system must not contain any zinc (eg. galvanized pipes).

If the plant incorporates normal iron pipes or cast iron accessories (eg. motor housings), a cooling unit with a heat exchanger must be used to separate the systems.

4.3 Filling Up and Bleeding the Internal Cooling Circuit

Both the drive and coolant must be at room temperature before filling up the cooling circuit.

Note

- The DC chopper module has no bleed valve, which is instead installed at the top of the cabinet.
- Make sure that the maximum permissible operating pressure is not exceeded. When necessary regulate the pressure to appropriate level by draining excess coolant out of the system.
- Bleeding of the cooling circuit is very important and has to be done with great care. Air bubbles in the cooling circuit may reduce or completely block coolant flow and lead to overheating. Let the air out of the cooling system while filling in coolant and, eg. after any power module replacements.
- In filling up the system, the drain valves in the line-up are used only to vent the air from the circuit so that it can be displaced by the coolant. The actual bleeding of the circuit must be done via an external bleed valve installed at the highest point of the cooling circuit. The most practical position of the valve is usually close to or located at the cooling device.

The steps are as follows:

1. Open the bleed valve at the cooling unit.
2. Attach a hose to the outlet-side drain valve and lead it into a suitable container.
3. Open the inlet valve and the outlet-side drain valve of one cubicle. Keep the outlet valve and the inlet-side drain valve closed.
4. Attach a hose to the outlet-side drain valve and lead it into a suitable contained.
5. Fill the circuit with coolant.
6. As the piping and modules in the cubicle fills up, coolant starts to flow from the hose. Let some coolant flow out, then close the drain valve.
7. Close the inlet valve.
8. Repeat steps 2 to 6 for all cubicles in the line-up.
9. Open the inlet and outlet valves in all cubicles. Let any air remaining in the system out through the bleed valve at the cooling unit.
10. Close the bleed valve at the cooling unit.
11. Open the bleed valve of the pump to let out any air.
12. Re-check the pressure and add coolant if necessary.
13. Start the coolant pump. Let any air remaining in the system out through the bleed valve at the cooling unit.
14. After one to two minutes, stop the pump or block the coolant flow with a valve.
15. Re-check the pressure and add coolant if necessary.
16. Repeat steps 13 to 15 a few times until all air is let out of the cooling circuit. Listen for a humming sound and/or feel the piping for vibration to find out if there is still air left in the circuit.

4.4 Draining the Internal Cooling Circuit

The modules in each cubicle can be drained through the drain valves without draining the whole internal cooling circuit.

Note

Hot, pressurized coolant can be present in the cooling circuit. Do not work on the cooling circuit before the pressure is released by stopping the pumps and draining coolant.

Take the following steps.

1. Attach hoses to each drain valve in the cubicle to be drained. Lead the hoses into a suitable container. Make sure the ends of the hoses are not immersed in coolant at any point so that air can displace the coolant in the system.
2. Open the drain valves. Wait until all coolant has drained.
3. If the drive is to be stored in temperatures below 0°C:
   a. Dry the cooling circuit with air.
   b. Fill the cooling circuit with 20% or 40% ethylene glycol solution.
   c. Drain the cooling circuit again.

5 HCU Control Module

HCU-80 is for the DC chopper control.

DC chopper control module	Communication with the chopper	DC chopper module	Installation mode
HCU-80	High-speed optical fiber	H7	Installed separately inside an auxiliary control cabinet.

The HCU control module has an external 24 VDC power supply, and internal multiple isolated power supplies which provide isolated digital power, InoLink communication RS485 isolated power and SOP-20-880 power. It can also provide power to the function modules installed on HCU expansion slots.

5.1 Module Composition

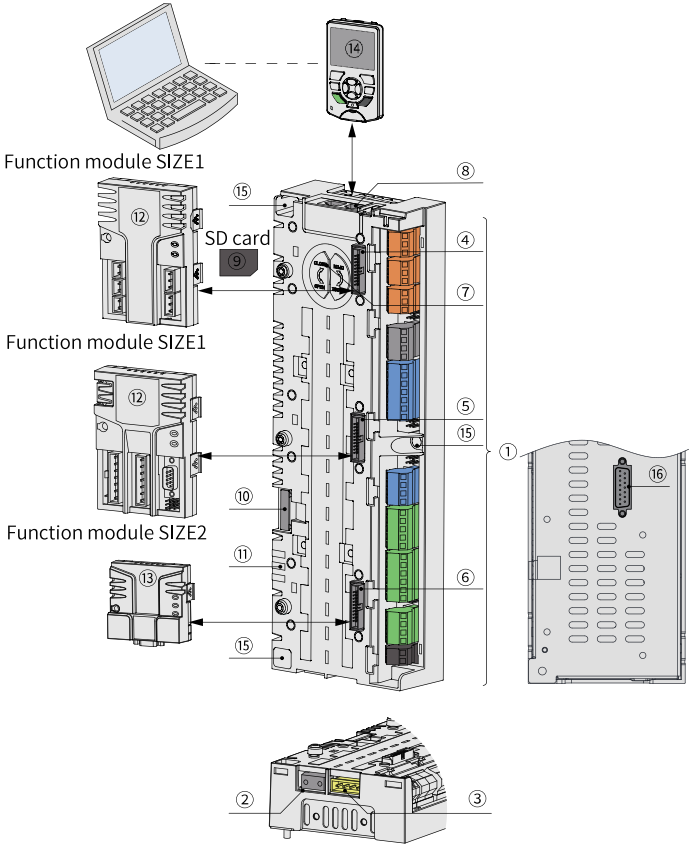


Figure 5-1 HCU control module composition

Table 5–1 HCU control module part description

No.	Name	Function
①	User terminal	Standard user I/O terminals
②	Optical fiber communication	Optical fiber communication port between the HCU-80 and the chopper module
③	XSTO	STO input
④	SLOT1	Function module interface: A1, A2, and A3
⑤	SLOT2	Function module interface: B1, B2, and B3
⑥	SLOT3	Function module interface: C1
⑦	Battery cover	Spare RTC battery cover. The RTC battery is non-rechargeable lithium battery that needs regular replacement.

No.	Name	Function
⑧	Smart operating panel (SOP) terminal	For connection between the HCU and SOP-20-880. The two RJ45 ports are identical for easy cascade connection.
⑨	SD card	An 8 GB microSD memory card is the standard part, which can be easily inserted and removed as needed.
⑩	Functional safety slot	For connection of functional safety modules
⑪	Indicator	Power, Run and Fault indicators
⑫	Function module SIZE1	105 x 73 x 24 mm function module
⑬	Function module SIZE2	75 x 73 x 24 mm function module
⑭	SOP-20-880 smart operating panel	HMI
⑮	Fixed hole	Holes for fixing the HCU. Quantity: 3
⑯	DB15 terminal	Communication port between the HCU-81 and the chopper module

Note

- Function modules are directly installed in SLOT1, SLOT2, and SLOT3. The addresses are A1, B1, and C1.
- The SLOT1 and SLOT2 slots can be used with the HOFM-30 and HESD-10 to achieve slot expansion. The addresses are A1, A2, A3, B1, B2, and B3.
- SLOT3 does not support slot expansion.

5.2 LED Indicators

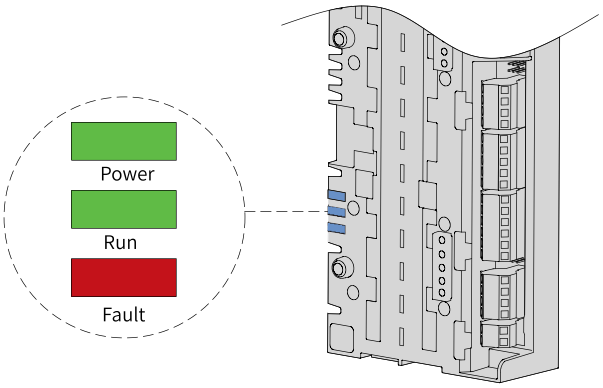


Figure 5-2 LED indicators

Table 5–2 Description of LED indicators

No.	Name	State	Description
1	Power	Steady ON	HCU power supply is normal.
		OFF	HCU is not energized or the power supply has failed.
2	Run	Steady ON	The DC chopper module is in the operation state.
		OFF	The DC chopper module is in the stop state.
3	Fault	Steady ON	A system fault occurs.
		OFF	The system is normal.
		Flashing	HCU auxiliary power has failed. Check all auxiliary power supplies for short circuit or overload.
4	Fault, Run	Flashing	PC or SOP-20-880 selects the HCU and ends after 10s.

5.3 SD Memory Card

The HCU is internally equipped with an SD card for storing real-time data from all stages of the control module to assist in monitoring and analyzing the power module. The data is stored on a microSD memory card and analyzed by a qualified service technician.

5.4 Outline Dimensions and Installation of the HCU Control Module

5.4.1 Preparations



- Do not use excessive torque to tighten the terminals to avoid damage.
- Do not disassemble the HCU module. Otherwise, the module may be damaged.
- Protect the HCU module from falling or impact to avoid damage to the module.
- To avoid damage, disconnect HCU input power before installing or removing a function module.
- To avoid damage, power off the cabinet for at least 15 minutes and disconnect the HCU input power before installing or removing HCU.

The HCU installation may require a 1# Phillips screwdriver, and the tightening torque for the M3 screw should be set to 0.55 N·m.

5.4.2 Outline Dimensions of the HCU Control Module

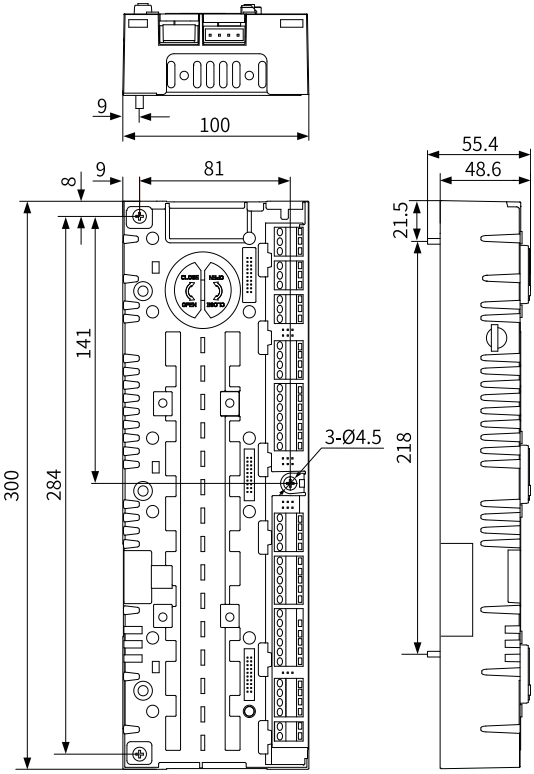


Figure 5-3 HCU outline dimensions (unit: mm)

5.4.3 Mounting Clearance

To install the HCU, certain space must be reserved as shown below. The HCU must be mounted on a conductive metal surface and ensure that the entire conductive bottom of the HCU is in good contact with the surface.

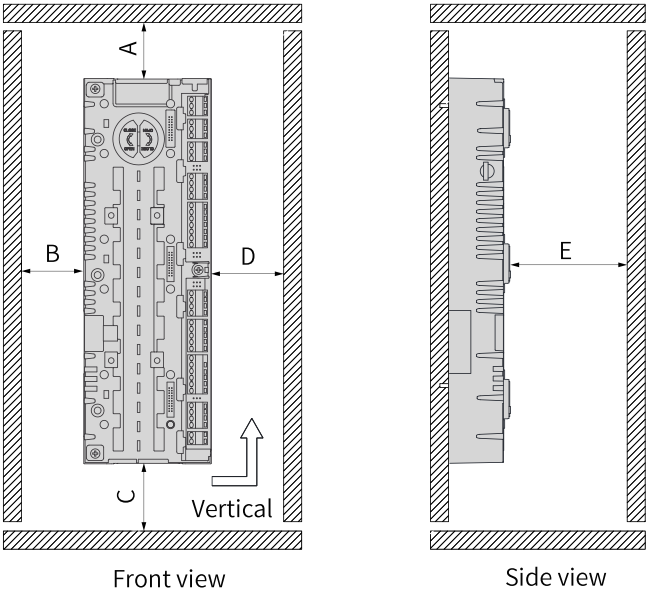


Figure 5-4 Mounting clearance details

A	B	C	D	E
⩾ 100 mm	⩾ 30 mm	⩾ 100 mm	⩾ 50 mm	⩾ 100 mm

5.4.4 Installation Steps

1. Align the HCU vertically with the two positioning holes on the metal mounting plate.
2. Use a #1 Phillips screwdriver to tighten the three M4 screws that secure the HCU in place, as shown below.

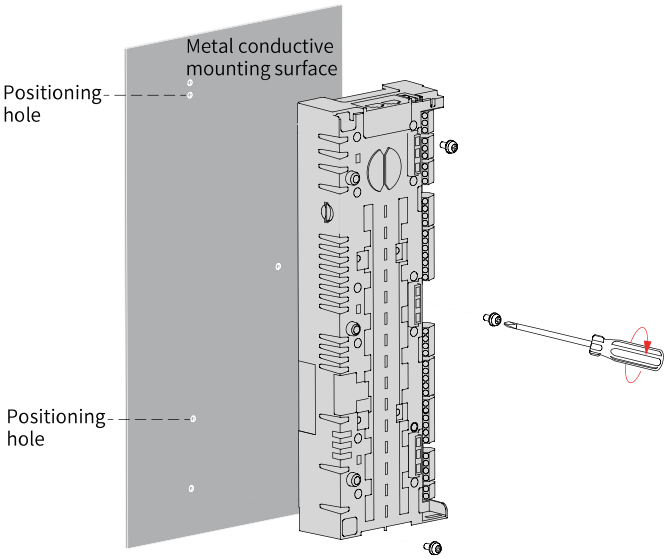


Figure 5-5 Installing the HCU

Note

- The HCU housing will be grounded to the cabinet housing through the screws on the mounting surface.
- The mounting plate of the HCU must be a bare metal plate and reliably grounded.

5.5 Overview of HCU Control Module Terminals

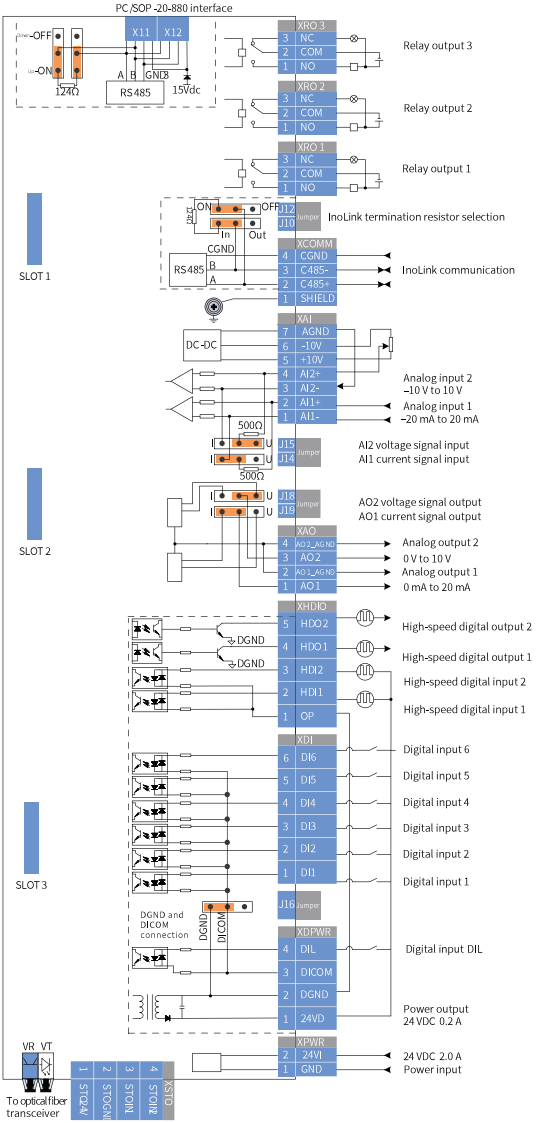


Figure 5-6 HCU terminals

5.5.1 Standard Terminals

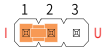
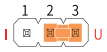
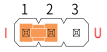
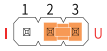
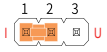
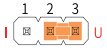
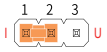
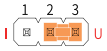
Table 5–3 Description of standard HCU terminals

Name	Terminal	Description
Input power supply	XPWR: 24VI	HCU power supply.
Digital power output	XDPWR: 24VD	Digital output power isolated from XPWR.
Digital input	XDI: DI1–DI6, DIL	Input type: relay contact, NPN or PNP.
High-speed digital input	XHDIO: HDI1, HDI2	Input type: NPN or PNP.
High-speed digital output	XHDIO: HDO1, HDO2	Output type: open collector output.
Analog output	XAO: AO1, AO2	Output type: current or voltage, selected by jumper.
Analog input	XAI: AI1, AI2	Input type: current or voltage, selected by jumper.
Relay output	XRO1, XRO2, XRO3	Relay output: NO, NC and COM.
InoLink communication	XCOMM	High-speed RS485, bus resistor selected by jumper.
RJ45 terminal	X11, X12	For communication with the SOP-20-880 or PC (RS485-RS232 converter required), identical for multiple HCU cascade units, connection cable less than 3 m.

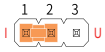
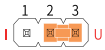
5.5.2 Terminals Description

Terminal	Name	Function	Cable size
XPWR: input power terminal			
1	GND	24.0 VDC±10%, 2.0 A	Dual-core twisted-pair cables are recommended. Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	24V		
XDPWR: DIL terminal			
1	24VD	Power supply for DI, HDI and HDO, 24.0 VDC±10%, 0.2 A	Twisted pairs, single-core cables Cross-sectional area: 0.5 mm^2 to 2.5 mm^2 Note: The load of 24VD must not exceed 0.2 A
2	DGND	24VD ground	
3	DICOM	DI common output which can be connected to DGND through jumper J11	
4	DIL	Digital interlock or common DI, technical parameters are the same as common DI	

Terminal	Name	Function	Cable size
Jumper J16: power supply selection			
		By shorting 1 and 2, DI is powered by 24VD internal power supply	
		By shorting 2 and 3, DI is powered by external power supply	
XDI: DI input terminal			
1	DI1	24 V logic level: "0" < 5 V; "1" > 15 V; Rin: 2.0 kohm Input type: NPN/PNP, relay contact Hardware filtering: 0.04 ms Imax: 15 mA	Single-core cable Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	DI2		
3	DI3		
4	DI4		
5	DI5		
6	DI6		
XHDIO: HDIO input terminal			
1	OP	HDI common terminal	Shielded twisted pairs are recommended. HDO and OP twisted pair HDI and DGND twisted pair Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	HDI1	Input type: NPN, PNP 24 V logic level: "0" < 5 V; "1" > 15 V; Rin: 2.0 kohm Input voltage range: 0 VDC to 30 VDC Input frequency range: 0 kHz to 100 kHz HDI max. load Imax: 15 mA	
3	HDI2		
4	HDO1	Output type: OC Output frequency range: 0 kHz to 100 kHz HDO max. load Imax: 20 mA Output voltage range: 0 VDC to 26.4 VDC	
5	HDO2		
XAO: AO output terminal			
1	AO1	AO1 output range: 0 mA to 20 mA Rload ⩽ 500 ohm 0 V to 10 V, Rload ⩾ 10 kohm AO2 output range: 0 mA to 20 mA Rload ⩽ 500 ohm 0 V to 10 V, Rload ⩾ 10 kohm Resolution: 11 bit + sign bit Accuracy: 2% full scale range	Shielded twisted pairs are recommended. AO1 and AO1_AGND twisted pair AO2 and AO2_AGND twisted pair Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	AO1_AGND		
3	AO2		
4	AO2_AGND		
Jumper J19: AO1 current and voltage signal selection			

<table>
<tr><th>Terminal</th><th>Name</th><th>Function</th><th>Cable size</th></tr>
<tr><td colspan="2"></td><td colspan="2">AO1 current signal output by shorting 1 and 2</td></tr>
<tr><td colspan="2"></td><td colspan="2">AO1 voltage signal output by shorting 2 and 3</td></tr>
<tr><td colspan="4">Jumper J18: AO2 current and voltage signal selection</td></tr>
<tr><td colspan="2"></td><td colspan="2">AO2 current signal output by shorting 1 and 2</td></tr>
<tr><td colspan="2"></td><td colspan="2">AO2 voltage signal output by shorting 2 and 3</td></tr>
<tr><td colspan="4">XAI: AI input terminal</td></tr>
<tr><td>1</td><td>AI1-</td><td rowspan="4">Current input: –20 mA to +20 mA, Rin: 500 ohm
Voltage input: –10 V to +10 V, Rin: 200 kohm
Differential input, input range: ±30 V
Sample interval per channel: 0.25 ms
Hardware filtering: 0.25 ms
Resolution: 11 bit + sign bit
Error: 1% full scale range</td><td rowspan="7">Use two 2-core twisted-pair shielded cables when using a two-channel AI;
Use one 4-core twisted-pair shielded cable for a single-channel AI when reference voltage is provided
Cross-sectional area: 0.5 mm^2 to 2.5 mm^2</td></tr>
<tr><td>2</td><td>AI1+</td></tr>
<tr><td>3</td><td>AI2-</td></tr>
<tr><td>4</td><td>AI2+</td></tr>
<tr><td>5</td><td>+10V</td><td rowspan="3">+10V: +10 V±1%
–10V: –10 V±1%
Rload: 1 kohm to 10 kohm</td></tr>
<tr><td>6</td><td>-10V</td></tr>
<tr><td>7</td><td>AGND</td></tr>
<tr><td colspan="4">Jumper J14: AI1 current or voltage signal input selection</td></tr>
<tr><td colspan="2"></td><td colspan="2">AI1 current signal input by shorting 1 and 2</td></tr>
<tr><td colspan="2"></td><td colspan="2">AI1 voltage signal input by shorting 2 and 3</td></tr>
<tr><td colspan="4">Jumper J15: AI2 current and voltage signal selection</td></tr>
<tr><td colspan="2"></td><td colspan="2">AI2 current signal input by shorting 1 and 2</td></tr>
<tr><td colspan="2"></td><td colspan="2">AI2 voltage signal input by shorting 2 and 3</td></tr>
<tr><td colspan="4">XCOMM: InoLink RS485 communication terminal</td></tr>
</table>

Terminal	Name	Function	Cable size
1	SHIELD	RS485 bus, standard level 5 V Termination resistor of the bus: 124 ohm Max. communication speed: 10 Mbps Max. number of nodes: 32 (without repeater) Max. transmission distance: 1200 m	4-core shielded twisted-pair cable When used for Inolink, the maximum number of nodes is 16, the maximum speed is 4 Mbps, and the maximum cable length is 40 m Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	C485+		
3	C485-		
4	CGND		
Jumpers J10 and J12: RS485 termination resistor selection (J10 and J12 must be in the same status.)			
		Connect the termination resistor by shorting 1 and 2	
		Disconnect the termination resistor by shorting 2 and 3.	
XRO1: output terminal of relay 1			
1	RO1_NO	Output type: passive NO and NC contacts Contact parameters: 250 VAC/30 VDC, 2 A	Single-core cable Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	RO1_COM		
3	RO1_NC		
XRO2: output terminal of relay 2			
1	RO2_NO	Output type: passive NO and NC contacts Contact parameters: 250 VAC/30 VDC, 2 A	Single-core cable Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	RO2_COM		
3	RO2_NC		
XRO3: output terminal of relay 3			
1	RO3_NO	Output type: passive NO and NC contacts Contact parameters: 250 VAC/30 VDC, 2 A	Single-core cable Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
2	RO3_COM		
3	RO3_NC		
X11, X12: RS485 communication terminals for PC or SOP-20-880			
1, 2, 7	N/C	RS485 bus, standard level 5 V Termination resistor of the bus: 124 ohm Max. communication speed: 4 Mbps Max. number of nodes: 32 (without repeater) Max. transmission distance: 1200 m	Standard LAN cable
3, 8	GND		
4	A		
5	B		
6	15V3	15V3: 15 V±15%	
Jumpers J12 and J15: termination resistor selection (J12 and J15 must be in the same status.)			

Terminal	Name	Function	Cable size
		Connect the termination resistor by shorting 1 and 2.	
		Disconnect the termination resistor by shorting 2 and 3.	
VR, VT: transceiver			
1	VR	Receive optical fiber communication signals	Optical fiber type: plastic optical fiber (POF)
2	VT	Transmit optical fiber communication signals	

5.5.3 HCU Wiring Terminals

The following table lists the DI/DO terminals of HCU.

Table 5-4 HCU wiring terminals of the DC chopper module

No.	Terminal	Default function	Recommended function	Remarks
1	XRO1	Output main contactor control	-	Unchangeable
2	XRO2	Fault output control	-	Default function, configurable
3	XRO3	Pre-charge circuit contactor control	-	Unchangeable
4	DI1	-	Local/Remote switchover	Recommended function, configurable
5	DI2	Start	-	Default function, configurable
6	DI3	Main contactor feedback signal	-	Unchangeable
7	DI4	Pre-charge contactor feedback	-	Unchangeable
8	DI5	Stop	-	Default function, configurable
9	DI6	Fault reset	-	Default function, configurable
10	DIL	Emergency stop signal	-	Default function, configurable
11	HDI1	Chopper reactor overtemperature fault	-	Unchangeable

5.6 HPCU Parallel Control Module

The HPCU parallel control module serves to receive drive and control signals sent from the HCU through communication and transmits such signals to each DC chopper module synchronously, acting as an intermediary in the system. Meanwhile, it uploads the current, voltage, and status data sent from the chopper to the HCU and controls synchronization, current sharing, reset, and start/stop operations of chopper modules connected in parallel.

Depending on system requirements, HPCU-40 (up to 4 parallel modules), HPCU-60 (up to 6 parallel modules) or HPCU-A0 (up to 10 parallel modules) can be selected.

5.6.1 Standard Terminals

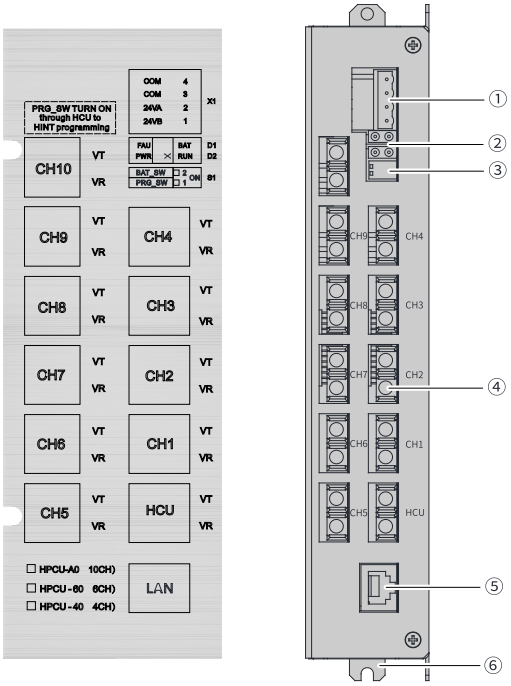


Figure 5-7 Standard HPCU terminals

Table 5–5 Description of standard HPCU terminals

No.	Name	Description	Description
①	Input power supply	COM: 24 V GND	External power supply of HPCU X1 terminal: 5.08 mm pitch, 4-pin black pluggable terminal Twisted pair cable Cross-sectional area: 0.5 mm^2 to 2.5 mm^2
		COM: 24 V GND	
		24VA: Input power A, 24.0 V±10% , 0.5 A	
		24VB: Input power B (redundant design), 24.0 V±10% , 0.5 A	
②	LED indicators	PWR/BAT/TX/RX	Power/Battery/Transmit/Receive
③	Battery DIP switch	S2: BAT_SW	Reserved
④	Optical fiber transceiver	CH1 to CH10 (parallel module channel 1 to channel 10)	VT: 80 M, transmit optical fiber communication signals VR: 80 M, receive optical fiber communication signals Optical fiber type: plastic optical fiber (POF) HPCU-40 contains channels: CH1 to CH4 HPCU-60 contains channels: CH1 to CH6 HPCU-A0 contains channels: CH1 to CH10
		HCU Inodrive, communication between HPCU and HCU	
⑤	LAN	PC control terminal	-
⑥	Fixed hole	Holes for fixing the HPCU. Quantity: 4	-

5.6.2 LED Indicators

Table 5–6 Description

No.	Name	State	Description
1	PWR	Steady ON	HPCU power supply is normal.
		OFF	HPCU is not energized or the power supply has failed.
2	RUN	Steady ON	The DC chopper module is in the operation state.
		OFF	The DC chopper module is in the stop state.
3	FAU	Flashing	A system fault occurs.
		OFF	The system is normal.

No.	Name	State	Description
4	BAT	Steady ON	Battery undervoltage occurs.
		OFF	The battery is normal.

5.6.3 Electrical Connection of HPCU

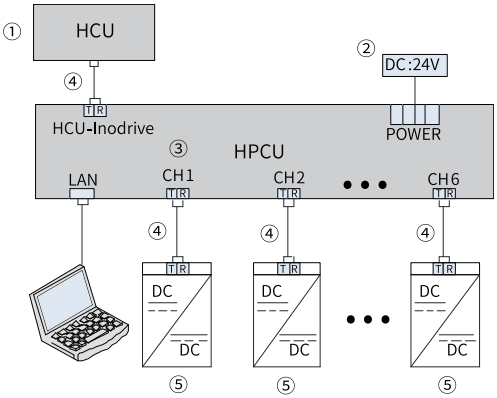


Figure 5-8 Electrical connection of HPCU

Table 5–7 Description of HPCU components

No.	Name	No.	Name
①	HCU control module	④	Optical fiber communication
②	External 24 VDC power supply	⑤	DC chopper module
③	HPCU parallel control module	-	-

5.7 HCU Control Module Function Applications

5.7.1 HCU Function Modules

The HCU can be used with other function modules to expand its functions. See the following table for details.

Table 5–8 Expansion modules used with HCU

No.	Name	Model	Description	Connection method	Dimensions (L x W x H) (mm)
1	I/O module	HIO-10	2 AIs 2 AOs 2 DIOs 1 relay output	SLOT	105 x 73 x 24
2	PROFIBUS-DP module	HDP-10	PROFIBUS-DP bus adaptation	SLOT	75 x 73 x 24
3	CANbus module	HCAN-10	CANopen bus adaptation	SLOT	75 x 73 x 24
4	MODBUS RTU module	HMBA-10	Modbus RTU bus adapter card	SLOT	75 x 73 x 24
5	EtherNet module	HETN-10	Ethernet commissioning module	SLOT	75 x 73 x 24
6	PROFINET I/O module	HPFN-10	PROFINET I/O industrial Ethernet	SLOT	75 x 73 x 24
7	MODBUS TCP module	HMBT-10	MODBUS TCP industrial Ethernet	SLOT	75 x 73 x 24
8	Optical fiber expansion module	HOFM-10	1 pair of 80 M optical fiber cables	SLOT	75 x 73 x 24
		HOFM-30	3 pair of 80 M optical fiber cables	SLOT	75 x 73 x 24
9	Parallel control module	HPCU-40	Supporting 2 to 4 parallel modules	Optical fiber	232 x 86 x 40
		HPCU-60	Supporting 2 to 6 parallel modules	Optical fiber	232 x 86 x 40
		HPCU-A0	Supporting 2 to 10 parallel modules	Optical fiber	232 x 86 x 40
10	Expansion module	HESD-10	1 SLOT expansion	Optical fiber	105 x 75 x 70
11	Sync voltage and current detection module	HSVM-20	DC voltage and current detection	Optical fiber	150 x 100 x 30
12	SOP	SOP-20-880	HMI	RS485	150 x 100 x 30

Note

- HOFM-30 can only be installed in SLOT1 or SLOT2.
- HDP-10 is recommended to be installed in SLOT3.

5.7.2 SLOT Expansion

Different function modules are available in the HCU application. The function modules are installed directly in the slots of the HCU.

The HCU only has three SLOT slots. When more modules are needed, install HOFM and HESD expansion modules. Each HESD can connect to one function module.

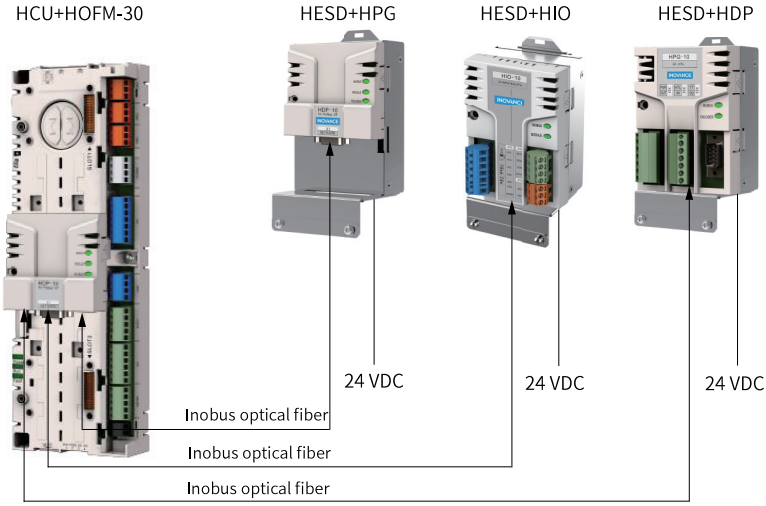


Figure 5-9 HESD wiring example

- Function modules can be directly installed in SLOT1, SLOT2 and SLOT3. The addresses are: SLOT1_1, SLOT2_1, and SLOT3_1.
- The SLOT1 and SLOT2 slots can be used with the HOFM-30 module to achieve up to three slot expansions. The addresses are SLOT1_1, SLOT1_2, SLOT1_3 for SLOT1 and SLOT2_1, SLOT2_2, SLOT2_3 for SLOT2 respectively.
- SLOT3 does not support slot expansion.
- In this case, the HESD module is not allowed to install another HOFM optical fiber expansion module.

6 Maintenance

6.1 Precautions on Cleaning



- Use a vacuum cleaner and a soft brush. For areas that cannot be easily reached, use dry compressed air (max. 1 bar) for cleaning.
- Always keep the air vents unobstructed and ensure that the cooling fan is functioning properly.
- Dust buildup inside the module must be cleaned thoroughly by authorized personnel in compliance with the safety regulations at least annually or more frequently if necessary.

6.2 Precautions Before Maintenance and Repair



- After you disconnect power from the system, always wait at least 15 minutes and confirm that the bus voltage of the chopper module is below 36 VDC. Otherwise, the residual charge on the capacitor will cause injury.
- When the external power supply is connected, hazardous voltage is still present even if the main circuit breaker is open. The fan has a tendency to continue its circular motion even after it is switched off due to the inertia of motion.

6.3 Precautions During Maintenance and Repair



- Only qualified personnel can install, repair and maintain the chopper module.
- The tools you use must meet the voltage withstand requirements and the housing must be well grounded.
- Follow operating instructions before starting any maintenance or repair work.
- Be careful with measurement inside the cabinet. Never touch the multimeter probes together or touch the other terminals by the probes.
- Carry out the work only after you de-energize and cool off the module.
- Follow standard safety precautions and local codes during installation and wiring.
- Residual voltage is still present in the cabinet even after you switch off the input circuit breaker. Check that no voltage exists before maintenance or repair.

6.4 Routine Maintenance

All available electrical components shall be inspected for possible wear and damage. The water quality needs to be tested regularly to meet the requirements in *"1.2 Technical Data" on page 13*.

6.5 Periodic Maintenance

Service Life of Components

Long term operation requires regular maintenance of the chopper module. The service life of the module components depends on the operating environment and conditions. The following tables lists the maintenance interval for your reference.

Table 6–1 Replacement interval of components

Name	Standard service life
Main cooling fan	8 years
Electrolytic capacitor	10 years
Control room cooling fan	10 years

Cable Terminals and Fasteners

Check whether the cable terminals and screws are secure. If not, tighten them. Check the cabling fault. If any component is damaged, replace it immediately.

Note

The actual maintenance cycle is determined by the mounting environment and operating conditions of the equipment.

6.6 Parts Replacement

6.6.1 Safety Precautions



- Be aware that the chopper module is operated with high voltage.
- All connection work must be done only after the module is de-energized.
- Only trained personnel can perform the maintenance and repair work. Failure to comply may result in severe injury, death, or property damage.
- Be careful with the work due to the possible external power supply voltage. Even when the motor does not rotate, the power supply and terminals may still carry voltage.
- The DC chopper module must be handled with care by trained personnel. Improper lifting or handling may result in severe injury, death, or property damage.

These electrical safety precautions are for all personnel who do maintenance and repair work.

1. Obtain work authorization from the person responsible for electrical installation.
2. Clearly identify the workplace and equipment.
3. Disconnect all possible voltage sources. Make sure that re-connection is not possible. Lock out and tag out.
   a. Open the main disconnecting device of the drive.
   b. Open the disconnector of the supply transformer.
   c. If you have a permanent magnet motor connected to the drive, disconnect the motor from the drive with a safety switch or by other means.
   d. Disconnect any dangerous external voltages from the control circuits.
   e. After you disconnect power from the drive, always wait at least 15 minutes to let the DC bus voltage be close to 0 V before you continue.
4. Avoid contact with any live parts in the workplace during maintenance and service.
5. Take special precautions when working near bare conductors.

6. Measure the voltage of the device to ensure that the device has been de-energized. Measure that the installation is de-energized. If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).
   - Make sure that the voltage between the drive input power terminals (L1, L2, L3) and the grounding (PE) busbar is close to 0 V.
   - Make sure that the voltage between the drive output terminals (U, V, W) and the grounding (PE) busbar is close to 0 V.
   - Make sure that the voltage between the drive DC busbar (+ and -) and the grounding (PE) busbar is close to 0 V.
7. Install temporary grounding as required by local code.

6.6.2 Overview

For the cabinet design, see *"2.3.3 Recommended Cabinet Layout" on page 30*. This section describes the components that need to be replaced at maintenance and inspection. The other components are not subject to wear normally and thus are not described here.

6.6.3 Maintainable Parts

Table 6–2 Maintainable Parts

No.	Name
1	DC fan
2	H7 DC chopper module
3	HCU control module
4	SOP-20-880 battery

6.6.4 Maintenance Tools

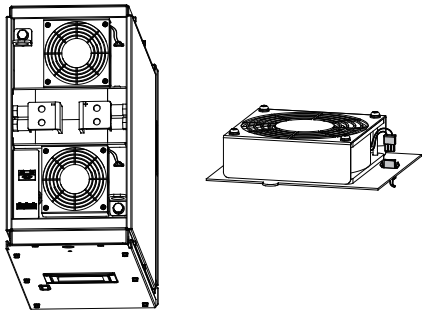
The following tools are required to repair or replace the parts.

- Torque wrench
- Phillips screwdriver, dimension 1/2
- Wrench or socket wrench, wrench opening angle 6
- Wrench or socket wrench, wrench opening angle 8
- Wrench or socket wrench, wrench opening angle 10
- Wrench or socket wrench, wrench opening angle 13
- It is recommended to use a socket wrench kit that carries two extension rods.

6.6.5 Replacing the DC Fan

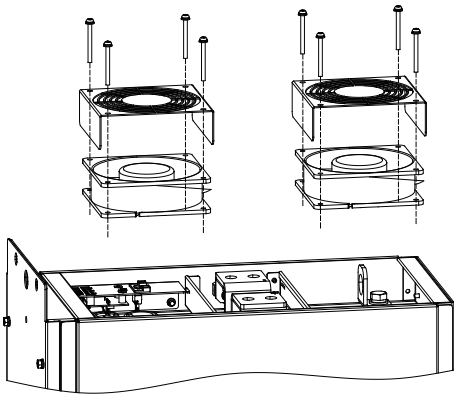
1. Follow the electrical safety procedures before you start.

2. Disconnect the fan wiring.



3. Undo the four M4 screws and pull the fan components out.

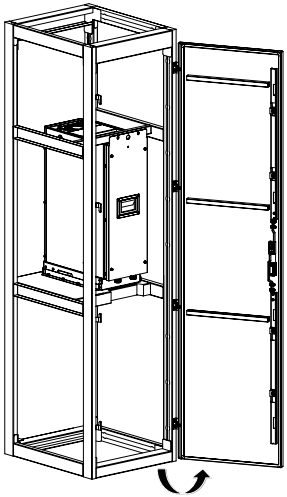
4. Install a new fan of the same specification in the same procedure, but in the reverse order.



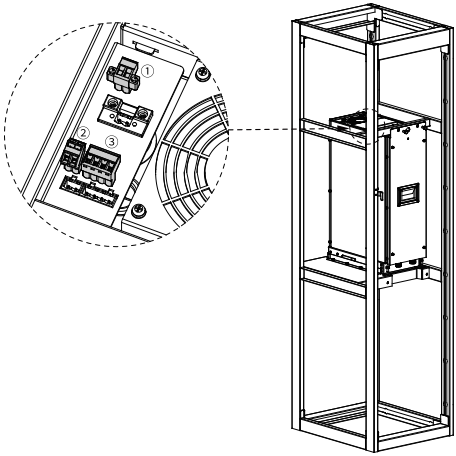
6.6.6 Replacing the H7 DC Chopper Module

1. Follow the electrical safety procedures before you start.

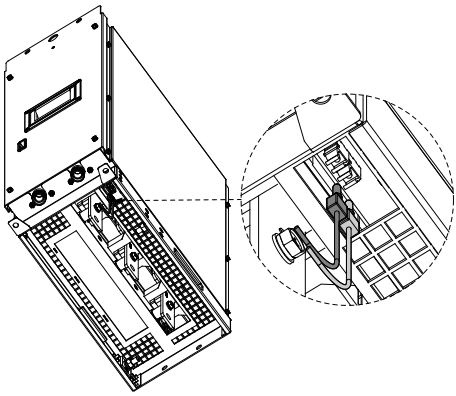
2. Open the cabinet door.



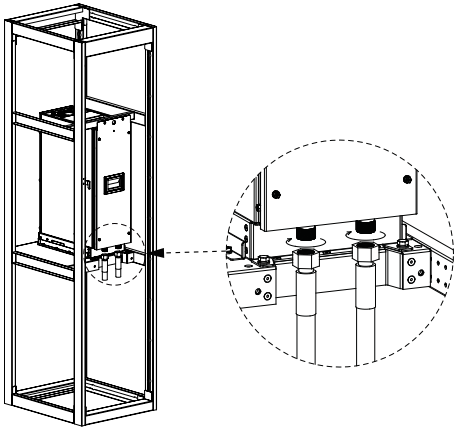
3. Unplug the wiring of control circuit terminals ①, ② and ③ at the top of DC chopper module. See *"3.8.1 Description of Control Circuit Terminals" on page 56* for control circuit terminal description.



4. Unplug the optical fiber from the bottom of the DC chopper module and place it in a proper position to avoid damage.

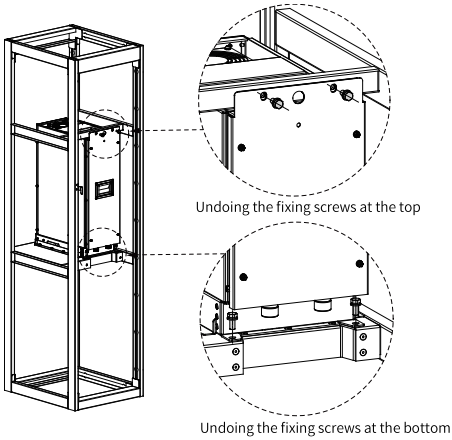


5. Drain all coolant inside the DC chopper module and remove the incoming and outgoing pipes. During pipe removal, lead water to a suitable container to prevent water contamination of the live equipment inside the cabinet.

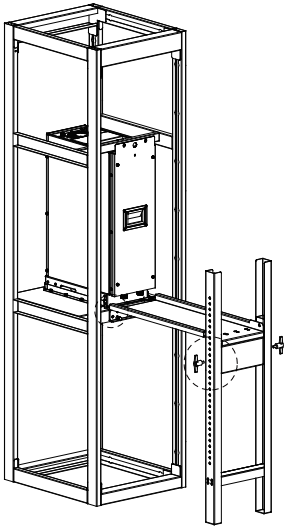


6. Disconnect the incoming and outgoing cables or copper busbars of the main circuit.

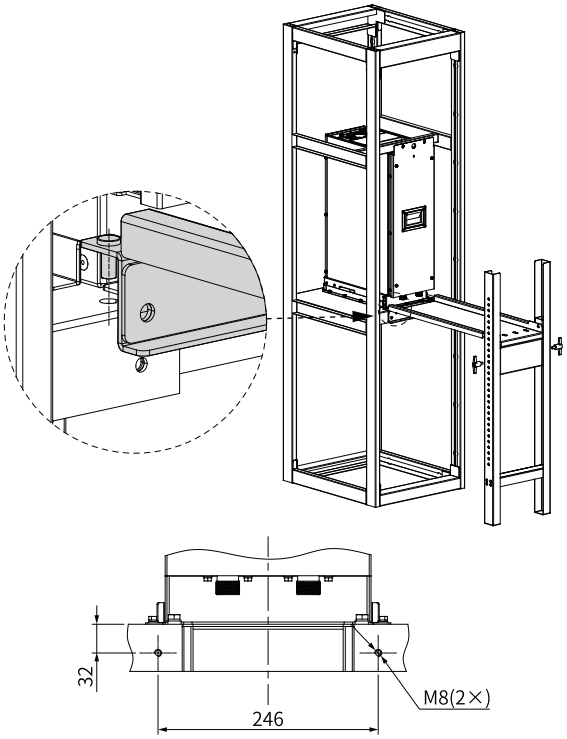
7. Undo the fixing screws at the top and bottom of the module.



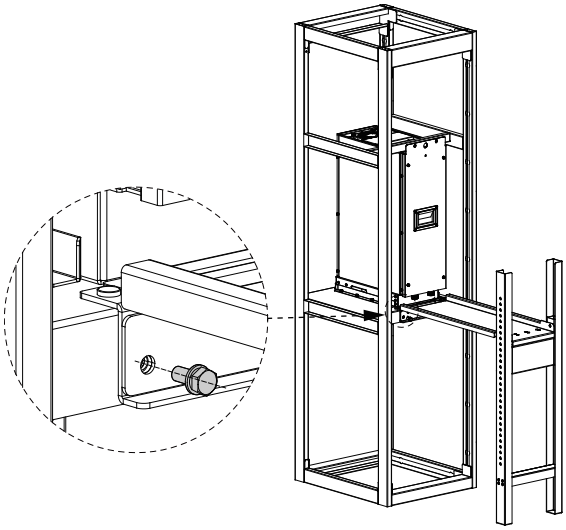
8. Install the supporting bracket for maintenance.



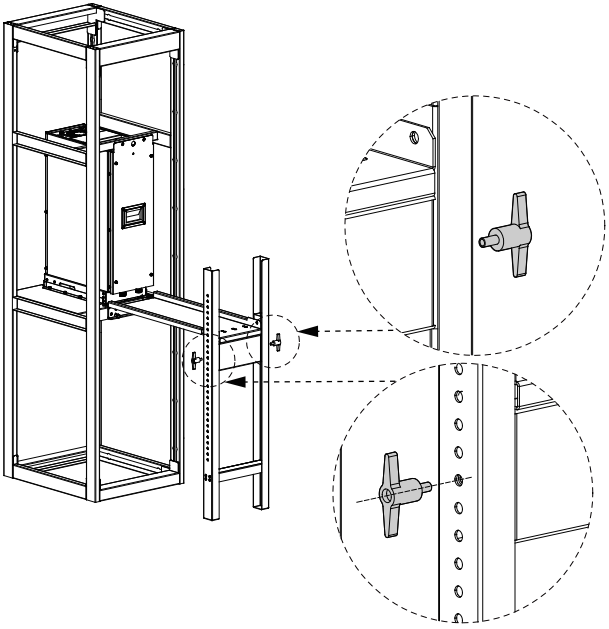
a. Place locating pins into the positioning holes and the following figure show the details.



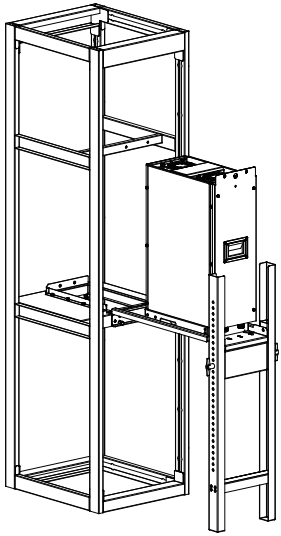
b. Fasten the bracket with two M8 screws.



c. Adjust with wing screws.



9. Slide out the module onto the supporting bracket.



10. Move the module onto the wooden pallet, and forklift it to the maintenance site.

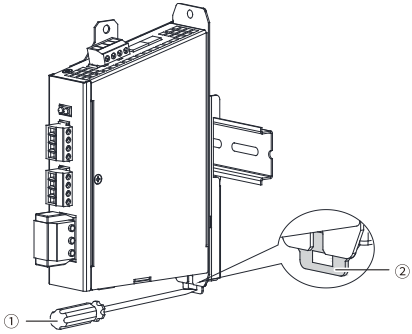
11. Install the chopper module in reverse order.

6.6.7 Replacing HSVM-20

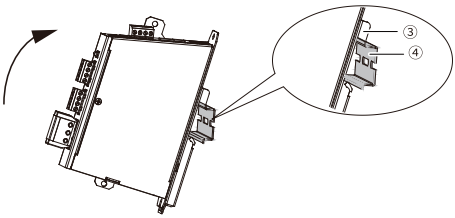
1. Follow the electrical safety procedures before you start.

2. Unplug all cables connected to the module.

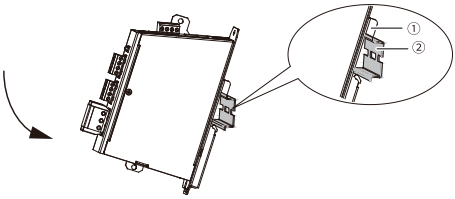
3. Press down with a screwdriver ① to unlock the guide rail mechanism ②.



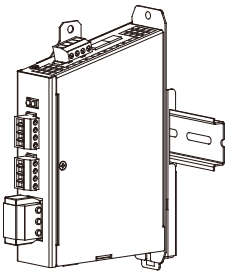
4. Rotate the module in the direction indicated by the arrow to remove the slot ③ from the guide rail ④.



5. Hold the HSVM-20 module to be installed, align the module slot with the guide rail, and slide the lower part of the slot ① in the direction indicated by the arrow until it fully engages with the guide rail ②.



6. The figure on the right shows how it looks after installation.



7. Connect the 24 VDC external power supply to the X4 terminal to complete the installation.

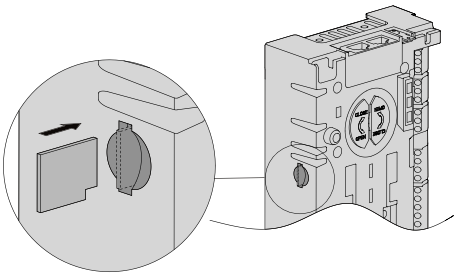
6.6.8 HCU Maintenance

After replacing the HCU control module, you can reserve present parameter settings by inserting the original SD card to the new module. The following shows the procedure for installing/removing the SD card.

1. Follow the electrical safety procedures before you start.

2. Press the SD memory card to eject it and withdraw it straight out.

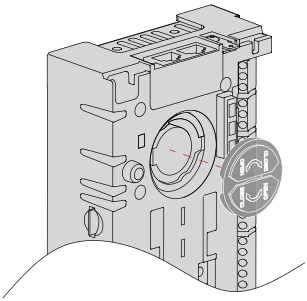
3. Push the SD memory card in the direction as shown below into the card holder of the control module.



4. Ensure the SD memory card is pushed into position. Otherwise, an abnormality will occur due to poor contact.

The following shows how to replace the battery.

1. Turn the battery cover 90° counterclockwise with a 2# straight screwdriver to open the cover.



2. Carefully pull the HCU battery out of and put a new one into the battery holder.

3. Close the cover and tighten the screws.

4. Dispose of the retired battery according to local laws and regulations.

6.6.9 Replacing the SOP-20-880 Battery

1. Follow the electrical safety procedures before you start.

2. Use a screwdriver or your fingers to remove the battery cover.

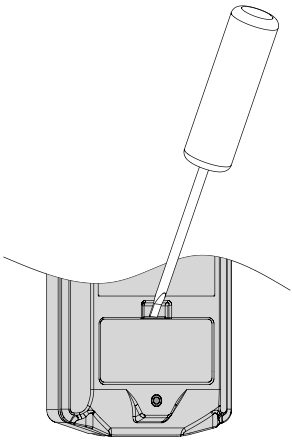


Figure 6-1 Opening the back battery cover

3. Take out the battery with a tweezer or a straight screwdriver.

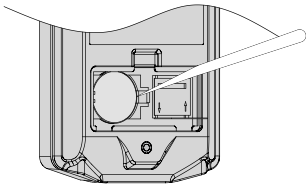


Figure 6-2 Taking out the battery

4. Place the battery into the battery holder (A side) first and then press the other end (B side).

5. Put the battery cover back.

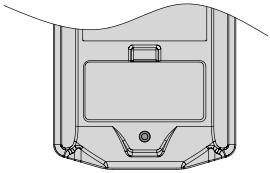


Figure 6-3 Putting the battery cover back

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