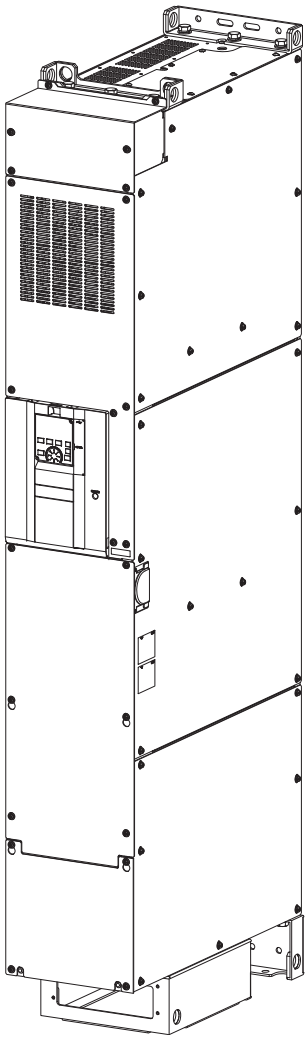
MITSUBISHI ELECTRIC

INVERTER
A800-E
FR-A872-E (SEPARATED CONVERTER TYPE)
INSTRUCTION MANUAL (HARDWARE)

High functionality and high performance

FR-A872-05690 to 07150-E



Safety instructions

Thank you for choosing Mitsubishi Electric inverter.
This Instruction Manual describes handling and cautions about the hardware, such as installation and wiring, for the FR-A802 (separated converter type) inverter that are different from the FR-A800.
Information about the software, such as basic operations and parameters, is described in the FR-A870 Instruction Manual (Function) on the CD-ROM enclosed with the product. For the details of Ethernet communication, refer to the FR-A800-E Ethernet Function Manual on the enclosed CD-ROM. In addition to this manual, read all the relevant instruction manuals on the enclosed CD-ROM carefully to ensure proper use. Do not use this product until you have full knowledge of this product's workings, safety information and instructions.
Please forward this Instruction Manual to the end user.
Do not attempt to install, operate, maintain or inspect this product until you have read the Instruction Manuals and supplementary documents carefully. Do not use this product until you have full knowledge of this product mechanism, safety information and instructions.
Installation, operation, maintenance and inspection must be performed by qualified personnel. Here, qualified personnel means a person who meets all the following conditions:

- A person who possesses a certification in regard with electric appliance handling, or person took a proper engineering training. Such training may be available at your local Mitsubishi Electric office. Contact your local sales office for schedules and locations.
- A person who can access operating manuals for the protective devices (for example, light curtain) connected to the safety control system, or a person who has read these manuals thoroughly and familiarized themselves with the protective devices.

In this Instruction Manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

⚠WARNING	**Incorrect handling may cause hazardous conditions, resulting in death or severe injury.**
⚠CAUTION	**Incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause only material damage.**

Note that even the ⚠ CAUTION level may lead to a serious consequence depending on conditions. Be sure to follow the instructions of both levels as they are critical to personnel safety.

◆Electric shock prevention

⚠WARNING

- Do not remove the front cover or the wiring cover while the power of this product is ON, and do not run this product with the front cover or the wiring cover removed as the exposed high voltage terminals or the charging part of the circuitry can be touched. Otherwise you may get an electric shock.
- Even if power is OFF, do not remove the front cover except for wiring or periodic inspection. as the inside of this product is charged. Otherwise you may get an electric shock.
- Before wiring or inspection, check that the LED display of the operation panel is OFF. Any person who is involved in wiring or inspection shall wait for 10 minutes or longer after the power supply has been cut off, and check that there are no residual voltage using a digital multimeter or the like. The capacitor is charged with high voltage for some time after power OFF, and it is dangerous.
- Be sure to earth (ground) the inverter. Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 61140 class 1 and other applicable standards).
- Any person who is involved in wiring or inspection of this product shall be fully competent to do the work.
- This product body must be installed before wiring. Otherwise you may get an electric shock or be injured.
- Do not touch the setting dial or keys with wed hands. Doing so may cause an electric shock.
- Do not subject the cables to scratches, excessive stress, heavy loads or pinching. Doing so may cause an electric shock.
- Do not change the cooling fan while power is ON as it is dangerous.
- Do not touch the printed circuit board or handle the cables with wet hands. Doing so may cause an electric shock.

◆Fire prevention

⚠CAUTION

- This product must be installed on a nonflammable wall without holes in it so that its components cannot be touched from behind. Installing it on or near flammable material may cause a fire.
- If this product becomes faulty, the product power must be switched OFF. A continuous flow of large current may cause a fire.
- Be sure to perform daily and periodic inspections as specified in the Instruction Manual. There is a possibility of explosion, damage, or fire if this product is used without inspection.

◆Injury prevention

⚠CAUTION

- The voltage applied to each terminal must be as specified in the Instruction Manual. Otherwise an explosion or damage may occur.
- The cables must be connected to the correct terminals. Otherwise an explosion or damage may occur.
- The polarity (+ and -) must be correct. Otherwise an explosion or damage may occur.
- While power is ON or for some time after power-OFF, do not touch this product as it will be extremely hot. Doing so may cause burns.

◆Additional instructions

The following instructions must be also followed. If this product is handled incorrectly, it may cause unexpected fault, an injury, or an electric shock.

⚠CAUTION

Transportation and installation

- To prevent injury, wear cut-resistant gloves when opening packaging with sharp tools.
- Use proper lifting techniques or a trolley when carrying products. Failure to do so may lead to injuries.
- Do not stand or place any heavy object on this product.
- Do not stack the boxes containing this product higher than the number recommended.
- When carrying this product, do not hold it by the front cover. It may fall or break.
- During installation, caution must be taken not to drop this product as doing so may cause injuries.
- The product must be installed on a surface that withstands the weight of the product.
- Do not install this product on a hot surface.
- Ensure the mounting orientation of this product is correct.
- Ensure this product is mounted securely in its enclosure.
- Do not install or operate this product if it is damaged or has parts missing.
- Foreign conductive objects must be prevented from entering this product. That includes screws and metal fragments or other flammable substance such as oil.
- As this product is a precision instrument, do not drop or subject it to impact.
- The surrounding air temperature must be between -10°C and +40°C (non-freezing). Otherwise this product may be damaged.
- The ambient humidity must be 95% RH or less (non-condensing) for this product. Otherwise this product may be damaged. (Refer to page 24 for details.)
- The temporary storage temperature (applicable to a short limited time such as a transportation time) must be between -20°C and +65°C. Otherwise this product may be damaged.
- This product must be used indoors (without corrosive gas, flammable gas, oil mist, dust and dirt). Otherwise this product may be damaged.
- This product must not be used at an altitude above 4000 m. The maximum amplitude amount must be 0.075 mm (frequency range: 10 to 57 Hz), and the maximum acceleration speed must be 1G (frequency range: 57 to 150 Hz). Otherwise this product may be damaged. (Refer to page 24 for details.)
- If halogens (including fluorine, chlorine, bromine, and iodine) contained in fumigants for wood packages enter this product, the product may be damaged. Prevent the entry of fumigant residuals or use an alternative method such as heat disinfection. Note that sterilization or disinfection of wood packages should be performed before packing the product.

Wiring

- Do not install a power factor correction capacitor, surge absorber, or radio noise filter on the output side of this product. These devices may overheat or burn out.
- The output of this product (output terminals U, V, W) must be correctly connected to a motor. Otherwise the motor will rotate inversely.

Test operation

- Before starting the test operation, confirm or adjust the parameter settings. Failure to do so may cause some machines to make unexpected motions.

⚠ WARNING

Usage

- Stay away from the equipment after using the retry function in this product as the equipment will restart suddenly after the output shutoff of this product.
- Depending on the function settings of this product, the product does not stop its output even when the STOP/RESET key on the operation panel is pressed. To prepare for it, provide a separate circuit and switch (to turn OFF the power of this product, or apply a mechanical brake, etc.) for an emergency stop.
- Be sure to turn OFF the start (STF/STR) signal before clearing the fault as this product will restart the motor suddenly after a fault is cleared.
- Use only a three-phase induction motor as a load on this product. Connection of any other electrical equipment to the output of this product may damage the equipment.
- Performing pre-excitation (by using the LX or X13 signal) during torque control (under Real sensorless vector control) may rotate a motor at a low speed even though a start command (STF or STR) is not given. This product with the start command ON may also rotate the motor at a low speed when the speed limit value is set to zero. Confirm that the motor running does not cause any safety problems before performing pre-excitation.
- Do not modify this product.
- Do not remove any part which is not instructed to be removed in the Instruction Manuals. Doing so may lead to a failure or damage of this product.

⚠CAUTION

Usage

- The electronic thermal O/L relay function may not be enough for protection of a motor from overheating. It is recommended to install an external thermal relay or a PTC thermistor for overheat protection.
- Do not repeatedly start or stop this product with a magnetic contactor on its input side. Doing so may shorten the life of this product.
- Use a noise filter or other means to minimize electromagnetic interference with other electronic equipment used nearby this product.
- Appropriate precautions must be taken to suppress harmonics. Otherwise harmonics in power systems generated from this product may heat/damage a power factor correction capacitor or a generator.
- To drive a 690 V class motor with this product, use an insulation-enhanced motor, or take measures to suppress surge voltage. Otherwise surge voltage, which is attributed to the length and thickness of wire, may occur at the motor terminals, causing the motor insulation to deteriorate.
- As all parameters return to their initial values after the Parameter clear or All parameter clear is performed, the needed parameters for this product operation must be set again before the operation is started.
- This product can be easily set for high-speed operation. Therefore, consider all things related to the operation such as the performance of a motor and equipment in a system before the setting change.
- This product's brake function cannot be used as a mechanical brake. Use a separate device instead.
- Perform an inspection and test operation of this product if it has been stored for a long period of time.
- To avoid damage to this product due to static electricity, static electricity in your body must be discharged before you touch this product.
- In order to protect the inverter and the system against unauthorized access by external systems via network, take security measures that include firewall settings.
- Depending on the network environment, the inverter may not operate as intended due to delays or disconnection in communication. Carefully consider what type of environment this product will be used in and any safety issues related to its use.

Emergency stop

- A safety backup such as an emergency brake must be provided for devices or equipment in a system to prevent hazardous situations from occurring in case of failure of this product or an external device controlling this product.
- If the breaker installed on the input side of this product trips, check for wiring faults (such as short circuits) and damage to internal parts of this product, etc. Identify and remove the cause of the trip before resetting the tripped breaker (or before applying the power to this product again).
- When any protective function is activated, take an appropriate corrective action before resetting this product to resume the operation.

Maintenance, inspection and parts replacement

- Do not carry out a megger (insulation resistance) test on the control circuit of this product. Doing so will cause failure.

Disposal

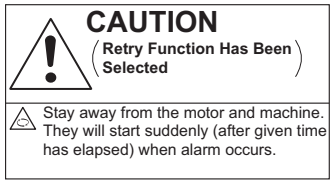
- This product must be treated as industrial waste.

Application of caution labels

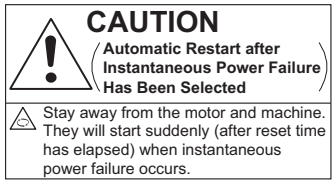
Caution labels are used to ensure safety during use of Mitsubishi Electric inverters.

Apply the following labels to the inverter if the "retry function" and/or "automatic restart after instantaneous power failure" have been enabled.

- For the retry function



- For automatic restart after instantaneous power failure



General instruction

- For clarity, illustrations in this Instruction Manual may be drawn with covers or safety guards removed. Ensure all covers and safety guards are properly installed prior to starting operation.

MEMO

CHAPTER 1 INTRODUCTION

1 INTRODUCTION

The contents described in this chapter must be read before using this product.
Always read the instructions before use.

◆ Abbreviations

Item	Description
DU	Operation panel (FR-DU08)
Operation panel	Operation panel (FR-DU08) and LCD operation panel (FR-LU08)
Parameter unit	Parameter unit (FR-PU07)
PU	Operation panel and parameter unit
Inverter	Mitsubishi Electric FR-A800 series inverter (separated converter type)
Ethernet board	Ethernet communication board (FR-A8ETH)
Vector control compatible option	FR-A8AP/FR-A8AL/FR-A8APA/FR-A8APR/FR-A8APS (plug-in option), FR-A8TP (control terminal option)
Pr.	Parameter number (Number assigned to function)
PU operation	Operation using the PU (operation panel / parameter unit)
External operation	Operation using the control circuit signals
Combined operation	Combined operation using the PU (operation panel / parameter unit) and External operation

◆ Trademarks

- Ethernet is a registered trademark of Fuji Xerox Corporation in Japan.
- Other company and product names herein are the trademarks and registered trademarks of their respective owners.

◆ Notes on descriptions in this Instruction Manual

- Connection diagrams in this Instruction Manual appear with the control logic of the input terminals as sink logic, unless otherwise specified. (For the control logic, refer to page 46.)

1.1 Product checking and accessories

Unpack the product and check the rating plate and the capacity plate of the inverter to ensure that the model is as ordered and the product is intact.

◆ Inverter model

Symbol	Voltage class
7	690V class

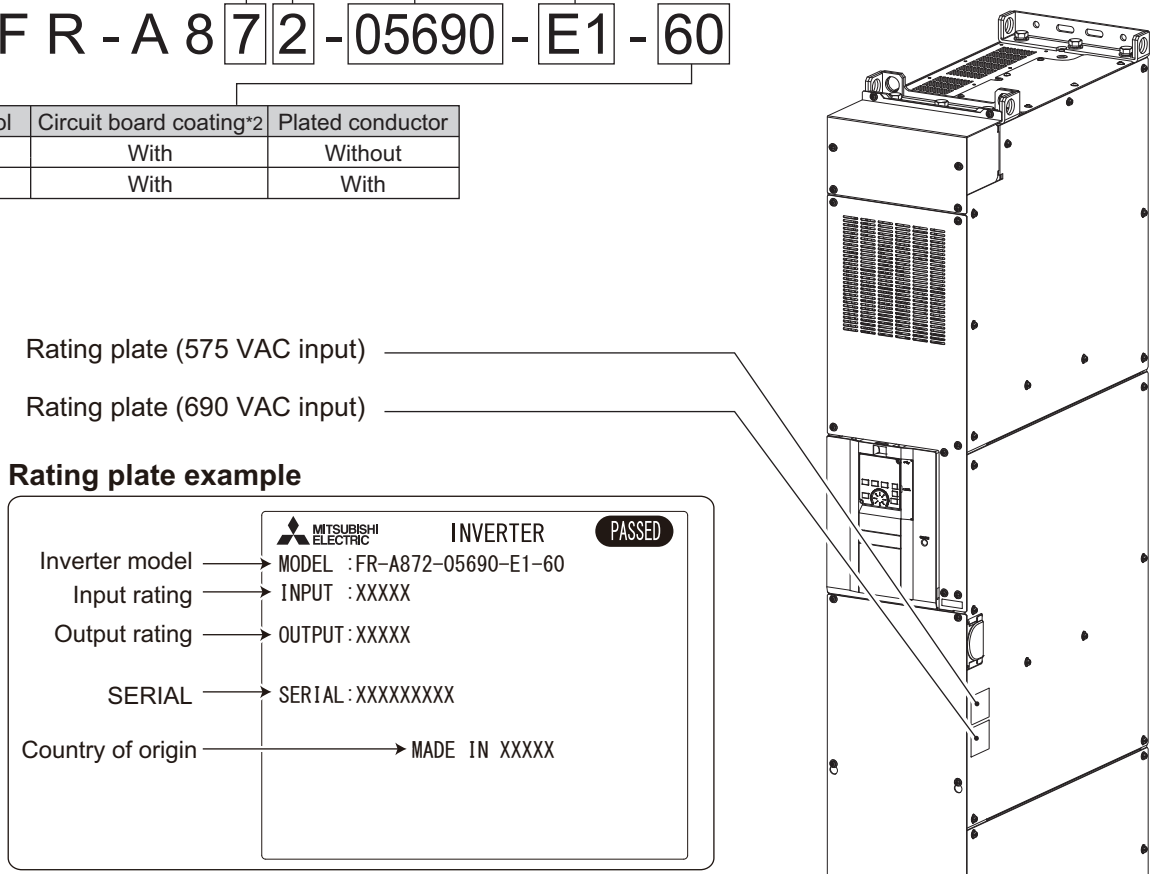
Symbol	Structure, functionality
2	Separated converter type

Symbol	Description
05690 to 07150	SLD rated inverter current (A)

Symbol	Type*1	Communication type
E1	FM	Ethernet
E2	CA	

F R - A 8 7 2 - 05690 - E1 - 60

Symbol	Circuit board coating*2	Plated conductor
60	With	Without
06	With	With



Rating plate example

*1 Specification differs by the type as follows.

Type	Monitor output	Initial setting		
		Control logic	Rated frequency	Pr.19 Base frequency voltage
FM (terminal FM equipped model)	Terminal FM (pulse train output) Terminal AM (analog voltage output (0 to ±10 VDC))	Sink logic	60 Hz	9999 (same as the power supply voltage)
CA (terminal CA equipped model)	Terminal CA (analog current output (0 to 20 mADC)) Terminal AM (analog voltage output (0 to ±10 VDC))	Source logic	50 Hz	8888 (95% of the power supply voltage)

*2 Conforming to IEC 60721-3-3 3C2/3S2

◆ How to read the SERIAL number

Rating plate example

□ ○ ○ ○○○○○○
Symbol Year Month Control number
SERIAL

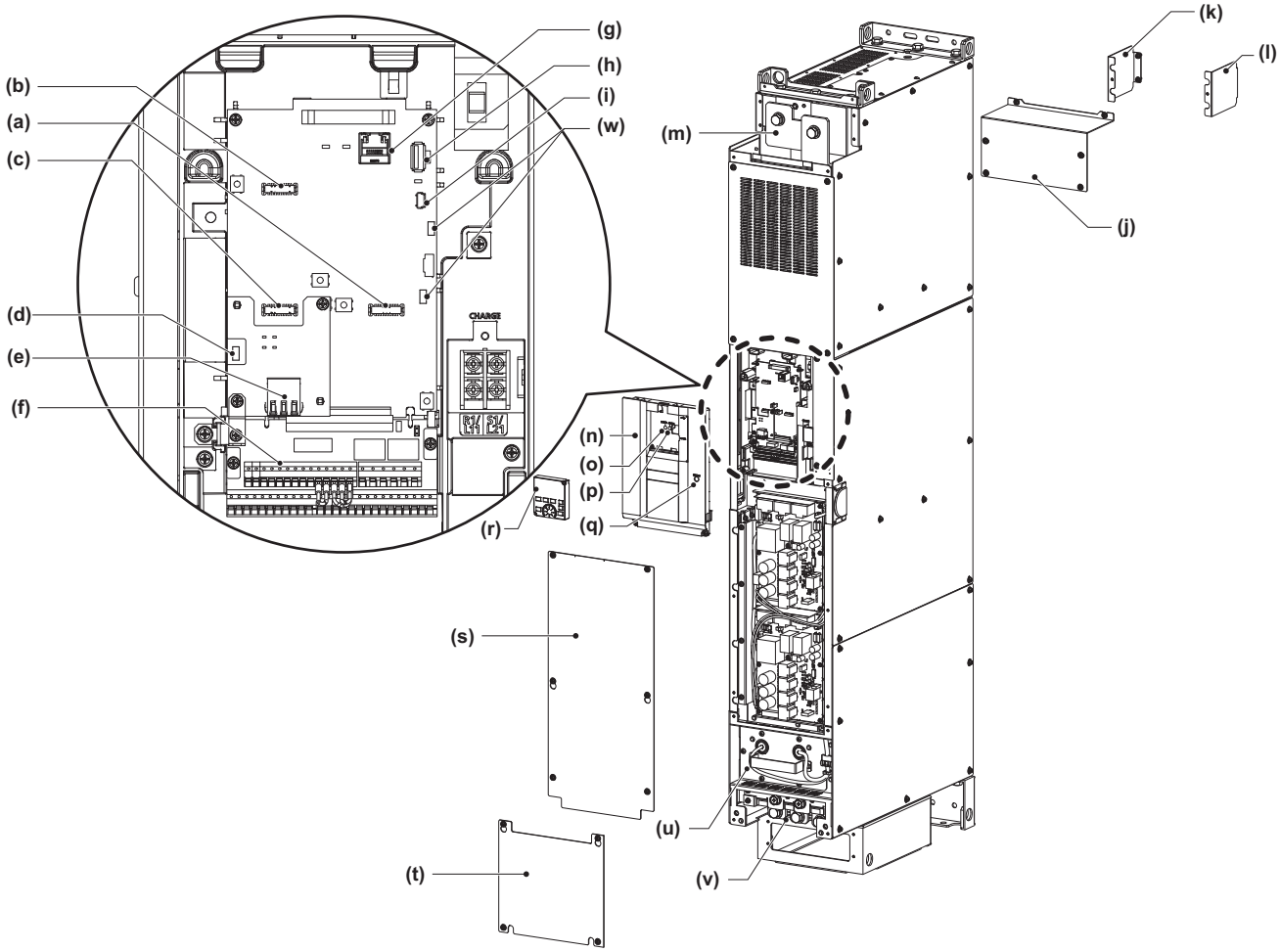
The SERIAL consists of one symbol, two characters indicating the production year and month, and six characters indicating the control number.
The last digit of the production year is indicated as the Year, and the Month is indicated by 1 to 9, X (October), Y (November), or Z (December).

◆ Accessory

- Earthing (grounding) cable (1): For connection with a communication option (refer to page 67).
- CD-ROM (1): Including the Instruction Manual (Function) and other documents.

1.2 Inverter component names

Component names are as follows.



Symbol	Name	Description	Refer to page
(a)	Plug-in option connector 1	Connects a plug-in option or a communication option.	Instruction Manual of the option
(b)	Plug-in option connector 3		
(c)	Plug-in option connector 2	The connector 2 cannot be used because the Ethernet board is installed in the initial status. The Ethernet board must be removed to install a plug-in option to the connector 2. (However, Ethernet communication is disabled in that case.)	*1
(d)	Voltage/current input switch (SW2)	Selects between voltage and current for the input via terminals 2 and 4.	*2
(e)	Ethernet communication connector	Connect the Ethernet dedicated cable for connection to the network.	58
(f)	Control circuit terminal block	Connects cables for the control circuit.	41
(g)	PU connector	Connects the operation panel (FR-DU08) or the parameter unit (FR-PU07). This connector also enables the RS-485 communication.	57
(h)	USB A connector	Connects a USB memory device.	58
(i)	USB mini B connector	The USB connection with a personal computer can be established.	58
(j)	Upper main circuit terminal cover (front)	Remove it when connecting cables to terminals P and N.	21
(k)	Upper main circuit terminal cover (left)		
(l)	Upper main circuit terminal cover (right)		
(m)	Main circuit terminal block (for terminals P and N)	Connected to the converter unit.	35
(n)	Upper front cover	Remove this cover for the installation of the product, installation of a plug-in (communication) option, switching of the voltage/current input switches, etc.	21
(o)	Power lamp	Stays ON while the power is supplied to the control circuit (R1/L11, S1/L21).	36
(p)	Alarm lamp	Turns ON when the protective function of the inverter is activated.	86
(q)	Charge lamp	Stays ON while the power is supplied to the main circuit.	36
(r)	Operation panel (FR-DU08)	Operates and monitors the inverter.	*2
(s)	Lower front cover	Remove this cover when removing the upper front cover.	21
(t)	Lower main circuit terminal block cover	Remove it when connecting cables to terminals U, V, and W.	21
(u)	Cooling fan	Cools the inverter.	97
(v)	Main circuit terminal block (for terminals U, V, and W)	Connects cables for the main circuit.	35
(w)	Switches (SW3 and SW4) for manufacturer setting	Do not change the initial setting (OFF ).	—

*1 For details on how to remove the Ethernet board, refer to the Ethernet Function Manual.
*2 Refer to the Instruction Manual (Function).

1.3 About the related manuals

The manuals related to this product are shown below.

Manual name	Manual number
FR-A870 Instruction Manual (Function)	IB-0600616ENG
FR-A800-E Ethernet Function Manual	IB-0600628ENG
FR-CC2-N Instruction Manual	IB-0600833ENG
FR-A800/F800 PLC Function Programming Manual	IB-0600492ENG
FR-A870 Safety Stop Function Instruction Manual	BCN-A23228-017(E)

MEMO

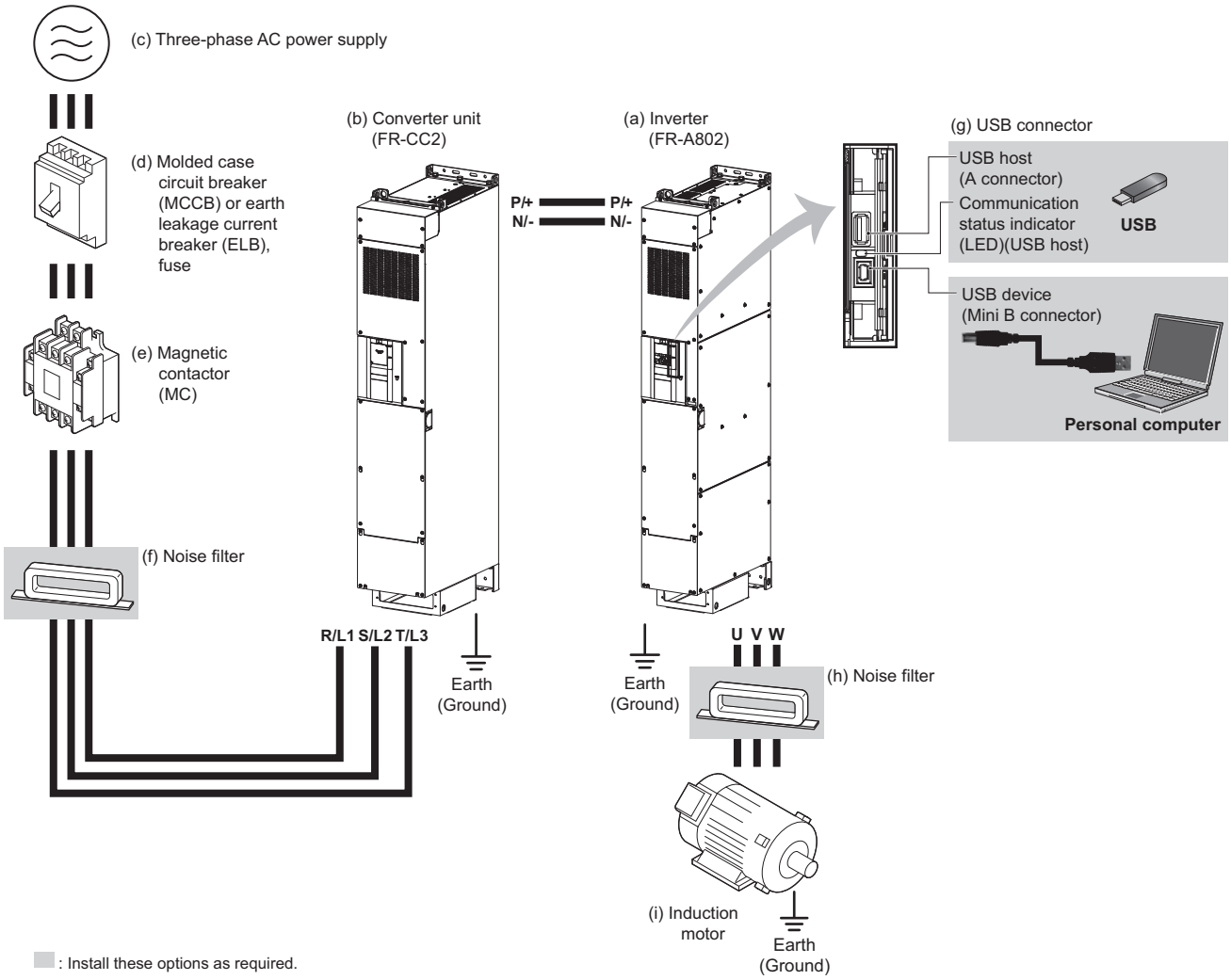
CHAPTER 2 INSTALLATION AND WIRING

2 INSTALLATION AND WIRING

This chapter explains the installation and the wiring of this product.
Always read the instructions before use.

2.1 Peripheral devices

2.1.1 Inverter and peripheral devices



NOTE

- To prevent an electric shock, always earth (ground) the motor and inverter.
- Do not install a power factor correction capacitor, surge suppressor, or capacitor type filter on the inverter's output side. Doing so will cause the inverter shut off or damage the capacitor or surge suppressor. If any of the above devices is connected, immediately remove it. When installing a molded case circuit breaker on the output side of the inverter, contact the manufacturer of the molded case circuit breaker.
- Electromagnetic wave interference:
  The input/output (main circuit) of the inverter includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the inverter. To minimize interference, enabling the built-in EMC filter or installing an external EMC filters is effective. (Refer to page 74.)
- For details of options and peripheral devices, refer to the respective Instruction Manual.

Symbol	Name	Overview	Refer to page
(a)	Inverter (FR-A802)	The life of the inverter and the converter unit is influenced by the surrounding air temperature. The surrounding air temperature should be as low as possible within the permissible range. This must be noted especially when the inverter is installed in an enclosure. Incorrect wiring may lead to damage of the inverter and the converter unit. The control signal lines must be kept fully away from the main circuit lines to protect them from noise. The built-in EMC filter of the converter unit can reduce the noise.	24, 30, 74
(b)	Converter unit (FR-CC2)		
(c)	Three-phase AC power supply	Must be within the permissible power supply specifications of the converter unit.	108
(d)	Molded case circuit breaker (MCCB), earth leakage circuit breaker (ELB), or fuse	Must be selected carefully since an inrush current flows in the converter unit at power ON.	19
(e)	Magnetic contactor (MC)	Install this to ensure safety. Do not use this to start and stop the inverter. Doing so will shorten the life of the inverter and the converter unit.	76
(f)	Noise filter	Suppresses the noise radiated from the power supply side of the converter unit.	71
(g)	USB connection	Connect between the inverter and a personal computer with a USB (ver. 1.1) cable. Use a USB memory device to copy parameter settings or use the trace function.	58
(h)	Noise filter	Install this to reduce the electromagnetic noise generated from the inverter and the converter unit. The noise filter is effective in the range from about 0.5 to 5 MHz.	71
(i)	Induction motor	Connect a squirrel-cage induction motor.	—

2.1.2 Peripheral devices

◆ Selecting the converter unit (FR-CC2)

Select the capacity of the FR-CC2 converter unit according to the connected motor capacity.

- 690 VAC power input

Motor capacity (kW)	Converter unit FR-CC2-[]	Inverter			
		SLD (superlight duty)		ND (normal duty, initial value)	
		Model FR-A872-[]	Rated current (A)	Model FR-A872-[]	Rated current (A)
450	N450K	—	—	05690	512
500	N500K	05690	569	06470	569
560	N560K	06470	647	07150	647
630	N630K	07150	715	—	—

- 575 VAC power input

Motor capacity (kW)	Converter unit FR-CC2-[]	Inverter			
		SLD (superlight duty)		ND (normal duty, initial value)	
		Model FR-A872-[]	Rated current (A)	Model FR-A872-[]	Rated current (A)
355	N450K	—	—	05690	512
400	N500K	05690	569	06470	569
450	N560K	06470	647	07150	647
500	N630K	07150	715	—	—

◆ Selecting the breaker / magnetic contactor

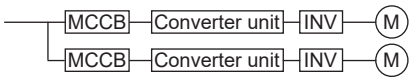
Check the model name of the inverter and the converter unit you purchased. Appropriate peripheral devices must be selected according to the capacity.

Refer to the following table to prepare appropriate peripheral devices.

Motor output (kW)	Applicable converter model*1	MCCB*1*2 or Earth Leakage Circuit Breaker (ELB)	Magnetic contactor (MC)*1*3 on converter unit's input side
450	FR-CC2-N450K	700 A	660 A
500	FR-CC2-N500K	800 A	660 A
560	FR-CC2-N560K	800 A	800 A
630	FR-CC2-N630K	900 A	800 A

*1 Assumes the use of a Mitsubishi 4-pole standard motor.

*2 Select an MCCB according to the power supply capacity.
Install one MCCB per converter unit. For the use in the United States or Canada, refer to page 120, and select the appropriate fuse.



*3 The matrix shows the magnetic contactor selected according to the standards of Japan Electrical Manufacturers' Association (JEM standards) for AC-1 class. The electrical durability of magnetic contactor is 500,000 times. When the MC is used for emergency stops during motor driving, the electrical durability is 25 times.

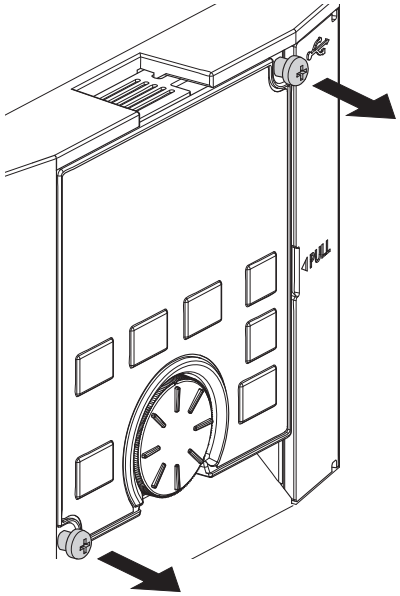
NOTE

- When the converter unit capacity is larger than the motor capacity, select an MCCB and a magnetic contactor according to the converter unit model, and select cables and reactors according to the motor output.
- When the breaker on the converter unit's input side trips, check for the wiring fault (short circuit), damage to internal parts of the inverter or the converter unit, etc. The cause of the output shutoff must be identified and removed before turning ON the power of the breaker.

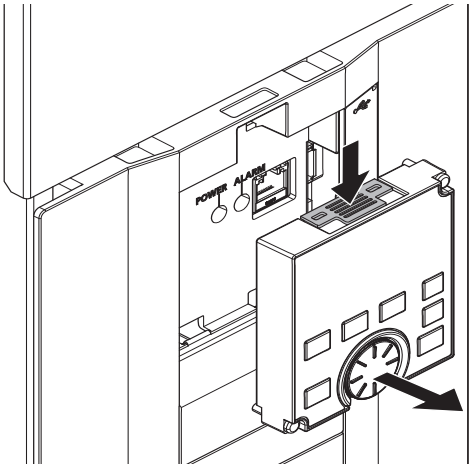
2.2 Removal and reinstallation of the operation panel or the front covers

◆ Removal and reinstallation of the operation panel

- Loosen the two screws on the operation panel. (These screws cannot be removed.)

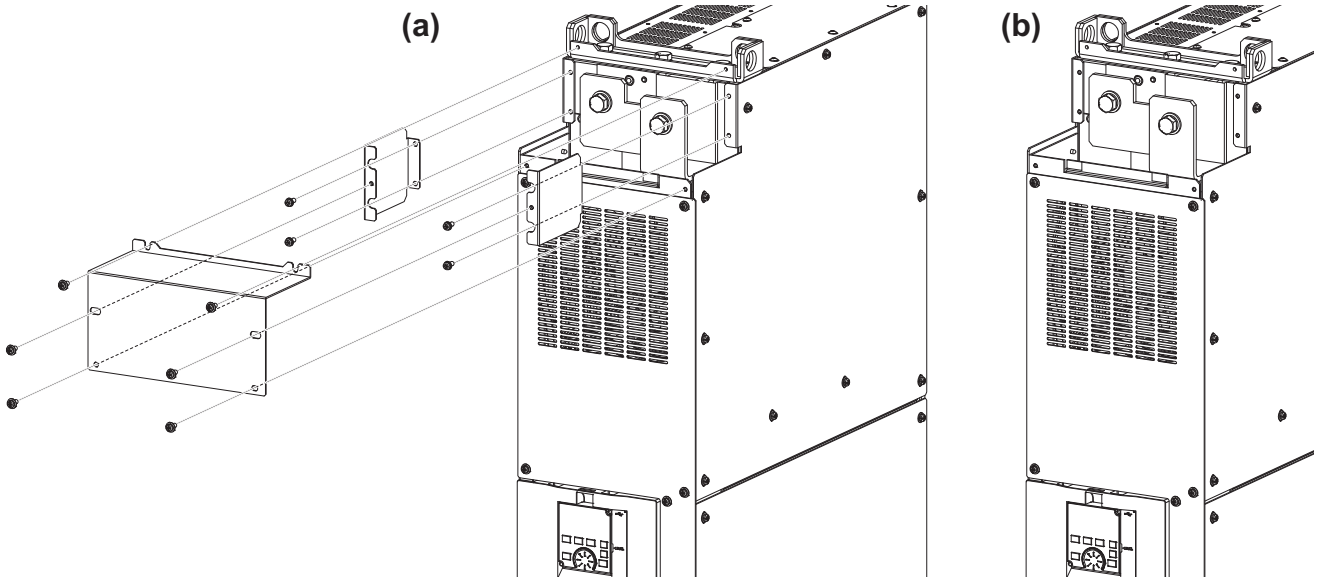


- Press the upper edge of the operation panel while pulling out the operation panel.



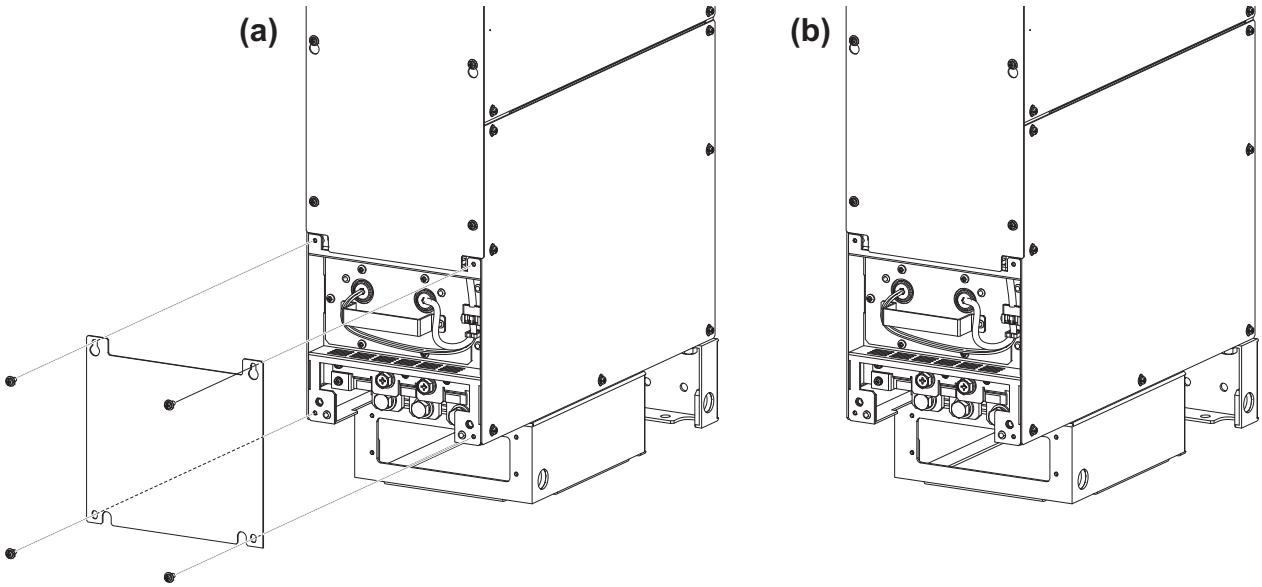
To reinstall the operation panel, align its connector on the back with the PU connector of the inverter, and insert the operation panel. After confirming that the operation panel is fit securely, tighten the screws. (Tightening torque: 0.40 to 0.45 N·m)

◆ Removal of the upper main circuit terminal cover



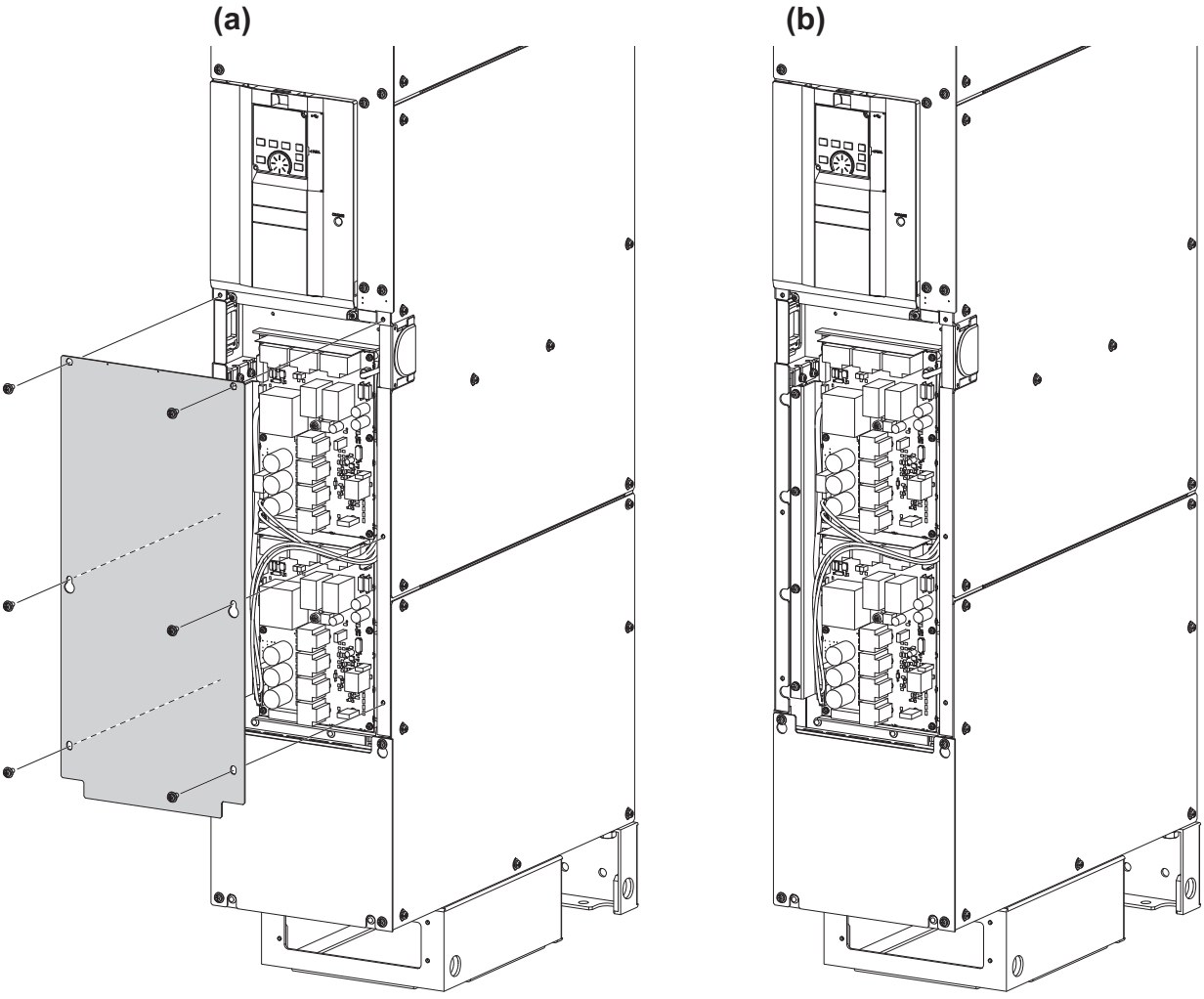
(a) Remove the mounting screws to remove the upper main circuit terminal cover.
(b) With the cover removed, terminals P and N can be wired.

◆ Removal of the lower main circuit terminal cover

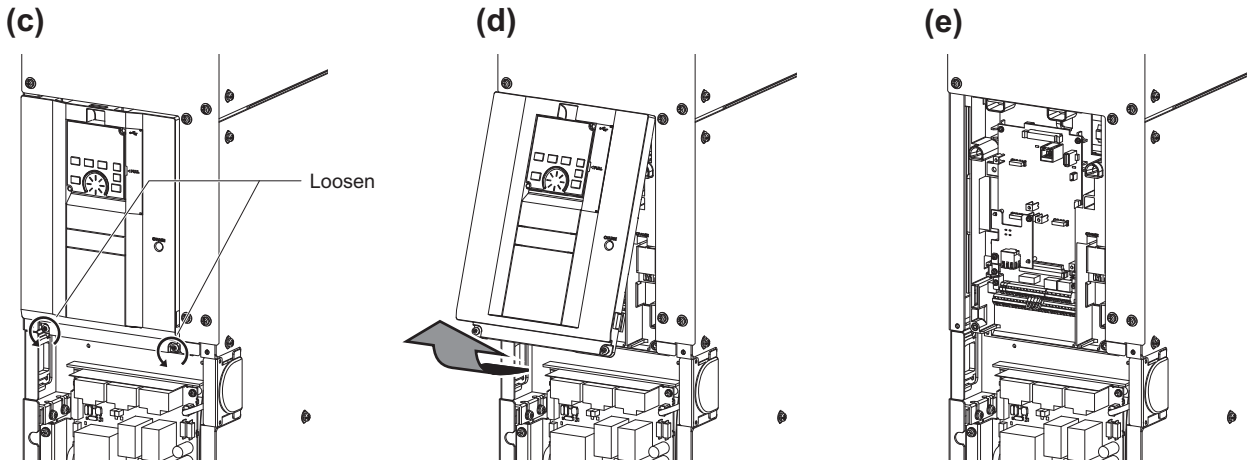


(a) Remove the mounting screws to remove the lower main circuit terminal cover.
(b) With the cover removed, terminals U, V, and W can be wired and the cooling fan can be replaced (refer to page 98).

◆ Removal of the front cover

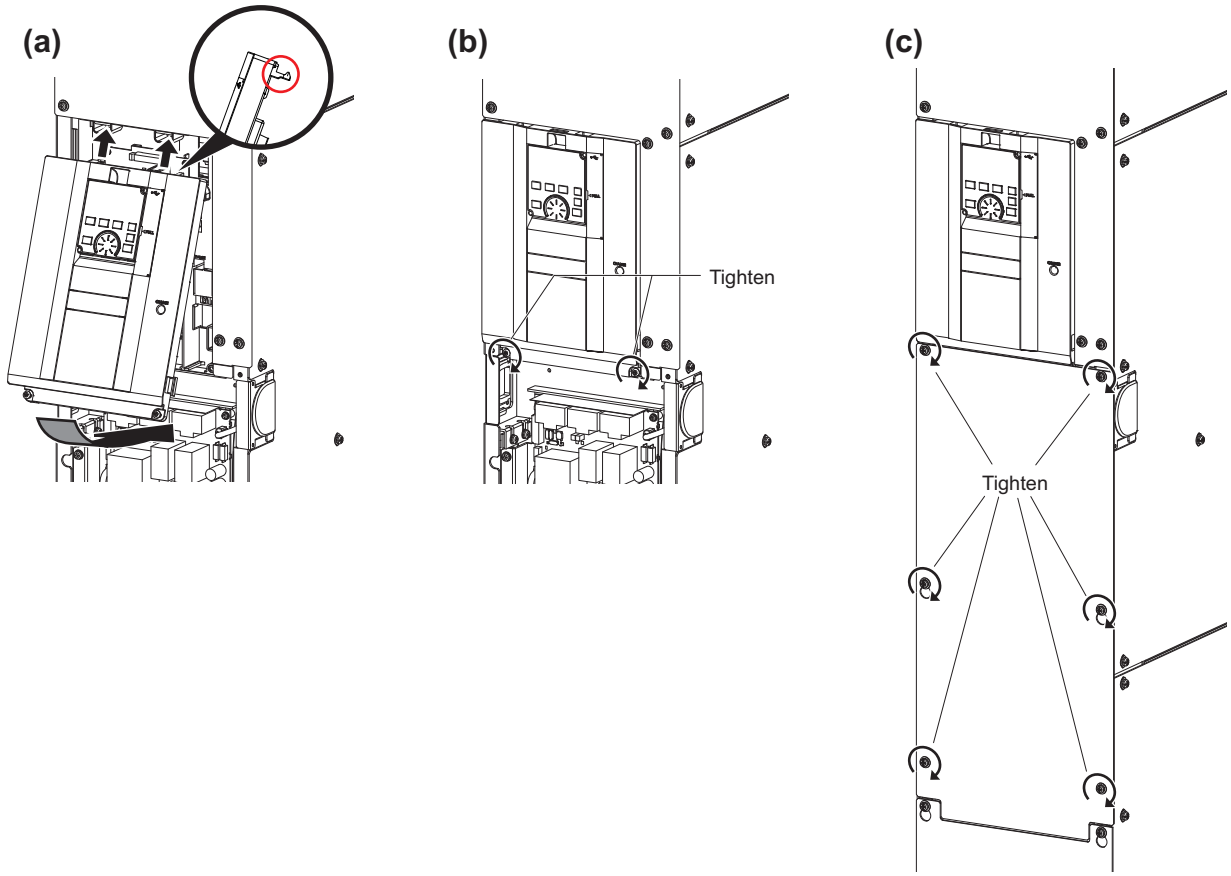


(a) Remove the mounting screws to remove the lower front cover.
(b) When the lower front cover is removed, the upper front cover can be removed.



(c) With the lower cover removed, loosen the mounting screws on the upper cover. (These screws cannot be removed.)
(d) Pull out the upper cover using its upper side as a support.
(e) With the upper cover removed, the control circuit can be wired and the plug-in option can be installed.

◆ Reinstallation of the front cover



(a) Insert the upper hooks of the upper front cover into the sockets of the inverter.
Securely install the cover to the inverter by fixing the hooks on the sides of the cover into place.
(b) Tighten the screws on the lower part of the cover.
(c) Attach the lower front cover using the screws.

NOTE

- When installing the upper front cover, fit the connector of the operation panel securely along the guides of the PU connector.
- Fully make sure that the front cover has been reinstalled securely. Always tighten the installation screws of the front cover.

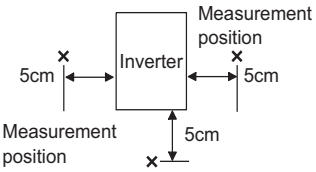
2.3 Installation of the inverter and enclosure design

When designing or manufacturing an inverter enclosure, determine the structure, size, and device layout of the enclosure by fully considering the conditions such as heat generation of the contained devices and the operating environment. An inverter uses many semiconductor devices. To ensure higher reliability and long period of operation, operate the inverter in the ambient environment that completely satisfies the equipment specifications.

2.3.1 Inverter installation environment

The following table lists the standard specifications of the inverter installation environment. Using the inverter in an environment that does not satisfy the conditions deteriorates the performance, shortens the life, and causes a failure. Refer to the following points, and take adequate measures.

◆ Standard environmental specifications of the inverter

Item	Description	
Surrounding air temperature	-10°C to +40°C (non-freezing)	
Ambient humidity	With circuit board coating (conforming to class 3C2/3S2 in IEC 60721-3-3): 95% RH or less (non-condensing)	
Storage temperature	-20°C to +65°C*1	
Atmosphere	Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)	
Altitude	Maximum 4000 m*2	
Vibration	Frequency range 10 to 57 Hz: maximum amplitude 0.075 mm. Frequency range 57 to 150 Hz: maximum acceleration speed 1G.	

*1 Temperature applicable for a short time, for example, in transit.

*2 For installation at an altitude above 1000 m, consider a 3% reduction in the rated current per 500 m increase in altitude.

◆ Temperature

The permissible surrounding air temperature of the inverter is between -10°C and +40°C. Always operate the inverter within this temperature range. Operation outside this range will considerably shorten the service lives of the semiconductors, parts, capacitors and others. Take the following measures to keep the surrounding air temperature of the inverter within the specified range.

■ Measures against high temperature

- Use a forced ventilation system or similar cooling system. (Refer to page 26.)
- Install the enclosure in an air-conditioned electric chamber.
- Block direct sunlight.
- Provide a shield or similar plate to avoid direct exposure to the radiated heat and wind of a heat source.
- Ventilate the area around the enclosure well.

■ Measures against low temperature

- Provide a space heater in the enclosure.
- Do not power OFF the inverter. (Keep the start signal of the inverter OFF.)

■ Sudden temperature changes

- Select an installation place where temperature does not change suddenly.
- Avoid installing the inverter near the air outlet of an air conditioner.
- If temperature changes are caused by opening/closing of a door, install the inverter away from the door.

NOTE

- For the amount of heat generated by the inverter unit, refer to page 26.

◆ Humidity

Normally operate the inverter within the ambient air humidity of 45% to 95%. Too high humidity will pose problems of reduced insulation and metal corrosion. On the other hand, too low humidity may cause a spatial electrical breakdown. The humidity conditions for the insulation distance defined in JEM 1103 standard "Insulation Distance from Control Equipment" is 45% to 85%.

■ Measures against high humidity

- Make the enclosure enclosed, and provide it with a hygroscopic agent.
- Provide dry air into the enclosure from outside.
- Provide a space heater in the enclosure.

■ Measures against low humidity

Air with proper humidity can be blown into the enclosure from outside. Also, when installing or inspecting the unit, discharge your body (static electricity) beforehand, and keep your body away from the parts and patterns.

■ Measures against condensation

Condensation may occur if frequent operation stops change the in-enclosure temperature suddenly or if the outside air temperature changes suddenly.

Condensation causes such faults as reduced insulation and corrosion.

- Take the measures against high humidity.
- Do not power OFF the inverter. (Keep the start signal of the inverter OFF.)

◆ Dust, dirt, oil mist

Dust and dirt will cause such faults as poor contacts, reduced insulation and cooling effect due to the moisture-absorbed accumulated dust and dirt, and in-enclosure temperature rise due to a clogged filter. In an atmosphere where conductive powder floats, dust and dirt will cause such faults as malfunction, deteriorated insulation and short circuit in a short time.

Since oil mist will cause similar conditions, it is necessary to take adequate measures.

■ Countermeasure

- Place the inverter in a totally enclosed enclosure.
  Take measures if the in-enclosure temperature rises. (Refer to page 26.)
- Purge air.
  Pump clean air from outside to make the in-enclosure air pressure higher than the outside air pressure.

◆ Corrosive gas, salt damage

If the inverter is exposed to corrosive gas or to salt near a beach, the printed board patterns and parts will corrode or the relays and switches will result in poor contact.

In such places, take the measures given in the previous paragraph.

◆ Explosive, flammable gases

As the inverter is non-explosion proof, it must be contained in an explosion-proof enclosure. In places where explosion may be caused by explosive gas, dust or dirt, an enclosure cannot be used unless it structurally complies with the guidelines and has passed the specified tests. This makes the enclosure itself expensive (including the test charges). The best way is to avoid installation in such places and install the inverter in a non-hazardous place.

◆ High altitude

Use the inverter at an altitude of within 4000 m. For use at an altitude above 1000 m, consider a 3% reduction in the rated current per 500 m increase in altitude.

If it is used at a higher place, it is likely that thin air will reduce the cooling effect and low air pressure will deteriorate dielectric strength.

◆ Vibration, impact

The vibration resistance of the inverter is as follows: the maximum amplitude is 0.075 mm (frequency range: 10 to 57 Hz), and the maximum acceleration speed is 1G (frequency range: 57 to 150 Hz). Applying vibration and impacts for a long time may loosen the structures and cause poor contacts of connectors, even if those vibration and impacts are within the specified values.

Especially when impacts are applied repeatedly, caution must be taken because such impacts may break the installation feet.

Countermeasure

- Provide the enclosure with rubber vibration isolators.
- Strengthen the structure to prevent the enclosure from resonance.
- Install the enclosure away from the sources of the vibration.

2.3.2 Amount of heat generated by the inverter

When the heat sink is installed inside the enclosure, the amount of heat generated by the inverter unit and converter unit is shown in the following tables.

Converter FR-CC2-N[]	Amount of heat generated (W)	
	690 V input	575 V input
450K	3360	3350
500K	3600	3590
560K	4030	4020
630K	4350	4340

Inverter FR-A872-[]	Amount of heat generated (W)			
	690 V input		575 V input	
	SLD	ND	SLD	ND
05690	5060	4580	4750	4280
06470	5760	5060	5420	4750
07150	6390	5760	6030	5420

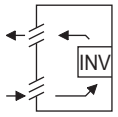
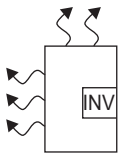
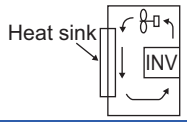
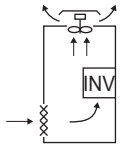
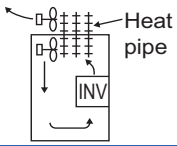
NOTE

- The amount of heat generated shown assumes that the output current is the inverter rated current, and the carrier frequency is 1 kHz.

2.3.3 Cooling system types for inverter enclosure

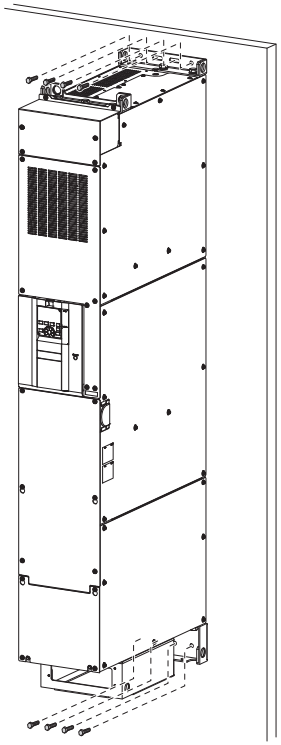
From the enclosure that contains the inverter, the heat of the inverter and other equipment (transformers, lamps, resistors, etc.) and the incoming heat such as direct sunlight must be dissipated to keep the in-enclosure temperature lower than the permissible temperatures of the in-enclosure equipment including the inverter.
The cooling systems are classified as follows in terms of the cooling calculation method.

- Cooling by natural heat dissipation from the enclosure surface (totally enclosed type)
- Cooling by heat sink (aluminum fin, etc.)
- Cooling by ventilation (forced ventilation type, pipe ventilation type)
- Cooling by heat exchanger or cooler (heat pipe, cooler, etc.)

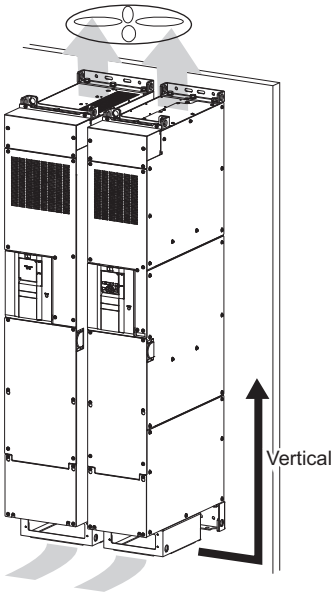
Cooling system		Enclosure structure	Comment
Natural	Natural ventilation (enclosed type / open type)		This system is low in cost and generally used, but the enclosure size increases as the inverter capacity increases. This system is for relatively small capacities.
	Natural ventilation (totally enclosed type)		Being a totally enclosed type, this system is the most appropriate for hostile environment having dust, dirt, oil mist, etc. The enclosure size increases depending on the inverter capacity.
Forced air	Heat sink cooling		This system has restrictions on the heat sink mounting position and area. This system is for relatively small capacities.
	Forced ventilation		This system is for general indoor installation. This is appropriate for enclosure downsizing and cost reduction, and often used.
	Heat pipe		This system is a totally enclosed type, and is appropriate for enclosure downsizing.

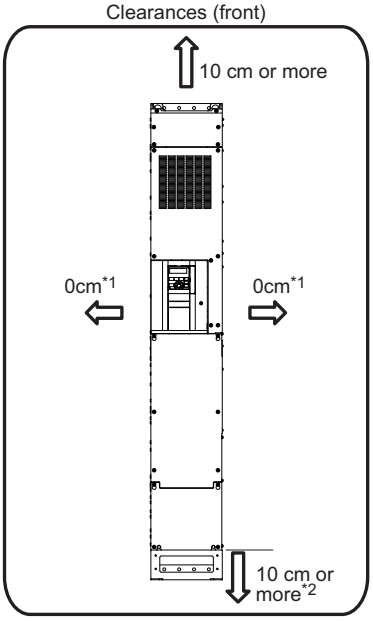
2.3.4 Inverter installation

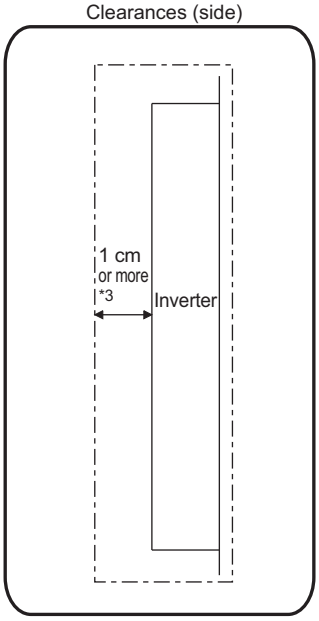
◆ Inverter placement



- Install the inverter on a strong surface securely with screws.
- Leave enough clearances and take cooling measures.
- Avoid places where the inverter is subjected to direct sunlight, high temperature and high humidity.
- Install the inverter on a nonflammable wall surface.
- When encasing multiple inverters in an enclosure, install them in parallel as a cooling measure.
- For heat dissipation and maintenance, keep clearance between the inverter and the other devices or enclosure surface. The clearance below the inverter is required as a wiring space, and the clearance above the inverter is required as a heat dissipation space. (Air flow must not be interrupted in the heat dissipation space.)
- When designing or building an enclosure for the inverter, carefully consider influencing factors such as heat generation of the contained devices and the operating environment.







*1 Side-by-side installation (0 cm clearance) is available. Note that clearance to pass cables is required. (Refer to page 50.)
*2 A 10 cm or more clearance is required below the bottom of the enclosure (regardless of the installation feet).
*3 There needs to be a space of at least 60 cm in front of the inverter to replace the cooling fan. Refer to page 97 for fan replacement.

◆ Installation orientation of the inverter

Install the inverter on a wall as specified. Do not mount it horizontally or in any other way.

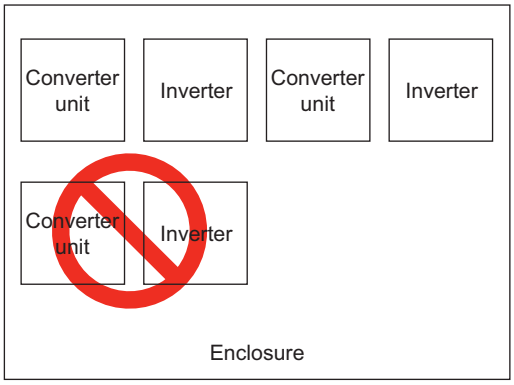
◆ Above the inverter

Heat is blown up from inside the inverter by the small fan built in the unit. Any equipment placed above the inverter should be heat resistant.

◆ Encasing multiple inverters and converter units

When multiple inverters and converter units are placed in the same enclosure, arrange them horizontally as shown in the figure below. Do not place multiple products vertically. The exhaust air temperature of the inverter and the converter unit may be increased.

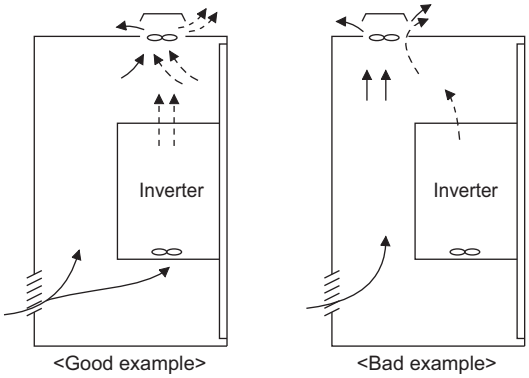
When mounting multiple inverters and converter units, fully take caution not to make the surrounding air temperature of the inverter and the converter unit higher than the permissible value by providing ventilation and increasing the enclosure size.



Arrangement of multiple inverters and converter units

◆ Arrangement of the ventilation fan and inverter

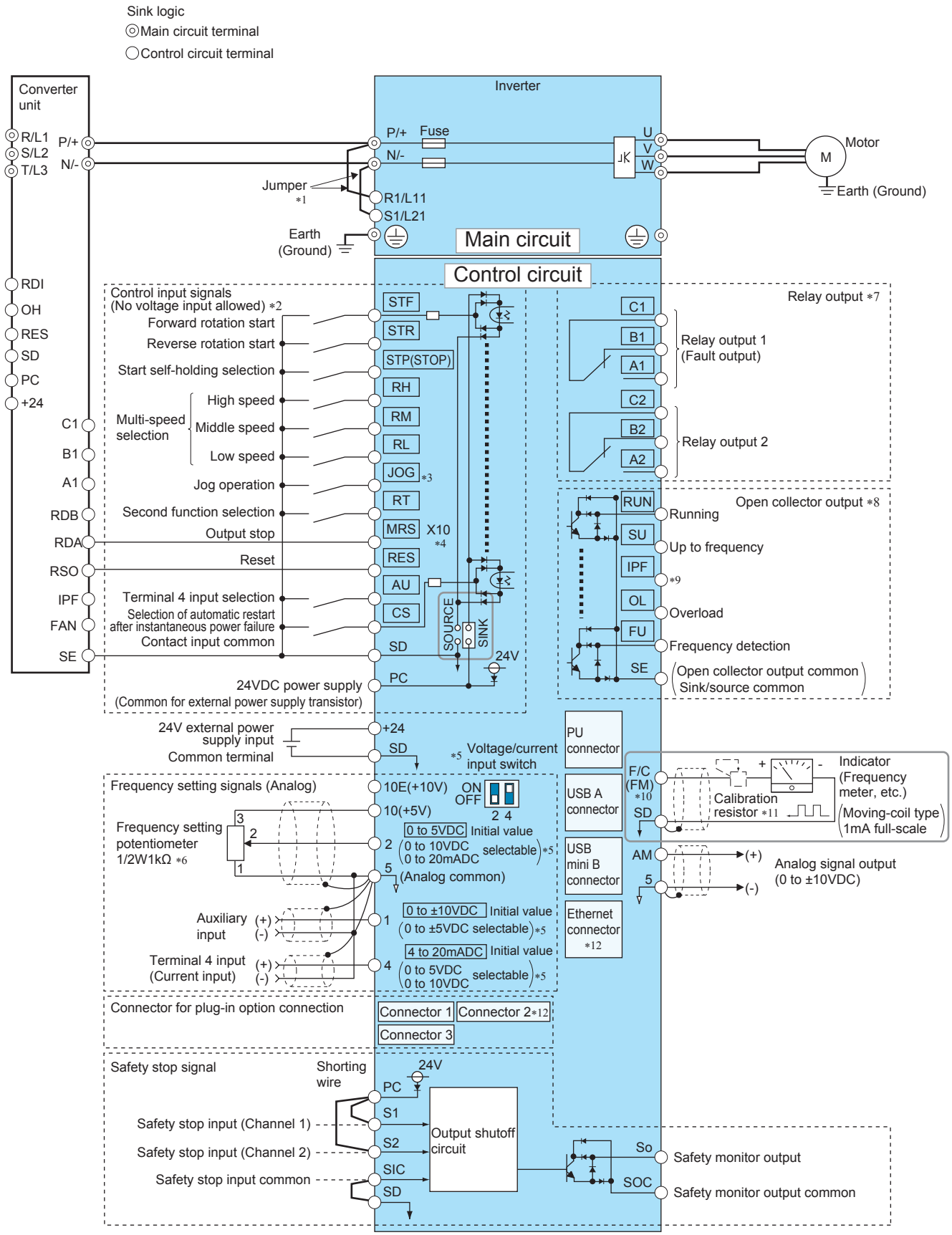
Heat generated in the inverter is blown up from the bottom of the unit as warm air by the cooling fan. When installing a ventilation fan for that heat, determine the place of ventilation fan installation after fully considering an air flow. (Air passes through areas of low resistance. Make an airway and airflow plates to expose the inverter to cool air.)



Arrangement of the ventilation fan and inverter

2.4 Terminal connection diagrams

◆ FM type

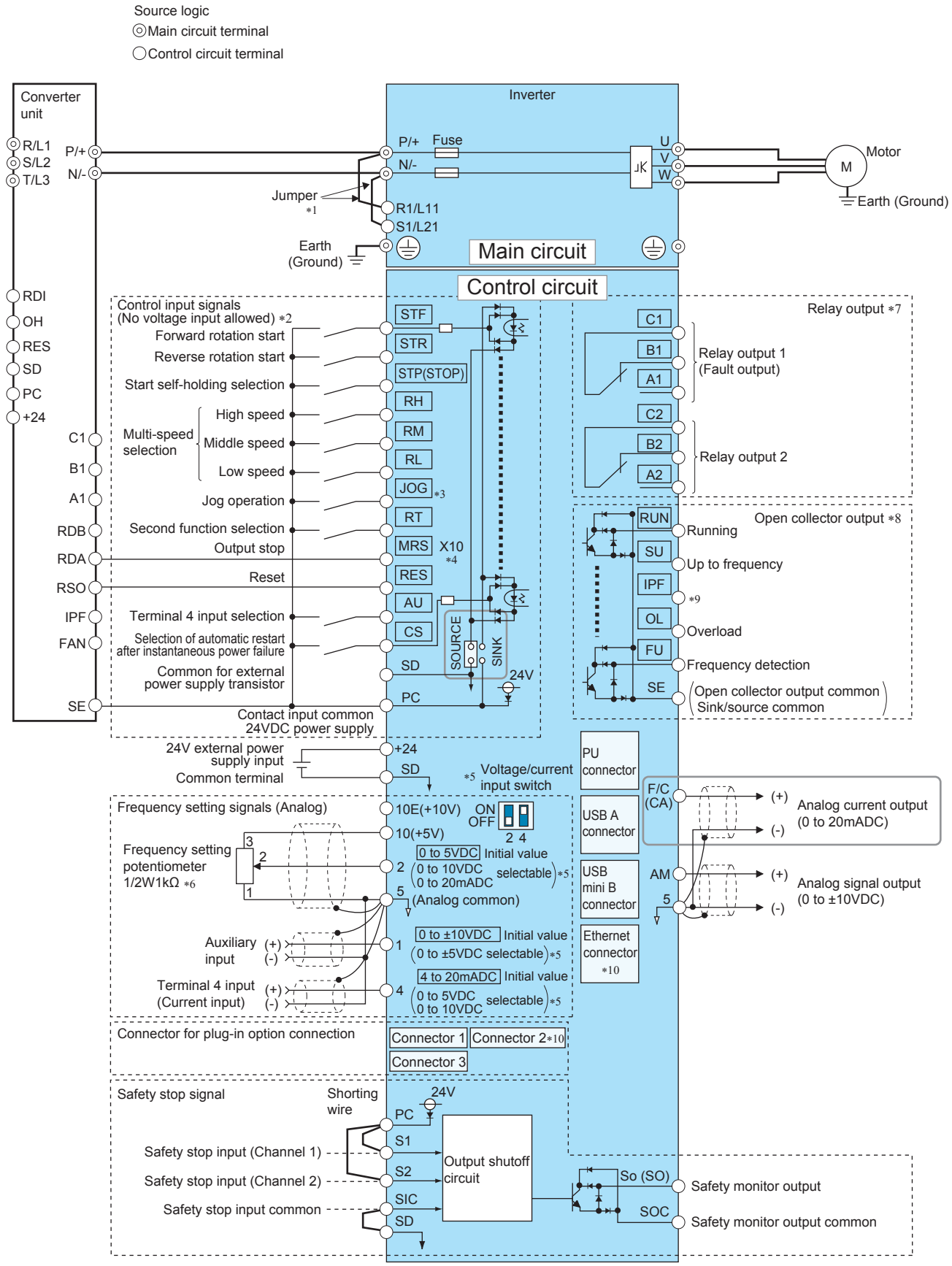


*1 A jumper is installed across terminal R1/L11 and terminal P/+, and across terminal S1/L21 and terminal N/-. When using a separate power supply for the control circuit, remove the jumpers connected to terminals R1/L11 and S1/L21.
*2 The function of these terminals can be changed using the Input terminal function selection (**Pr.178 to Pr.189**).
*3 Terminal JOG is also used as a pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
*4 The X10 signal (NC contact input specification) is assigned to the terminal MRS in the initial setting. Set **Pr.599** = "0" to change the input specification of the X10 signal to NO contact.
*5 Terminal input specifications can be changed by analog input specification switchover (**Pr.73, Pr.267**). To input voltage (0 to 5 V/0 to 10 V), set the voltage/current input switch OFF. To input current (4 to 20 mA), set the voltage/current input switch ON. Terminals 10 and 2 are also used as a PTC input terminal. **(Pr.561)**
*6 It is recommended to use 2 W 1 kΩ when the frequency setting signal is changed frequently.
*7 The function of these terminals can be changed using the Output terminal function selection (**Pr.195 or Pr.196**).
*8 The function of these terminals can be changed using the Output terminal function selection (**Pr.190 to Pr.194**).
*9 No function is assigned in the initial setting. Use **Pr.192** for function assignment.
*10 Terminal FM can be used to output pulse trains as open collector output by setting **Pr.291**.
*11 Not required when calibrating the scale with the operation panel.
*12 The option connector 2 cannot be used because the Ethernet board is installed in the initial status. The Ethernet board must be removed to install a plug-in option to the option connector 2. (However, Ethernet communication is disabled in that case.)

NOTE

- To prevent a malfunction due to noise, keep the signal cables 10 cm or more away from the power cables. Also, keep the cables of the main circuit for input and output separated.
- After wiring, wire offcuts must not be left in the inverter.
  Wire offcuts can cause a fault, failure or malfunction. Always keep the inverter clean.
  When drilling mounting holes in an enclosure etc., take caution not to allow chips and other foreign matter to enter the inverter.
- Set the switches of the voltage/current input selection switch assembly correctly. Incorrect setting may cause a fault, failure or malfunction.

◆ CA type



*1 A jumper is installed across terminal R1/L11 and terminal P/+, and across terminal S1/L21 and terminal N/-. When using a separate power supply for the control circuit, remove the jumpers connected to terminals R1/L11 and S1/L21.

*2 The function of these terminals can be changed using the Input terminal function selection (**Pr.178 to Pr.189**).

*3 Terminal JOG is also used as a pulse train input terminal. Use **Pr.291** to choose JOG or pulse.

*4 The X10 signal (NC contact input specification) is assigned to the terminal MRS in the initial setting. Set **Pr.599** = "0" to change the input specification of the X10 signal to NO contact.

*5 Terminal input specifications can be changed by analog input specification switchover (**Pr.73, Pr.267**). To input voltage (0 to 5 V/0 to 10 V), set the voltage/current input switch OFF. To input current (4 to 20 mA), set the voltage/current input switch ON. Terminals 10 and 2 are also used as a PTC input terminal. **(Pr.561)**

*6 It is recommended to use 2 W 1 kΩ when the frequency setting signal is changed frequently.

*7 The function of these terminals can be changed using the Output terminal function selection (**Pr.195 or Pr.196**).

*8 The function of these terminals can be changed using the Output terminal function selection (**Pr.190 to Pr.194**).

*9 No function is assigned in the initial setting. Use **Pr.192** to assign a function to the terminal.

*10 The option connector 2 cannot be used because the Ethernet board is installed in the initial status. The Ethernet board must be removed to install a plug-in option to the option connector 2. (However, Ethernet communication is disabled in that case.)

NOTE

- To prevent a malfunction due to noise, keep the signal cables 10 cm or more away from the power cables. Also, keep the cables of the main circuit for input and output separated.
- After wiring, wire offcuts must not be left in the inverter.
  Wire offcuts can cause a fault, failure or malfunction. Always keep the inverter clean.
  When drilling mounting holes in an enclosure etc., take caution not to allow chips and other foreign matter to enter the inverter.
- Set the switches of the voltage/current input selection switch assembly correctly. Incorrect setting may cause a fault, failure or malfunction.

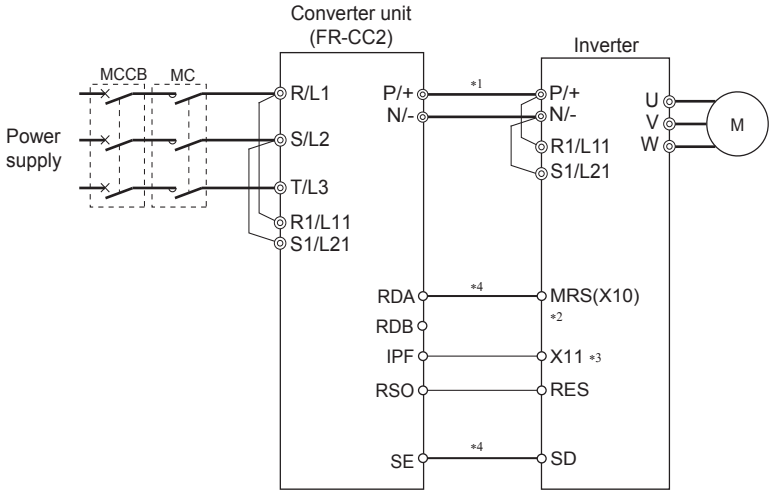
◆ Connection between the converter unit and the inverter

Wire correctly to ensure the command transmission from the converter unit to the inverter. Otherwise, the converter unit and the inverter may be damaged.

For the wiring length, refer to the following tables.

Location in the connection diagram	Total wiring length
Between the terminals P and P and the terminals N and N	50m or shorter
Other control signal cables	30m or shorter

For the cable gauge of the cable across the main circuit terminals P/+ and N/- (P and P, N and N), refer to page 38.



*1 Do not install an MCCB across terminals P/+ and N/- (between terminals P and P/+ or between terminals N and N/-). Connecting the opposite polarity of terminals N/- and P/+ will damage the inverter.

*2 For the X10 signal input, set "10" in any parameter from **Pr.178 to Pr.189 (Input terminal function selection)** to assign the function. (The X10 signal is assigned to terminal MRS in the initial setting.)
The state of contact at terminal MRS is initially set to normally closed (NC). To change the contact state to normally open (NO), set **Pr.599** = "0".

*3 For the X11 signal input, set "11" in any parameter from **Pr.178 to Pr.189 (Input terminal function selection)** to assign the function.
For RS-485 or any other form of communication where the start command is only transmitted once, use the X11 signal to save the operation mode at the time of an instantaneous power failure.

*4 Always connect terminal RDA of the converter unit and terminal MRS (X10) of the inverter, and terminal SE of the converter unit and terminal SD (sink logic) of the inverter. Otherwise, the converter unit may be damaged.

2.5 Main circuit terminals

2.5.1 Details on the main circuit terminals of the inverter

Terminal symbol	Terminal name	Terminal function description	Refer to page
U, V, W	Inverter output	Connect a three-phase squirrel-cage motor.	—
R1/L11, S1/L21	Power supply for the control circuit	Connected to terminals P/+ and N/-. To retain the fault display and fault output, or to use the converter unit (FR-CC2), remove the jumpers installed in terminals R1/L11 and S1/L21, and apply external power supply to these terminals. When using a separate power supply connected to terminals R1/L11 and S1/L21, the required power capacity is 80 VA.	51
P/+, N/-	Converter unit connection	Connect the converter unit (FR-CC2).	30
⏚	Earth (ground)	For earthing (grounding) the inverter chassis. Be sure to earth (ground) the inverter.	40

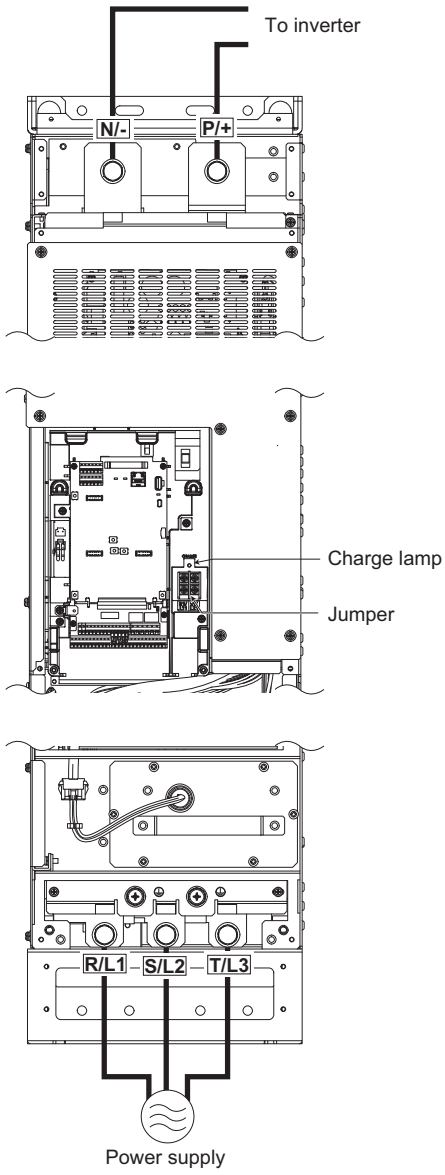
2.5.2 Details on the main circuit terminals of the converter unit (FR-CC2)

Terminal symbol	Terminal name	Terminal function description	Refer to page
R/L1, S/L2, T/L3	AC power input	Connect these terminals to the commercial power supply.	—
R1/L11, S1/L21	Power supply for the control circuit	Connected to the AC power supply terminals R/L1 and S/L2. To retain the fault display and fault output, remove the jumpers across terminals R/L1 and R1/L11 and across S/L2 and S1/L21, and apply external power to these terminals. When using a separate power supply connected to terminals R1/L11 and S1/L21, the required power capacity is 80 VA.	51
P/+, N/-	Inverter connection	Connected to the inverter terminals P/+ and N/-.	30
⏚	Earth (ground)	For earthing (grounding) the converter unit chassis. This product must be earthed (grounded).	40

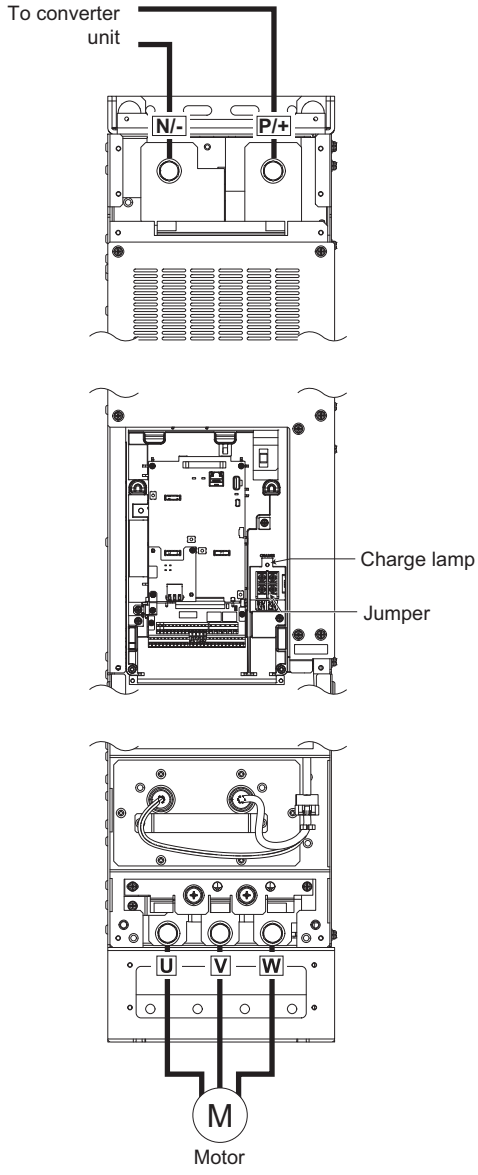
2.5.3 Terminal layout of the main circuit terminals, wiring of power supply and the motor

◆ Terminal layout

Converter unit



Inverter

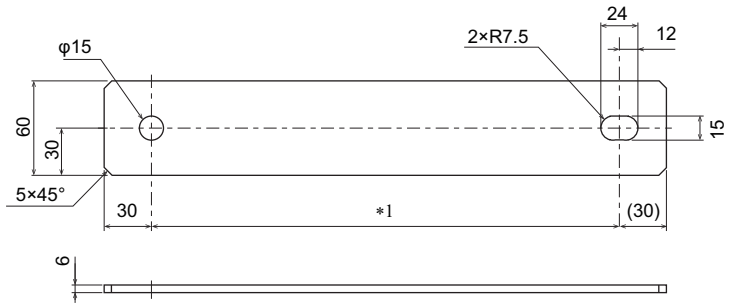


NOTE

- Make sure the power cables are connected to the R/L1, S/L2, and T/L3. (Phase need not be matched.) Never connect the power cable to the U, V, and W of the inverter. Doing so will damage the inverter.
- Connect the motor to U, V, and W. (The phases must be matched.)

◆ Recommended bus bar dimensions (for terminals P/+ and N/-)

Refer to the following for bus bars for terminals P/+ and N/-.



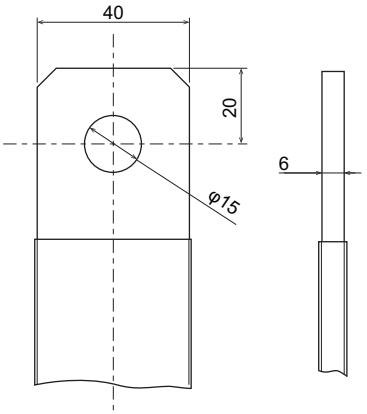
(Unit: mm)

*1 The bus bar dimensions differ depending on the arrangement of the inverter and the converter unit as shown in the following table.

Arrangement of the units		Dimension
Left	Right	
Inverter	Converter unit	Clearance between the units + 258.2 mm
Converter unit	Inverter	Clearance between the units + 265 mm

◆ Recommended bus bar dimensions (for terminals U, V, and W)

Refer to the following for bus bars for terminals U, V, and W.

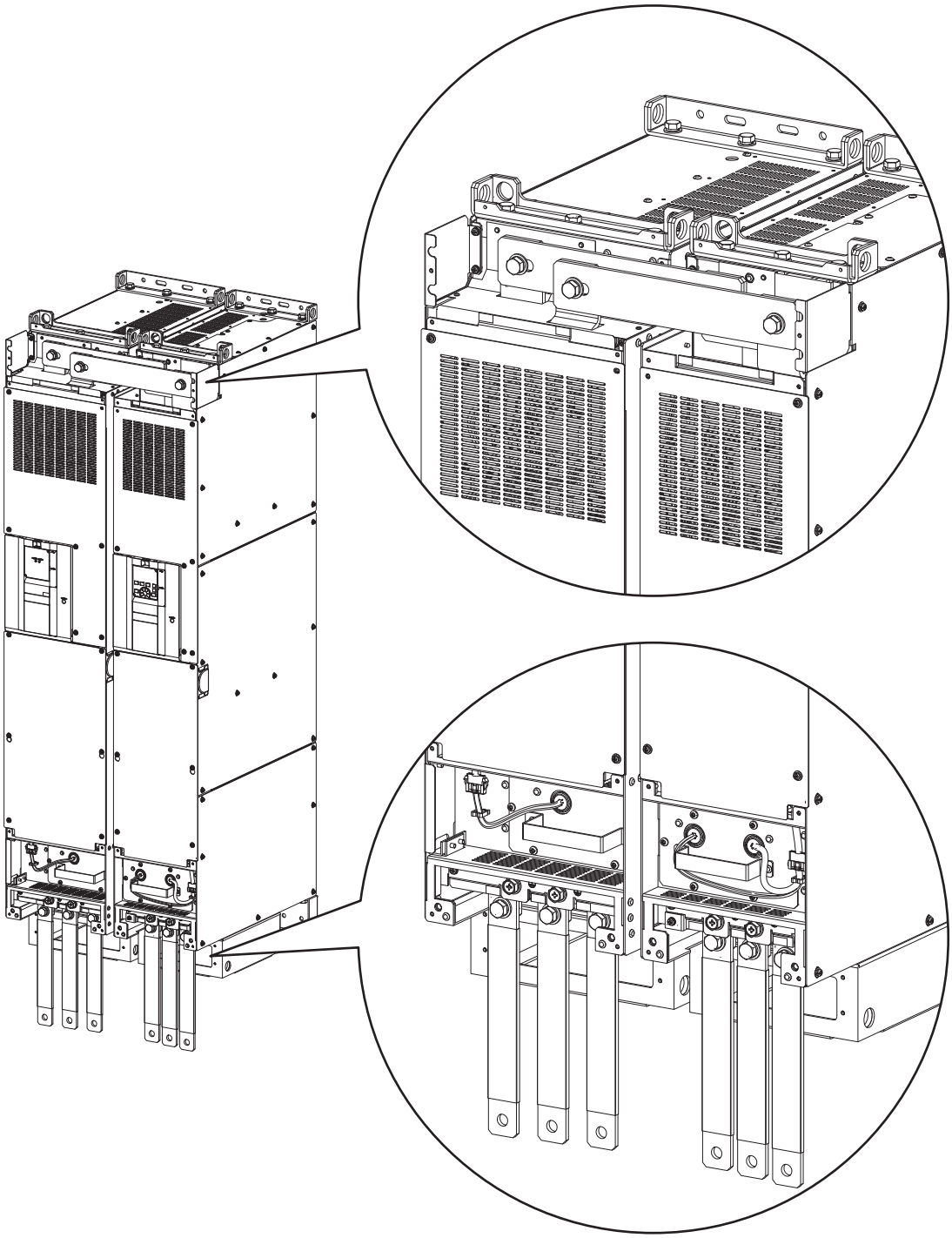


(Unit: mm)

◆ Bus bar connection example

- Use bus bars to connect terminal P/+ of the converter unit and terminal P/+ of the inverter, and terminal N/- of the converter unit and terminal N- of the inverter. Remove the upper main circuit terminal cover (right or left) to allow for the connection of bus bars.

- The figure below shows how to connect bus bars to the main circuit terminals.



NOTE

- Ensure the upper main circuit terminal cover (front) and the lower main circuit terminal cover is reinstalled before the operation is started.

2.5.4 Applicable cables and wiring length

Select a recommended size cable to ensure that the voltage drop ratio is within 2%.
If the wiring distance is long between the inverter and motor, the voltage drop in the main circuit will cause the motor torque to decrease especially at a low speed.

◆ Bus bar connection

The following tables show combinations recommended when a wiring length is 20 m (at 690 V input power supply).

- Converter unit (FR-CC2)

Converter model FR-CC2-N[]	Terminal screw size*2	Tightening torque (N·m)	Bus bar dimensions (for each phase)	Earth (ground) cable size
			R, S, T	PVC cables, etc. (mm^2)*1
450K to 630K	M12 (M10)	24.5	6 mm thick and 40 mm wide	2×80

- Inverter (common between ND rated and SLD rated)

Inverter model FR-A872-[]	Terminal screw size*2	Tightening torque (N·m)	Bus bar dimensions (for each phase)		Earth (ground) cable size
			U, V, W	P, N	PVC cables, etc. (mm^2)*1
05690 to 07150	M12 (M10)	24.5	6 mm thick and 40 mm wide	6 mm thick and 60 mm wide	2×80

*1 The recommended cable size is that of the cable (XLPE cable) with continuous maximum permissible temperature of 90°C. It assumes a surrounding air temperature of 40°C or lower and in-enclosure wiring.
(Selection example mainly for use in Europe.)

*2 The screw size for terminals R/L1, S/L2, T/L3, U, V, W, P/+, N/-, and the earthing (grounding) terminal are shown.
Screw size for earthing (grounding) is indicated in parentheses.

The line voltage drop can be calculated by the following formula:

$$\text{Line voltage drop [V]} = \frac{\sqrt{3} \times \text{wire resistance [m}\Omega\text{/m]} \times \text{wiring distance [m]} \times \text{current [A]}}{1000}$$

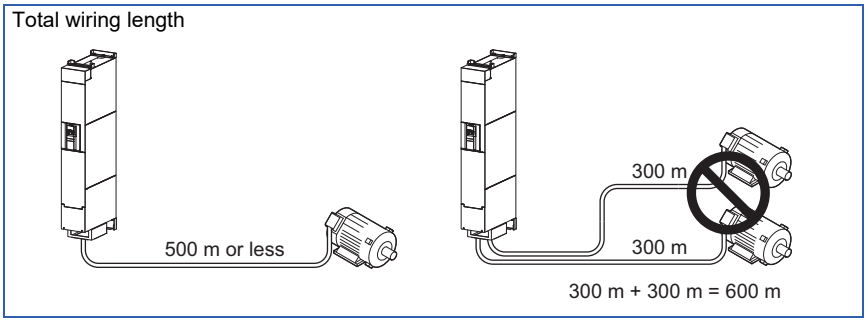
Use a larger diameter cable (or a bus bar) when the wiring distance is long or when it is desired to decrease the voltage drop (torque reduction) in the low speed range.

NOTE

- Tighten the terminal screw to the specified torque.
  A screw that has been tightened too loosely can cause a short circuit or malfunction.
  A screw that has been tightened too tightly can cause a short circuit or malfunction due to the unit breakage.
- Use crimp terminals with insulation sleeves to wire the power supply and motor.
- The creepage distance between terminals is 15.4 mm. When more insulation distance is required, secure a sufficient distance or use insulating material for bus bars.

◆Total wiring length

Connect one or more general-purpose motors within the total wiring length 500 m. (The wiring length should be 100 m or shorter under Vector control.)



When driving a 690 V class motor by the inverter, surge voltages attributable to the wiring constants may occur at the motor terminals, deteriorating the insulation of the motor. In this case, use a 690 V class inverter-driven insulation-enhanced motor. When the wiring length exceeds 100 m, set "4" (4 kHz) or less in **Pr.72 PWM frequency selection** (carrier frequency).

NOTE

- Especially for long-distance wiring, the inverter may be affected by a charging current caused by stray capacitances of the wiring, leading to an activation of the overcurrent protection, malfunction of the fast-response current limit operation, or even to an inverter failure. It may also cause a malfunction or fault of the equipment connected ON the inverter output side. If the fast-response current limit function malfunctions, disable the function. (For the details of **Pr.156 Stall prevention operation selection**, refer to the Instruction Manual (Function).)
- For the details of **Pr.72 PWM frequency selection**, refer to the Instruction Manual (Function).
- Refer to page 77 to drive a 690 V class motor by an inverter.

2.5.5 Earthing (grounding) precautions

- Always earth (ground) the motor, the inverter, and the converter unit.

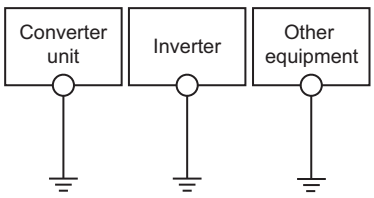
◆ Purpose of earthing (grounding)

Generally, an electrical apparatus has an earth (ground) terminal, which must be connected to the ground before use.
An electrical circuit is usually insulated by an insulating material and encased. However, it is impossible to manufacture an insulating material that can shut off a leakage current completely, and actually, a slight current flows into the case. The purpose of earthing (grounding) the case of an electrical apparatus is to prevent operators from getting an electric shock from this leakage current when touching it.
To avoid the influence of external noises, the earthing (grounding) is important to EMI-sensitive equipment that handle low-level signals or operate very fast such as audio equipment, sensors, computers.

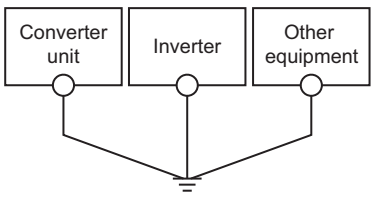
◆ Earthing (grounding) system to be established

As described previously, the purpose of earthing (grounding) is roughly classified into the electrical shock prevention and the prevention of malfunction due to the influence of electromagnetic noise. These two purposes should be clearly distinguished, and the appropriate earth (ground) system must be established to prevent the leakage current having the inverter's high frequency components from reversing through another earth (ground) point for malfunction prevention by following these instructions:

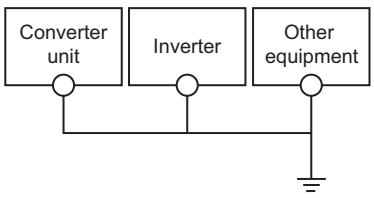
- Make the separate earth (ground) connection (I) for high frequency products such as the inverter from any other devices (EMI-sensitive devices described above) wherever possible.
  Establishing adequate common (single-point) earth (ground) system (II) shown in the following figure is allowed only in cases where the separate earth (ground) system (I) is not feasible. Do not make inadequate common (single-point) earth (ground) connection (III).
  As leakage currents containing many high frequency components flows into the earthing (grounding) cables of the inverter and peripheral devices (including a motor), the inverter must also be earthed (grounded) separately from EMI-sensitive devices described above.
  In a high building, it may be effective to use its iron structure frames as earthing (grounding) electrode for EMI prevention in order to separate from the earth (ground) system for electric shock prevention.
- Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 61140 class 1 and other applicable standards).
- Use the thickest possible earthing (grounding) cable. The earthing (grounding) cable should be the size indicated in the table on page 38.
- The earthing (grounding) point should be as close as possible to the inverter, and the earth (ground) wire length should be as short as possible.
- Run the earthing (grounding) cable as far away as possible from the I/O wiring of the EMI-sensitive devices and run them in parallel in the minimum distance.



(I) Independent earthing (grounding).....Good



(II) Common earthing (grounding).....Good



(III) Common earthing (grounding) cable.....Not allowed

NOTE

- To be compliant with the EU Directive (Low Voltage Directive), refer to page 117.

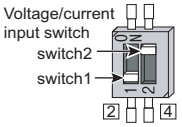
2.6 Control circuit

2.6.1 Details on the control circuit terminals of the inverter

For the parameter details, refer to the Instruction Manual (Function).

◆ Input signal

Type	Terminal symbol	Terminal name	Terminal function description		Rated specification
Contact input	STF[*1]	Forward rotation start	Turn ON the STF signal to start forward rotation and turn it OFF to stop.	When the STF and STR signals are turned ON simultaneously, the stop command is given.	Input resistance: 4.7 kΩ, voltage when contacts are open: 21 to 27 VDC, current when contacts are short-circuited: 4 to 6 mADC
	STR[*1]	Reverse rotation start	Turn ON the STR signal to start reverse rotation and turn it OFF to stop.		
	STOP[*1]	Start self-holding selection	Turn ON the STOP signal to self-hold the start signal.		
	RH RM RL[*1]	Multi-speed selection	Multi-speed can be selected according to the combination of RH, RM and RL signals.		
	JOG[*1]	Jog mode selection	Turn ON the JOG signal to enable JOG operation (initial setting) and turn ON the start (STF or STR) signal to start JOG operation.		
		Pulse train input	Terminal JOG is also used as a pulse train input terminal. To use as a pulse train input terminal, change the **Pr.291** setting. (maximum input pulse: 100k pulses/s)		Input resistance: 2 kΩ, current when contacts are short-circuited: 8 to 13 mADC
	RT[*1]	Second function selection	Turn ON the RT signal to enable the second function. When the second function such as "second torque boost" and "second V/F (base frequency)" is set, turning ON the RT signal enables the selected function.		Input resistance: 4.7 kΩ, voltage when contacts are open: 21 to 27 VDC, current when contacts are short-circuited: 4 to 6 mADC
	MRS (X10)[*1]	Output stop (Inverter operation enable)	Connect to the terminal RDA of the converter unit (FR-CC2). When the RDA signal is turned OFF, the inverter output is shut off. The X10 signal (NC contact) is assigned to the terminal MRS in the initial setting. Use **Pr.599** to change the specification to NO contact.		
	RES[*1]	Reset	Use this signal to reset a fault output provided when a protective function is activated. Turn ON the RES signal for 0.1 second or longer, then turn it OFF. In the initial setting, reset is always enabled. Setting **Pr.75** makes reset possible only after the occurrence of a inverter fault. The inverter will restart about 1 second after reset.		
	AU[*1]	Terminal 4 input selection	The terminal 4 function is available only when the AU signal is ON. Turning the AU signal ON makes terminal 2 invalid.		
	CS[*1]	Selection of automatic restart after instantaneous power failure	When the CS signal is left ON, the inverter restarts automatically at power restoration. Note that restart setting is necessary on both the inverter and the converter unit for this operation. In the initial setting, a restart is disabled.		
	SD	Contact input common (sink)[*3]	Common terminal for the contact input terminal (sink logic) and terminal FM.		—
		External transistor common (source)[*4]	Connect this terminal to the power supply common terminal of a transistor output (open collector output) device, such as a programmable controller, in the source logic to avoid malfunction by undesirable current.		
		24 VDC power supply common	Common terminal for the 24 VDC power supply (terminal PC, terminal +24). Isolated from terminals 5 and SE.		
	PC	External transistor common (sink)[*3]	Connect this terminal to the power supply common terminal of a transistor output (open collector output) device, such as a programmable controller, in the sink logic to avoid malfunction by undesirable current.		Power supply voltage range: 19.2 to 28.8 VDC, permissible load current: 100 mA
		Contact input common (source)[*4]	Common terminal for contact input terminal (source logic).		
		24 VDC power supply	Can be used as a 24 VDC 0.1 A power supply.		

Type	Terminal symbol	Terminal name	Terminal function description	Rated specification
Frequency setting	10E	Frequency setting power supply	When connecting the frequency setting potentiometer at an initial status, connect it to terminal 10. Change the input specifications of terminal 2 using **Pr.73** when connecting it to terminal 10E.	10 ±0.4 VDC, permissible load current: 10 mA
	10			5 ±0.5 VDC, permissible load current: 10 mA
	2	Frequency setting (voltage)	Inputting 0 to 5 VDC (or 0 to 10 V, 0 to 20 mA) provides the maximum output frequency at 5 V (10 V, 20 mA) and makes input and output proportional. Use **Pr.73** to switch among input 0 to 5 VDC (initial setting), 0 to 10 VDC, and 0 to 20 mA. Set the voltage/current input switch in the ON position to select current input (0 to 20 mA).*2	For voltage input, Input resistance: 10 ±1 kΩ, maximum permissible voltage: 20 VDC. For current input, Input resistance: 245 ±5 Ω, maximum permissible current: 30 mA. 
	4	Frequency setting (current)	Inputting 4 to 20 mADC (or 0 to 5 V, 0 to 10 V) provides the maximum output frequency at 20 mA and makes input and output proportional. This input signal is valid only when the AU signal is ON (terminal 2 input is invalid). Use **Pr.267** to switch among input 4 to 20 mA (initial setting), 0 to 5 VDC, and 0 to 10 VDC. Set the voltage/current input switch in the OFF position to select voltage input (0 to 5 V / 0 to 10 V).*2 Use **Pr.858** to switch terminal functions.	
	1	Frequency setting auxiliary	Input 0 to ±5 VDC or 0 to ±10 VDC to add this signal to the frequency setting signal input via terminal 2 or 4. Use **Pr.73** to switch between input 0 to ±5 VDC and 0 to ±10 VDC (initial setting). Use **Pr.868** to switch terminal functions.	Input resistance: 10 ±1 kΩ, maximum permissible voltage: ±20 VDC.
	5	Frequency setting common	Common terminal for the frequency setting signal (via terminal 2, 1, or 4) and for the analog output terminals AM and CA. Do not earth (ground).	—
Thermistor	10 2	PTC thermistor input	For receiving PTC thermistor outputs. When PTC thermistor is valid (**Pr.561** ≠ "9999"), terminal 2 is not available for frequency setting.	Applicable PTC thermistor specification, overheat detection resistance: 0.5 to 30 kΩ (Set by **Pr.561**)
Power supply input	+24	24 V external power supply input	For connecting a 24 V external power supply. If a 24 V external power supply is connected, power is supplied to the control circuit while the main power circuit is OFF.	Input voltage: 23 to 25.5 VDC, input current: 1.4 A or less

*1 Terminal functions can be selected using **Pr.178 to Pr.189 (Input terminal function selection)**.

*2 Set **Pr.73, Pr.267**, and the voltage/current input switch correctly, then input an analog signal in accordance with the setting.
Applying a voltage with the switch ON (current input is selected) or applying a current with the switch OFF (voltage input is selected) could cause component damage of the inverter or analog circuits of output devices. (Refer to the Instruction Manual (Function).)

*3 Sink logic is initially set for the FM-type inverter.

*4 Source logic is initially set for the CA-type inverter.

◆ Output signal

Type	Terminal symbol	Terminal name	Terminal function description		Rated specification
Relay	A1, B1, C1[*1]	Relay output 1 (fault output)	1 changeover contact output that indicates that an inverter's protective function has been activated and the outputs are stopped. Fault: discontinuity across B and C (continuity across A and C), Normal: continuity across B and C (discontinuity across A and C)		Contact capacity: 230 VAC 0.3 A (power factor = 0.4), 30 VDC 0.3 A
	A2, B2, C2[*1]	Relay output 2	1 changeover contact output		
Open collector	RUN[*1]	Inverter running	The output is in LOW state when the inverter output frequency is equal to or higher than the starting frequency (initial value: 0.5 Hz). The output is in HIGH state during stop or DC injection brake operation.		Permissible load: 24 VDC (27 VDC at maximum) 0.1 A (The voltage drop is 2.8 V at maximum while the signal is ON.) The open collector transistor is ON (conductive) in LOW state. The transistor is OFF (not conductive) in HIGH state.
	SU[*1]	Up to frequency	The output is in LOW state when the output frequency is within the set frequency range ±10% (initial value). The output is in HIGH state during acceleration/deceleration and at a stop.	Fault code (4 bits) output.	
	OL[*1]	Overload alarm	The output is in LOW state when stall prevention is activated by the stall prevention function. The output is in HIGH state when stall prevention is canceled.		
	IPF[*1]	Open collector output	No function is assigned in the initial setting. Use **Pr.192** to assign a function to the terminal.		
	FU[*1]	Frequency detection	The output is in LOW state when the inverter output frequency is equal to or higher than the preset detection frequency, and is in HIGH state when it is less than the preset detection frequency.		
	SE	Open collector output common	Common terminal for terminals RUN, SU, OL, IPF, FU		—
Pulse	FM[*2]	For meter	Among several monitor items such as output frequency, select one to output it via these terminals. The signal is not output during an inverter reset. The size of output signal is proportional to the magnitude of the corresponding monitor item. Use **Pr.55, Pr.56, and Pr.866** to set full scales for the monitored output frequency, output current, and torque.	Output item: output frequency (initial setting)	Permissible load current: 2 mA, pulse for full scale: 1440 pulses/s
		NPN open collector output		This terminal can be used for open collector outputs by setting **Pr.291**.	Maximum output pulse: 50k pulses/s, permissible load current: 80 mA
Analog	AM	Analog voltage output		Output item: output frequency (initial setting)	Output signal: 0 ±10 VDC, permissible load current: 1 mA (load impedance 10 kΩ or more), resolution: 8 bits
	CA[*3]	Analog current output			Load impedance: 200 to 450 Ω, output signal: 0 to 20 mADC

*1 Terminal functions can be selected using **Pr.190 to Pr.196 (Output terminal function selection)**.
*2 Terminal FM is provided in the FM-type inverter.
*3 Terminal CA is provided in the CA-type inverter.

◆ Communication

Type	Terminal symbol	Terminal name	Terminal function description	
Ethernet	—	Ethernet connector	Communication can be made via Ethernet. Category: 100BASE-TX/10BASE-T Data transmission speed: 100 Mbps (100BASE-TX) / 10 Mbps (10BASE-T) Transmission method: Baseband Maximum segment length: 100 m between the hub and the inverter Number of cascade connection stages: Up to 2 (100BASE-TX) / up to 4 (10BASE-T) Interface: RJ-45 Number of interfaces available: 1 IP version: IPv4	
RS-485	—	PU connector	RS-485 communication can be made through the PU connector (For connection on a 1:1 basis only) Conforming standard: EIA-485 (RS-485) Transmission format: Multidrop link Communication speed: 4800 to 115200 bps Wiring length: 500 m	
USB	—	USB A connector	A connector (receptacle). Plug a USB memory device into this connector to copy parameter settings or use the trace function.	Interface: conforms to USB 1.1 (USB 2.0 full-speed compatible) Transmission speed: 12 Mbps
		USB B connector	Mini B connector (receptacle). The inverter can be connected to a personal computer.	

◆ Safety stop signal

Terminal symbol	Terminal name	Terminal function description	Rated specification	Refer to page
S1	Safety stop input (Channel 1)	Use terminals S1 and S2 to receive the safety stop signal input from the safety relay module. Terminals S1 and S2 can be used at a time (dual channel). The Inverter judges the condition of the internal safety circuit from the status (shorted/opened) between terminals S1 and SIC, or between S2 and SIC. When the status is opened, the inverter output is shut off. In the initial status, terminal S1 and S2 are shorted with terminal PC by shorting wires. Terminal SIC is shorted with terminal SD. Remove the shorting wires and connect the safety relay module when using the safety stop function.	Input resistance: 4.7 kΩ, input current: 4 to 6 mADC (with 24 VDC input)	55
S2	Safety stop input (Channel 2)			
SIC	Safety stop input terminal common	Common terminal for terminals S1 and S2.	—	
So (SO)	Safety monitor output (open collector output)	The output status varies depending on the input status of the safety stop signals. The output is in HIGH state during occurrence of the internal safety circuit failure. The output is in LOW state otherwise. (The open collector transistor is ON (conductive) in LOW state. The transistor is OFF (not conductive) in HIGH state.) Refer to the Safety Stop Function Instruction Manual if the output becomes in HIGH state even though both terminals S1 and S2 are open. (Contact your sales representative for this manual.)	Permissible load: 24 VDC (27 VDC at maximum), 0.1 A (The voltage drop is 3.4 V at maximum while the signal is ON.)	
SOC	Safety monitor output terminal common	Common terminal for terminal So (SO).	—	

2.6.2 Details on the control circuit terminals of the converter unit (FR-CC2).

For the parameter details, refer to the FR-CC2 Instruction Manual.

◆ Input signal

Type	Terminal symbol	Terminal name	Terminal function description	Rated specification
Contact input	RES*1	Reset	Use this signal to reset a fault output provided when a protective function is activated. Turn ON the RES signal for 0.1 second or longer, then turn it OFF. In the initial setting, reset is always enabled. Setting **Pr.75** makes reset possible only after the occurrence of a converter unit fault. The converter will restart about 1 second after reset.	Input resistance: 4.7 kΩ, voltage when contacts are open: 21 to 27 VDC, current when contacts are short-circuited: 4 to 6 mADC
	OH*1	External thermal relay input	The External thermal relay input (OH) signal is used when using the external thermal relay or the thermal protector built into the motor to protect the motor from overheating. When the thermal relay is activated, the inverter output is shut off by the external thermal relay operation (E.OHT).	
	RDI*1	Contact input	Use **Pr.178** to assign a function to the terminal.	
	SD	Contact input common (sink)	Common terminal for the contact input terminal (sink logic) and terminal FM.	—
		External transistor common (source)	Connect this terminal to the power supply common terminal of a transistor output (open collector output) device, such as a programmable controller, in the source logic to avoid malfunction by undesirable current.	
		24 VDC power supply common	Common terminal for the 24 VDC power supply (terminal PC, terminal +24). Isolated from terminals 5 and SE.	
	PC	External transistor common (sink)	Connect this terminal to the power supply common terminal of a transistor output (open collector output) device, such as a programmable controller, in the sink logic to avoid malfunction by undesirable current.	Power supply voltage range: 19.2 to 28.8 VDC, permissible load current: 100 mA
		Contact input common (source)	Common terminal for contact input terminal (source logic).	
		24 VDC power supply	Can be used as a 24 VDC 0.1 A power supply.	
Power supply input	+24	24 V external power supply input	For connecting a 24 V external power supply. If a 24 V external power supply is connected, power is supplied to the control circuit while the main power circuit is OFF.	Input voltage: 23 to 25.5 VDC, input current: 1.4 A or less

*1 Terminal functions can be selected using **Pr.178, Pr.187, or Pr.189 (Output terminal function selection)**.

◆ Output signal

Type	Terminal symbol	Terminal name	Terminal function description	Rated specification
Relay	A1, B1, C1*1	Relay output 1 (fault output)	1 changeover contact output that indicates that the protective function of the converter unit has been activated and the outputs are stopped. Fault: discontinuity across B and C (continuity across A and C), Normal: continuity across B and C (discontinuity across A and C)	Contact capacity: 230 VAC 0.3 A (power factor = 0.4), 30 VDC 0.3 A
	88R, 88S	For manufacturer setting. Do not use.		
Open collector	RDA*1	Inverter operation enable (NO contact)	Switched to LOW when the converter unit operation is ready. Assign the signal to the terminal MRS (X10) of the inverter. The inverter can be started when the RDA status is LOW.	Permissible load: 24 VDC (27 VDC at maximum) 0.1 A (The voltage drop is 2.8 V at maximum while the signal is ON.) The open collector transistor is ON (conductive) in LOW state. The transistor is OFF (not conductive) in HIGH state.
	RDB*1	Inverter operation enable (NC contact)	Switched to LOW when a converter unit fault occurs or the converter is reset. The inverter can be started when the RDB status is HIGH.	
	RSO*1	Inverter reset	Switched to LOW when the converter is reset (RES-ON). Assign the signal to the terminal RES of the inverter. The inverter is reset when it is connected with the RSO status LOW.	
	IPF*1	Instantaneous power failure	Switched to LOW when an instantaneous power failure is detected.	
	FAN*1	Cooling fan fault	Switched to LOW when a cooling fan fault occurs.	
	SE	Open collector output common	Common terminal for terminals RDA, RDB, RSO, IPF, FAN Connect this terminal to the terminal SD (sink logic) or PC (source logic) of the inverter.	—

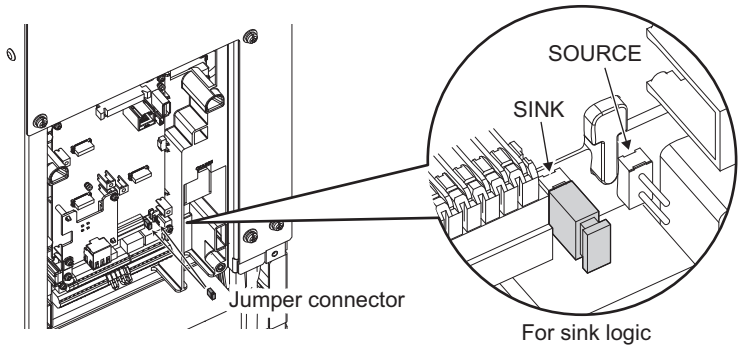
*1 Terminal functions can be selected using **Pr.190 to Pr.195 (Output terminal function selection)**.

⚠CAUTION

- Do not use the empty terminals (NC) of the control circuit. Doing so may lead to damage of the converter unit and the inverter.
- Always connect the terminal RDA of the converter unit and the terminal MRS (X10) of the inverter, and the terminal SE of the converter unit and the terminal SD (terminal PC in the source logic) of the inverter. Not doing so may lead to damage of the converter unit.

2.6.3 Control logic (sink/source) change

Switch the control logic of input signals as necessary.
To change the control logic, change the jumper connector position on the control circuit board.
Connect the jumper connector to the connector pin of the desired control logic.
The control logic of input signals is initially set to the sink logic (SINK) for the type FM inverter.
The control logic of input signals is initially set to the source logic (SOURCE) for the type CA inverter.
(The output signals may be used in either the sink or source logic independently of the jumper connector position.)



NOTE

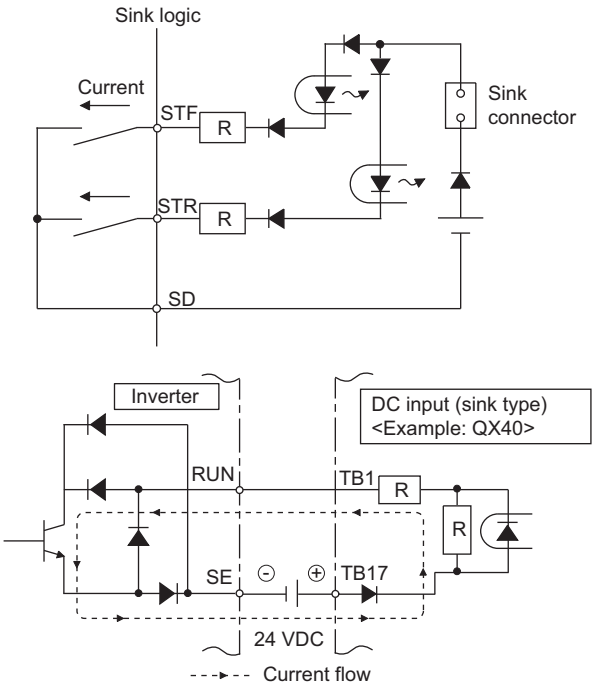
- Make sure that the jumper connector is installed correctly.
- Never change the control logic while power is ON.

◆Sink logic and source logic

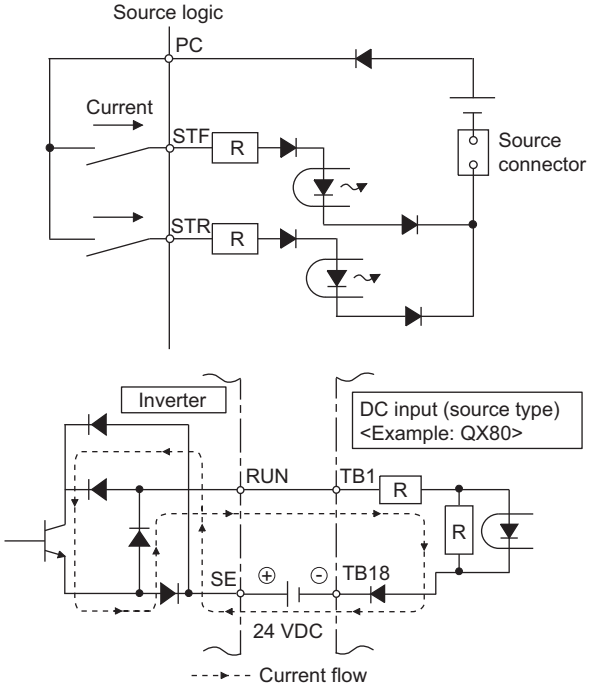
- In the sink logic, a signal turns ON when a current exits from the corresponding signal input terminal.
  Terminal SD is common to the contact input signals. Terminal SE is common to the open collector output signals.

- In the source logic, a signal turns ON when a current enters into the corresponding signal input terminal.
  Terminal PC is common to the contact input signals. Terminal SE is common to the open collector output signals.

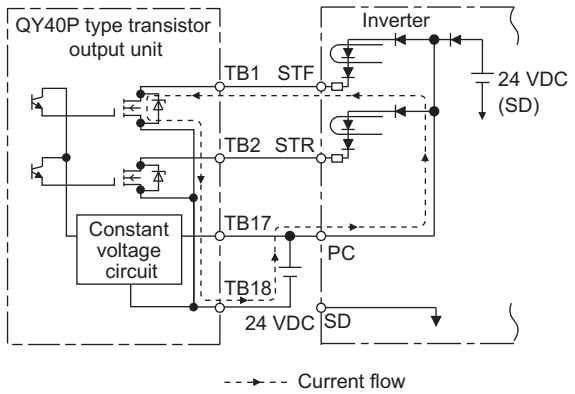
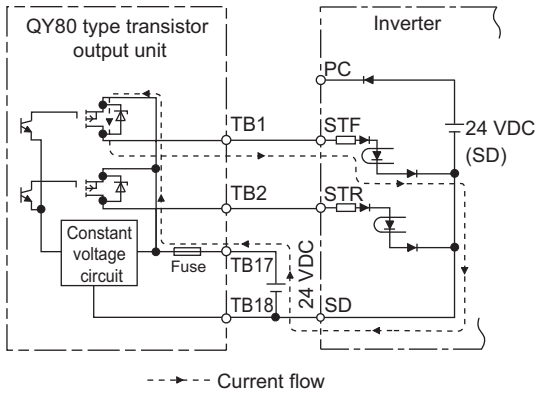
●Current flow concerning the input/output signal when sink logic is selected



●Current flow concerning the input/output signal when source logic is selected

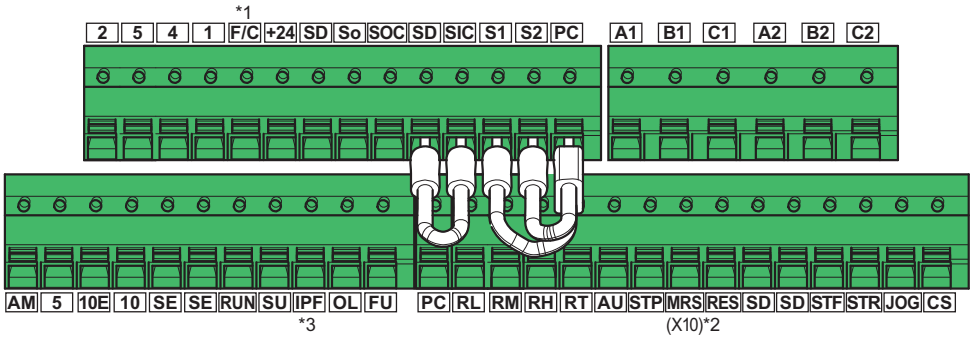


- When using an external power supply for transistor output

Sink logic	Source logic
Use terminal PC as a common terminal, and perform wiring as follows. (Do not connect terminal SD on the inverter with the terminal of 0 V for the external power supply. When using terminals PC-SD as a 24 VDC power supply, do not install an external power supply in parallel with the inverter. Doing so may cause a malfunction in the inverter due to undesirable currents.)	Use terminal SD as a common terminal, and perform wiring as follows. (Do not connect terminal PC on the inverter with the terminal of +24 V for the external power supply. When using terminals PC-SD as a 24 VDC power supply, do not install an external power supply in parallel with the inverter. Doing so may cause a malfunction in the inverter due to undesirable currents.)
	

2.6.4 Wiring of inverter control circuit

◆ Control circuit terminal layout



*1 This terminal operates as terminal FM for the type FM inverter. For the type CA inverter, the terminal operates as terminal CA.
*2 The X10 signal is assigned to terminal MRS in the initial setting.
*3 No function is assigned in the initial setting.

◆ Wiring method

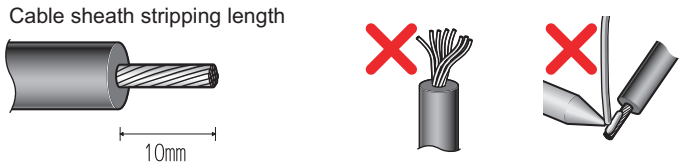
■ Power supply connection

For the control circuit wiring, strip off the sheath of a cable, and use it with a blade terminal. For a single wire, strip off the sheath of the wire and apply directly.

Insert the blade terminal or the single wire into a socket of the terminal.

1. Strip off the sheath for the below length. If the length of the sheath peeled is too long, a short circuit may occur with neighboring wires. If the length is too short, wires might come off.

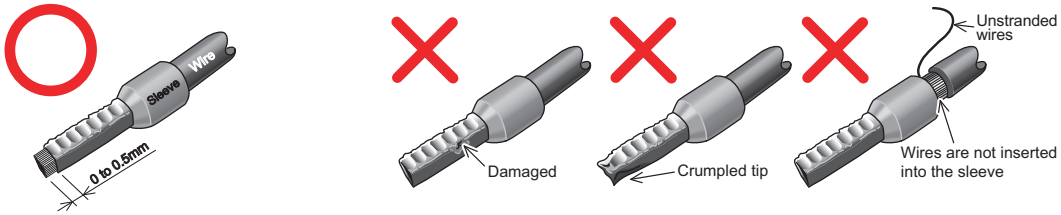
Wire the stripped cable after twisting it to prevent it from becoming loose. Do not solder it.



2. Crimp the blade terminal.

Insert wires to a blade terminal, and check that the wires come out for about 0 to 0.5 mm from a sleeve.

Check the condition of the blade terminal after crimping. Do not use a blade terminal of which the crimping is inappropriate, or the face is damaged.



Blade terminals commercially available (as of January 2017)

- Phoenix Contact Co., Ltd.

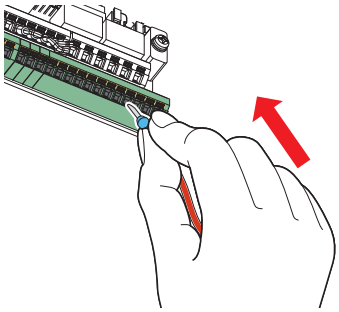
Cable gauge (mm^2)	Ferrule terminal model			Crimping tool name
	With insulation sleeve	Without insulation sleeve	For UL wire*1	
0.3	AI 0,34-10TQ	—	—	CRIMPFOX 6
0.5	AI 0,5-10WH	—	AI 0,5-10WH-GB	
0.75	AI 0,75-10GY	A 0,75-10	AI 0,75-10GY-GB	
1	AI 1-10RD	A 1-10	AI 1-10RD/1000GB	
1.25, 1.5	AI 1, 5-10BK	A 1, 5-10	AI 1, 5-10BK/1000GB*2	
0.75 (two-wire product)	AI-TWIN 2×0,75-10GY	—	—	

*1 A ferrule terminal with an insulation sleeve compatible with the MTW wire which has a thick wire insulation.
*2 Applicable for terminals A1, B1, C1, A2, B2, C2.

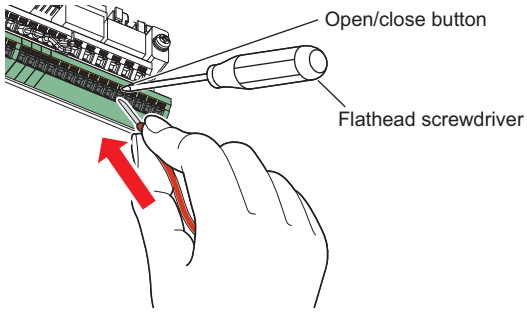
- NICHIFU Co., Ltd.

Cable gauge (mm^2)	Blade terminal product number	Insulation cap product number	Crimping tool product number
0.3 to 0.75	BT 0.75-11	VC 0.75	NH 69

3. Insert the wires into a socket.



When using single wire or stranded wire without crimp terminal, push an open/close button all the way down with a flathead screw driver, and insert the wire.

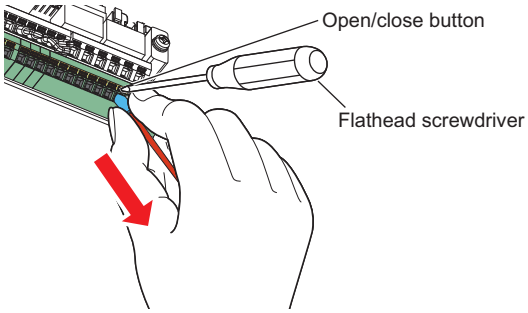


NOTE

- When using stranded wires without a blade terminal, twist enough to avoid short circuit with a nearby terminals or wires.
- Place the flathead screwdriver vertical to the open/close button. In case the blade tip slips, it may cause an inverter damage or injury.

■Wire removal

Pull the wire while pushing the open/close button all the way down firmly with a flathead screwdriver.



NOTE

- Pulling out the wire forcefully without pushing the open/close button all the way down may damage the terminal block.
- Use a small flathead screwdriver (tip thickness: 0.4 mm / tip width: 2.5 mm).
  If a flathead screwdriver with a narrow tip is used, terminal block may be damaged.
  Commercially available products (as of February 2016)

Product name	Model	Manufacturer
Driver	SZF 0- 0,4 × 2,5	Phoenix Contact Co., Ltd.

- Place the flathead screwdriver vertical to the open/close button. In case the blade tip slips, it may cause an inverter damage or injury.

◆Common terminals of the control circuit (SD, PC, 5, SE)

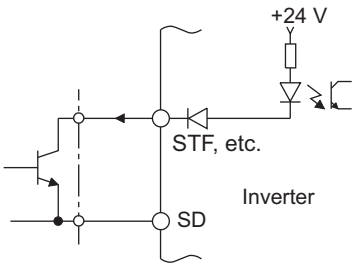
- Terminals SD (sink logic), PC (source logic), 5, and SE are common terminals (0 V) for I/O signals. (All common terminals are isolated from each other.) Do not earth (ground) these terminals. Avoid connecting terminal SD (sink logic) with terminal 5, terminal PC (source logic) with terminal 5, and terminal SE with terminal 5.
- In the sink logic, terminal SD is a common terminal for the contact input terminals (STF, STR, STP (STOP), RH, RM, RL, JOG, RT, MRS, RES, AU, and CS) and the pulse train output terminal (FM[*1]). The open collector circuit is isolated from the internal control circuit by photocoupler.

- In the source logic, terminal PC is a common terminal for the contact input terminals (STF, STR, STP (STOP), RH, RM, RL, JOG, RT, MRS, RES, AU, CS). The open collector circuit is isolated from the internal control circuit by photocoupler.
- Terminal 5 is a common terminal for the frequency setting terminals (1, 2, and 4) and the analog output terminals (AM and CA[*2]). It should be protected from external noise using a shielded or twisted cable.
- Terminal SE is a common terminal for the open collector output terminals (RUN, SU, OL, IPF, and FU). The contact input circuit is isolated from the internal control circuit by photocoupler.

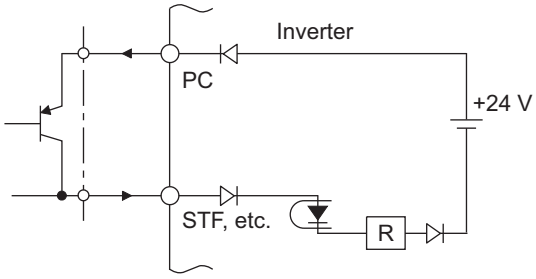
*1 Terminal FM is provided in the FM-type inverter.
*2 Terminal CA is provided in the CA-type inverter.

◆ Signal inputs by contactless switches

The contact input terminals of the inverter (STF, STR, STP (STOP), RH, RM, RL, JOG, RT, MRS, RES, AU, and CS) can be controlled using a transistor instead of a contact switch as follows.



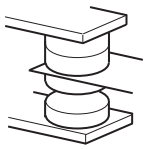
External signal input using transistor (sink logic)



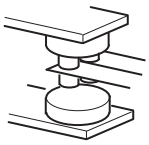
External signal input using transistor (source logic)

2.6.5 Wiring precautions

- It is recommended to use a cable of 0.3 to 0.75 mm^2 for the connection to the control circuit terminals.
- The wiring length should be 30 m (200 m for terminal FM) at the maximum.
- Use two or more parallel micro-signal contacts or twin contacts to prevent contact faults when using contact inputs since the control circuit input signals are micro-currents.



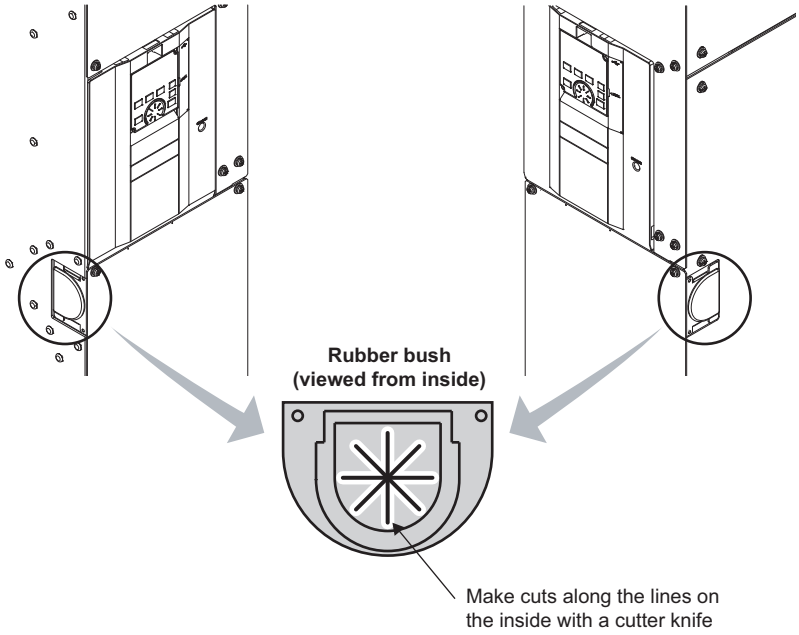
Micro signal contacts



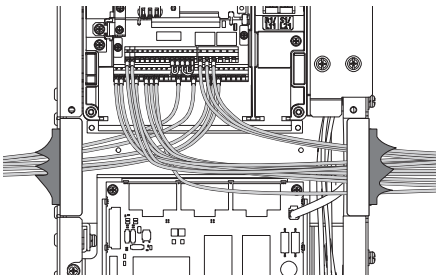
Twin contacts

- To suppress EMI, use shielded or twisted cables for the control circuit terminals and run them away from the main circuit (except for terminals R1/L11 and S1/L21) and power circuits (including the 200 V relay sequence circuit). For the cables connected to the control circuit terminals, connect their shields to the common terminal of the connected control circuit terminal. When connecting an external power supply to terminal PC, however, connect the shield of the power supply cable to the negative side of the external power supply. Do not directly earth (ground) the shield to the enclosure, etc.
- Always apply a voltage to the fault output terminals (A1, B1, C1, A2, B2, C2) via a relay coil, lamp, etc.

- Separate the wiring of the control circuit away from the wiring of the main circuit (except for terminals R1/L11 and S1/L21). Make cuts in rubber bush of the inverter side and lead the wires through.



<Wiring example>



2.6.6 When using separate power supplies for the control circuit and the main circuit

◆ Cable size for the control circuit power supply (terminals R1/L11 and S1/L21)

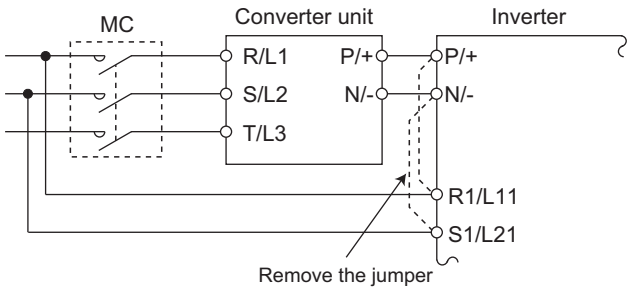
- Terminal screw size: M4
- Cable gauge: 0.75 to 2 mm^2
- Tightening torque: 1.5 N·m

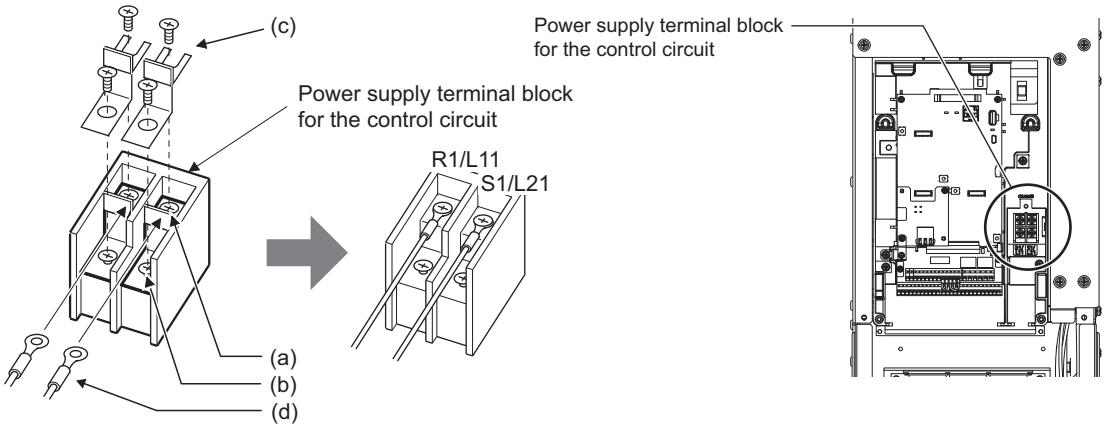
◆ Connection method

If a fault occurs and the electromagnetic contactor (MC) installed at the inverter's input line is opened, power supply to the control circuit is also stopped and the fault signals cannot be output anymore. Terminals R1/L11 and S1/L21 of the control circuit are provided to keep outputting the fault signals in such a case. Follow the following steps to wire terminals R1/L11 and S1/L21 on the inverter to the power input lines of the MC.

A jumper is installed across terminal R1/L11 and terminal P/+, and across terminal S1/L21 and terminal N/-. Do not connect the power cable to incorrect terminals. Doing so may damage the inverter.

Connection diagram





(a) Remove the upper screws.

(b) Remove the lower screws.

(c) Pull the jumper toward you to remove.

(d) Connect the separate power supply cable for the control circuit to the upper terminals (R1/L11, S1/L21).

NOTE

- When using separate power supplies, always remove the jumpers connected to terminals R1/L11 and S1/L21. The inverter may be damaged if the jumpers are not removed.
- When the control circuit power is supplied from other than the input line of the MC, the voltage of the separate power supply must be the same as that of the main control circuit.
- When using a separate power supply connected to terminals R1/L11 and S1/L21, the required power capacity is 80 VA.
- If the main circuit power is switched OFF (for 0.1 second or more) then ON again, the inverter is reset and a fault output will not be held.

2.6.7 When supplying 24 V external power to the control circuit

Connect the 24 V external power supply across terminals +24 and SD to turn the I/O terminal ON/OFF operation, keep the operation panel ON, and carry out communication during communication operation even at power-OFF state of inverter's main circuit power supply. When the main circuit power supply is turned ON, the power supply is switched from the 24 V external power supply to the main circuit power supply.

◆ Specification of the applied 24 V external power supply

Item	Rated specification
Input voltage	23 to 25.5 VDC
Input current	1.4 A or less

Commercially available products (as of April 2019)

Model	Product overview	Manufacturer
S8FS-G05024C*1	Specifications: Capacity 50 W, output voltage 24 VDC, output current 2.2 A Installation method: Direct installation, screw type terminal block with cover Input: Single-phase 100 to 240 VAC	OMRON Corporation
S8VK-S06024*1	Specifications: Capacity 60 W, output voltage 24 VDC, output current 2.5 A Installation method: DIN rail, push-in (spring) type terminal block Input: Single-phase 100 to 240 VAC	
S8VK-WA24024*1	Specifications: Capacity 240 W, output voltage 24 VDC, output current 10 A Installation method: DIN rail, push-in (spring) type terminal block Input: Three-phase 200 to 240 VAC	

*1 For the latest information about OMRON power supply, contact OMRON corporation.

◆ Starting and stopping the 24 V external power supply operation

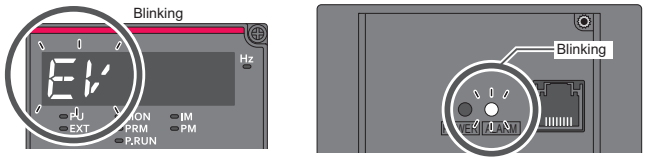
- Supplying 24 V external power while the main circuit power is OFF starts the 24 V external power supply operation. Likewise, turning OFF the main circuit power while supplying 24 V external power starts the 24 V external power supply operation.
- Turning ON the main circuit power stops 24 V external power supply operation and enables the normal operation.

NOTE

- When the 24 V external power is supplied while the main circuit power supply is OFF, the inverter operation is disabled.
- In the initial setting, when the main power supply is turned ON during the 24 V external power supply operation, a reset is performed in the inverter, then the power supply changes to the main circuit power supply. (The reset can be disabled using **Pr.30**.)

◆ Confirming the 24 V external power supply input

- During 24 V external power supply operation, "EV" blinks on the operation panel. The alarm LED also blinks. Thus, the 24 V external power supply operation can be confirmed even when the operation panel is removed.



- During 24 V external power supply operation, the 24 V external power supply operation (EV) signal is output. To use the EV signal, set "68 (positive logic) or 168 (negative logic)" in one of **Pr.190 to Pr.196 (Output terminal function selection)** to assign function to an output terminal.

◆ Operation while the 24 V external power is supplied

- Fault records and parameters can be read and parameters can be written (when the parameter write from the operation panel is enabled) using the operation panel keys.
- The safety stop function is invalid during the 24 V external power supply operation.
- During the 24 V external power supply operation, the monitor items related to inputs to main circuit power supply, such as the output current and converter output voltage, are invalid.
- The alarms, which have occurred when the main circuit power supply is ON, continue to be output after the power supply is changed to the 24 V external power supply. Perform the inverter reset or turn OFF then ON the power to reset the faults.
- The output data is retained when "1 or 11" is set in **Pr.495 Remote output selection**.

NOTE

- Inrush current equal to or higher than the 24 V external power supply specification may flow at power-ON. Confirm that the power supply and other devices are not affected by the inrush current and the voltage drop caused by it. Depending on the power supply, the inrush current protection may be activated to disable the power supply. Select the power supply and capacity carefully.
- When the wiring length between the external power supply and the inverter is long, the voltage often drops. Select the appropriate wiring size and length to keep the voltage in the rated input voltage range.
- In a serial connection of several inverters, the current increases when it flows through the inverter wiring near the power supply. The increase of the current causes voltage to drop further. When connecting different inverters to different power supplies, use the inverters after confirming that the input voltage of each inverter is within the rated input voltage range. Depending on the power supply, the inrush current protection may be activated to disable the power supply. Select the power supply and capacity carefully.
- When an external 24 V power supply is used, "E.SAF" or "E.P24" may appear if the power supply start-up time is too long (less than 1.5 V/s).
- "E.P24" may appear when the 24 V external power supply input voltage is low. Check the external power supply input.
- Do not touch the control circuit terminal block (circuit board) during the 24 V power supply operation (when conducted). Otherwise you may get an electric shock or burn.

2.6.8 Safety stop function

◆ Function description

The terminals related to the safety stop function are as follows.

Terminal symbol	Terminal function description	
S1[*1]	Input terminal as the safety stop channel 1.	Status of both the circuit between terminals S1 and SIC and the circuit between terminals S2 and SIC Open: Safety stop is activated. Shorted: Safety stop is not activated
S2[*1]	Input terminal as the safety stop channel 2.	
SIC[*1]	Common terminal for S1 and S2.	
So (SO)	Output terminal used for fault detection and fault indication display. The terminal is ON (conducted) while no internal safety circuit failure[*2] exists.	OFF: Internal safety circuit fault[*2] ON: No internal safety circuit failure[*2]
SOC	Open collector output (terminal So (SO)) common	

*1 In the initial status, terminals S1 and PC, S2 and PC, and SIC and SD are respectively shorted with shorting wires. To enable the safety stop function, remove all the shorting wires, and then connect a safety relay module as shown in the connection diagram.

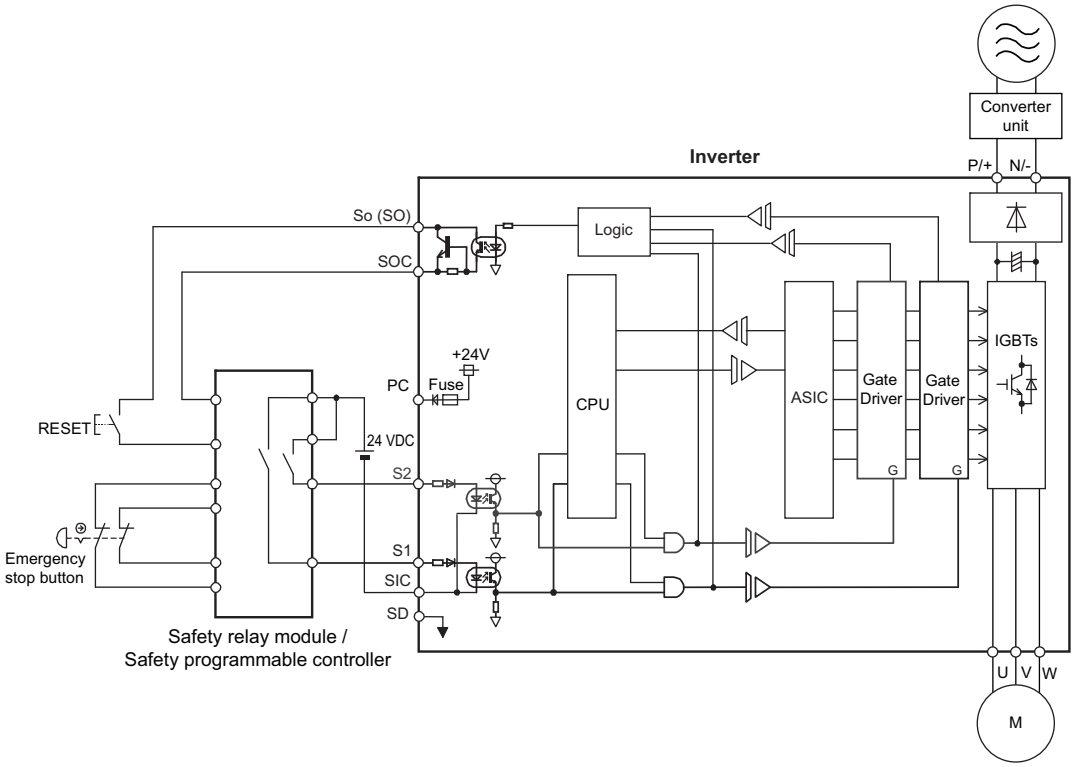
*2 When any fault listed on the next page occurs in the internal safety circuit, the corresponding indication is shown on the operation panel.

NOTE

- Terminal So (SO) can be used to display a fault indication and to prevent restarting of the inverter. The signal output from terminal So (SO) cannot be used to input a safety stop signal to other devices.

◆ Connection diagram

To prevent restart at failure occurrence, connect terminals So (SO) and SOC to the reset button, which are the feedback input terminals of the safety relay module.



◆ Safety stop function operation

Input power	Internal safety circuit status	Input terminal[*1*2]		Output terminal	Output signal[*8*9*10]	Inverter operating status	Operation panel indication	
		S1	S2	So (SO)	SAFE		E.SAF[*6]	SA[*7]
OFF	—	—	—	OFF	OFF	Output shutoff (Safe state)	Not displayed	Not displayed
ON	Normal	ON	ON	ON[*3]	OFF	Operation enabled	Not displayed	Not displayed
	Normal	ON	OFF	OFF[*4]	OFF[*4]	Output shutoff (Safe state)	Displayed	Displayed
	Normal	OFF	ON	OFF[*4]	OFF[*4]	Output shutoff (Safe state)	Displayed	Displayed
	Normal	OFF	OFF	ON[*3]	ON[*3]	Output shutoff (Safe state)	Not displayed	Displayed
	Fault	ON	ON	OFF	OFF	Output shutoff (Safe state)	Displayed	Not displayed[*5]
	Fault	ON	OFF	OFF	OFF	Output shutoff (Safe state)	Displayed	Displayed
	Fault	OFF	ON	OFF	OFF	Output shutoff (Safe state)	Displayed	Displayed
	Fault	OFF	OFF	OFF	OFF	Output shutoff (Safe state)	Displayed	Displayed

*1 The terminal ON state shows that the terminal is conducted (the line is closed), and the OFF state shows that the terminal is not conducted (the line is open).

*2 When not using the safety stop function, short across terminals S1 and PC, S2 and PC, and SIC and SD to use the inverter. (In the initial status, terminals S1 and PC, S2 and PC, and SIC and SD are respectively shorted with shorting wires.)

*3 If any of the faults shown in the following table occurs, terminal So (SO) and the SAFE signal turn OFF.

Fault type	Operation panel indication
Option fault	E.OPT
Communication option fault	E.OP1 to E.OP3
Parameter storage device fault (control circuit board)	E.PE
Retry count excess	E.RET
Parameter storage device fault (main circuit board)	E.PE2
Operation panel power supply short circuit	E.CTE
24 VDC power fault	E.P24
Safety circuit fault	E.SAF

Fault type	Operation panel indication
Overspeed occurrence	E.OS
Speed deviation excess detection	E.OSD
Signal loss detection	E.ECT
Excessive position fault	E.OD
Brake sequence fault	E.MB1 to E.MB7
CPU fault	E.CPU
	E.5 to E.7
Encoder phase fault	E.EP
Internal circuit fault	E.13

*4 When the internal safety circuit is operated normally (no faults occurs), terminal So (SO) and the SAFE signal remains ON until "E.SAF" is displayed. Terminal So (SO) and the SAFE signal turns OFF when "E.SAF" is displayed.

*5 "SA" is displayed when terminals S1 and S2 are identified as OFF due to a fault occurred in the internal safety circuit.

*6 If another fault occurs when the fault E.SAF occurs, the other fault indication may be displayed.

*7 If another warning occurs when the warning SA occurs, the other warning indication may be displayed.

*8 The ON/OFF state of the output signal is the one for the positive logic. The ON and OFF are reversed for the negative logic.

*9 To assign the function of the SAFE signal to an output terminal, set either value shown in the following table in any parameter from **Pr.190 to Pr.196 (Output terminal function selection)**.

Output signal	Pr.190 to Pr.196 settings	
	Positive logic	Negative logic
SAFE	80	180

*10 The use of SAFE signal has not been certified for compliance with safety standards.

For more details, refer to the Safety Stop Function Instruction Manual.

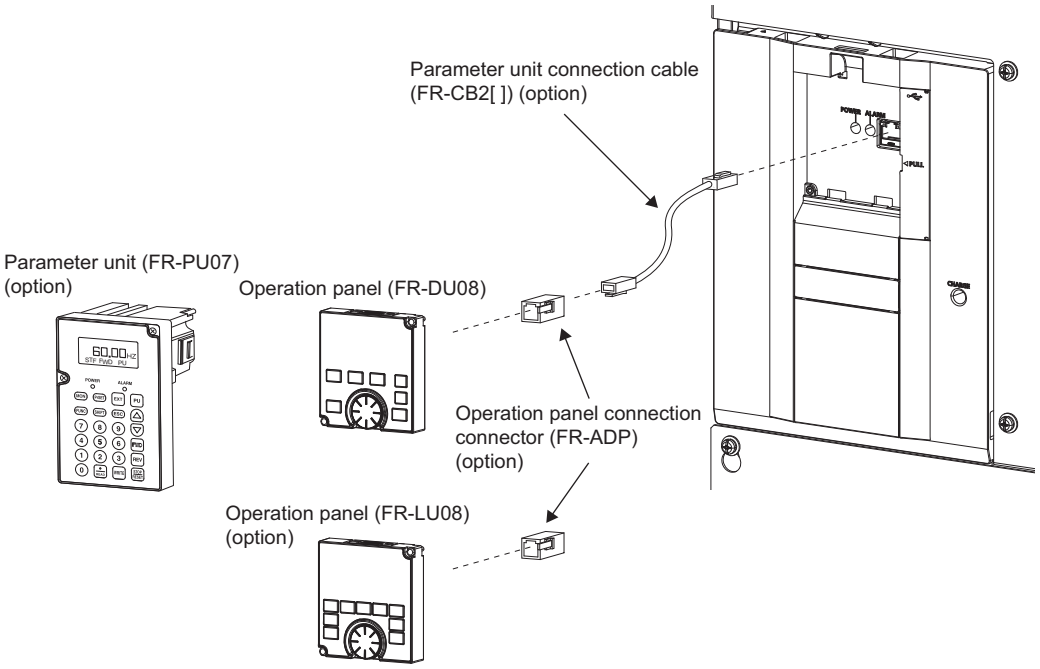
Find a PDF file of the manual in the CD-ROM enclosed with the product.

2.7 Communication connectors and terminals

2.7.1 PU connector

◆ Mounting the operation panel or the parameter unit on the enclosure surface

- Having an operation panel or a parameter unit on the enclosure surface is convenient. With a connection cable, the operation panel or the parameter unit can be mounted to the enclosure surface and connected to the inverter.
  Use the option FR-CB2[], or connectors and cables available on the market.
  (To mount the operation panel, the optional connector (FR-ADP) is required.)
  Securely insert one end of the cable into the PU connector and the other end into the connection connector on the parameter unit or the FR-ADP attached on the operation panel until the stoppers are fixed.



NOTE

- Refer to the following table when fabricating the cable on the user side. Keep the total cable length within 20 m.
- Commercially available products (as of February 2015)

Name	Model	Manufacturer
Communication cable	SGLPEV-T (Cat5e/300 m) 24AWG × 4P	Mitsubishi Cable Industries, Ltd.
RJ-45 connector	5-554720-3	Tyco Electronics

◆ Communication operation

- Using the PU connector as a computer network port enables communication operation from a personal computer, etc. When the PU connector is connected with a personal, FA or other computer by a communication cable, a user program can run to monitor the inverter or read and write parameters.
  Communication can be performed with the Mitsubishi inverter protocol (computer link operation).
  For details, refer to the Instruction Manual (Function).

2.7.2 Ethernet connector

◆ Ethernet communication specifications

Item	Description
Category	100BASE-TX/10BASE-T
Data transmission speed	100 Mbps (100BASE-TX) / 10 Mbps (10BASE-T)
Transmission method	Baseband
Maximum segment length	100 m between the hub and the inverter
Number of cascade connection stages	Up to 2 (100BASE-TX) / up to 4 (10BASE-T)
Interface	RJ-45
Number of interfaces available	1
IP version	IPv4

◆ Connection cable

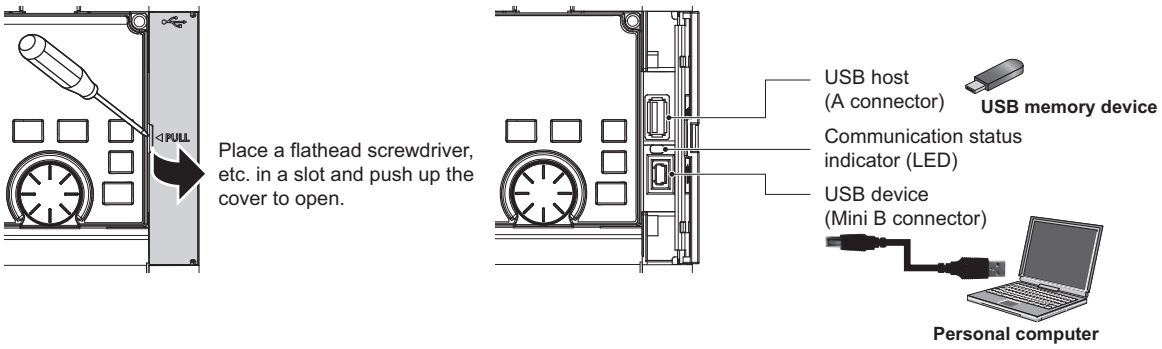
Use Ethernet cables compliant with the following standards.

Communication speed	Cable	Connector	Type
100 Mbps	Category 5 or higher, (shielded / STP) straight cable	RJ-45 connector	100BASE-TX
10 Mbps	Category 3 or higher, (shielded / STP) straight cable		10BASE-T
	Category 3 or higher, (UTP) straight cable		

◆ Hubs

Use a hub that supports a desired transmission speed of the Ethernet.

2.7.3 USB connector



◆ USB host communication

Interface		Conforms to USB 1.1
Transmission speed		12 Mbps
Wiring length		Maximum 5 m
Connector		USB A connector (receptacle)
Compatible USB memory	**Format**	FAT32
	Capacity	1 GB or more (used in the recorder mode of the trace function)
	Encryption function	Not available

- Different inverter data can be saved in a USB memory device.
  The USB host communication enables the following functions.

Function	Description
Parameter copy	• Copies the parameter settings from the inverter to the USB memory device. A maximum of 99 parameter setting files can be saved in a USB memory device. • The parameter setting data copied in the USB memory device can be copied to other inverters. This function is useful in backing up the parameter setting or for sharing the parameter setting among multiple inverters.
Trace	• The monitoring data and output status of the signals can be saved in a USB memory device.
PLC function data copy	• This function copies the PLC function project data to a USB memory device when the PLC function is used. • The PLC function project data copied in the USB memory device can be copied to other inverters. • This function is useful in backing up the parameter setting and for allowing multiple inverters to operate by the same sequence programs.

- When the inverter recognizes the USB memory device without any problem, USb.-A is briefly displayed on the operation panel.
- When the USB memory device is removed, USb.-- is briefly displayed on the operation panel.
- The operating status of the USB host can be checked on the LED display of the inverter.

LED display status	Operating status
OFF	No USB connection.
ON	The communication is established between the inverter and the USB device.
Fast blinking	The USB memory device is being accessed. (Do not remove the USB memory device.)
Slow blinking	Error in the USB connection.

- When a device such as a USB charger is connected to the USB connector and an excessive current (500 mA or higher) flows, USB host error "UF " (UF warning) is displayed on the operation panel.
- When the UF warning appears, the USB error can be canceled by removing the USB device and setting **Pr.1049** = "1". (The UF warning can also be canceled by resetting the inverter power or resetting with the RES signal.)

NOTE

- Do not connect devices other than a USB memory device to the inverter.
- If a USB device is connected to the inverter via a USB hub, the inverter cannot recognize the USB memory device properly.
- For the detail of usage, refer to the Instruction Manual (Function).

◆USB device communication

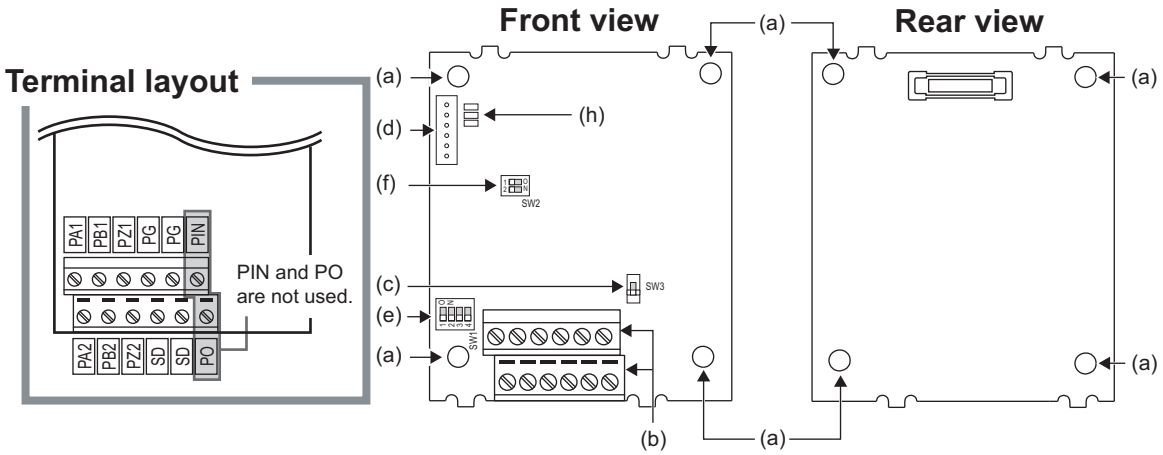
The inverter can be connected to a personal computer with a USB (ver. 1.1) cable.

Interface	Conforms to USB 1.1
Transmission speed	12 Mbps
Wiring length	Maximum 5 m
Connector	USB mini B connector (receptacle)
Power supply	Self-powered

2.8 Connection to a motor with encoder (Vector control)

Using encoder-equipped motors together with a Vector control compatible option enables speed, torque, and positioning control operations under orientation control, encoder feedback control, and full-scale Vector control.
This section explains wiring for use of the FR-A8AP.

◆Appearance and parts name of the FR-A8AP



Symbol	Name	Description	Refer to page
(a)	Mounting hole	Used for installation to the inverter.	—
(b)	Terminal block	Connected with the encoder.	63
(c)	Encoder type selection switch (SW3)	Switches the encoder type (differential line driver/complementary).	61
(d)	CON2 connector	Used for extension.	—
(e)	Terminating resistor selection switches (SW1)	Switch ON or OFF the internal terminating resistor.	61
(f)	Switches (SW2) for manufacturer setting	Do not change the initial setting (both SW2-1 and SW2-2 switches: OFF).	—
(g)	Board mounted option connector	Used to connect this product to the option connector on the inverter.	14
(h)	LED for manufacturer check	Not used.	—

◆Terminals of the FR-A8AP

Terminal symbol	Terminal name	Description
PA1	Encoder A-phase signal input terminal	A-, B- and Z-phase signals are input from the encoder.
PA2	Encoder A-phase inverse signal input terminal	
PB1	Encoder B-phase signal input terminal	
PB2	Encoder B-phase inverse signal input terminal	
PZ1	Encoder Z-phase signal input terminal	
PZ2	Encoder Z-phase inverse signal input terminal	
PG	Encoder power supply (positive) input terminal	Input terminal for the encoder power supply. Connect the external power supply (5 V, 12 V, 15 V, 24 V) and the encoder power cable. When the encoder output is the differential line driver type, only 5 V can be input. Make the voltage of the external power supply same as the encoder output voltage. (Check the encoder specification.)
SD	Encoder power supply ground terminal	
PIN	Not used.	
PO		

NOTE

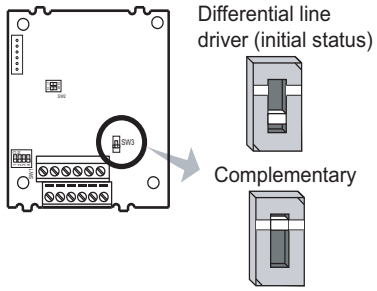
- When the encoder's output voltage differs from its input power supply voltage, the signal loss detection (E.ECT) may occur.
- Incorrect wiring or faulty setting to the encoder will cause a fault such as an overcurrent (E.OC[]) and an inverter overload (E.THT). Correctly perform the encoder wiring and setting.

◆ Switches on the FR-A8AP

- Encoder type selection switch (SW3)

  Selects either the differential line driver or complementary setting.

  It is initially set to the differential line driver. Switch its position according to the output circuit.

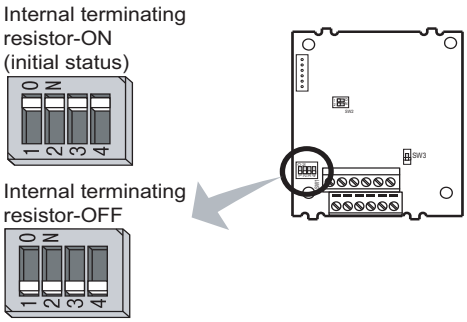


- Use the terminating resistor selection switches (SW1) to select ON/OFF of the internal terminating resistor.

  Set the switches ON (initial status) when an encoder output type is differential line driver, and set OFF when complementary.

  ON: With internal terminating resistor (initial status)

  OFF: Without internal terminating resistor



NOTE

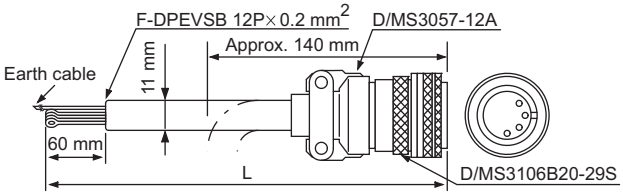
- Set all switches to the same setting (ON/OFF).
- Set the switches OFF when sharing an encoder with another unit (NC (computerized numerical controller), etc.) having a terminating resistor under the differential line driver setting.
- Prepare the power supply (5 V/12 V/15 V/24 V) for the encoder according to the encoder's output voltage. When the control terminal option FR-A8TP is installed, 24 V power supply can be provided from the FR-A8TP. When the encoder output is the differential line driver type, only 5 V can be input.
- The SW2 switches are for manufacturer setting. Do not change the setting.
- When the power supply of the inverter is turned OFF, also turn off the power supply of the encoder. Otherwise, the plug-in option may be damaged.

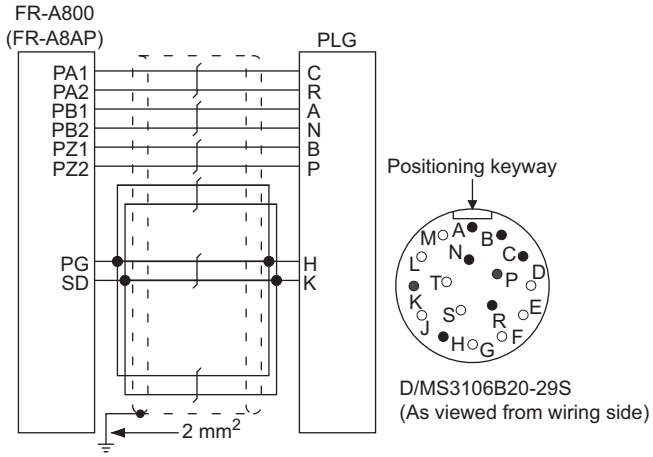
- Encoder specification

Item	Specification
Resolution	0 to 4096 Pulse/Rev (setting by **Pr.369**)
Power supply voltage	5 V, 12 V, 15 V, or 24 V
Output signal form	A, B phases (90° phase shift), Z phase: 1 pulse/rev
Output circuit	Differential line driver or complementary

◆ Encoder cable

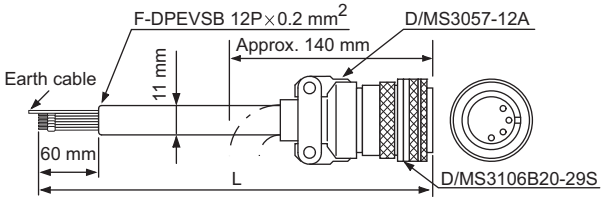
■ FR-JCBL



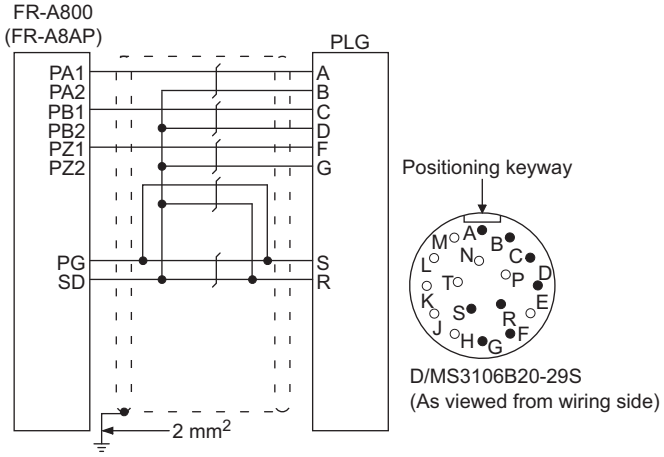


Model	Length L (m)
FR-JCBL5	5
FR-JCBL15	15
FR-JCBL30	30

■ FR-V7CBL



A P clip for earthing (grounding) a shielded cable is provided.



Model	Length L (m)
FR-V7CBL5	5
FR-V7CBL15	15
FR-V7CBL30	30

- As the terminal block of the FR-A8AP is an insertion type, cables need to be treated when the encoder cables of the inverter are crimping terminals. Cut the crimp terminal of the encoder cable and strip its sheath to make its cable wires loose. Also, treat the shielding wires of the shielded twisted pair cable to ensure that they do not contact conductive areas. Wire the stripped cable after twisting it to prevent it from becoming loose. In addition, do not solder it.

NOTE

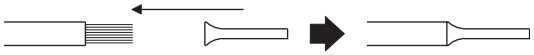
- Information on blade terminals
  Commercially available products (as of January 2017)
  Phoenix Contact Co., Ltd.

Terminal screw size	Cable gauge (mm^2)	Ferrule part No.		Crimping tool name
		With insulation sleeve	Without insulation sleeve	
M2	0.3	AI 0,34-6TQ	A 0,34-7	CRIMPFOX 6
	0.5	AI 0,5-6WH	A 0,5-6	

NICHIFU Co., Ltd.

Terminal screw size	Cable gauge (mm^2)	Blade terminal part No.	Insulation cap part No.	Crimping tool model No.
M2	0.3 to 0.75	BT 0.75-7	VC 0.75	NH 69

- When using a blade terminal (without insulation sleeve), take caution that the twisted wires do not come out.



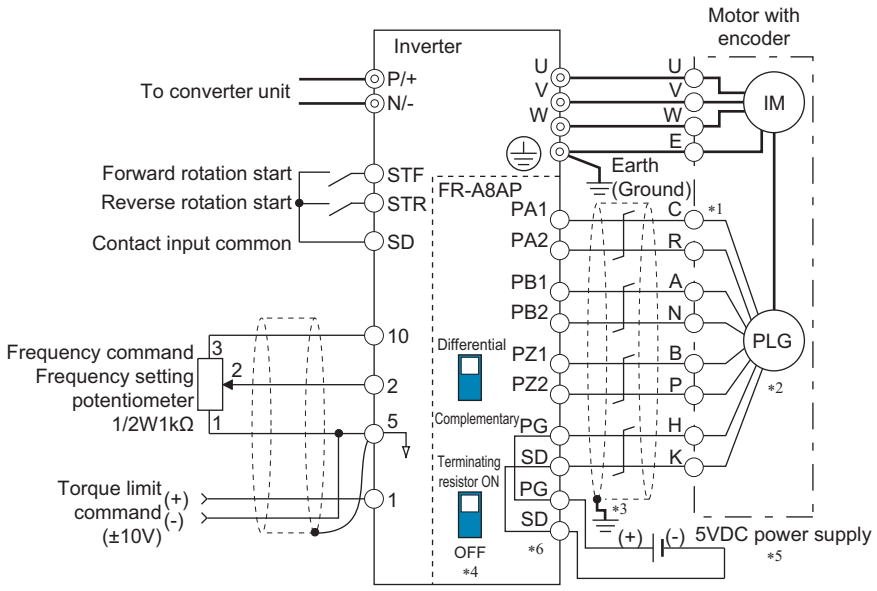
- Connection terminal compatibility table

Encoder cable		FR-V7CBL	FR-JCBL
FR-A8AP terminal	PA1	PA	PA
	PA2	Do not connect anything to this.	PAR
	PB1	PB	PB
	PB2	Do not connect anything to this.	PBR
	PZ1	PZ	PZ
	PZ2	Do not connect anything to this.	PZR
	PG	PG	5E
	SD	SD	AG2

◆ Wiring example

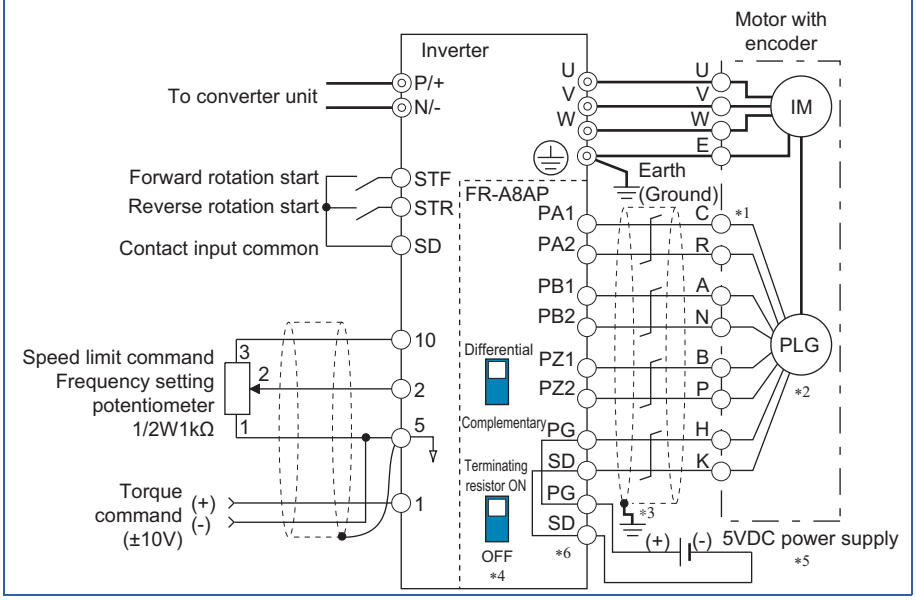
- Speed control

Standard motor with encoder, 5 V differential line driver



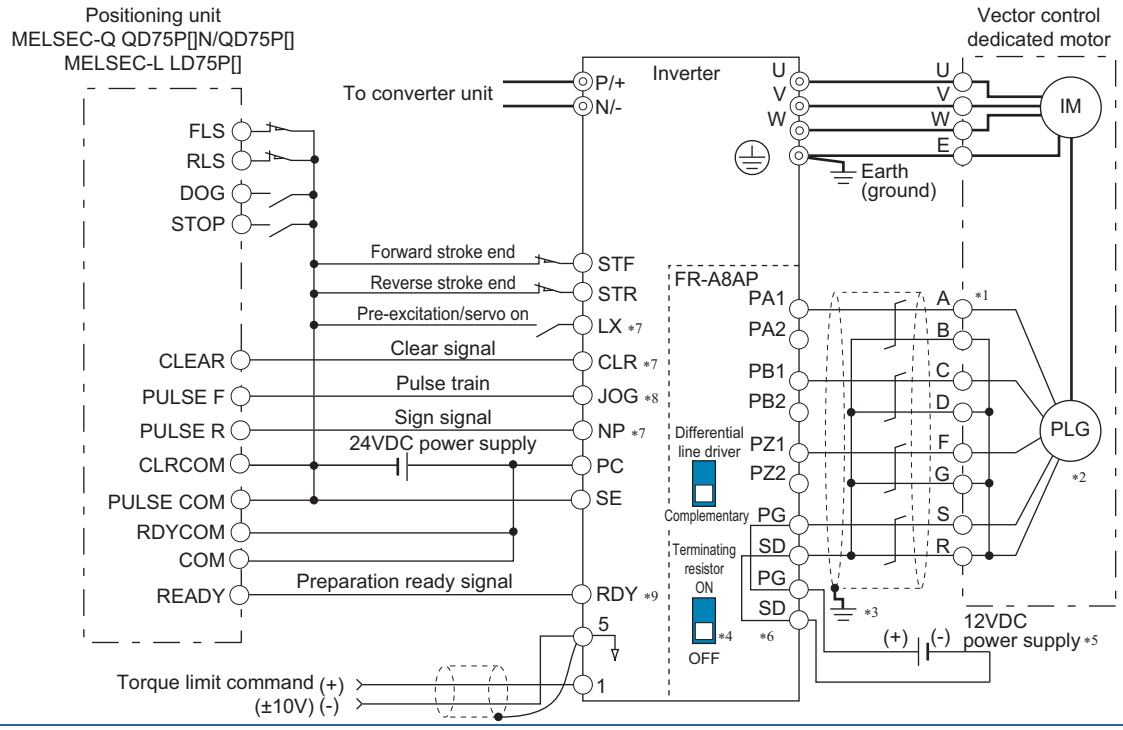
- Torque control

Standard motor with encoder, 5 V differential line driver



- Position control

Vector control dedicated motor, 12 V complementary



*1 The pin number differs according to the encoder used.
Speed, control, torque control, and position control by pulse train input are available with or without the Z-phase being connected.

*2 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio must be 1:1.

*3 Earth (ground) the shield of the encoder cable to the enclosure using a tool such as a P-clip. (Refer to page 65.)

*4 For the complementary, set the terminating resistor selection switches in the OFF position. (Refer to page 61.)

*5 A separate power supply of 5 V/12 V/15 V/24 V is necessary according to the encoder power specification.
When the encoder output is the differential line driver type, only 5 V can be input.
Make the voltage of the external power supply same as the encoder output voltage, and connect the external power supply between PG and SD.

*6 For terminal compatibility of the FR-JCBL, FR-V7CBL, and FR-A8AP, refer to page 63.

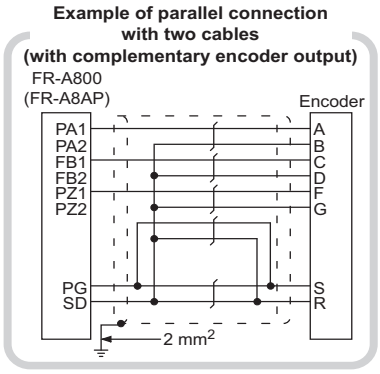
*7 Assign the function using **Pr.178 to Pr.184, Pr.187 to Pr.189 (Input terminal function selection)**.

*8 When position control is selected, terminal JOG function is invalid and simple position pulse train input terminal becomes valid.

*9 Assign the function using **Pr.190 to Pr.194 (Output terminal function selection)**.

◆ Instructions for encoder cable wiring

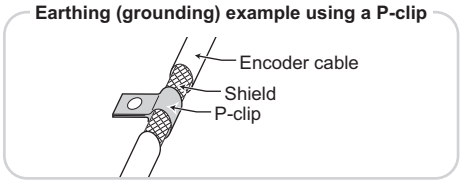
- Use shielded twisted pair cables (0.2 mm^2 or larger) to connect the FR-A8AP. For the wiring to terminals PG and SD, use several cables in parallel or use a thick cable, according to the wiring length.
  To protect the cables from noise, run them away from any source of noise (such as the main circuit and power supply voltage).



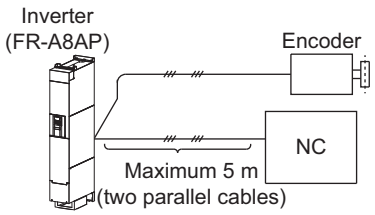
Wiring length	Parallel connection		Larger-size cable
Within 10 m	At least two cables in parallel	Cable gauge 0.2mm^2	0.4 mm^2 or larger
Within 20 m	At least four cables in parallel		0.75 mm^2 or larger
Within 100 m*1	At least six cables in parallel		1.25 mm^2 or larger

*1 When differential line driver is set and a wiring length is 30 m or more.
The wiring length can be extended to 100 m by increasing the 5 V power supply (approximately to 5.5 V) while using six or more 0.2 mm^2 gauge cables in parallel or a 1.25 mm^2 or larger gauge cable. The voltage applied must be within power supply specifications of encoder.

- To reduce noise of the encoder cable, earth (ground) the encoder's shielded cable to the enclosure (as close as possible to the inverter) with a metal P-clip or U-clip.



- When one encoder is shared between the FR-A8AP and CNC (computerized numerical controller), its output signal should be connected as follows. In this case, the wiring length between the FR-A8AP and CNC should be as short as possible, within 5 m.



NOTE

- For the details of the optional encoder dedicated cable (FR-JCBL/FR-V7CBL), refer to page 62.
- The FR-V7CBL is provided with a P-clip for earthing (grounding) shielded cables.

2.9 Parameter settings for a motor with encoder

◆ Parameter for the encoder (Pr.359, Pr.369, Pr.851, Pr.852)

- Set the encoder specifications.

Pr.		Name	Initial value	Setting range	Description	
359 C141	852 C241	Encoder rotation direction	1	0	Set when using a motor for which forward rotation (encoder) is clockwise (CW) viewed from the shaft 	Set for the operation at 120 Hz or less.
				100		Set for the operation at a frequency higher than 120 Hz.
				1	Set when using a motor for which forward rotation (encoder) is counterclockwise (CCW) viewed from the shaft. 	Set for the operation at 120 Hz or less.
				101		Set for the operation at a frequency higher than 120 Hz.
369 C140	851 C240	Number of encoder pulses	1024	0 to 4096	Set the number of encoder pulses. Set the number of pulses before it is multiplied by 4.	

The parameters above can be set when a Vector control compatible option is installed.

- The following table shows parameters to be set according to the Vector control compatible option to be used.

Item	FR-A8AP/FR-A8AL/FR-A8APA parameter	FR-A8APR parameter	FR-A8APS parameter	FR-A8TP parameter
Encoder/Resolver rotation direction	**Pr.359**			**Pr.852**
Number of detector pulses	**Pr.369**	— (fixed pulses of 1024)	— (obtained via communication from the encoder)	**Pr.851**

◆ Parameter settings for the motor under Vector control

Motor model	Pr.9 Electronic thermal O/L relay	Pr.71 Applied motor	Pr.80 Motor capacity	Pr.81 Number of motor poles	Pr.359/Pr.852 Encoder rotation direction	Pr.369/Pr.851 Number of encoder pulses
Standard motor	Rated motor current	0 (3)*1	Motor capacity	Number of motor poles	*2	*2
Constant-torque motor	Rated motor current	1 (13)*1	Motor capacity	Number of motor poles	*2	*2

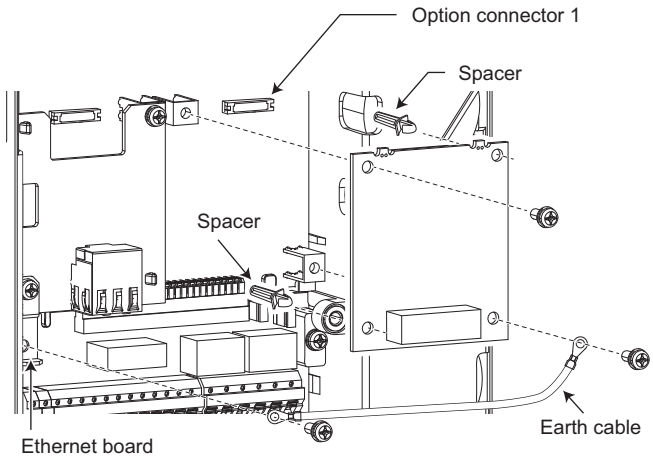
*1 Offline auto tuning is required. (Refer to the Instruction Manual (Function).)

*2 Set this parameter according to the motor.

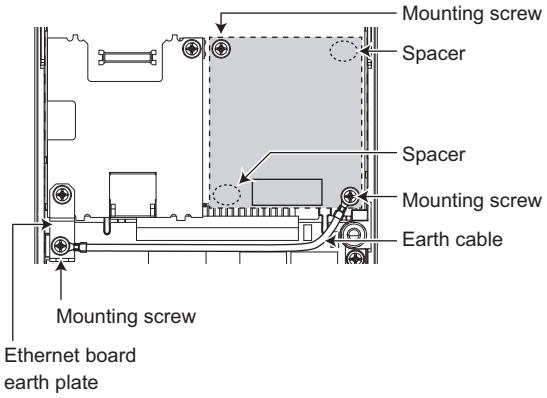
2.10 Installing a communication option

To use a communication option, the enclosed earthing (grounding) cable needs to be installed. Install the cable according to the following procedure.

No.	Description
1	Insert spacers into the mounting holes that will not be tightened with the option mounting screws.
2	Fit the connector of the communication option to the guide of the connector of the inverter, and insert the option as far as it goes. (Insert it to the inverter option connector 1.)
3	Remove the mounting screw (lower) of the Ethernet board earth plate. Fit the one terminal of the earthing (grounding) cable on the Ethernet board earth plate and fix it securely to the inverter with the mounting screw (tightening torque 0.33 to 0.40 N·m).
4	Fix the left part of the communication option securely with the option mounting screw, and place another terminal of the earthing (grounding) cable on the right part of the option and fix the cable terminal and the option with the option mounting screw (tightening torque: 0.33 to 0.40 N·m). If the screw holes do not line up, the connector may not be inserted deep enough. Check the connector.



Example of FR-A8NC



NOTE

- The number and shape of the spacers used differ depending on the communication option type. Refer to the Instruction Manual of each communication option for details.
- The earth plate enclosed with a communication option is not used.

MEMO

CHAPTER 3 PRECAUTIONS FOR USE OF THE INVERTER

3 PRECAUTIONS FOR USE OF THE INVERTER

This chapter explains the precautions for use of this product.
Always read the instructions before use.

3.1 Electro-magnetic interference (EMI) and leakage currents

3.1.1 Leakage currents and countermeasures

Capacitances exist between the inverter I/O cables, other cables and earth and in the motor, through which a leakage current flows. Since its value depends on the static capacitances, carrier frequency, etc., low acoustic noise operation at the increased carrier frequency of the inverter will increase the leakage current. Therefore, take the following countermeasures. Select the earth leakage current breaker according to its rated sensitivity current, independently of the carrier frequency setting.

◆To-earth (ground) leakage currents

Leakage currents may flow not only into the inverter's own line but also into the other lines through the earthing (grounding) cable, etc. These leakage currents may operate earth leakage circuit breakers and earth leakage relays unnecessarily.

■Countermeasures

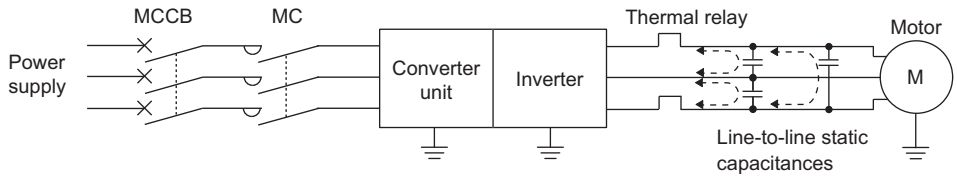
- If the carrier frequency setting is high, decrease the **Pr.72 PWM frequency selection** setting.
  Note that motor noise increases. Selecting **Pr.240 Soft-PWM operation selection** makes the sound inoffensive.
- By using earth leakage circuit breakers designed for harmonic and surge suppression in the inverter's own line and other line, operation can be performed with the carrier frequency kept high (with low noise).

■To-earth (ground) leakage currents

- Take caution as long wiring will increase the leakage current. Decreasing the carrier frequency of the inverter reduces the leakage current.
- High motor capacity will increase the leakage current.

◆Line-to-line leakage currents

Harmonics of leakage currents flowing in static capacitances between the inverter output cables may operate the external thermal relay unnecessarily.



Line-to-line leakage currents path

■Countermeasures

- Use **Pr.9 Electronic thermal O/L relay**.
- If the carrier frequency setting is high, decrease the **Pr.72 PWM frequency selection** setting.
  Note that motor noise increases. Selecting **Pr.240 Soft-PWM operation selection** makes the sound inoffensive.
  To ensure that the motor is protected against line-to-line leakage currents, it is recommended to use a temperature sensor to directly detect motor temperature.

■ Installing and selecting MCCB

Install a molded case circuit breaker (MCCB) on the power receiving side to protect the wiring at the inverter input side. Select an MCCB according to the inverter input side power factor, which depends on the power supply voltage, output frequency and load. Especially for a completely electromagnetic MCCB, a slightly large capacity must be selected since its operation characteristic varies with harmonic currents. (Check it in the data of the corresponding breaker.) As an earth leakage current breaker, use the earth leakage current breaker designed for harmonics and surge suppression.

3.1.2 Techniques and measures for electromagnetic compatibility (EMC)

Some electromagnetic noises enter the inverter or the converter unit to cause its malfunction, and others are radiated by the inverter or the converter unit to cause the peripheral devices to malfunction. Though the inverter or the converter unit is designed to have high immunity performance, it handles low-level signals, so it requires the following basic techniques. Pay attention to the electromagnetic noises that could be generated by the inverter since the inverter chops outputs at high carrier frequency. If these electromagnetic noises cause peripheral devices to malfunction, EMI countermeasures should be taken to suppress noises. These techniques differ slightly depending on EMI paths.

◆ Basic measures

- Do not run the power cables (I/O cables) and signal cables of the inverter or the converter unit in parallel with each other and do not bundle them.
- Use shielded twisted pair cables for the detector connecting and control signal cables and connect the sheathes of the shielded cables to terminal SD.
- Ground (Earth) the inverter or the converter unit, motor, etc. at one point.

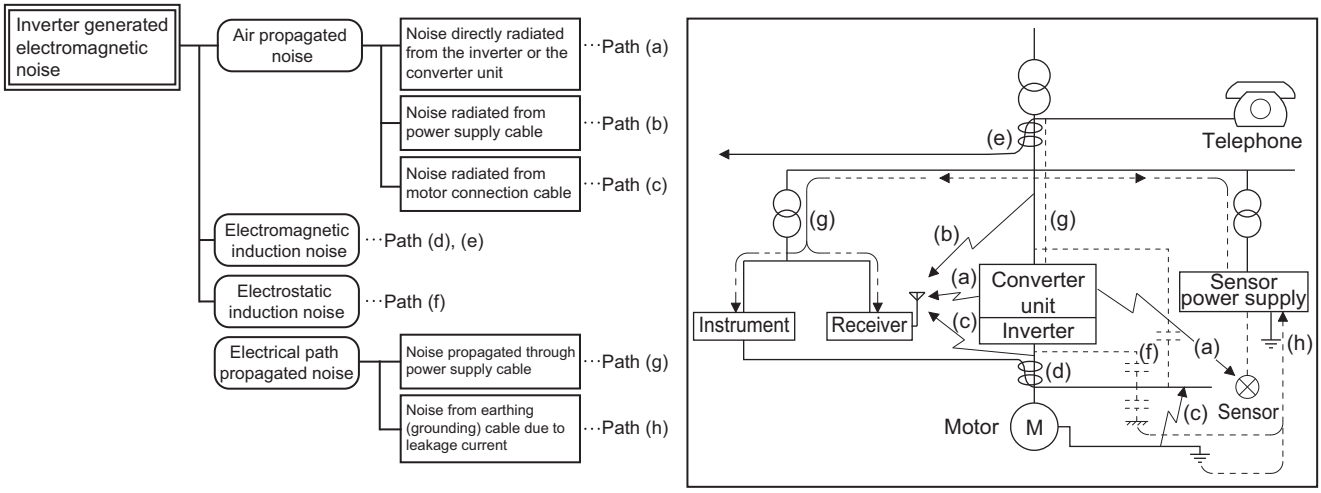
◆ Techniques to reduce electromagnetic noises that enter and cause a malfunction of the inverter or the converter unit (EMI countermeasures)

When devices that generate many electromagnetic noises (which use magnetic contactors, electromagnetic brakes, many relays, for example) are installed near the inverter or the converter unit and it may malfunction due to electromagnetic noises, the following countermeasures must be taken:

- Provide surge suppressors for devices that generate many electromagnetic noises to suppress electromagnetic noises.
- Install data line filters (page 72) to signal cables.
- Ground (Earth) the shields of the detector connection and control signal cables with cable clamp metal.

◆ Techniques to reduce electromagnetic noises that are radiated by the inverter or the converter unit to cause the peripheral devices to malfunction (EMI countermeasures)

Noises generated from the inverter or the converter unit are largely classified into those radiated by the cables connected to the inverter or the converter unit and its main circuits (I/O), those electromagnetically and electrostatically induced to the signal cables of the peripheral devices close to the main circuit power supply, and those transmitted through the power supply cables.



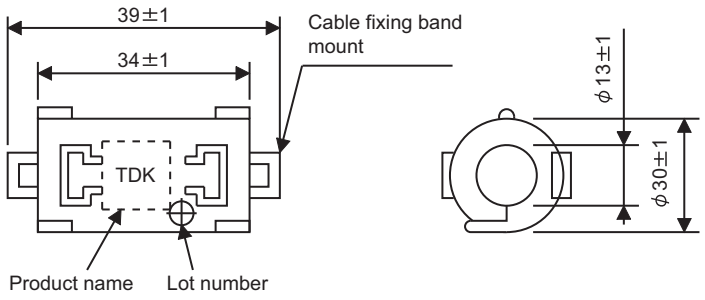
Noise propagation path	Countermeasure
(a), (b), (c)	When devices that handle low-level signals and are liable to malfunction due to electromagnetic noises, e.g. instruments, receivers and sensors, are contained in the enclosure that contains the inverter or the converter unit, or when their signal cables are run near the inverter, the devices may malfunction due to by air-propagated electromagnetic noises. The following countermeasures must be taken: • Install easily affected devices as far away as possible from the inverter or the converter unit. • Run easily affected signal cables as far away as possible from the inverter or the converter unit, and its I/O cables. • Do not run the signal cables and power cables (inverter or converter unit I/O cables) in parallel with each other, and do not bundle them. • Set the EMC filter ON/OFF connector of the converter unit to the ON position. (Refer to page 74.) • Inserting a line noise filter into the output suppresses the radiated noise from the cables. • Use shielded cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
(d), (e), (f)	When the signal cables are run in parallel with or bundled with the power cables, magnetic and static induction noises may be propagated to the signal cables to cause malfunction of the devices and the following countermeasures must be taken: • Install easily affected devices as far away as possible from the inverter or the converter unit. • Run easily affected signal cables as far away as possible from the inverter or the converter unit, and its I/O cables. • Do not run the signal cables and power cables (inverter or converter unit I/O cables) in parallel with each other, and do not bundle them. • Use shielded cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
(g)	When the power supplies of the peripheral devices are connected to the power supply of the inverter or the converter unit in the same line, its generated noises may flow back through the power supply cables to cause malfunction of the devices and the following countermeasures must be taken: • Set the EMC filter ON/OFF connector of the converter unit to the ON position. (Refer to page 74.) • Install the line noise filter to the power cables (output cables) of the inverter.
(h)	When a closed loop circuit is formed by connecting the peripheral device wiring to the inverter or the converter unit, leakage currents may flow through the earthing (grounding) cable of the inverter or the converter unit to cause the device to malfunction. In that case, disconnecting the earthing (grounding) cable from the device may stop the malfunction of the device.

■ Data line filter

Data line filter is effective as an EMI countermeasure. Provide a data line filter for the detector cable, etc.

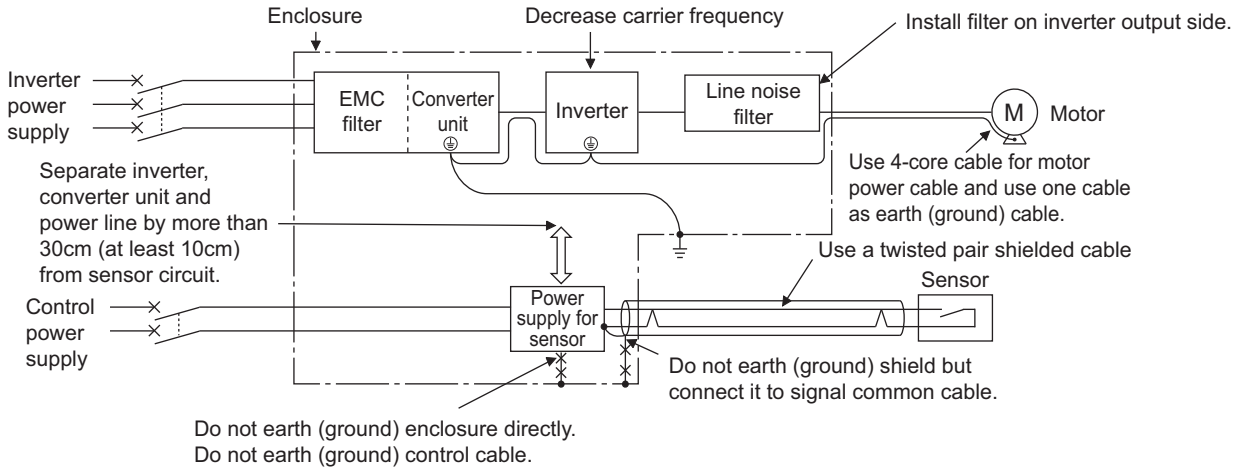
- Commercially available data line filter: ZCAT3035-1330 (by TDK), ESD-SR-250 (by NEC TOKIN)

- Specification example (ZCAT3035-1330 by TDK)

Item	Description	
Impedance (Ω)	10 to 100 MHz	80
	100 to 500 MHz	150
Outline dimension drawings (mm)		

The impedance values above are reference values, and not guaranteed values.

■ EMI measure example

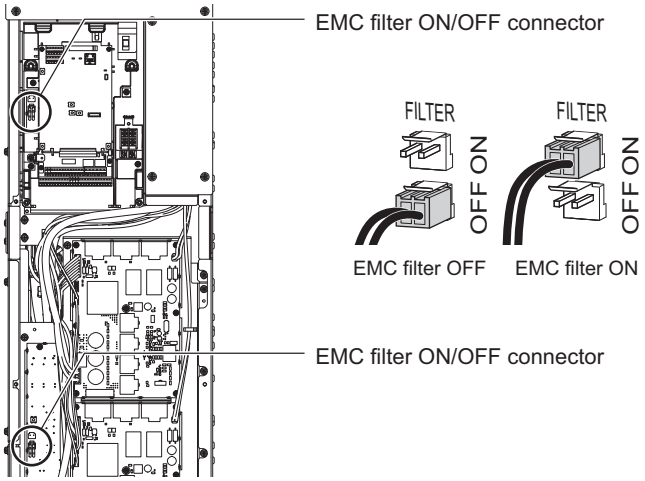


NOTE

- For compliance with the EU EMC Directive, refer to page 117.

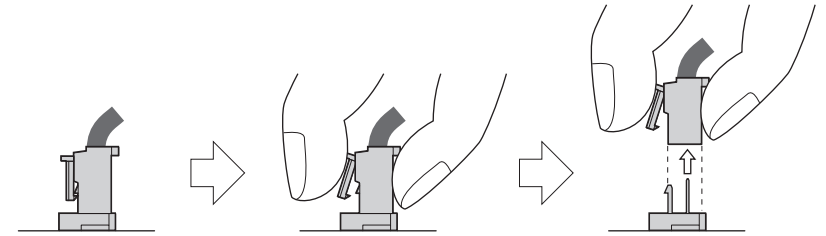
3.1.3 Converter unit (FR-CC2) built-in EMC filter

The converter unit (FR-CC2) is equipped with a built-in EMC filter (capacitive filter).
These filters are effective in reducing air-propagated noise on the input side of the converter unit.
To enable the EMC filter, set the EMC filter ON/OFF connector to the ON position.
Two female connectors are initially connected to the OFF (disabled) male connectors.
To enable the EMC filter, fit both of the EMC filter ON/OFF connectors to the "enabled" (ON) position.



◆How to enable or disable the filter

- Before removing a front cover, check to make sure that the indication of the inverter operation panel is OFF, wait for at least 10 minutes after the power supply has been switched OFF, and check that there is no residual voltage using a digital multimeter or the like.
- When disconnecting the connector, push the fixing tab and pull the connector straight without pulling the cable or forcibly pulling the connector with the tab fixed.
  When installing the connector, also engage the fixing tab securely.
  (If it is difficult to disconnect the connector, use a pair of needle-nose pliers, etc.)



NOTE

- Fit the connector to either ON or OFF position.
- Enabling (turning ON) the EMC filter increases leakage current. (Refer to page 70.)

⚠WARNING

- While power is ON, do not open the front cover. Otherwise you may get an electric shock.

3.2 Power supply harmonics

3.2.1 Power supply harmonics

The inverter may generate power supply harmonics from its converter circuit to affect the power generator, power factor correction capacitor etc. Power supply harmonics are different from noise and leakage currents in source, frequency band and transmission path. Take the following countermeasure suppression techniques.

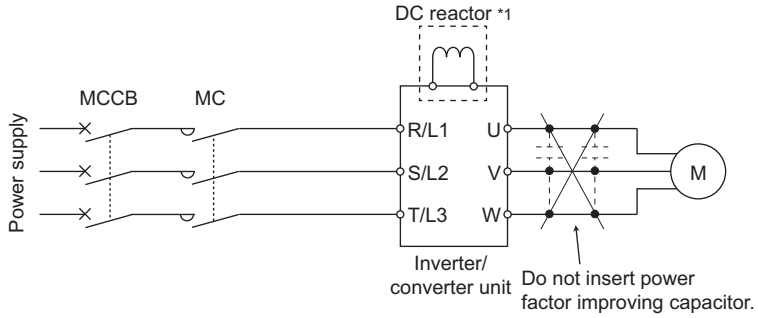
- Differences between harmonics and noises

Item	Harmonics	Noise
frequency	Normally 40th to 50th degrees or less (3 kHz or less).	High frequency (several 10 kHz to 1 GHz order).
Location	To-electric channel, power impedance.	To-space, distance, wiring path.
Quantitative understanding	Theoretical calculation possible.	Random occurrence, quantitative grasping difficult.
Generated amount	Nearly proportional to the load capacity.	Changes with the current variation ratio. (Gets larger as switching speed increases.)
Affected equipment immunity	Specified by standards per equipment.	Different depending on maker's equipment specifications.
Countermeasure	Provide a reactor.	Increase distance.

- Countermeasures

  The harmonic current generated from the inverter to the input side differs according to various conditions such as the wiring impedance, whether a reactor is used or not, and output frequency and output current on the load side.

  For the output frequency and output current, we understand that this should be calculated in the conditions under the rated load at the maximum operating frequency.



*1 The converter unit (FR-CC2) has a built-in DC reactor.

NOTE

- The power factor improving capacitor and surge suppressor on the inverter output side may be overheated or damaged by the harmonic components of the inverter output. Also, since an excessive current flows in the inverter to activate overcurrent protection, do not provide a capacitor and surge suppressor on the inverter output side when the motor is driven by the inverter.

3.3 Power shutdown and magnetic contactor (MC)

◆Converter unit input side magnetic contactor (MC)

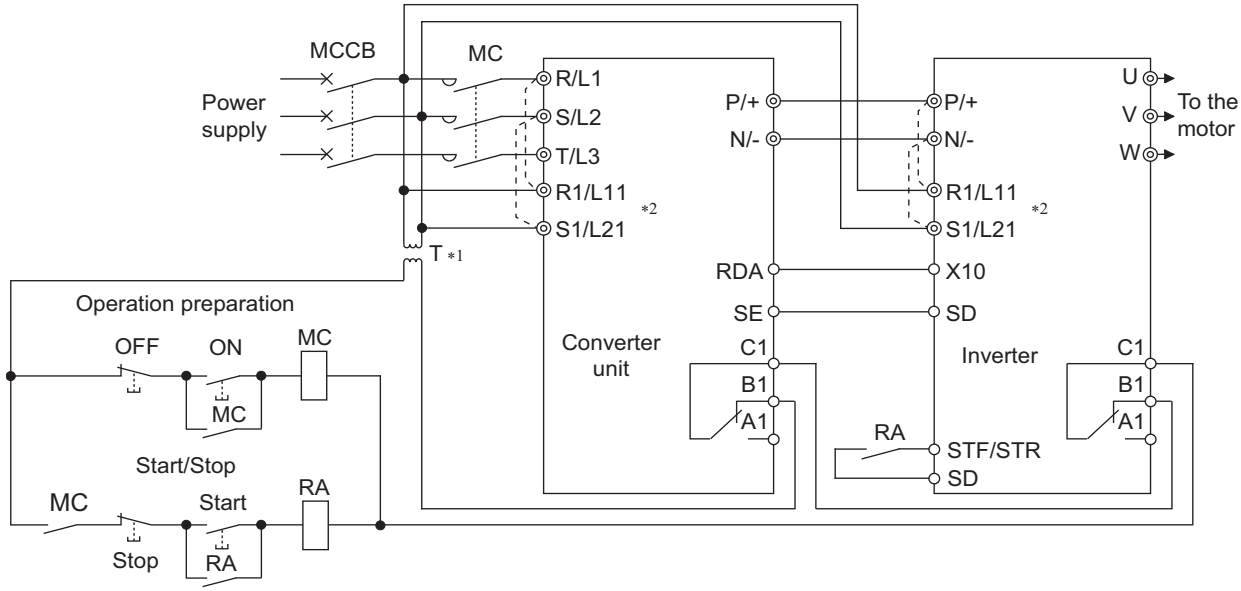
On the converter unit input side, it is recommended to provide an MC for the following purposes.
(Refer to page 19 for selection.)

- To disconnect the inverter from the power supply at activation of a protective function or at malfunctioning of the driving system (emergency stop, etc.).
- To prevent any accident due to an automatic restart at power restoration after an inverter stop made by a power failure.
- To separate the inverter from the power supply to ensure safe maintenance and inspection work.

NOTE

- Since repeated inrush currents at power ON will shorten the life of the converter circuit (switching life is about 1,000,000 times), frequent starts and stops of the magnetic contactor must be avoided. Turn ON or OFF the start (STF/STR) signal for the inverter start control to run or stop the inverter.

- Inverter start/stop circuit example
  As shown in the following figure, always use the start signal (turn ON or OFF the STF/STR signal) to make a start or stop.



*1 Install a stepdown transformer.

*2 To hold the Fault signal when the inverter's protective circuit is activated, connect the control circuit power supply terminals R1/L11 and S1/L21 to the input side of the MC. At this time, remove the jumpers connected to terminals R1/L11 and S1/L21. (Refer to page 51 for removal of the jumper.)

◆Handling of the magnetic contactor on the inverter's output side

Switch the magnetic contactor between the inverter and motor only when both the inverter and motor are at a stop. When the magnetic contactor is turned ON while the inverter is operating, overcurrent protection of the inverter and such will activate. When an MC is provided to switch to a commercial power supply, for example, it is recommended to use the commercial power supply-inverter switchover function **Pr.135 to Pr.139**.

3.4 Countermeasures against deterioration of the 690 V class motor insulation

In the PWM type inverter, a surge voltage attributable to wiring constants is generated at the motor terminals. Especially in a 690 V class motor, the surge voltage may deteriorate the insulation. When the 690 V class motor is driven by the inverter, consider the following countermeasures:

For the 690 V class motor, use an insulation-enhanced motor.
Specifically,

- Order a "690 V class inverter-driven insulation-enhanced motor".
- When the wiring length exceeds 100 m, set "4" (4 kHz) or less in **Pr.72 PWM frequency selection** (carrier frequency).

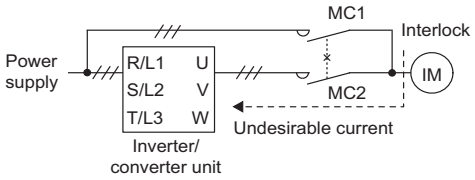
NOTE

- For the details of **Pr.72 PWM frequency selection**, refer to the Instruction Manual (Function).

3.5 Checklist before starting operation

This product and the FR-CC2 converter unit are highly reliable products, but incorrect peripheral circuit making or operation/handling method may shorten the product life or damage the products.
Before starting operation, always recheck the following points.

Checkpoint	Countermeasure	Refer to page	Check by user
Crimp terminals are insulated.	Use crimp terminals with insulation sleeves to wire the power supply and the motor.	—	
The wiring between the power supply (terminals R/L1, S/L2, T/L3) and the motor (terminals U, V, W) is correct.	Application of power to the output terminals (U, V, W) of the inverter will damage the inverter. Never perform such wiring.	36	
No wire offcuts are left from the time of wiring.	Wire offcuts can cause an alarm, failure or malfunction. Always keep the inverter and the converter unit clean. When drilling mounting holes in an enclosure etc., take caution not to allow chips and other foreign matter to enter the inverter or the converter unit.	—	
The main circuit cable gauge is correctly selected.	Use an appropriate cable gauge to suppress the voltage drop to 2% or less. If the wiring distance is long between the inverter and motor, a voltage drop in the main circuit will cause the motor torque to decrease especially during the output of a low frequency.	38	
The total wiring length is within the specified length.	Keep the total wiring length within the specified length. In long distance wiring, charging currents due to stray capacitance in the wiring may degrade the fast-response current limit operation or cause the equipment on the inverter's output side to malfunction. Pay attention to the total wiring length.	38	
Countermeasures are taken against EMI.	The input/output (main circuit) of the inverter or the converter unit includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the inverter or the converter unit. In such case, enable the EMC filter (turn ON the EMC filter ON/OFF connector) to minimize interference.	74	
On the inverter's output side, there is no power factor correction capacitor, surge suppressor, or radio noise filter installed.	Doing so will shut off the inverter output or damage the capacitor or surge suppressor. If any of the above devices is connected, immediately remove it.	—	
When performing an inspection or rewiring on the product that has been energized, the operator has waited long enough after shutting off the power supply.	For a short time after the power-OFF, a high voltage remains in the smoothing capacitor, and it is dangerous. Before performing an inspection or rewiring, wait 10 minutes or longer after the power supply turns OFF, then confirm that the voltage across the main circuit terminals P/+ and N/- of the inverter is low enough using a digital multimeter, etc.	—	
The inverter's output side has no short circuit or ground fault occurring.	• A short circuit or ground fault on the inverter's output side may damage the inverter module. • Fully check the insulation resistance of the circuit prior to inverter operation since repeated short circuits caused by peripheral circuit inadequacy or an earth (ground) fault caused by wiring inadequacy or reduced motor insulation resistance may damage the inverter module. • Fully check the to-earth (ground) insulation and phase-to-phase insulation of the inverter's output side before power-ON. Especially for an old motor or use in hostile atmosphere, securely check the motor insulation resistance, etc.	—	
The circuit is not configured to use the converter unit's input-side magnetic contactor to start/stop the inverter frequently.	Since repeated inrush currents at power ON will shorten the life of the inverter and the converter unit, frequent starts and stops of the magnetic contactor must be avoided. Turn ON or OFF the inverter's start (STF/STR) signal to run or stop the inverter.	76	
The voltage applied to the I/O signal circuits of the inverter and the converter unit are within the specifications.	Application of a voltage higher than the permissible voltage to the I/O signal circuits of the inverter or the converter unit or opposite polarity may damage the I/O devices. Especially check the wiring to prevent the speed setting potentiometer from being connected incorrectly to short circuit terminals 10E and 5.	41	

Checkpoint	Countermeasure	Refer to page	Check by user
The converter unit and the inverter are correctly connected.	• Make sure that the terminal P/+ of the converter unit and the terminal P/+ of the inverter, and the terminal N/- of the converter unit and the terminal N- of the inverter are correctly connected. Connecting the opposite polarity of terminals N/- and P/+ will damage the inverter. Also, do not install an MCCB across the terminals P/+ and N/- (across terminals P and P/+ or across N and N/-). • Always connect the terminal RDA of the converter unit and the terminal MRS (X10) of the inverter, and the terminal SE of the converter unit and the terminal SD (terminal PC in the source logic) of the inverter. Not doing so may lead to damage of the converter unit.	34	
When using the electronic bypass operation, electrical and mechanical interlocks are provided between the electronic bypass contactors MC1 and MC2.	When using a switching circuit as shown below, chattering due to misconfigured sequence or arc generated at switching may allow undesirable current to flow in and damage the inverter. Miswiring may also damage the inverter. (The commercial power supply operation is not available with Vector control dedicated motors.)  If switching to the commercial power supply operation while a failure such as an output short circuit has occurred between the magnetic contactor MC2 and the motor, the damage may further spread. Therefore, make sure to take precautions against such a failure, for example, providing a protection circuit using the OH input signal.	—	
A countermeasure is provided for power restoration after a power failure.	If the machine must not be restarted when power is restored after a power failure, provide an MC in the converter unit's input side and also make up a sequence which will not switch ON the start signal. If the start signal (start switch) remains ON after a power failure, the inverter will automatically restart as soon as the power is restored.	—	
For Vector control, the encoder is properly installed.	The encoder must be directly connected to a motor shaft without any backlash. (Real sensorless vector control does not require an encoder.)	60	
A magnetic contactor (MC) is installed on the converter unit's input side.	On the converter unit's input side, connect an MC for the following purposes: • To disconnect the inverter and the converter unit from the power supply at activation of a protective function or at malfunctioning of the driving system (emergency stop, etc.). • To prevent any accident due to an automatic restart at power restoration after an inverter stop made by a power failure. • To separate the inverter and the converter unit from the power supply to ensure safe maintenance and inspection work.	76	
The magnetic contactor on the inverter's output side is properly handled.	Switch the magnetic contactor between the inverter and motor only when both the inverter and motor are at a stop.	76	
An EMI countermeasure is provided for the frequency setting signals.	If electromagnetic noise generated from the inverter and the converter unit causes the frequency setting signal to fluctuate and motor rotation speed to become unstable when changing the motor speed with an analog signals, the following measures are effective. • Do not run the signal cables and power cables (inverter and converter unit I/O cables) in parallel with each other, and do not bundle them. • Run the signal cables as far away as possible from the power cables (inverter and converter unit I/O cables). • Use shielded cables. • Install a ferrite core on the signal cable (Example: ZCAT3035-1330 TDK).	—	
A countermeasure is provided for an overload operation.	When performing frequent starts/stops by the inverter, rise/fall in the temperature of the transistor element of the inverter will repeat due to a repeated flow of large current, shortening the life from thermal fatigue. Since thermal fatigue is related to the amount of current, the life can be increased by reducing current at locked condition, starting current, etc. Reducing the current may extend the service life but may also cause torque shortage, which leads to a start failure. Adding a margin to the current can eliminate such a condition. Use the inverter and the converter unit of higher capacities (up to two ranks).	—	
The specifications and rating match the system requirements.	Make sure that the specifications and rating match the system requirements.	—	

Checkpoint	Countermeasure	Refer to page	Check by user
Countermeasures are taken against electrical corrosion on the motor bearing.	When a motor is driven by the inverter, axial voltage is generated on the motor shaft, which may cause electrical corrosion of the bearing in rare cases depending on the wiring, load, operating conditions of the motor or specific inverter settings (high carrier frequency and EMC filter ON). Contact your sales representative to take appropriate countermeasures for the motor. The following shows examples of countermeasures for the inverter. • Decrease the carrier frequency. • Turn OFF the EMC filter. • Provide a common mode choke*1 on the output side of the inverter. (This is effective regardless of the EMC filter ON/OFF connector setting.)	—	

*1 Recommended common mode choke: FT-3KM F series FINEMET® common mode choke cores manufactured by Hitachi Metals, Ltd.
FINEMET is a registered trademark of Hitachi Metals, Ltd.

3.6 Failsafe system which uses the inverter

When a fault is detected by the protective function, the protective function activates and outputs the Fault signal. However, the Fault signal may not be output at an inverter's fault occurrence when the detection circuit or output circuit fails, etc. Although Mitsubishi assures the best quality products, provide an interlock which uses inverter status output signals to prevent accidents such as damage to the machine when the inverter fails for some reason. Also at the same time consider the system configuration where a failsafe from outside the inverter, without using the inverter, is enabled even if the inverter fails.

◆ Interlock method which uses the inverter status output signals

By combining the inverter output signals to provide an interlock as shown below, an inverter failure can be detected.

No.	Interlock method	Check method	Used signals
a	Inverter protective function operation	Operation check of an alarm contact. Circuit error detection by negative logic.	Fault (ALM) signal
b	Inverter operating status	Operation ready signal check.	Inverter operation ready (RY) signal
c	Inverter running status	Logic check of the start signal and running signal.	Start (STF or STR) signal Inverter running (RUN) signal
d	Inverter running status	Logic check of the start signal and output current.	Start (STF or STR) signal Output current detection (Y12) signal

- When using various signals, assign the functions to **Pr.190 to Pr.196 (Output terminal function selection)** referring to the table on the left.

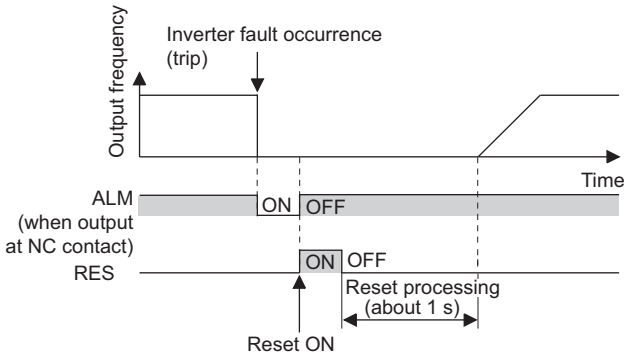
Output signal	Pr.190 to Pr.196 setting	
	Positive logic	Negative logic
ALM	99	199
RY	11	111
RUN	0	100
Y12	12	112

NOTE

- Changing the terminal assignment using **Pr.190 to Pr.196 (Output terminal function selection)** may affect the other functions. Set parameters after confirming the function of each terminal.

■ Checking by using the Fault signal output from the inverter... (a)

When the inverter's protective function activates and the inverter output is stopped, the Fault (ALM) signal is output. (The ALM signal is assigned to terminal A1B1C1 in the initial setting). With this signal, check that the inverter operates properly. In addition, negative logic can be set. (ON when the inverter is normal, OFF when the fault occurs.)

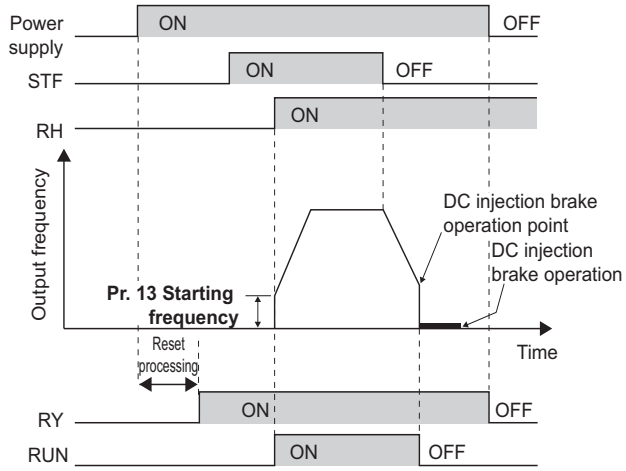


■ Checking the inverter operating status by using the Inverter operation ready signal output from the inverter ... (b)

The Inverter operation ready (RY) signal is output when the inverter power is ON and the inverter becomes operative. Check if the RY signal is output after powering ON the inverter.

■ Checking the inverter operating status by using the start signal input to the inverter and the Inverter running signal output from the inverter ... (c)

The Inverter running (RUN) signal is output when the inverter is running. (The RUN signal is assigned to terminal RUN in the initial setting.) Check if the RUN signal is output while a start signal (the STF/STR signal for forward/reverse rotation command) is input to the inverter. Even after the start signal is turned OFF, the RUN signal is kept output until the inverter makes the motor to decelerate and to stop. For the logic check, configure a sequence considering the inverter's deceleration time.



■ Checking the motor operating status by using the start signal input to the inverter and the Output current detection signal output from the inverter ... (d)

The Output current detection (Y12) signal is output when the inverter operates and currents flows into the motor.

Check if the Y12 signal is output while a start signal (the STF/STR signal for forward/reverse rotation command) is input to the inverter. The Y12 signal is initially set to be output at 150% inverter rated current. Adjust the level to around 20% using no load current of the motor as reference with **Pr.150 Output current detection level**.

Like the Inverter running (RUN) signal, even after the start signal is turned OFF, the Y12 signal is kept output until the inverter stops the output to a decelerating motor. For the logic check, configure a sequence considering the inverter's deceleration time.

◆ Backup method which does not use the inverter

Even if the interlock is provided by the inverter status signal, enough failsafe is not ensured depending on the failure status of the inverter itself. For example, if an inverter CPU fails in a system interlocked with the inverter's Fault, start, and RUN signals, no Fault signals will be output and the RUN signal will be kept ON because the inverter CPU is down.

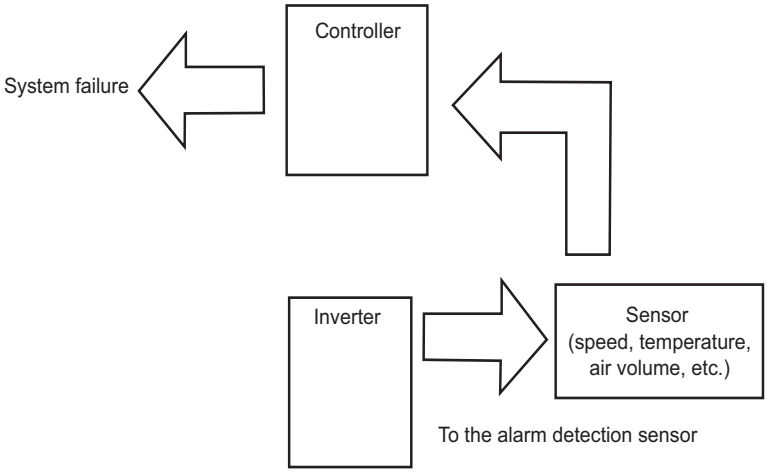
Provide a speed detector to detect the motor speed and current detector to detect the motor current, and consider the backup system such as performing a check as follows according to the level of importance of the system.

■ Start signal and actual operation check

Check the motor running and motor current while the start signal is input to the inverter by comparing the start signal to the inverter and detected speed of the speed detector or detected current of the current detector. Note that the current is flowing through the motor while the motor coasts to stop, even after the inverter's start signal is turned OFF. For the logic check, configure a sequence considering the inverter's deceleration time. In addition, it is recommended to check the three-phase current when using the current detector.

■ Command speed and actual operation check

Check for a gap between the actual speed and commanded speed by comparing the inverter's speed command and the speed detected by the speed detector.


Controller
System failure
Inverter
Sensor
(speed, temperature,
air volume, etc.)
To the alarm detection sensor

MEMO

CHAPTER 4 PROTECTIVE FUNCTIONS

4 PROTECTIVE FUNCTIONS

This chapter explains the "PROTECTIVE FUNCTIONS" that operate in this product.
Always read the instructions before use.

4.1 Inverter fault and alarm indications

- When the inverter detects a fault, depending on the nature of the fault, the operation panel displays an error message or warning, or a protective function is activated to shut off the inverter output.
- When any fault occurs, take an appropriate corrective action, then reset the inverter, and resume the operation. Restarting the operation without a reset may break or damage the inverter.
- When a protective function is activated, note the following points.

Item	Description
Fault output signal	Opening the magnetic contactor (MC) provided on the input side of the inverter at a fault occurrence shuts off the control power to the inverter, therefore, the fault output will not be retained.
Fault or alarm indication	When a protective function is activated, the operation panel displays a fault indication.
Operation restart method	While a protective function is activated, the inverter output is kept shutoff. Reset the inverter to restart the operation.

- Inverter fault or alarm indications are categorized as follows.

Displayed item	Description
Error message	A message regarding operational fault and setting fault by the operation panel and the parameter unit. The inverter output is not shut off.
Warning	The inverter output is not shut off even when a warning is displayed. However, failure to take appropriate measures will lead to a fault.
Alarm	The inverter output is not shut off. An Alarm (LF) signal can also be output with a parameter setting.
Fault	When a protective function is activated, the inverter output is shut off and a Fault (ALM) signal is output.

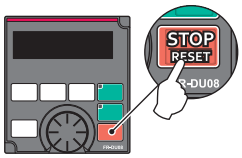
NOTE

- For the details of fault indications and other malfunctions, refer to the Instruction Manual (Function).
- The last eight faults can be displayed on the operation panel. (Fault history) (For operation, refer to page 88.)

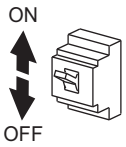
4.2 Reset method for the protective functions

Reset the inverter by performing any of the following operations. Note that the accumulated heat value of the electronic thermal relay function and the number of retries are cleared (erased) by resetting the inverter.
The inverter recovers about 1 second after the reset is released.

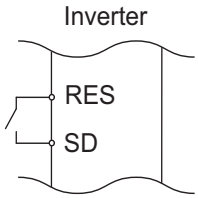
- On the operation panel, press STOP RESET to reset the inverter.
  (This may only be performed when a fault occurs.)



- Switch the power OFF once, then switch it ON again.



- Turn ON the Reset (RES) signal for 0.1 second or more. (If the RES signal is kept ON, "Err" appears (blinks) to indicate that the inverter is in a reset status.)



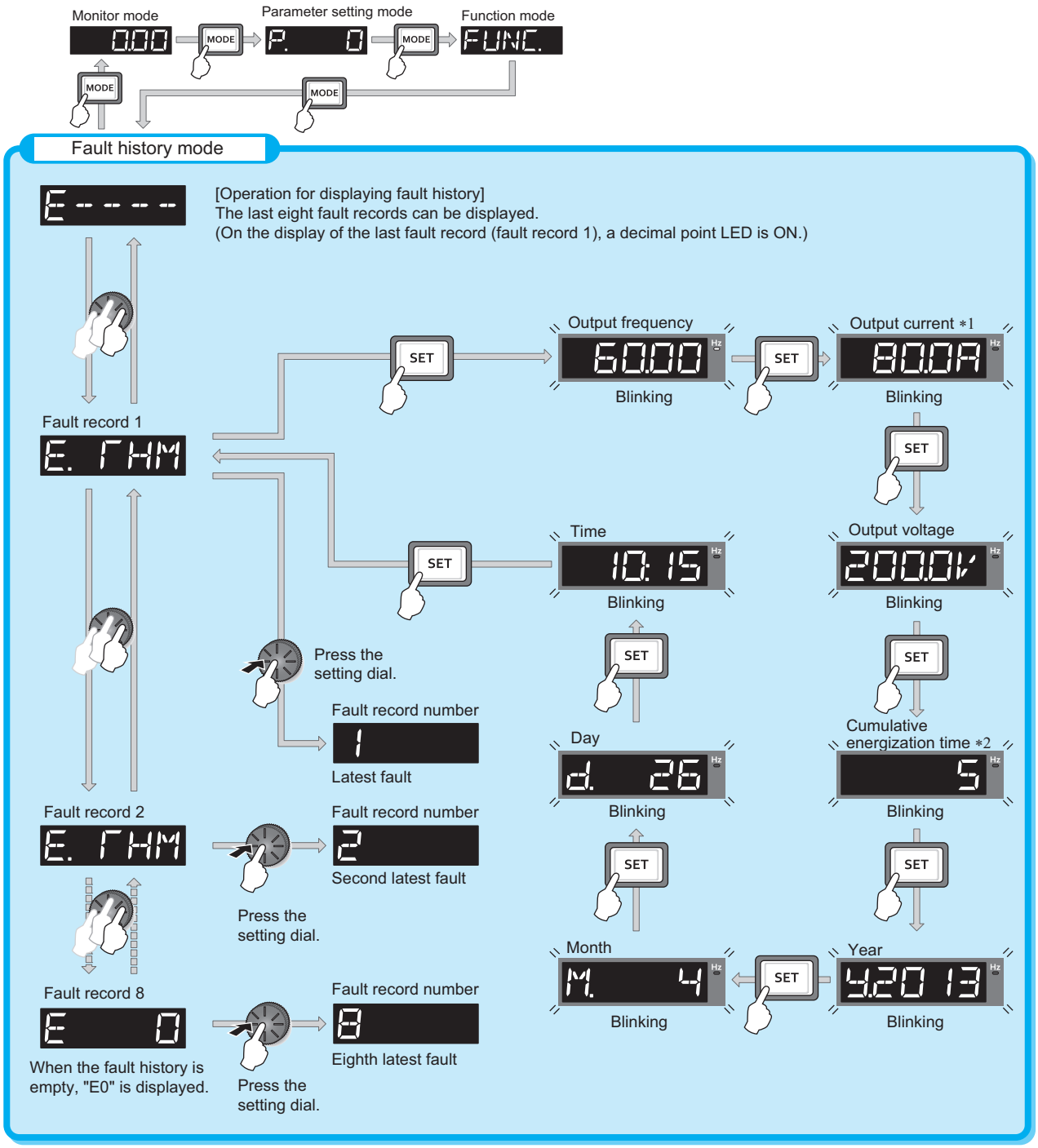
NOTE

- OFF status of the start signal must be confirmed before resetting the inverter fault. Resetting an inverter fault with the start signal ON restarts the motor suddenly.

4.3 Check and clear of the fault history

The operation panel stores the past eight fault records which appears when a protective function is activated. (Fault history)

◆ Check for the fault history



*1 When an overcurrent trip occurs by an instantaneous overcurrent, the monitored current value saved in the fault history may be lower than the actual current that has flowed.

*2 The cumulative energization time and actual operation time are accumulated from 0 to 65535 hours, then cleared, and accumulated again from 0.

◆ Fault history clearing procedure

Point

- Set **Err.CL Fault history clear** = "1" to clear the fault history.

Operating procedure

1. Turning ON the power of the inverter

The operation panel is in the monitor mode.

2. Selecting the parameter setting mode

Press MODE to choose the parameter setting mode. (The parameter number read previously appears.)

3. Selecting the parameter number

Turn  until "Er.CL" (Fault history clear) appears. Press SET to read the present set value. "0" (initial value) appears.

4. Fault history clear

Turn  to change the set value to "1". Press SET to start clearing.

"1" and "Er.CL" are displayed alternately after parameters are cleared.

- Turn  to read another parameter.
- Press SET to show the setting again.
- Press SET twice to show the next parameter.

4.4 List of fault displays

For the details, refer to the Instruction Manual (Function).

◆ Error message

- A message regarding operational fault and setting fault by the operation panel and the parameter unit is displayed. The inverter output is not shut off.

Operation panel indication		Name
HOLd	HOLD	Operation panel lock
LOCd	LOCD	Password locked
Er 1 to Er4 Er8	Er1 to Er4, Er8	Parameter write error
rE 1 to rE8	rE1 to rE8	Copy operation error
Err.	Err.	Error

◆ Warning

- The inverter output is not shut off even when a warning is displayed. However, failure to take appropriate measures will lead to a fault.

Operation panel indication		Name
OL	OL	Stall prevention (overcurrent)
oL	oL	Stall prevention (overvoltage)
TH	TH	Electronic thermal relay function pre-alarm
PS	PS	PU stop
SL	SL	Speed limit indication
CF	CF	Continuous operation during communication fault
CP	CP	Parameter copy
SA	SA	Safety stop
MT 1 to MT3	MT1 to MT3	Maintenance timer 1 to 3
UF	UF	USB host error
HP 1	HP1	Home position return setting error
HP2	HP2	Home position return uncompleted
HP3	HP3	Home position return parameter setting error
LdF	LDF	Load fault warning
EHR	EHR	Ethernet communication fault

◆ Alarm

- The inverter output is not shut off. An Alarm (LF) signal can also be output with a parameter setting.

Operation panel indication		Name
FN	FN	Fan alarm

◆ Fault

- When a protective function is activated, the inverter output is shut off and a Fault (ALM) signal is output.
- The data code is used for checking the fault detail via communication or with **Pr.997 Fault initiation**.

Operation panel indication		Name
E. OC 1	E.OC1	Overcurrent trip during acceleration
E. OC2	E.OC2	Overcurrent trip during constant speed
E. OC3	E.OC3	Overcurrent trip during deceleration or stop
E. OV 1	E.OV1	Regenerative overvoltage trip during acceleration
E. OV2	E.OV2	Regenerative overvoltage trip during constant speed
E. OV3	E.OV3	Regenerative overvoltage trip during deceleration or stop
E. THT	E.THT	Inverter overload trip (electronic thermal relay function)
E. THM	E.THM	Motor overload trip (electronic thermal relay function)
E. FIN	E.FIN	Heat sink overheat
E. UVT	E.UVT	Undervoltage
E. OLT	E.OLT	Stall prevention stop
E. LUP	E.LUP	Upper limit fault detection
E. LdN	E.LDN	Lower limit fault detection
E. GF	E.GF	Output side earth (ground) fault overcurrent
E. LF	E.LF	Output phase loss
E. OHT	E.OHT	External thermal relay operation
E. PTC	E.PTC	PTC thermistor operation
E. OPT	E.OPT	Option fault
E. OP 1 to E. OP3	E.OP1 to E.OP3	Communication option fault

Operation panel indication		Name
E. 16 to E. 20	E.16 to E.20	User definition error by the PLC function
E. PE	E.PE	Parameter storage device fault (control circuit board)
E. PUE	E.PUE	PU disconnection
E. RET	E.RET	Retry count excess
E. PE2	E.PE2	Parameter storage device fault (main circuit board)
E. CPU E. 5 to E. 7	E.CPU, E. 5 to E. 7	CPU fault
E. CTE	E.CTE	Operation panel power supply short circuit
E. P24	E.P24	24 VDC power fault
E. CdO	E.CDO	Abnormal output current detection
E. EHR	E.EHR	Ethernet communication fault
E. AI E	E.AIE	Analog input fault
E. USb	E.USB	USB communication fault
E. SAF	E.SAF	Safety circuit fault
E. PbT E. 13	E.PBT, E. 13	Internal circuit fault
E. OS	E.OS	Overspeed occurrence
E. OSd	E.OSD	Speed deviation excess detection
E. ECT	E.ECT	Signal loss detection
E. Od	E.OD	Excessive position fault
E. Mb 1 to E. Mb7	E.MB1 to E.MB7	Brake sequence fault
E. EP	E.EP	Encoder phase fault
E. EF	E.EF	External fault during output operation
E. LCI	E.LCI	4 mA input fault
E. PCH	E.PCH	Pre-charge fault
E. PId	E.PID	PID signal fault
E. 1 to E. 3	E. 1 to E. 3	Option fault
E. 11	E.11	Opposite rotation deceleration fault

◆ Others

- The fault history and the operation status of the inverter are displayed. It is not a fault indication.

Operation panel indication		Name
E -- -- -- --	E----	Fault history
E. 0	E.0	No fault records
EV	EV	24 V external power supply operation
Rd	RD	Backup in progress
WR	WR	Restoration in progress

If faults other than the above appear, contact your sales representative.

4

MEMO

CHAPTER 5 PRECAUTIONS FOR MAINTENANCE AND INSPECTION

5 PRECAUTIONS FOR MAINTENANCE AND INSPECTION

This chapter explains the precautions for maintenance and inspection of this product.
Always read the instructions before use.

5.1 Inspection item

The inverter is a static unit mainly consisting of semiconductor devices. Daily inspection must be performed to prevent any fault from occurring due to the adverse effects of the operating environment, such as temperature, humidity, dust, dirt and vibration, changes in the parts with time, service life, and other factors.

◆Precautions for maintenance and inspection

When accessing the inverter for inspection, wait for at least 10 minutes after the power supply has been switched OFF. Then, make sure that the voltage across the main circuit terminals P/+ and N/- on the inverter is not more than 30 VDC using a digital multimeter, etc.

5.1.1 Daily inspection

Basically, check for the following faults during operation.

- Motor operation fault
- Improper installation environment
- Cooling system fault
- Abnormal vibration, abnormal noise
- Abnormal overheat, discoloration

5.1.2 Periodic inspection

Check the areas inaccessible during operation and requiring periodic inspection. Consult us for periodic inspection.

Check and clean the cooling system:	Clean the air filter, etc.
Check the tightening and retighten:	The screws and bolts may become loose due to vibration, temperature changes, etc. Check and tighten them. Tighten them according to the specified tightening torque. (Refer to page 38.)

Check the conductors and insulating materials for corrosion and damage.
Measure the insulation resistance.
Check and change the cooling fan and relay.

NOTE

- When using the safety stop function, periodic inspection is required to confirm that safety function of the safety system operates correctly. For more details, refer to the Safety Stop Function Instruction Manual.

5.1.3 Daily and periodic inspection

Area of inspection	Inspection item	Description	Inspection interval		Corrective action at fault occurrence	Check by user
			Daily	Periodic[*3]		
General	Surrounding environment	Check the surrounding air temperature, humidity, dirt, corrosive gas, oil mist, etc.	○		Improve the environment.	
	Overall unit	Check for unusual vibration and noise.	○		Check fault location and retighten.	
		Check for dirt, oil, and other foreign material.[*1]	○		Clean.	
	Power supply voltage	Check that the main circuit voltage and control circuit voltage are normal.[*2]	○		Inspect the power supply.	
Main circuit	General	• Check with megger (between main circuit terminals and earth (ground) terminal).		○	Contact the manufacturer.	
		• Check for loose screws and bolts.		○	Retighten.	
		• Check for overheat traces on the parts.		○	Contact the manufacturer.	
		• Check for stains.		○	Clean.	
	Conductors and cables	• Check conductors for distortion.		○	Contact the manufacturer.	
		• Check cable sheaths for breakage and deterioration (crack, discoloration, etc.).		○	Contact the manufacturer.	
	Transformer/ reactor	Check for unusual odor and abnormal increase of whining sound.	○		Stop the equipment and contact the manufacturer.	
	Terminal block	Check for a damage.		○	Stop the equipment and contact the manufacturer.	
	Smoothing aluminum electrolytic capacitor	• Check for liquid leakage.		○	Contact the manufacturer.	
		• Check for safety valve projection and bulge.		○	Contact the manufacturer.	
		• Visual check		○		
	Relay/contactor	Check that the operation is normal and no chattering sound is heard.		○	Contact the manufacturer.	
Control circuit, protective circuit	Operation check	• Check for an output voltage imbalance between phases while operating the inverter alone.		○	Contact the manufacturer.	
		• Check that no fault is found in protective and display circuits in a sequence protective operation test.		○	Contact the manufacturer.	
	Components check: Overall	• Check for unusual odor and discoloration.		○	Stop the equipment and contact the manufacturer.	
		• Check for serious rust development.		○	Contact the manufacturer.	
	Components check: Aluminum electrolytic capacitor	• Check for liquid leakage in a capacitor and deformation trace.		○	Contact the manufacturer.	
		• Visual check and judge by the life check of the control circuit capacitor (**Pr.257**).		○		
Cooling system	Cooling fan	• Check for unusual vibration and noise.	○		Replace the fan.	
		• Check for loose screws and bolts.		○	Fix with the fan cover fixing screws.	
		• Check for stains.		○	Clean.	
	Heat sink	• Check for clogging.		○	Clean.	
		• Check for stains.		○	Clean.	
Display	Indication	• Check that indications are correct.	○		Contact the manufacturer.	
		• Check for stains.		○	Clean.	
	Meter/counter	Check that readouts are correct.	○		Stop the equipment and contact the manufacturer.	
Load motor	Operation check	Check for vibration and abnormal increase in operation noise.	○		Stop the equipment and contact the manufacturer.	

*1 Oil component of the heat dissipation grease used inside the inverter may leak out. The oil component, however, is not flammable, corrosive, nor conductive and is not harmful to humans. Wipe off such oil component.

*2 It is recommended to install a voltage monitoring device for checking the voltage of the power supplied to the inverter.

*3 One to two years of periodic inspection cycle is recommended. However, it differs according to the installation environment. Consult us for periodic inspection.

NOTE

- Continuous use of a leaked, deformed, or degraded smoothing aluminum electrolytic capacitor (as shown in the table above) may lead to a burst, breakage, or fire. Replace such capacitor without delay.
- For the detail of **Pr.257 Control circuit capacitor life display**, refer to the Instruction Manual (Function).

5.1.4 Checking the inverter and converter semiconductor devices

◆ Preparation

- Disconnect the external power supply cables (R/L1, S/L2, T/L3) and motor cables (U, V, W). (Measurement can be made without disconnecting the cables connecting the inverter and the converter unit (FR-CC2).)
- Prepare a continuity tester. (For the resistance measurement, use the 100 Ω range.)

◆ Checking method

Change the polarity of the tester alternately at the inverter terminals R/L1, S/L2, T/L3, U, V, W, P/+, and N/- and check the electric continuity.

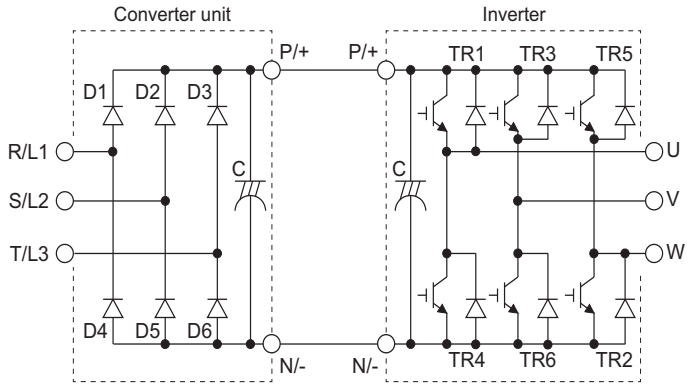
NOTE

- Before measurement, check that the smoothing capacitor is discharged.
- At the time of electric discontinuity, the measured value is almost ∞. When there is an instantaneous electric continuity, due to the smoothing capacitor, the tester may not indicate ∞. At the time of electric continuity, the measured value is several Ω to several tens of Ω. When all measured values are almost the same (although values may not be constant depending on the tester type), it shows that there are no electrical paths with problems.

◆ Semiconductor device numbers and terminals to be checked

		Tester polarity ⊕	Tester polarity ⊖	Continuity		Tester polarity ⊕	Tester polarity ⊖	Continuity
Converter unit	D1	R/L1	P/+	No	D4	R/L1	N/-	Yes
		P/+	R/L1	Yes		N/-	R/L1	No
	D2	S/L2	P/+	No	D5	S/L2	N/-	Yes
		P/+	S/L2	Yes		N/-	S/L2	No
	D3	T/L3	P/+	No	D6	T/L3	N/-	Yes
		P/+	T/L3	Yes		N/-	T/L3	No
Inverter	TR1	U	P/+	No	TR4	U	N/-	Yes
		P/+	U	Yes		N/-	U	No
	TR3	V	P/+	No	TR6	V	N/-	Yes
		P/+	V	Yes		N/-	V	No
	TR5	W	P/+	No	TR2	W	N/-	Yes
		P/+	W	Yes		N/-	W	No

(Assuming that an analog meter is used.)



5.1.5 Cleaning

Always run the inverter in a clean status.

When cleaning the inverter, gently wipe dirty areas with a soft cloth immersed in neutral detergent or ethanol.

NOTE

- Do not use solvent, such as acetone, benzene, toluene and alcohol, as these will cause the inverter surface paint to peel off.
- The display, etc. of the operation panel (FR-DU08) and parameter unit (FR-PU07) are vulnerable to detergent and alcohol. Therefore, avoid using them for cleaning.

5.1.6 Replacement of parts

The inverter consists of many electronic parts such as semiconductor devices.

The following parts may deteriorate with age because of their structures or physical characteristics, leading to reduced performance or fault of the inverter. For preventive maintenance, the parts must be replaced periodically.

Use the life check function as a guidance of parts replacement.

Part name	Estimated lifespan *1	Description
Cooling fan	10 years	Replace (as required)
Main circuit smoothing capacitor	10 years *2	Replace (as required)
On-board smoothing capacitor	10 years *2	Replace the board (as required).
Relays	—	As required
Main circuit fuse	10 years	Replace (as required)

*1 Estimated lifespan for when the yearly average surrounding air temperature is 40°C. (without corrosive gas, flammable gas, oil mist, dust and dirt etc.)

*2 Output current: 80% of the inverter rating

NOTE

- For parts replacement, contact the nearest Mitsubishi Electric FA center.

◆ Inverter parts life display

The inverter diagnoses the control circuit capacitor and the cooling fan by itself, and estimates their lives.

The self-diagnostic warning is output when the life span of each part is near its end. It gives an indication of replacement time.

Guideline for life judgment using the life warning output

Part	Judgment level
Control circuit capacitor	Estimated remaining life 10%
Cooling fan	Not more than the specified speed

NOTE

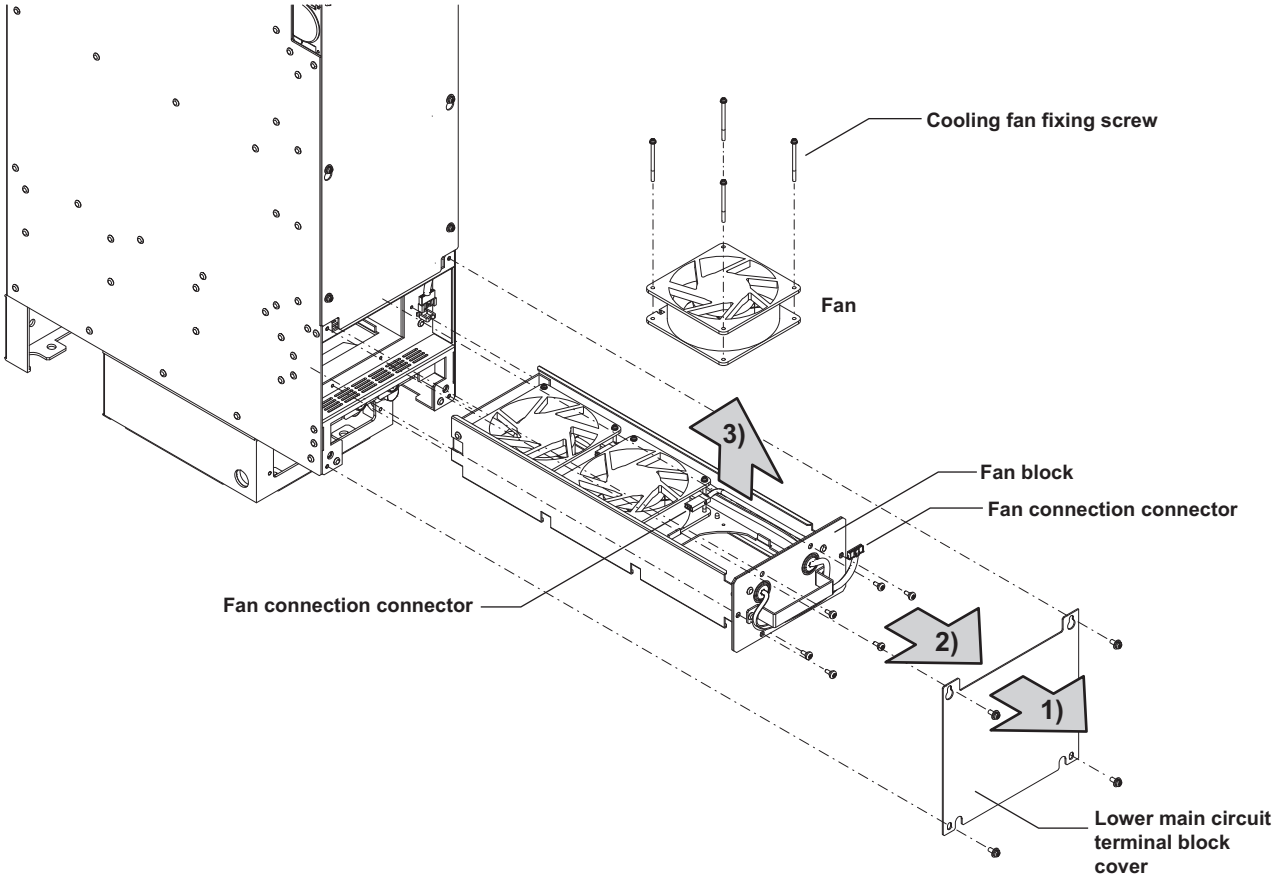
- Refer to the Instruction Manual (Function) to perform the life check of the inverter parts.

◆ Replacement procedure of the cooling fan

The replacement interval of the cooling fan used for cooling the parts generating heat such as the main circuit semiconductor is greatly affected by the surrounding air temperature. When unusual noise and/or vibration are noticed during inspection, the cooling fan must be replaced immediately.

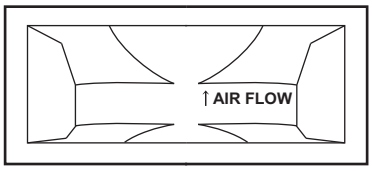
■ Removal

1. Remove the installation screws, and then remove the lower main circuit terminal cover.
2. Remove the fan block fixing screws and the fan connector, and pull out the fan block.
3. Remove the fan fixing screws and the fan connector, and remove the fan.



■ Reinstallation

1. After confirming the orientation of the fan, reinstall the fan so that the "AIR FLOW" faces up.



<Fan side face>

2. Install fans referring to the above figure. The tightening torque of the fan fixing screws is 0.73 N·m. The tightening torque of the fan block screws is 1.42 to 1.89 N·m.

NOTE

- Installing the fan in the opposite direction of air flow may shorten the inverter life.
- Ensure that the cables are not caught when the fan is installed.
- Switch OFF the power before starting the fan replacement work.

◆ Smoothing capacitors

A large-capacity aluminum electrolytic capacitor is used for smoothing in the DC section of the main circuit, and an aluminum electrolytic capacitor is used for stabilizing the control power in the control circuit. Adverse effects from ripple currents deteriorate capacitors. Replacement intervals of capacitors vary greatly with surrounding temperatures and operating conditions. Replace them roughly every 10 years when used in normal air-conditioned environments.

Inspecting the product visually:

- Case: Check that the sides and bottom of the capacitor have not ruptured.
- Rubber seal: Check for any noticeable bulging or severe cracks.
- Check for external cracks, discoloration, leakage, etc. It is assumed that the capacitor has reached the end of its life when its capacity has dropped below 80% of its rated capacity.

NOTE

- The inverter diagnoses the control circuit capacitor by itself, and estimates its life. (Refer to the Instruction Manual (Function).)

◆ Relay output terminals

- The contacts of relays deteriorate over time. To prevent faults from occurring, relays must be replaced when they have reached the maximum of switching operations (switching life).
- The control terminal block must be replaced in case of failure of either relay connected to the relay output terminals A1, B1, and C1, or A2, B2, and C2.

◆ Main circuit fuse

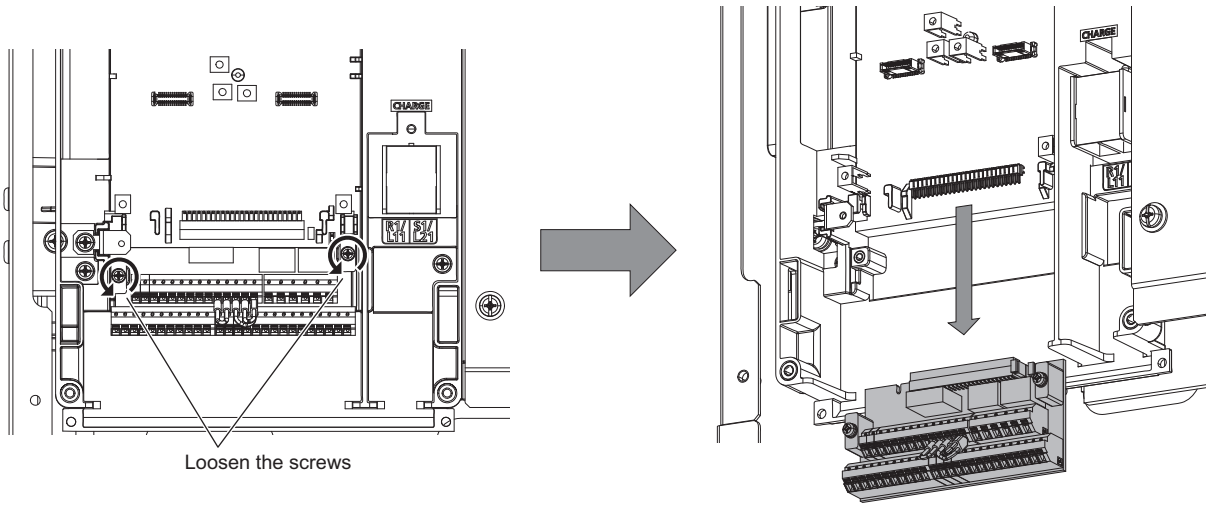
Fuses are used in some inverters. Replacement intervals of capacitors vary greatly with surrounding temperatures and operating conditions. Replace them roughly every 10 years when used in normal air-conditioned environments.

5.1.7 Removal and reinstallation of the control circuit terminal block

This product has a removable control circuit terminal block, which can be replaced with a new one or a control terminal option.

◆ Removal and reinstallation

1. Loosen the two installation screws at the both side of the control circuit terminal block. (These screws cannot be removed.)
Slide down the control circuit terminal block to remove it.



2. Be careful not to bend the pins of the inverter's control circuit connector, reinstall the control circuit terminal block and fix it with the mounting screws.

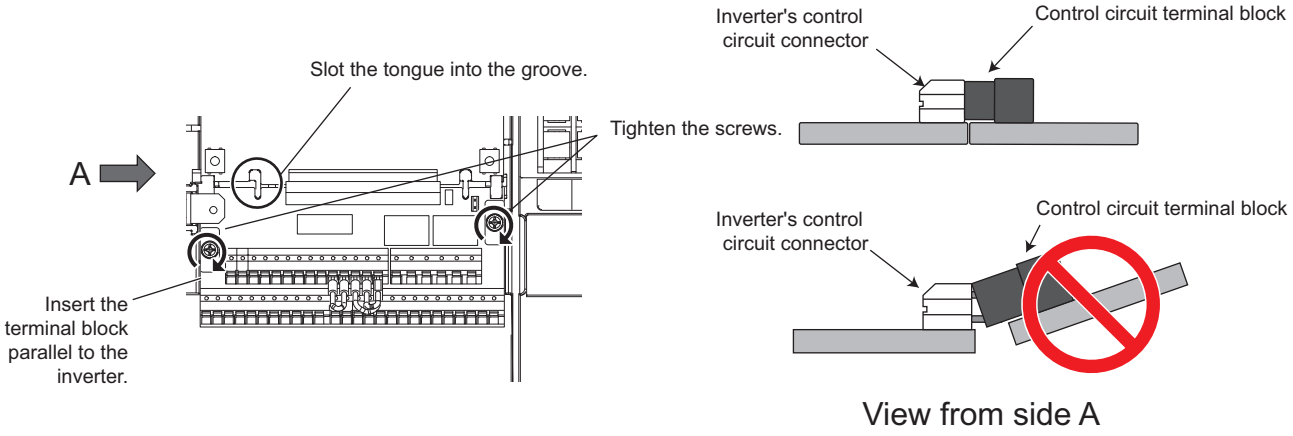
NOTE

- Before starting the replacement, power OFF the inverter, wait for at least 10 minutes, and then check that the charge lamp is OFF to ensure safety.

◆Removal and reinstallation precautions

Precautions to be taken when removing or reinstalling the control circuit terminal block are shown below. Observe the following precautions and handle the inverter properly to avoid malfunctions or failures.

- To remove or reinstall the control circuit terminal block, keep it upright so that it is parallel with the inverter.
- To install the control circuit terminal block, slide it upward so that the tongues on the inverter slot into the grooves on the terminal block.
- Check that the terminal block is parallel to the inverter and the pins on the inverter control circuit connector are not bent. After checking proper connection, fix the terminal block in place with two screws.



NOTE

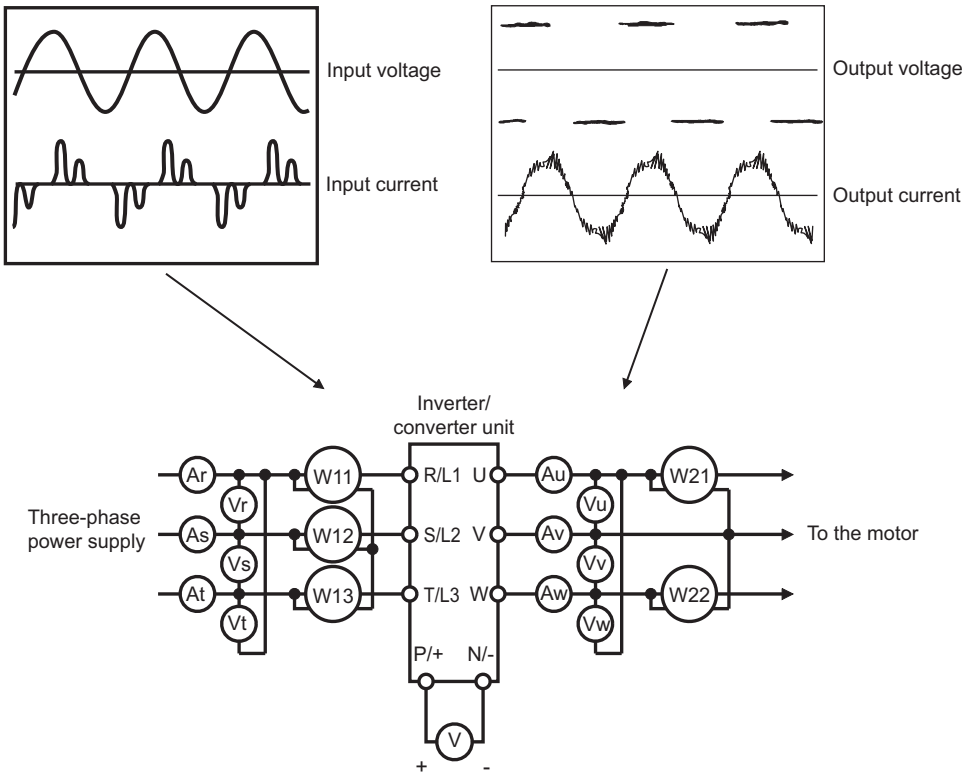
- Do not tilt the terminal block while tightening the screws or removing it from the inverter. (Otherwise, a stress applied to the control circuit terminal block or the control circuit connector may cause damage to them.)
- After replacing the control terminal block, connect the jumper connector to the correct position in accordance with the control logic of input signals. (Refer to page 46.)

5.2 Measurement of main circuit voltages, currents, and powers

Since the voltages and currents on the inverter power supply and output sides include harmonics, measurement data depends on the instruments used and circuits measured. When instruments for commercial frequency are used for measurement, measure the following circuits with the instruments given on the next page.

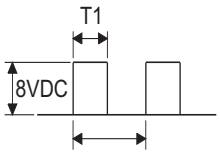
NOTE

- When installing meters etc. on the inverter output side
  When the inverter-to-motor wiring length is long, the meters and CTs may generate heat due to line-to-line leakage current. Therefore, choose equipment which has enough capacity for the current rating.
  To measure and display the output voltage and output current of the inverter, it is recommended that the terminal AM and FM/CA output functions of the inverter are used.



◆ Measuring points and instruments

	Item	Measuring point	Measuring instrument	Remarks (reference measured value)	
Converter unit (FR-CC2)	Power supply voltage V1	Between R/L1 and S/L2, S/L2 and T/L3, and T/L3 and R/L1	Digital power meter (designed for inverter)	Commercial power Within permissible AC voltage fluctuation. (Refer to page 108.)	
	Input current I1	Line current at R/L1, S/L2, and T/L3			
	Input power P1	At R/L1, S/L2, and T/L3, and between R/L1 and S/L2, S/L2 and T/L3, and T/L3 and R/L1		P1 = W11 + W12 + W13 (3-wattmeter method)	
	Input power factor Pf1	Calculate after measuring input voltage, input current and input power. $Pf_1 = \frac{P_1}{\sqrt{3}V_1 \times I_1} \times 100\%$			
	Converter output	Between P/+ and N/-	Digital multimeter or other tester	Inverter LED indication 1.35 × V1	
	Operation enable signal External thermal relay signal Reset signal	Across terminals RDI, OH, RES(+) and SD (for sink logic)	Digital multimeter or other tester, or moving-coil type instrument (internal resistance 50 kΩ or more)	Voltage when terminal is open: 20 to 30 VDC. Voltage when signal is ON: 1 V or less.	Terminal SD is a common terminal.
	Fault signal	Between A1 and C1 Between B1 and C1	Digital multimeter or other tester	Continuity check[*3] [Normal] Across A1 and C1: Discontinuity Across B1 and C1: Continuity [Fault] Across A1 and C1: Continuity Across B1 and C1: Discontinuity	

	Item	Measuring point	Measuring instrument	Remarks (reference measured value)	
Inverter	Output voltage V2	Between U and V, V and W, and W and U	Digital power meter (designed for inverter)[*1]	Difference between the phases must be within 1% of the maximum output voltage.	
	Output current I2	Line current at U, V, and W		Difference between the phases must be within 10%.	
	Output power P2	At U, V, and W, and between U and V, and V and W	Digital power meter (designed for inverter)	P2 = W21 + W22 2-wattmeter method (or 3-wattmeter method)	
	Output power factor Pf2	Calculate in similar manner to the input power factor. $Pf_2 = \frac{P_2}{\sqrt{3}V_2 \times I_2} \times 100\%$			
	Frequency setting signal	2, and between 4(+) and 5	Digital multimeter or other tester, or moving-coil type instrument (internal resistance 50 kΩ or more)	0 to 10 VDC, 4 to 20 mA	Terminal 5 is a common terminal.
		Between 1(+) and 5		0 to ±5 VDC and 0 to ±10 VDC	
	Power supply for a frequency setting potentiometer	Between 10(+) and 5		5.2 VDC	
		Between 10E(+) and 5		10 VDC	
	Frequency meter signal	Between AM(+) and 5		Approximately 10 VDC at maximum frequency (without frequency meter)	
		Between CA(+) and 5		Approximately 20 mADC at maximum frequency	
		Between FM(+) and SD		Approximately 5 VDC at maximum frequency (without frequency meter)  Pulse width T1: Adjust with **C0 (Pr.900)**. Pulse cycle T2: Set with **Pr.55** (for frequency monitor only).	Terminal SD is a common terminal.
	Start signal, Select signal, Reset signal, Output stop signal	Across STF, STR, RH, RM, RL, JOG, RT, AU, STOP, CS, RES, MRS(+) and SD (for sink logic)		Voltage when terminal is open: 20 to 30 VDC. Voltage when signal is ON: 1 V or less.	
	Fault signal	Between A1 and C1 Between B1 and C1	Digital multimeter or other tester	Continuity check[*3] [Normal] Across A1 and C1: Discontinuity Across B1 and C1: Continuity [Fault] Across A1 and C1: Continuity Across B1 and C1: Discontinuity	

*1 Use an FFT to measure the output voltage accurately. A digital multimeter or general measuring instrument cannot measure accurately.

*2 When the carrier frequency exceeds 5 kHz, do not use this instrument since using it may increase eddy current losses produced in metal parts inside the instrument, leading to burnout. In this case, use an approximate-effective value type.

*3 When the setting of **Pr.195 ABC1 terminal function selection** is the positive logic.

5.2.1 Measurement of powers

Use a digital power meter (for inverter) for the input side of the converter unit (FR-CC2) and the output side of the inverter.

5.2.2 Measurement of voltages

◆ Converter unit (FR-CC2) input side

Use a digital power meter for inverters for the input side voltage.

◆ Inverter output side

Always use a digital power meter for inverter for measurement as the output side voltage has a PWM-controlled rectangular wave.

The value displayed on the operation panel is the inverter-controlled voltage itself. Hence, that value is accurate and it is recommended to monitor values using the operation panel. Monitoring values via the operation panel or by outputting the analog signal is recommended as these values are accurate.

5.2.3 Measurement of currents

Use a digital power meter (for inverter) for the input side of the converter unit (FR-CC2) and the output side of the inverter.
Since the converter unit input current tends to be unbalanced, measurement of three phases is recommended. The correct value cannot be obtained by measuring only one or two phases. On the other hand, the unbalanced ratio of each phase of the output current should be within 10%.
The inverter output current can be monitored on the operation panel. The value displayed on the operation panel is accurate even if the output frequency varies. Hence, it is recommended to monitor values on the operation panel.

5.2.4 Example of measuring converter unit (FR-CC2) input power factor

Calculate the factor from the effective power and the apparent power. A power-factor meter cannot indicate an exact value.

$$\text{Total power factor of the converter unit} = \frac{\text{Effective power}}{\text{Apparent power}}$$

$$= \frac{\text{Three-phase input power found by the 3-wattmeter method}}{\sqrt{3} \times \text{V (power supply voltage)} \times \text{I (input current effective value)}}$$

5.2.5 Measurement of converter output voltage (between terminals P and N)

The output voltage of the converter is output across terminals P and N, and can be measured with a voltmeter such as a digital multimeter. The voltage varies according to the power supply voltage. Approximately 540 to 600 VDC is output when no load is applied. The voltage decreases when a load is applied.
When energy is regenerated from the motor during deceleration, for example, the converter output voltage rises to nearly 800 to 900 VDC maximum.

5.2.6 Measurement of inverter output frequency

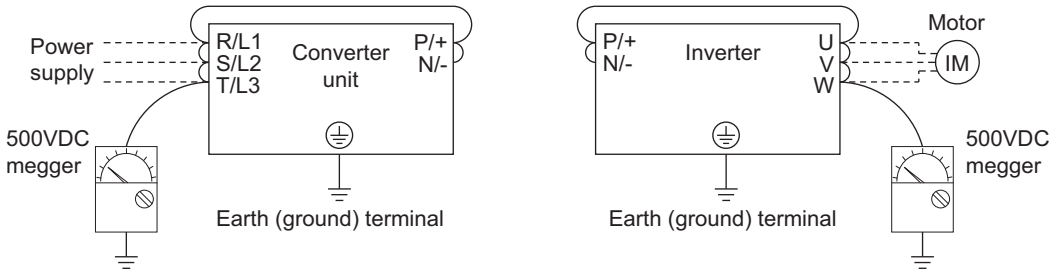
In the initial setting of the FM type inverter, a pulse train proportional to the output frequency is output across the pulse train output terminals FM and SD on the inverter. This pulse train output can be counted by a frequency counter, or a digital multimeter can be used to read the mean value of the pulse train output voltage. When a digital multimeter is used to measure the output frequency, approximately 5 VDC is indicated at the maximum frequency.
For detailed specifications of the pulse train output terminal FM, refer to the FR-A800 Instruction Manual (Function).
In the initial setting of the CA type inverter, a pulse train proportional to the output frequency is output across the analog current output terminals CA and 5 on the inverter. Measure the current using a digital multimeter.
For detailed specifications of the analog current output terminal CA, refer to the FR-A800 Instruction Manual (Function).

5.2.7 Insulation resistance test using megger

- For the inverter and the converter unit (FR-CC2), conduct the insulation resistance test on the main circuit only as follows and do not perform the test on the control circuit. (Use a 500 VDC megger.)

NOTE

- Before performing the insulation resistance test on the external circuit, disconnect the cables from all terminals of the inverter and the converter unit so that the test voltage is not applied to the inverter and the converter unit.
- For the continuity test of the control circuit, use a tester for high resistance range and do not use the megger or buzzer.



5.2.8 Withstand voltage test

Do not conduct a withstand voltage test. Deterioration may occur.

MEMO

CHAPTER 6 SPECIFICATIONS

6 SPECIFICATIONS

This chapter explains the specifications of this product.
Always read the instructions before use.

6.1 Inverter rating

◆690 VAC power input

- Inverter

Model FR-A872-[]			05690	06470	07150
Applicable motor capacity (kW)*1		SLD	500	560	630
		ND (initial setting)	450	500	560
Output	Rated capacity (kVA)*2	SLD	680	773	855
		ND (initial setting)	612	680	773
	Rated current (A)*3	SLD	569	647	715
		ND (initial setting)	512	569	647
	Overload current rating*4	SLD	110% 60 s, 120% 3 s (inverse-time characteristics) at surrounding air temperature of 40°C		
		ND (initial setting)	150% 60 s, 200% 3 s (inverse-time characteristics) at surrounding air temperature of 40°C		
	Rated voltage*5		Three-phase 600 to 690 V		
Input power	Power supply voltage		849 to 1025 VDC		
	Control power supply auxiliary input		Single-phase 525 to 690 V, 50/60 Hz		
	Permissible control power supply auxiliary input fluctuation		Frequency ±5%, voltage ±10%		
Protection rating of structure (IEC 60529)*6			Open type (IP00)		
Cooling system			Forced air		
Noise level (dB)*7			74	74	74
Approx. mass (kg)			186	186	186

*1 Indicates the maximum capacity applicable to voltage of 690 V.

*2 The rated output capacity is the value with respect to 690 V output voltage.

*3 Possible output currents during continuous operation under Real sensorless vector control or Vector control are shown in the table below.

PWM carrier frequency	05690		06470		07150	
	SLD	ND	SLD	ND	SLD	ND
2 kHz	472 A	440 A	537 A	489 A	593 A	556 A
4 kHz	284 A	296 A	323 A	330 A	357 A	375 A

The PWM carrier frequency is automatically decreased to 2 kHz for heavy duty applications when operating the motor under Real sensorless vector control or Vector control with a PWM carrier frequency of more than 6 kHz (**Pr.72** ≥ 6). The carrier frequency stays at 4 kHz in fast-response operation.

*4 The percentage of the overload current rating is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.

*5 The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the maximum point of the voltage waveform at the inverter output side is the power supply voltage multiplied by about $\sqrt{2}$.

*6 FR-DU08: IP40 (except for the PU connector)

*7 Values measured 1 m in front of the inverter and 1.6 m from the floor.

◆ 575 VAC power input

- Inverter

Model FR-A872-[]			05690	06470	07150
Applicable motor capacity (kW)*1		SLD	400	450	500
		ND (initial setting)	355	400	450
Output	Rated capacity (kVA)*2	SLD	567	644	712
		ND (initial setting)	510	567	644
	Rated current (A)*3	SLD	569	647	715
		ND (initial setting)	512	569	647
	Overload current rating*4	SLD	110% 60 s, 120% 3 s (inverse-time characteristics) at surrounding air temperature of 40°C		
		ND (initial setting)	150% 60 s, 200% 3 s (inverse-time characteristics) at surrounding air temperature of 40°C		
	Rated voltage*5		Three-phase 525 to 600 V		
Input power	Power supply voltage		742 to 891 VDC		
	Control power supply auxiliary input		Single-phase 525 to 690 V, 50/60 Hz		
	Permissible control power supply auxiliary input fluctuation		Frequency ±5%, voltage ±10%		
Protection rating of structure (IEC 60529)*6			Open type (IP00)		
Cooling system			Forced air		
Noise level (dB)*7			74	74	74
Approx. mass (kg)			186	186	186

*1 Indicates the maximum capacity applicable to voltage of 575 V.

*2 The rated output capacity is the value with respect to 575 V output voltage.

*3 Possible output currents during continuous operation under Real sensorless vector control or Vector control are shown in the table below.

PWM carrier frequency	05690		06470		07150	
	SLD	ND	SLD	ND	SLD	ND
2 kHz	472 A	440 A	537 A	489 A	593 A	556 A
4 kHz	284 A	296 A	323 A	330 A	357 A	375 A

The PWM carrier frequency is automatically decreased to 2 kHz for heavy duty applications when operating the motor under Real sensorless vector control or Vector control with a PWM carrier frequency of more than 6 kHz (**Pr.72** ≥ 6). The carrier frequency stays at 4 kHz in fast-response operation.

*4 The percentage of the overload current rating is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.

*5 The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the maximum point of the voltage waveform at the inverter output side is the power supply voltage multiplied by about $\sqrt{2}$.

*6 FR-DU08: IP40 (except for the PU connector)

*7 Values measured 1 m in front of the inverter and 1.6 m from the floor.

6.2 Common specifications

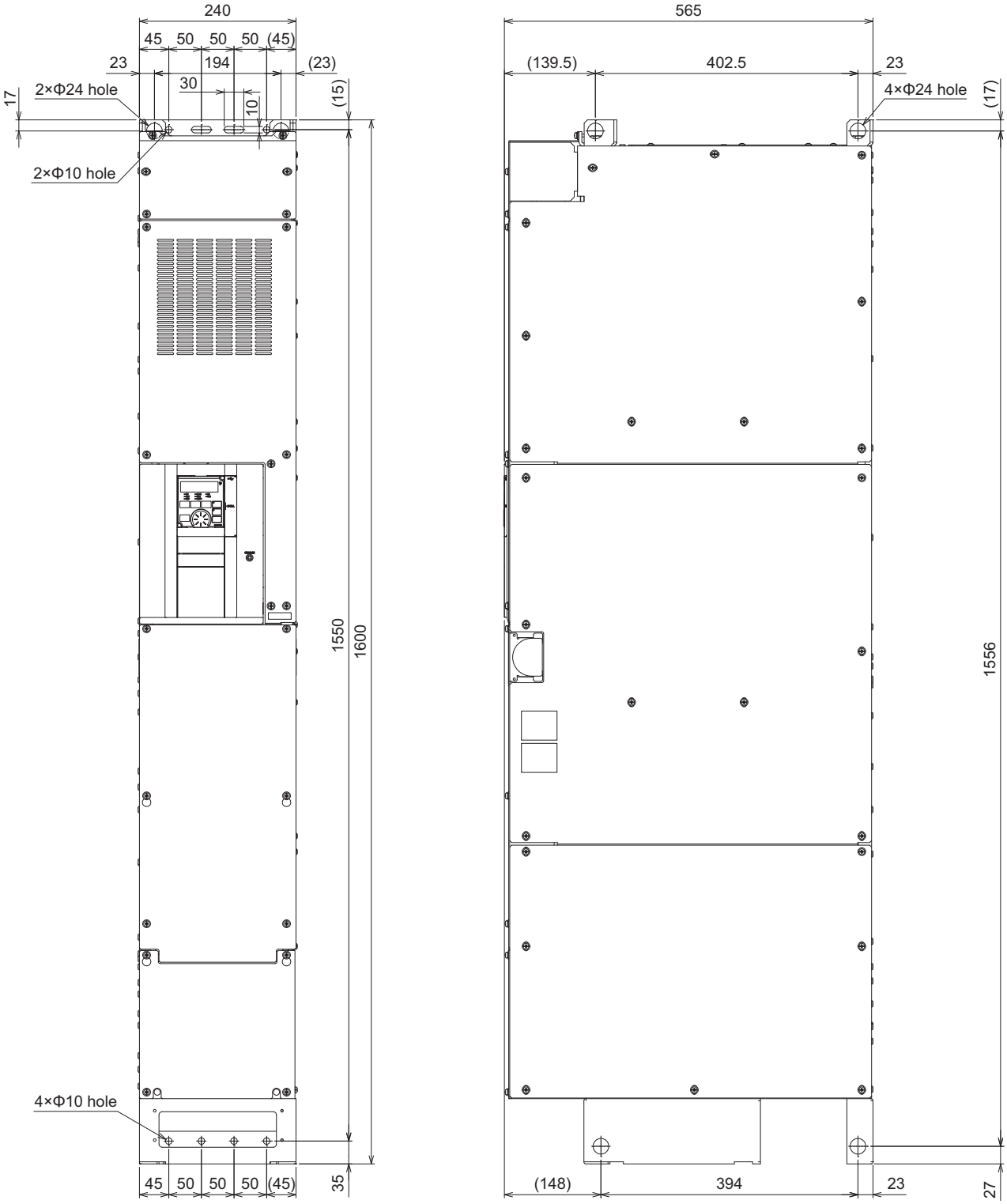
Control	Control method		Soft-PWM control, high carrier frequency PWM control (selectable among V/F control, Advanced magnetic flux vector control, Real sensorless vector control), Optimum excitation control, and Vector control[*1]
	Output frequency range		0.2 to 590 Hz (The upper-limit frequency is 400 Hz under Advanced magnetic flux vector control, Real sensorless vector control, and Vector control[*1].)
	Frequency setting resolution	Analog input	0.015 Hz/60 Hz at 0 to 10 V/12 bits (terminals 2 and 4). 0.03 Hz/60 Hz at 0 to 5 V/11 bits or 0 to 20 mA/approx. 11 bits (terminals 2 and 4), at 0 to ±10 V/12 bits (terminal 1). 0.06 Hz/60 Hz at 0 to ±5 V/11 bits (terminal 1).
		Digital input	0.01 Hz
	Frequency accuracy	Analog input	Within ±0.2% of the maximum output frequency (25°C ±10°C)
		Digital input	0.01% or less of the set output frequency
	Voltage/frequency characteristics		Base frequency can be set from 0 to 590 Hz. Constant-torque/variable-torque pattern or adjustable 5 points V/F can be selected.
	Starting torque		SLD rating: 120% 0.3 Hz, ND rating: 200%[*2] 0.3 Hz, (under Real sensorless vector control or Vector control[*1])
	Torque boost		Manual torque boost
	Acceleration/deceleration time setting		0 to 3600 s (acceleration and deceleration can be set individually), linear or S-pattern acceleration/deceleration mode, backlash countermeasures acceleration/deceleration can be selected.
	DC injection brake (induction motor)		Operation frequency (0 to 120 Hz), operation time (0 to 10 s), operation voltage (0% to 30%) variable
	Stall prevention operation level		Activation range of stall prevention operation (SLD rating: 0% to 120%, ND rating: 0% to 220%). Whether to use the stall prevention or not can be selected (V/F control, Advanced magnetic flux vector control).
	Torque limit level		Torque limit value can be set (0% to 400% variable). (Real sensorless vector control, Vector control[*1])
Operation	Frequency setting signal	Analog input	Terminals 2 and 4: 0 to 10 V / 0 to 5 V / 4 to 20 mA (0 to 20 mA). Terminal 1: -10 to +10 V / -5 to +5 V.
		Digital input	Input using the setting dial of the operation panel or parameter unit. Input of four-digit BCD (Binary-coded decimal) or 16-bit binary (when the option FR-A8AX is installed).
	Start signal		Forward and reverse rotation or start signal automatic self-holding input (3-wire input) can be selected.
	Input signal (12)		Low-speed operation command, Middle-speed operation command, High-speed operation command, Second function selection, Terminal 4 input selection, Jog operation selection, Selection of automatic restart after instantaneous power failure / flying start, Output stop, Start self-holding selection, Forward rotation command, Reverse rotation command, Inverter reset The signal to be input can be changed using **Pr.178 to Pr.189 (Input terminal function selection)**.
		Pulse train input	100k pulses/s
	Operational function		Maximum and minimum frequency settings, multi-speed operation, acceleration/deceleration pattern, thermal protection, DC injection brake, starting frequency, JOG operation, output stop (MRS), stall prevention, regeneration avoidance, increased magnetic excitation deceleration, frequency jump, rotation display, automatic restart after instantaneous power failure, electronic bypass sequence, remote setting, automatic acceleration/deceleration, retry function, carrier frequency selection, fast-response current limit, forward/reverse rotation prevention, operation mode selection, slip compensation, droop control, load torque high-speed frequency control, speed smoothing control, traverse, auto tuning, applied motor selection, gain tuning, RS-485 communication, Ethernet communication, PID control, PID pre-charge function, easy dancer control, cooling fan operation selection, stop selection (deceleration stop/coasting), power failure time deceleration-to-stop function, stop-on-contact control, PLC function, life diagnosis, maintenance timer, current average monitor, multiple rating, orientation control[*1], speed control, torque control, position control, pre-excitation, torque limit, test run, 24 V power supply input for control circuit, safety stop function, anti-sway control
	Output signal Open collector output (five terminals) Relay output (two terminals)		Inverter running, Up to frequency, Overload warning, Output frequency detection, Fault The signal to be output can be changed using **Pr.190 to Pr.196 (Output terminal function selection)**. Fault codes (4 bits) of the inverter can be output from the open collector.
		Pulse train output	50k pulses/s

Indication	For indication on external meters	Pulse train output (FM type inverter)	Max. 2.4 kHz via one terminal (for the indication of inverter output frequency). The item for monitoring can be changed using **Pr.54 FM/CA terminal function selection**.
		Current output (CA type inverter)	Max. 20 mADC via one terminal (for the indication of inverter output frequency). The item for monitoring can be changed using **Pr.54 FM/CA terminal function selection**.
		Voltage output	Max. 10 VDC via one terminal (for the indication of inverter output frequency). The item for monitoring can be changed using **Pr.158 AM terminal function selection**.
	Operation panel (FR-DU08)	Status monitoring	Output frequency, output current, output voltage, and frequency setting value are monitored. The item for monitoring can be changed using **Pr.52 Operation panel main monitor selection**.
		Fault record	When a protective function is activated, a fault indication is displayed and the output voltage, output current, output frequency, cumulative energization time, date (year, month, day) and time at the occurrence of the fault are stored. Each fault is recorded and the last 8 records can be displayed.
Protective function		Fault	Overcurrent trip during acceleration, Overcurrent trip during constant speed, Overcurrent trip during deceleration or stop, Regenerative overvoltage trip during acceleration, Regenerative overvoltage trip during constant speed, Regenerative overvoltage trip during deceleration or stop, Inverter overload trip (electronic thermal relay function), Motor overload trip (electronic thermal relay function), Heat sink overheat, Stall prevention stop, Upper limit fault detection, Lower limit fault detection, Output side earth (ground) fault overcurrent, Output phase loss, External thermal relay operation[*5], PTC thermistor operation[*5], Option fault, Communication option fault, Parameter storage device fault (control circuit board), Parameter storage device fault (main circuit board), PU disconnection, Retry count excess[*5], CPU fault, Operation panel power supply short circuit, 24 VDC power fault, Abnormal output current detection, Ethernet communication fault, Analog input fault, USB communication fault, Safety circuit fault, Overspeed occurrence[*5], Speed deviation excess detection[*1*5], Signal loss detection[*1*5], Excessive position fault[*1*5], Brake sequence fault[*5], Encoder phase fault[*1*5], 4 mA input fault[*5], Pre-charge fault[*5], PID signal fault[*5], Opposite rotation deceleration fault[*5], Internal circuit fault, External fault during output operation[*5]
		Alarm, Warning, Error message	Fan alarm, Stall prevention (overcurrent), Stall prevention (overvoltage), Electronic thermal relay function pre-alarm, PU stop, Speed limit indication[*5], Parameter copy, Safety stop, Maintenance signal output[*5], USB host error, Home position return setting error[*5], Home position return uncompleted[*5], Home position return parameter setting error[*5], Operation panel lock[*5], Password locked[*5], Parameter write error, Copy operation error, 24 V external power supply operation, Continuous operation during communication fault, Ethernet communication fault[*5]
Environment	Surrounding air temperature		-10°C to +40°C (non-freezing)
	Surrounding air humidity		95% RH or less (non-condensing) (With circuit board coating (conforming to IEC 60721-3-3 3C2/3S2)
	Storage temperature[*3]		-20°C to +65°C
	Ambience		Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
	Altitude/vibration		Maximum 4000 m[*4]. Frequency range 10 to 57 Hz: maximum amplitude 0.075 mm. Frequency range 57 to 150 Hz: maximum acceleration speed 1G

*1 Available when a Vector control compatible option is installed.
*2 In the initial setting, the starting torque is limited to 150% by the torque limit level.
*3 Applicable to conditions for a short time, for example, in transit.
*4 For installation at an altitude above 1000 m, consider a 3% reduction in the rated current per 500 m increase in altitude.
*5 Not activated in the inverter in the initial state.

6.3 Outline dimension drawings

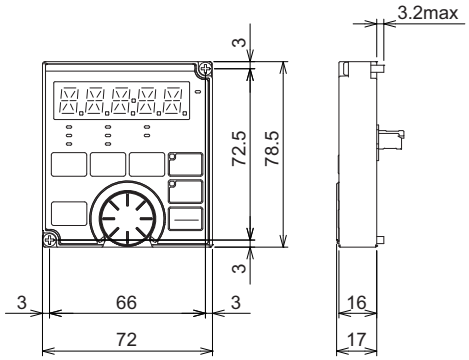
FR-A872-05690 to 07150



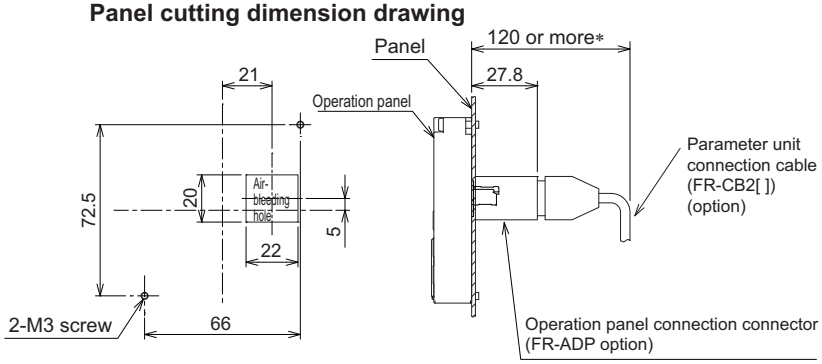
(Unit: mm)

Operation panel (FR-DU08, FR-LU08)

Outline drawing



Panel cutting dimension drawing



* Denotes the space required to connect an optional parameter unit connection cable (FR-CB2[ ]). When using another cable, leave the space required for the cable specification.

(Unit: mm)

MEMO

CHAPTER 7 APPENDIX

7 APPENDIX

APPENDIX provides the reference information for use of this product.
Refer to APPENDIX as required.

7.1 Comparison with FR-A870

Item	FR-A870	FR-A872
Pr.30 Regenerative function selection	Setting ranges: "0, 1, 100, 101" Initial value: "0"	Setting ranges: "2, 10, 11, 102, 110, 111" Initial value: "10"
Input terminal function selection (Pr.178 to Pr.189)	Inverter run enable (X10) (FR-CC2 connection), FR-CC2 connection, instantaneous power failure detection (X11): Unavailable	Inverter run enable (X10) (FR-CC2 connection), FR-CC2 connection, instantaneous power failure detection (X11): Available
Pr.187 MRS terminal function selection	Initial value "24" (MRS)	Initial value "10" (X10)
Output terminal function assignment selection (Pr.190 to Pr.196, Pr.313 to Pr.322)	Instantaneous power failure/undervoltage (IPF), Main circuit capacitor life (Y87), Inrush current limit circuit life (Y89), (Y248): Available	Instantaneous power failure/undervoltage (IPF), Main circuit capacitor life (Y87), Inrush current limit circuit life (Y89), (Y248): Unavailable
Pr.192 IPF terminal function selection	Initial value "2" (IPF)	Initial value "9999" (No function)
Inrush current limit circuit life display, Main circuit capacitor life display (Pr.256, Pr.258, Pr.259, Pr.506)	With the parameter	Without the parameter
Pr.599 X10 terminal input selection	Without the parameter	With the parameter
Pr.872 Input phase loss protection selection	With the parameter	Without the parameter
Warning, protective functions	Instantaneous power failure (E.IPF), Undervoltage (E.UVT), Input phase loss (E.ILF), Brake transistor alarm detection (E.BE)*1, Inrush current limit circuit fault: Available	Instantaneous power failure (E.IPF), Undervoltage (E.UVT), Input phase loss (E.ILF), Brake transistor alarm detection (E.BE), Inrush current limit circuit fault: Unavailable

*1 Built-in brake transistor model only.

7.2 Instructions for compliance with the EU Directives

The EU Directives are issued to standardize different national regulations of the EU Member States and to facilitate free movement of the equipment, whose safety is ensured, in the EU territory.
Since 1996, compliance with the EMC Directive that is one of the EU Directives has been legally required. Since 1997, compliance with the Low Voltage Directive, another EU Directive, has been also legally required. When a manufacturer confirms its equipment to be compliant with the EMC Directive and the Low Voltage Directive, the manufacturer must declare the conformity and affix the CE marking.

- The authorized representative in the EU
  The authorized representative in the EU is shown below.
  Name: Mitsubishi Electric Europe B.V.
  Address: Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

◆ EMC Directive

We declare that this inverter conforms with the EMC Directive and affix the CE marking on the inverter.

- EMC Directive: 2014/30/EU
- Standard(s): EN 61800-3:2004+A1:2012 (Second environment / PDS Category "C3")
- This inverter is not intended to be used on a low-voltage public network which supplies domestic premises. When using the inverter in a residential area, take appropriate measures and ensure the conformity of the inverter used in the residential area.
- Radio frequency interference is expected if used on such a network.
- The installer shall provide a guide for installation and use, including recommended mitigation devices.

Note:
First environment
Environment including buildings/facilities which are directly connected to a low voltage main supply which also supplies residential buildings. Directly connected means that there is no intermediate transformer between these buildings.
Second environment
Environment including all buildings/facilities which are not directly connected to a low voltage main supply which also supplies residential buildings.

■ Note

Ensure the EMC filter is enabled, install the product as stated below, and, then carry out any wiring.

- The converter unit has a built-in EMC filter (Class C3). Enable the EMC filter. (For the details, refer to page 74.)
- Connect the inverter and the converter unit to an earthed (grounded) power supply.
- To make full use of the built-in EMC filter, motor cable lengths should not exceed 20 m.
- Ensure that the finalized system which includes an inverter and converter unit complies with the EMC Directive.

◆ Low Voltage Directive

We have self-confirmed our inverters as products compliant to the Low Voltage Directive and affix the CE marking on the inverters.

- Low Voltage Directive: 2014/35/EU
- Conforming standard: EN 61800-5-1:2007

■ Outline of instructions

- Do not use an earth leakage circuit breaker as an electric shock protector without connecting the equipment to the earth. Connect the equipment to the earth (ground) securely.
- Wire the earth terminal independently. (Do not connect two or more cables to one terminal.)
- Use the cable sizes on page 38 under the following conditions.
  • Surrounding air temperature: 40°C maximum
  If conditions are different from the above, select appropriate wire according to EN 60204-1 or IEC 60364-5-52.

- Use a tinned (plating should not include zinc) crimping terminal to connect the earth (ground) cable. When tightening the screw, be careful not to damage the threads.
- For use as a product compliant with the Low Voltage Directive, use PVC cable whose size is indicated on page 38.
- A large leakage current flows into the protective earth (ground) conductor. The amount of current leakage from the FR-CC2 and FR-A872 measures 20 mA at maximum (in AC/DC current measuring range specified in IEC 60990). Do not use earth (ground) wires smaller than those specified in national and local safety regulations regarding leakage currents.
- Use the molded case circuit breaker and magnetic contactor which conform to the EN or IEC Standard.
- DC current may flow from the inverter to a protective earth (ground) conductor. When using a residual current device (RCD) or residual current monitor (RCM), connect a type B RCD or RCM to the power supply side.
- Use the inverter under the conditions of overvoltage category II (regardless of the earth (ground) condition of the power supply), or overvoltage category III (inverters must be used with the earth-neutral system power supply) specified in IEC 60664.
  To use the inverter under the conditions of pollution degree 2, install it in the enclosure of IP2X or higher.
  To use the inverter under the conditions of pollution degree 3, install it in the enclosure of IP54 or higher.
- On the input and output of the inverter and the converter unit, use cables of the size and type set forth in EN 60204-1 or IEC 60364-5-52.
- The operating capacity of the relay outputs (terminal symbols A1, B1, C1, A2, B2, C2) should be 30 VDC, 0.3 A. (Relay output has basic isolation from the internal circuit of the inverter and the converter unit.)
- Control circuit terminals on page 30 are safely isolated from the main circuit.
- Environment (For the details, refer to page 24.)

	During operation	In storage	During transportation
Surrounding air temperature	-10°C to +40°C	-20°C to +65°C	-20°C to +65°C
Humidity	95% RH or less	95% RH or less	95% RH or less
Maximum altitude	4000 m*1	4000 m	10000 m

*1 For installation at an altitude above 1000 m, consider a 3% reduction in the rated current per 500 m increase in altitude.

■ Branch circuit protection

Provide an appropriate fuse in accordance with the table below.

Converter model	Fuse model*1	Manufacturer	Fuse rating (A)
FR-CC2-N450K	170M6xx5	Bussmann	700 V, 1100 A
FR-CC2-N500K	170M6xx5	Bussmann	700 V, 1100 A
FR-CC2-N560K	170M6xx6	Bussmann	700 V, 1250 A
FR-CC2-N630K	170M6xx7	Bussmann	700 V, 1400 A

*1 "xx" in a model name is "41, 46, 51, or 56".

■ Short circuit ratings

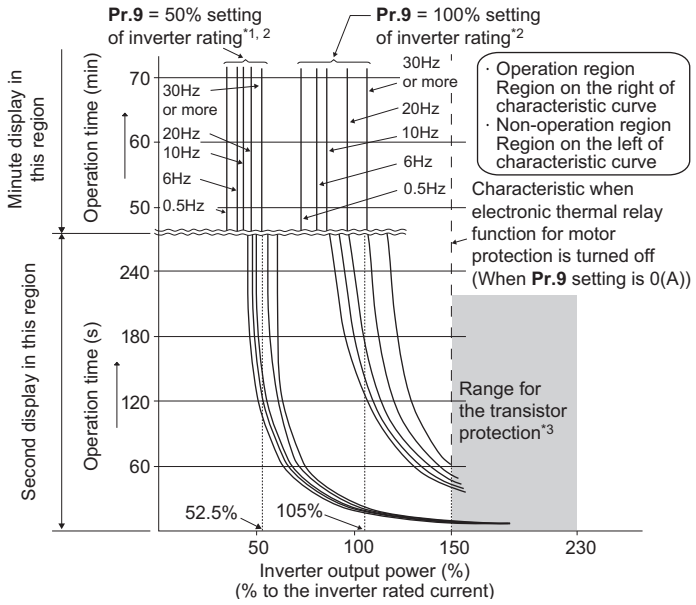
Suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 690 V maximum.

◆ Motor overload protection

When using the electronic thermal relay function as motor overload protection, set the rated motor current in **Pr.9 Electronic thermal O/L relay**.

This function detects the overload of the motor and shut off the inverter output by stopping the operation of the transistor at the inverter output side. (The operation characteristic is shown below.)

Operational characteristic of the electronic thermal relay function



*1 When setting **Pr.9** to a value (current value) of 50% of the inverter rated output current.

*2 The % value denotes the percentage to the inverter rated current. It is not the percentage to the rated motor current.

*3 Transistor protection is activated depending on the temperature of the heat sink. The protection may be activated even with less than 150% depending on the operating conditions.

NOTE

- The internal accumulated heat value of the electronic thermal O/L relay is reset to the initial value by the inverter's power reset or reset signal input. Avoid unnecessary reset and power-OFF.
- Install an external thermal relay (OCR) between the inverter and motors to operate several motors, a multi-pole motor or a dedicated motor with one inverter. When configuring an external thermal relay, note that the current indicated on the motor rating plate is affected by the line-to-line leakage current. (Refer to the Instruction Manual (Function).)
- The cooling effect of the motor drops during low-speed operation. Use a thermal protector or a motor with built-in thermistor.
- When the difference between the inverter and motor capacities is large and the setting is small, the protective characteristics of the electronic thermal relay function will be deteriorated. In such case, use an external thermal relay.
- A dedicated motor cannot be protected by the electronic thermal relay. Use an external thermal relay.
- Motor over temperature sensing is not provided by the drive.
- The electronic thermal memory retention function is not provided by the drive.
- The electronic thermal relay cannot protect the motor by detecting the motor speed.

7.3 Instructions for UL and cUL

(Standard to comply with: UL 61800-5-1, CSA 22.2 No. 274)

◆ General precaution

CAUTION - Risk of Electric Shock -

The bus capacitor discharge time is 10 minutes. Before starting wiring or inspection, switch power off, wait for more than 10 minutes, and check for residual voltage between terminal P/+ and N/- with a meter etc., to avoid a hazard of electrical shock.

WARNING

Operation of this equipment requires detailed installation and operation instructions provided in the installation/Operation manual intended for use with this product.

WARNING

The opening of the branch-circuit protective device may be an indication that a fault current has been interrupted. To reduce the risk of fire or electric shock, current-carrying parts and other components of the controller should be examined and replaced if damaged.

ATTENTION - Risque de choc électrique -

La durée de décharge du condensateur de bus est de 10 minutes. Avant de commencer le câblage ou l'inspection, mettez l'appareil hors tension et attendez plus de 10 minutes.

AVERTISSEMENT

L'utilisation de cet équipement nécessite des instructions détaillées d'installation et d'utilisation fournies dans le manuel d'installation/utilisation destiné à être utilisé avec ce produit.

AVERTISSEMENT

L'ouverture du dispositif de protection de circuit de dérivation peut indiquer qu'un courant de défaut a été interrompu. Pour réduire le risque d'incendie ou de choc électrique, les pièces sous tension et les autres composants du contrôleur doivent être examinés et remplacés s'ils sont endommagés.

◆ Installation

The below types of inverter have been approved as products for use in enclosure.

Design the enclosure so that the surrounding air temperature, humidity and ambience of the inverter will satisfy the specifications. (refer to page 24).

■ Branch circuit protection

Short circuit protection of the inverter cannot be used as branch circuit protection.

For installation in the United States, the semiconductor fuses shown in the following table must be provided, in accordance with the National Electrical Code and any applicable local codes.

For installation in Canada, the semiconductor fuses shown in the following table must be provided, in accordance with the Canadian Electrical Code and any applicable local codes.

Converter model	Fuse model*1	Manufacturer	Fuse rating (A)
FR-CC2-N450K	170M6xx5	Bussmann	700 V, 1100 A
FR-CC2-N500K	170M6xx5	Bussmann	700 V, 1100 A
FR-CC2-N560K	170M6xx6	Bussmann	700 V, 1250 A
FR-CC2-N630K	170M6xx7	Bussmann	700 V, 1400 A

*1 "xx" in a model name is "41, 46, 51, or 56".

◆ Wiring to the power supply and the motor

Refer to the National Electrical Code (Article 310) regarding the allowable current of the cable. Select the cable size for 125% of the rated current according to the National Electrical Code (Article 430).

For wiring the input (R/L1, S/L2, T/L3) terminals of the converter unit and output (U, V, W) terminals of the inverter, use the UL listed copper, stranded wires (rated at 75°C) and round crimp terminals. Crimp the terminals with the crimping tool recommended by the terminal manufacturer.

◆ Short circuit ratings

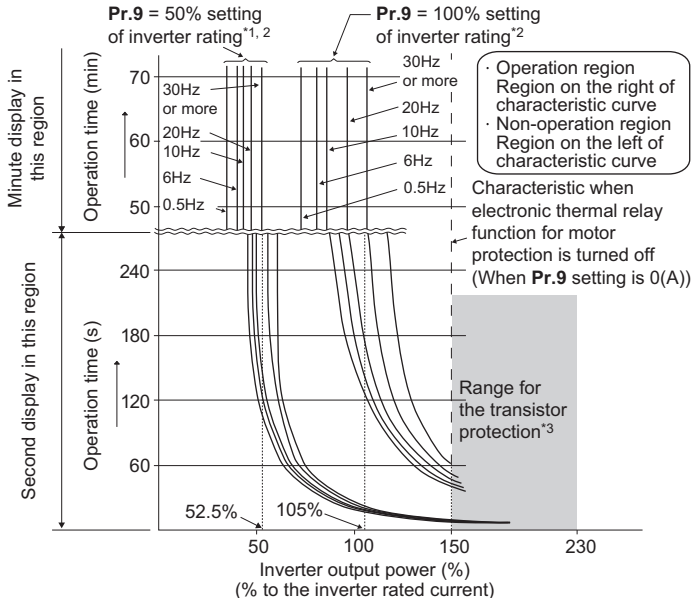
Suitable for use in a circuit capable of delivering not more than 100 kA rms symmetrical amperes, 600 V maximum.

◆ Motor overload protection

When using the electronic thermal relay function as motor overload protection, set the rated motor current in **Pr.9 Electronic thermal O/L relay**.

This function detects the overload (overheat) of the motor and shut off the inverter output by stopping the operation of the transistor at the inverter output side. (The operation characteristic is shown below.)

Operational characteristic of the electronic thermal relay function



*1 When setting **Pr.9** to a value (current value) of 50% of the inverter rated output current.

*2 The % value denotes the percentage to the inverter rated current. It is not the percentage to the rated motor current.

*3 Transistor protection is activated depending on the temperature of the heat sink. The protection may be activated even with less than 150% depending on the operating conditions.

NOTE

- The internal accumulated heat value of the electronic thermal O/L relay is reset to the initial value by the inverter's power reset or reset signal input. Avoid unnecessary reset and power-OFF.
- Install an external thermal relay (OCR) between the inverter and motors to operate several motors, a multi-pole motor or a dedicated motor with one inverter. When configuring an external thermal relay, note that the current indicated on the motor rating plate is affected by the line-to-line leakage current. (Refer to the Instruction Manual (Function).)
- The cooling effect of the motor drops during low-speed operation. Use a thermal protector or a motor with built-in thermistor.
- When the difference between the inverter and motor capacities is large and the setting is small, the protective characteristics of the electronic thermal relay function will be deteriorated. In such case, use an external thermal relay.
- A dedicated motor cannot be protected by the electronic thermal relay. Use an external thermal relay.
- Motor over temperature sensing is not provided by the drive.

7.4 Instructions for EAC

The product certified in compliance with the Eurasian Conformity has the EAC marking.

Note: EAC marking
In 2010, three countries (Russia, Belarus, and Kazakhstan) established a Customs Union for the purposes of revitalizing the economy by forming a large economic bloc by abolishing or reducing tariffs and unifying regulatory procedures for the handling of articles.
Products to be distributed over these three countries of the Customs Union must comply with the Customs Union Technical Regulations (CU-TR), and the EAC marking must be affixed to the products.

For information on the country of origin, manufacture year and month, and authorized sales representative (importer) in the CU area of this product, refer to the following:

- Country of origin indication
  Check the rating plate of the product. (Refer to page 13.)
  Example: MADE IN JAPAN
- Manufactured year and month
  Check the SERIAL number indicated on the rating plate of the product. (Refer to page 13.)
- Authorized sales representative (importer) in the CU area
  The authorized sales representative (importer) in the CU area is shown below.
  Name: Mitsubishi Electric (Russia) LLC
  Address: 52, bld 1 Kosmodamianskaya Nab 115054, Moscow, Russia
  Phone: +7 (495) 721-2070
  Fax: +7 (495) 721-2071

7.5 Restricted Use of Hazardous Substances in Electronic and Electrical Products

The mark of restricted use of hazardous substances in electronic and electrical products is applied to the product as follows based on the "Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products" of the People's Republic of China.

电器电子产品有害物质限制使用标识要求

本产品中所含有的有害物质的名称、含量、含有部件如下表所示。

• 产品中所含有害物质的名称及含量

部件名称 *2	有害物质 *1					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
电路板组件（包括印刷电路板及其构成的零部件，如电阻、电容、集成电路、连接器等）、电子部件	×	○	×	○	○	○
金属壳体、金属部件	×	○	○	○	○	○
树脂壳体、树脂部件	○	○	○	○	○	○
螺丝、电线	○	○	○	○	○	○

上表依据 SJ/T11364 的规定编制。

○：表示该有害物质在该部件所有均质材料中的含量均在 GB/T26572 规定的限量要求以下。

×：表示该有害物质在该部件的至少一种均质材料中的含量超出 GB/T26572 规定的限量要求。

*1 即使表中记载为 ×，根据产品型号，也可能会有有害物质的含量为限制值以下的情况。

*2 根据产品型号，一部分部件可能不包含在产品中。

7.6 Referenced Standard (Requirement of Chinese standardized law)

This Product is designed and manufactured accordance with the following Chinese standards.

Machinery safety:	GB/T 16855.1 GB/T 12668.502 GB 28526 GB/T 12668.3
Electrical safety:	GB/T 12668.501
EMC	GB/T 12668.3

MEMO

WARRANTY

When using this product, make sure to understand the warranty described below.

1. Warranty period and coverage

We will repair any failure or defect (hereinafter referred to as "failure") in our FA equipment (hereinafter referred to as the "Product") arisen during warranty period at no charge due to causes for which we are responsible through the distributor from which you purchased the Product or our service provider. However, we will charge the actual cost of dispatching our engineer for an on-site repair work on request by customer in Japan or overseas countries. We are not responsible for any on-site readjustment and/or trial run that may be required after a defective unit are repaired or replaced.

[Term]

The term of warranty for Product is twelve months after your purchase or delivery of the Product to a place designated by you or eighteen months from the date of manufacture whichever comes first ("Warranty Period"). Warranty period for repaired Product cannot exceed beyond the original warranty period before any repair work.

[Limitations]

(1) You are requested to conduct an initial failure diagnosis by yourself, as a general rule. It can also be carried out by us or our service company upon your request and the actual cost will be charged.
However, it will not be charged if we are responsible for the cause of the failure.

(2) This limited warranty applies only when the condition, method, environment, etc. of use are in compliance with the terms and conditions and instructions that are set forth in the instruction manual and user manual for the Product and the caution label affixed to the Product.

(3) Even during the term of warranty, the repair cost will be charged on you in the following cases;
- a failure caused by your improper storing or handling, carelessness or negligence, etc., and a failure caused by your hardware or software problem
- a failure caused by any alteration, etc. to the Product made on your side without our approval
- a failure which may be regarded as avoidable, if your equipment in which the Product is incorporated is equipped with a safety device required by applicable laws and has any function or structure considered to be indispensable according to a common sense in the industry
- a failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
- any replacement of consumable parts (condenser, cooling fan, etc.)
- a failure caused by external factors such as inevitable accidents, including without limitation fire and abnormal fluctuation of voltage, and acts of God, including without limitation earthquake, lightning and natural disasters
- a failure generated by an unforeseeable cause with a scientific technology that was not available at the time of the shipment of the Product from our company
- any other failures which we are not responsible for or which you acknowledge we are not responsible for

2. Term of warranty after the stop of production

(1) We may accept the repair at charge for another seven (7) years after the production of the product is discontinued. The announcement of the stop of production for each model can be seen in our Sales and Service, etc.

(2) Please note that the Product (including its spare parts) cannot be ordered after its stop of production.

3. Service in overseas

Our regional FA Center in overseas countries will accept the repair work of the Product; however, the terms and conditions of the repair work may differ depending on each FA Center. Please ask your local FA center for details.

4. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi Electric shall not be liable for compensation to:

(1) Damages caused by any cause found not to be the responsibility of Mitsubishi Electric.

(2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi Electric products.

(3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi Electric products.

(4) Replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

5. Change of Product specifications

Specifications listed in our catalogs, manuals or technical documents may be changed without notice.

6. Application and use of the Product

(1) For the use of our product, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in product, and a backup or fail-safe function should operate on an external system to product when any failure or malfunction occurs.

(2) Our product is designed and manufactured as a general purpose product for use at general industries.
Therefore, applications substantially influential on the public interest for such as atomic power plants and other power plants of electric power companies, and also which require a special quality assurance system, including applications for railway companies and government or public offices are not recommended, and we assume no responsibility for any failure caused by these applications when used.
In addition, applications which may be substantially influential to human lives or properties for such as airlines, medical treatments, railway service, incineration and fuel systems, man-operated material handling equipment, entertainment machines, safety machines, etc. are not recommended, and we assume no responsibility for any failure caused by these applications when used.
We will review the acceptability of the abovementioned applications, if you agree not to require a specific quality for a specific application. Please contact us for consultation.

About the enclosed CD-ROM

The enclosed CD-ROM contains PDF files of manuals related to this product.

◆Before using the enclosed CD-ROM

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- No part of the enclosed CD-ROM may be copied or reproduced without the permission of Mitsubishi Electric Corporation.
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- Warranty

  We do not provide a warranty against defects in the enclosed CD-ROM and related documents.

NOTE

- This is a personal computer dedicated CD-ROM. Do not attempt to play it on ordinary audio devices. The loud volume may damage hearing and speakers.

◆System requirements for the enclosed CD-ROM

- The following system is required to read instruction manuals contained in the enclosed CD-ROM.

Item	Specification
OS	Microsoft® Windows® 10, Windows® 8.1, Windows® 8, Windows® 7, Windows Vista®
CPU	Intel® Pentium® or better processor
Memory	128 MB of RAM
Hard disk	90 MB of available hard-disk space
CD-ROM drive	Double speed or more (more than quadruple speed is recommended)
Monitor	800x600 dot or more
Application	Adobe® Reader® 7.0 or higher Internet Explorer® 6.0 or higher

◆Operating method of the enclosed CD-ROM

- How to read instruction manuals

  Step 1. Start the computer and place the enclosed CD-ROM in the CD-ROM drive.

  Step 2. The main window will automatically open in the web browser.

  Step 3. Choose your language from the language menu.

  Step 4. Click the manual you want to read in the "INSTRUCTION MANUAL" list.

  Step 5. The PDF manual will open.

- Manual opening of the enclosed CD-ROM

  Step 1. Start the computer and place the enclosed CD-ROM in the CD-ROM drive.

  Step 2. Open the "index.html" file.

  Step 3. The main window will open in the web browser. Follow the previous steps from Step 3 to Step 5.

- PDF data of the instruction manual are stored in "MANUAL" folder on this CD-ROM.

REVISIONS

*The manual number is given on the bottom left of the back cover.

Revision date	*Manual number	Revision
Jul. 2019	IB(NA)-0600830ENG-A	First edition

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