

MITSUBISHI ELECTRIC INVERTER

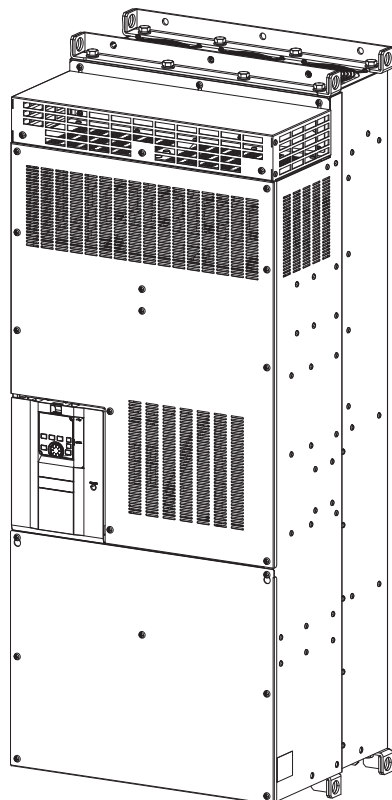


A800

FR-A802-P (SEPARATED CONVERTER TYPE FOR PARALLEL OPERATION) INSTRUCTION MANUAL (HARDWARE)

High functionality and high performance

FR-A842-09620(400K) to 12120(500K)-P



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Thank you for choosing this Mitsubishi inverter.

This Instruction Manual describes handling and cautions about the hardware, such as installation and wiring, for the FR-A802-P (separated converter type for parallel operation) that are different from the FR-A800.

Information about the software, such as basic operations and parameters, is described in the FR-A800 Instruction Manual (Detailed) in the CD-ROM enclosed with the product. Also, for information about the parameters and restrictions on the parallel operation specifications, refer to the Parallel Operation Function Manual in the enclosed CD-ROM. In addition to this manual, please read the manuals in the enclosed CD-ROM carefully. Do not use this product until you have a full knowledge of the equipment, safety information and instructions.

Please forward this Instruction Manual to the end user.

Safety Instructions

Do not attempt to install, operate, maintain or inspect the product until you have read through this Instruction Manual (Detailed) and appended documents carefully and can use the equipment correctly. Do not use this product until you have a full knowledge of the equipment, safety information and instructions.

Installation, operation, maintenance and inspection must be performed by qualified personnel. Here, an expert means a person who meets all the conditions below.

• A person who 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 (e.g. light curtain) connected to the safety control system. A person who has read and familiarized himself/herself with the manuals.


In this Instruction Manual (Detailed), 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.

The  CAUTION level may even lead to a serious consequence according to conditions. Both instruction levels must be followed because these are important to personal safety.

◆ Electric Shock Prevention

WARNING

- While the inverter power is ON, do not remove the front cover or the wiring cover. Do not run the inverter with the front cover or the wiring cover removed. Otherwise you may access the exposed high voltage terminals or the charging part of the circuitry and get an electric shock.
- Even if power is OFF, do not remove the front cover except for wiring or periodic inspection. You may accidentally touch the charged inverter circuits and get an electric shock.
- Before wiring or inspection, LED indication of the operation panel must be switched OFF. Any person who is involved in wiring or inspection shall wait for at least 10 minutes after the power supply has been switched OFF and check that there are no residual voltage using a tester or the like. The capacitor is charged with high voltage for some time after power OFF, and it is dangerous.
- This inverter must be earthed (grounded). Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 536 class 1 and other applicable standards). A neutral-point earthed (grounded) power supply inverter in compliance with EN standard must be used.
- Any person who is involved in wiring or inspection of this equipment shall be fully competent to do the work.
- The inverter must be installed before wiring. Otherwise you may get an electric shock or be injured.
- Setting dial and key operations must be performed with dry hands to prevent an electric shock. Otherwise you may get an electric shock.
- Do not subject the cables to scratches, excessive stress, heavy loads or pinching. Otherwise you may get an electric shock.
- Do not change the cooling fan while power is ON. It is dangerous to change the cooling fan while power is ON.
- Do not touch the printed circuit board or handle the cables with wet hands. Otherwise you may get an electric shock.

◆ Fire Prevention

CAUTION

- Inverter must be installed on a nonflammable wall without holes (so that nobody touches the inverter heatsink on the rear side, etc.). Mounting it to or near flammable material may cause a fire.
- If the inverter has become faulty, the inverter 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. If a product is used without any inspection, a burst, breakage, or a fire may occur.

◆ Injury Prevention

CAUTION

- The voltage applied to each terminal must be the ones specified in the Instruction Manual. Otherwise burst, damage, etc. may occur.
- The cables must be connected to the correct terminals. Otherwise burst, damage, etc. may occur.
- The polarity (+ and -) must be correct. Otherwise burst, damage, etc. may occur.
- While power is ON or for some time after power-OFF, do not touch the inverter as it will be extremely hot. Touching these devices may cause a burn.

◆ Additional Instructions

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

CAUTION

Transportation and Mounting

- Any person who is opening a package using a sharp object, such as a knife and cutter, must wear gloves to prevent injuries caused by the edge of the sharp object.
- The product must be transported in correct method that corresponds to the weight. Failure to do so may lead to injuries.
- Do not stand or rest heavy objects on the product.
- Do not stack the boxes containing inverters higher than the number recommended.
- When carrying the inverter, do not hold it by the front cover; it may fall off or fail.
- During installation, caution must be taken not to drop the inverter as doing so may cause injuries.
- The product must be installed on the surface that withstands the weight of the inverter.
- Do not install the product on a hot surface.
- The mounting orientation of the inverter must be correct.
- The inverter must be installed on a strong surface securely with screws so that it will not drop.
- Do not install or operate the inverter if it is damaged or has parts missing.
- Foreign conductive objects must be prevented from entering the inverter. That includes screws and metal fragments or other flammable substance such as oil.
- As the inverter is a precision instrument, do not drop or subject it to impact.
- The surrounding air temperature must be between -10 and +50°C (non-freezing). Otherwise the inverter may be damaged.
- The ambient humidity must be 95%RH or less (non-condensing). Otherwise the inverter may be damaged. (Refer to [page 17](#) for details.)

⚠ CAUTION

Transportation and Mounting

- The storage temperature (applicable for a short time, e.g. during transit) must be between -20 and +65°C. Otherwise the inverter may be damaged.
- The inverter must be used indoors (without corrosive gas, flammable gas, oil mist, dust and dirt etc.) Otherwise the inverter may be damaged.
- The inverter must be used at an altitude of 2500 m or less, with 2.9 m/s² or less vibration at 10 to 55 Hz (directions of X, Y, Z axes). Otherwise the inverter may be damaged. (Refer to [page 17](#) for details.)
- If halogen-based materials (fluorine, chlorine, bromine, iodine, etc.) infiltrate into a Mitsubishi product, the product will be damaged. Halogen-based materials are often included in fumigant, which is used to sterilize or disinfest wooden packages. When packaging, prevent residual fumigant components from being infiltrated into Mitsubishi products, or use an alternative sterilization or disinfection method (heat disinfection, etc.) for packaging. Sterilization or disinfection of wooden package should also be performed before packaging the product.

Wiring

- Do not install a power factor correction capacitor or surge suppressor/capacitor type filter on the inverter output side. These devices on the inverter output side may be overheated or burn out.
- The output side terminals (terminals U, V, and W) must be connected correctly. Otherwise the motor will rotate inversely.

Trial run

- Before starting operation, each parameter must be confirmed and adjusted. A failure to do so may cause some machines to make unexpected motions.

⚠ WARNING

Usage

- Since pressing the STOP/RESET key may not stop output depending on the function setting status, separate circuit and switch that make an emergency stop (power OFF, mechanical brake operation for emergency stop, etc.) must be provided.
- OFF status of the start signal must be confirmed before resetting the inverter fault. Resetting inverter fault with the start signal ON restarts the motor suddenly.
- Use this inverter only with three-phase induction motors. Connection of any other electrical equipment to the inverter output may damage the equipment.
- Performing pre-excitation (LX signal and X13 signal) under torque control (Real sensorless vector control) may start the motor running at a low speed even when the start command (STF or STR) is not input. The motor may run also at a low speed when the speed limit value = 0 with a start command input. It must be confirmed that the motor running will not cause any safety problem before performing pre-excitation.
- Do not modify the equipment.
- Do not perform parts removal which is not instructed in this manual. Doing so may lead to fault or damage of the product.

⚠ CAUTION

Usage

- The electronic thermal relay function does not guarantee protection of the motor from overheating. It is recommended to install both an external thermal and PTC thermistor for overheat protection.
- Do not use a magnetic contactor on the inverter input for frequent starting/stopping of the inverter. Otherwise the life of the inverter decreases.
- The effect of electromagnetic interference must be reduced by using a noise filter or by other means. Otherwise nearby electronic equipment may be affected.
- Appropriate measures must be taken to suppress harmonics. Otherwise power supply harmonics from the inverter may heat/damage the power factor correction capacitor and generator.
- When driving a 400 V class motor by the inverter, the motor must be an insulation-enhanced motor or measures must be taken to suppress surge voltage. Surge voltage attributable to the wiring constants may occur at the motor terminals, deteriorating the insulation of the motor.
- When parameter clear or all parameter clear is performed, the required parameters must be set again before starting operations because all parameters return to their initial values.
- The inverter can be easily set for high-speed operation. Before changing its setting, the performances of the motor and machine must be fully examined.
- Stop status cannot be hold by the inverter's brake function. In addition to the inverter's brake function, a holding device must be installed to ensure safety.
- Before running an inverter which had been stored for a long period, inspection and test operation must be performed.
- Static electricity in your body must be discharged before you touch the product.

Emergency stop

- A safety backup such as an emergency brake must be provided to prevent hazardous conditions to the machine and equipment in case of inverter failure.
- When the breaker on the inverter input side trips, the wiring must be checked for fault (short circuit), and internal parts of the inverter for a damage, etc. The cause of the trip must be identified and removed before turning ON the power of the breaker.
- When a protective function is activated, take an appropriate corrective action, then reset the inverter, and resume the operation.

Maintenance, inspection and parts replacement

- Do not carry out a megger (insulation resistance) test on the control circuit of the inverter. It will cause a failure.

Disposal

- The inverter must be treated as industrial waste.

General instruction

- Many of the diagrams and drawings in the Instruction Manual show the product without a cover or partially open for explanation. Never operate the product in this manner. The cover must be always reinstalled and the instruction in the Instruction Manual must be followed when operating the product.

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MEMO

1 INTRODUCTION

This chapter contains the descriptions that must be read before using this product.

Always read the instructions before using the equipment.

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<Abbreviations>

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 FR-A802-P series inverter (separated converter type for parallel operation)
Converter unit	Converter unit FR-CC2-P series (for parallel operation)
Vector control compatible option	FR-A8AP/FR-A8AL (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

<Notes on descriptions in this Instruction Manual>

- Connection diagrams in this Instruction Manual suppose that the control logic of the input terminal is the sink logic, unless otherwise specified. (For the control logic, refer to [page 42](#).)

Harmonic Suppression Guidelines

All the models of the inverters used by specific consumers are covered by "the Harmonic Suppression Guidelines for Consumers Who Receive High Voltage or Special High Voltage". For the details, refer to [page 70](#).

1.1 Product checking and accessories

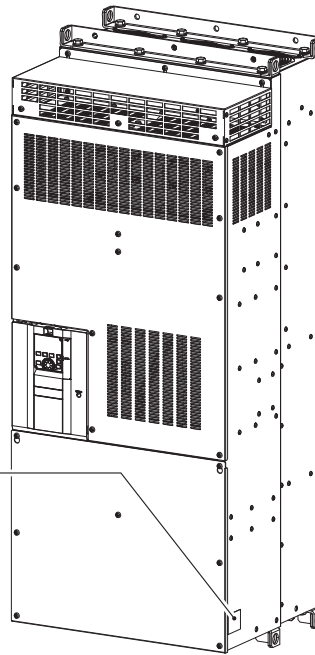
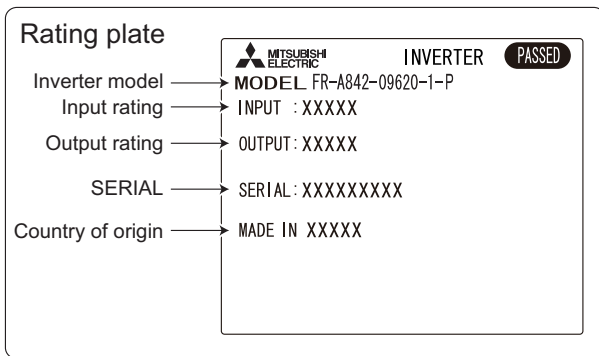
Unpack the product and check the rating plate and the capacity plate of the inverter to ensure that the model agrees with the order and the product is intact.

◆ Applicable inverter model

Symbol	Voltage class	Symbol	Structure, functionality	Symbol	Description	Symbol	Type*1
4	400 V class	2	Separated converter type	09620 to 12120	Inverter rated current (SLD rated current of the single standard FR-A802) (A)	1	FM
				400K to 500K	ND rated inverter capacity (kW)	2	CA

FR - A 8 4 2 - 09620 - 1 - [] P

Symbol	Circuit board coating (conforming to IEC60721-3-3 3C2/3S2)	Plated conductor	Symbol	Function
None	Without	Without	P	Parallel operation
60	With	Without		
06	With	With		



*1 Specification differs by the type as follows.

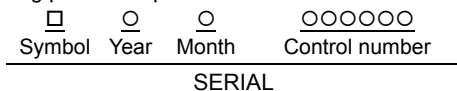
Type	Monitor output	Initial setting			
		Built-in EMC filter	Control logic	Rated frequency	Pr.19 Base frequency voltage
FM (terminal FM equipped model)	Terminal FM (pulse train output) Terminal AM (analog voltage output (0 to ±10 VDC))	OFF	Sink logic	60 Hz	9999 (same as the power supply voltage)
CA (terminal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

NOTE

- In this Instruction Manual, the inverter model name consists of the rated current and the applicable motor capacity. (Example) FR-A842-12120(500K)

◆ How to read the SERIAL number

Rating plate example



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).

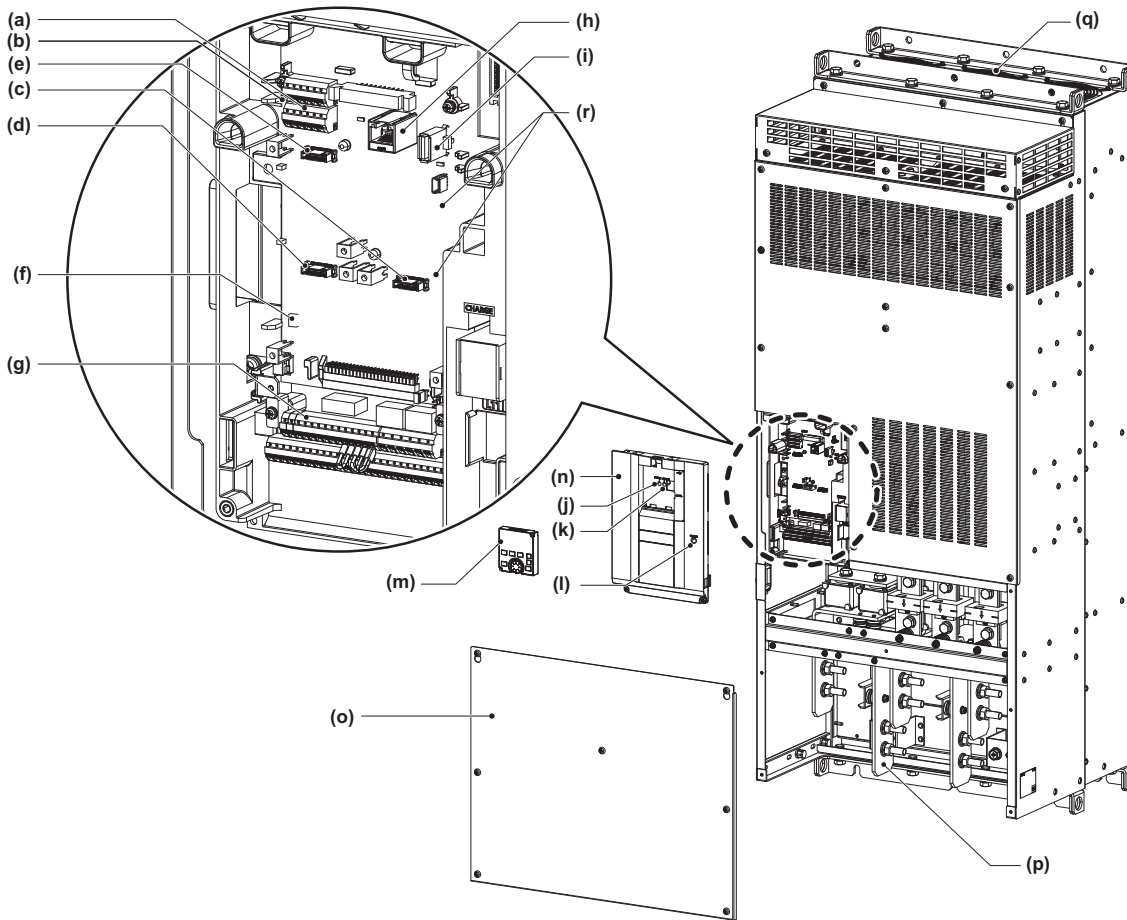
◆ Accessory

- CD-ROM (1): Including the Instruction Manual (Detailed) and other documents.
- Ferrite core (ZCAT3035-1330) × 2: Use two cores on RS-485 cables for communication between two inverters to reduce noise. (Refer to [page 50](#).)



1.2 Inverter component names

Component names are shown below.



Symbol	Name	Description	Refer to page
(a)	RS-485 terminals	Enables RS-485 communication between the master and the slave for the parallel operation.	50
(b)	Terminating resistor selection switch (SW1)	Select whether or not to use the terminating resistor for RS-485 communication.	50
(c)	Plug-in option connector 1	Connects a plug-in option or a communication option.*2	Instruction Manual of the option
(d)	Plug-in option connector 2		
(e)	Plug-in option connector 3		
(f)	Voltage/current input switch (SW2)	Selects between voltage and current for the terminal 2 and 4 inputs.	*1
(g)	Control circuit terminal block	Connects cables for the control circuit.	38
(h)	PU connector	Connects the operation panel or the parameter unit. This connector also enables the RS-485 communication.	52
(i)	USB A connector	Connects a USB memory device.	53
(j)	Power lamp	Stays ON while the power is supplied to the control circuit (R1/L11, S1/L21).	34
(k)	Alarm lamp	Turns ON when the protective function of the inverter is activated.	79
(l)	Charge lamp	Stays ON while the power is supplied to the main circuit.	34
(m)	Operation panel (FR-DU08)	Operates and monitors the inverter.	*1
(n)	Front cover (upper side)	Remove this cover for the installation of the product, installation of a plug-in (communication) option, RS-485 terminal wiring, switching of the voltage/current input switch, etc.	15
(o)	Front cover (lower side)	Remove this cover for wiring.	15
(p)	Main circuit terminal block	Connects cables for the main circuit.	33
(q)	Cooling fan	Cools the inverter.	92
(r)	Switches for manufacturer setting (SW3 and SW4)	Do not change the initial setting (OFF OFF ON).	—

*1 Refer to the FR-A800 Instruction Manual (Detailed).

*2 The Vector control compatible options cannot be used with the slave.

1.3 About the related manuals

The manuals related to this inverter are shown below.

Manual name	Manual number
Parallel Operation Function Manual	IB-0600654ENG
FR-A800 Instruction Manual (Detailed)	IB-0600503ENG
FR-CC2-P Instruction Manual	IB-0600657ENG

2 **INSTALLATION AND WIRING**

This chapter explains the "installation" and the "wiring" of this product.

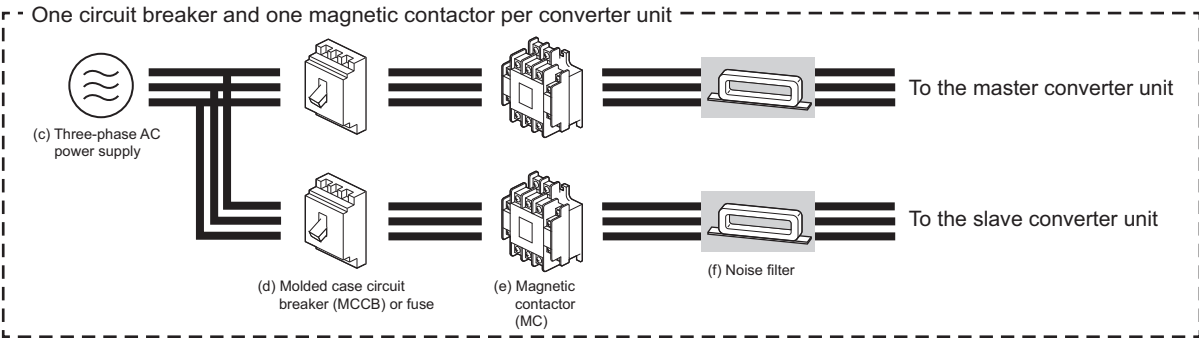
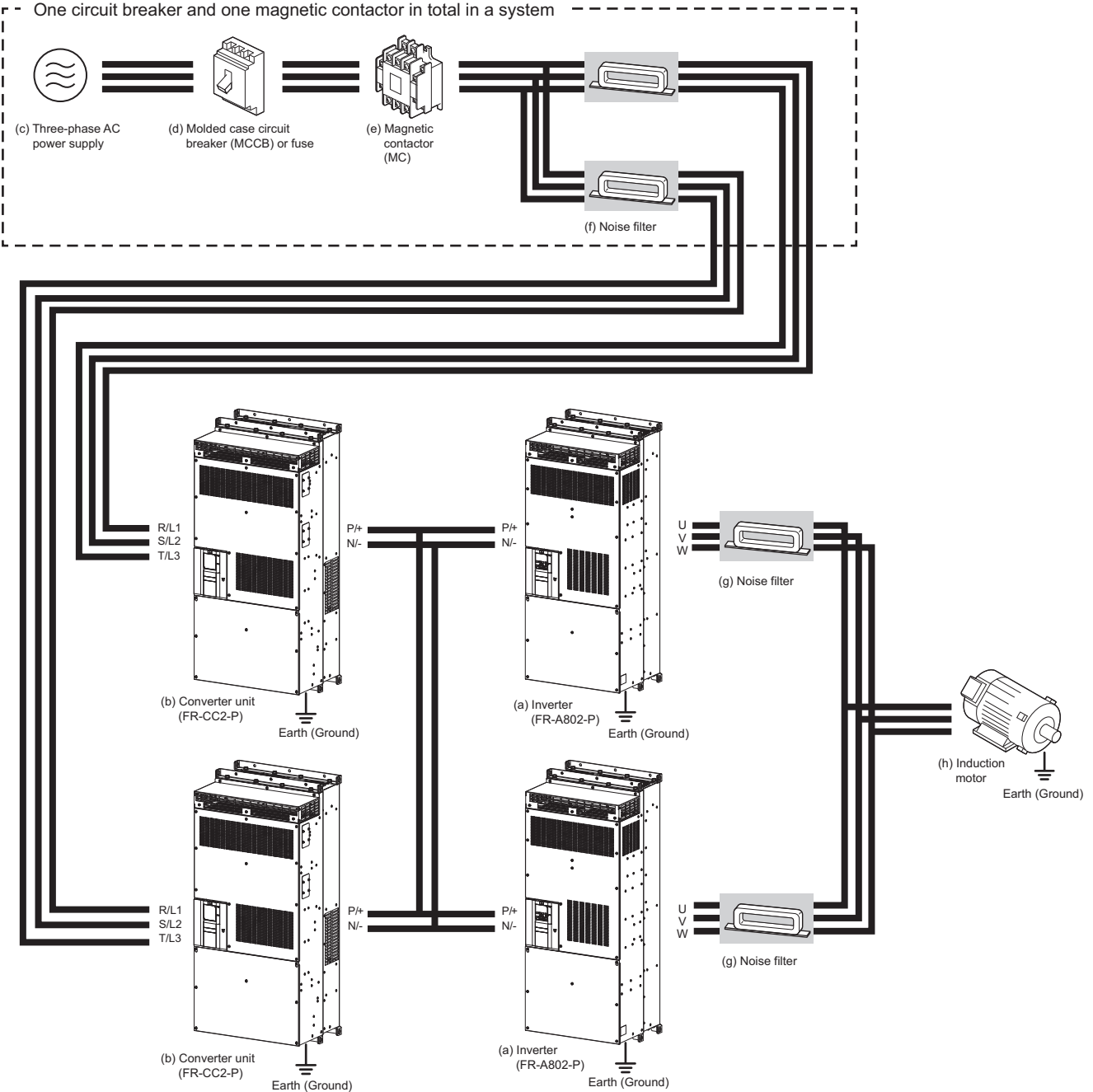
Always read the instructions before using the equipment.


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2.1 Peripheral devices

2.1.1 Inverter and peripheral devices

- For operating two inverters in parallel



 : Install these options as required.

Symbol	Name	Overview	Refer to page
(a)	Inverter (FR-A802-P)	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 converter unit built-in EMC filter can reduce the noise.	17 24 68
(b)	Converter unit (FR-CC2-P)		
(c)	Three-phase AC power supply	Must be within the permissible power supply specifications of the converter unit.	100
(d)	Molded case circuit breaker (MCCB), earth leakage circuit breaker (ELB), or fuse *1	Must be selected carefully since an inrush current flows in the converter unit at power ON.	13
(e)	Magnetic contactor (MC) *2	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.	72
(f)	Noise filter	Suppresses the noise radiated from the power supply side of the converter unit.	65
(g)	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 MHz to 5 MHz.	65
(h)	Induction motor	Connect a squirrel-cage induction motor.	—

*1 Do not use an earth leakage circuit breaker as a circuit breaker which is intended to be installed per converter unit. Doing so may cause unintended operation of the inverter.

*2 For every magnetic contactor installed for a converter unit in parallel connection, switching of power with the same timing is critical to supplying power simultaneously. Otherwise, the converter units may be damaged.

NOTE

- To prevent an electric shock, always earth (ground) the motor, the inverter, and the converter unit.
- Do not install a power factor correction capacitor or surge suppressor or capacitor type filter on the inverter's output side. Doing so will cause the inverter output shutoff or the capacitor and surge suppressor to be damaged. 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 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 this case, activating the EMC filter of the converter unit may minimize interference. (Refer to [page 68](#).)
- For details of options and peripheral devices, refer to the respective Instruction Manual.

2.1.2 Peripheral devices

◆ Selecting the converter unit

According to the connected motor capacity, configure the converter units and the inverters as follows.

The capacity of all converter units must be the same in a system, and that of all inverters also must be the same.

Motor capacity (kW)*1	Number of units	Converter unit FR-CC2-[]-P	Inverter					
			LD (light duty)			ND (normal duty, initial value)		
			Model FR-A842-[]-P	Rated current (A)	Model FR-A842-[]-P	Rated current (A)		
630	2	H400K	-	-	-	400K	09620	1232
710	2	H450K	400K	09620	1386	450K	10940	1386
800	2	H500K	450K	10940	1539	500K	12120	1539
900	2	H560K	500K	12120	1750	-	-	-
945	3	H400K	-	-	-	400K	09620	1848
1065	3	H450K	400K	09620	2078	450K	10940	2078
1200	3	H500K	450K	10940	2309	500K	12120	2309
1350	3	H560K	500K	12120	2626	-	-	-

*1 The motor capacity indicates the maximum capacity of a 4-pole motor driven by all of the inverters in parallel connection.

◆ Selecting the breaker/magnetic contactor

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

Refer to the table below to prepare appropriate peripheral devices.

- One circuit breaker and one magnetic contactor in total in a system

Motor capacity (kW)*1	Number of units	Converter unit FR-CC2-[]-P	Molded case circuit breaker (MCCB) *2 or earth leakage circuit breaker (ELB) (type NF or NV)	Input-side magnetic contactor*3
630	2	H400K	1500 A	1300 A rated product
710	2	H450K	1600 A	1400 A rated product
800	2	H500K	1800 A	1600 A rated product
900	2	H560K	2100 A*4	1800 A rated product
945	3	H400K	2200 A*4	1900 A rated product
1065	3	H450K	2400 A*4	2100 A rated product
1200	3	H500K	2700 A*4	2400 A rated product
1350	3	H560K	3100 A*4	2700 A rated product

*1 The motor output indicates the output power of a 4-pole motor at 400 VAC 50 Hz driven by all of the inverters in parallel connection.

*2 Select an MCCB according to the power supply capacity.

For the use in the United States or Canada, provide the appropriate UL and cUL listed fuse that is suitable for branch circuit protection. (Refer to page 109.)

*3 The magnetic contactor is selected based on the AC-1 class. The electrical durability of magnetic contactor is 500,000 times. When the magnetic contactor is used for emergency stops during motor driving, the electrical durability is 25 times.

If using an MC for emergency stop during driving the motor, select an MC regarding the converter unit input side current as JEM1038-AC-3 class rated current. When using an MC on the inverter output side for commercial-power supply operation switching using a general-purpose motor, select an MC regarding the rated motor current as JEM1038-AC-3 class rated current.

*4 An air circuit breaker is also applicable in a system in which a 2000 A breaker or higher is applicable.

- One circuit breaker and one magnetic contactor per converter unit

Motor output (kW)*5	Number of units	Applicable converter unit FR-CC2-[]-P	Molded case circuit breaker (MCCB)*6 (NF type)	Input-side magnetic contactor*7
630	2	H400K	900 A	S-N800
710	2	H450K	1000 A	1000 A rated product
800	2	H500K	1200 A	1000 A rated product
900	2	H560K	1500 A	1200 A rated product
945	3	H400K	900 A	S-N800
1065	3	H450K	1000 A	1000 A rated product
1200	3	H500K	1200 A	1000 A rated product
1350	3	H560K	1500 A	1200 A rated product

*5 The motor output indicates the output power of a 4-pole motor at 400 VAC 50 Hz driven by all of the inverters in parallel connection.

*6 Select an MCCB according to the power supply capacity.

For the use in the United States or Canada, provide the appropriate UL and cUL listed fuse that is suitable for branch circuit protection. (Refer to page 109.)

*7 The magnetic contactor is selected based on the AC-1 class. The electrical durability of magnetic contactor is 500,000 times. When the magnetic contactor is used for emergency stops during motor driving, the electrical durability is 25 times.

If using an MC for emergency stop during driving the motor, select an MC regarding the converter unit input side current as JEM1038-AC-3 class rated current. When using an MC on the inverter output side for commercial-power supply operation switching using a general-purpose motor, select an MC regarding the rated motor current as JEM1038-AC-3 class rated current.

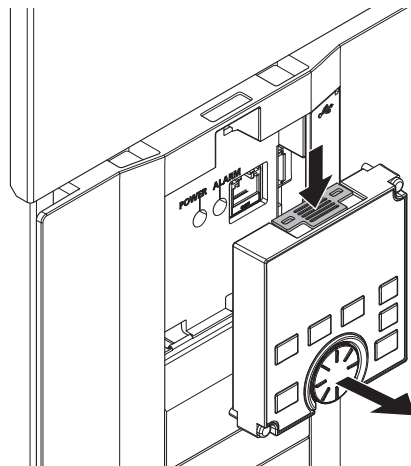
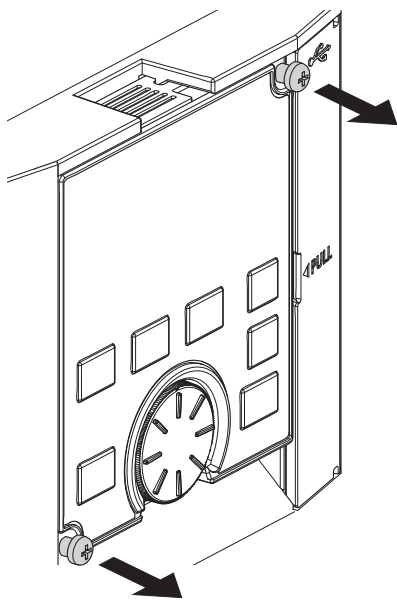
NOTE

- 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 and the converter unit, etc. The cause of the trip 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

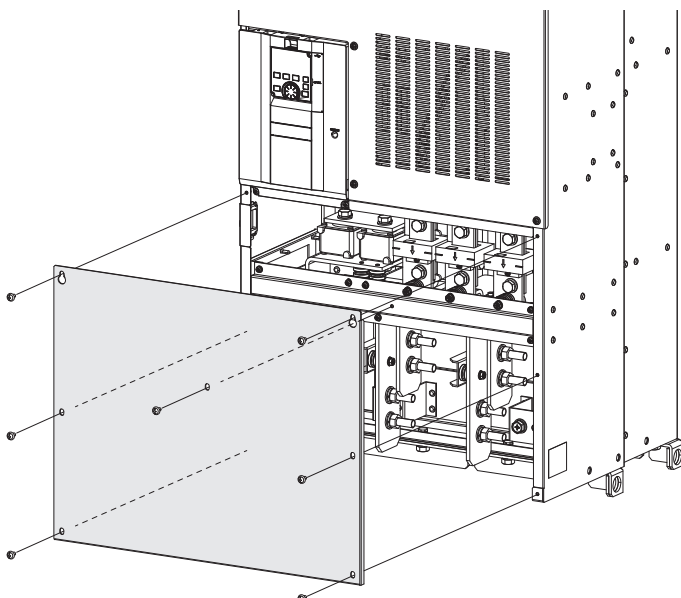
- Loosen the two screws on the operation panel.
(These screws cannot be removed.)
- Push the upper part of the operation panel and pull the operation panel to remove.



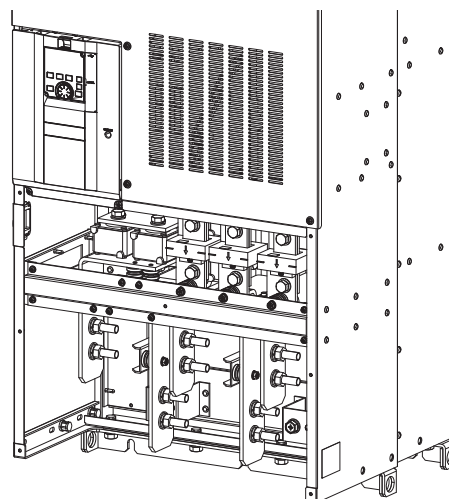
To reinstall the operation panel, align its connector on the back with the PU connector of the inverter, and insert the operation panel. After confirming that the operation panel is fit securely, tighten the screws. (Tightening torque: 0.40 to 0.45 N·m)

◆ Removal of the front cover (lower side)

(a)

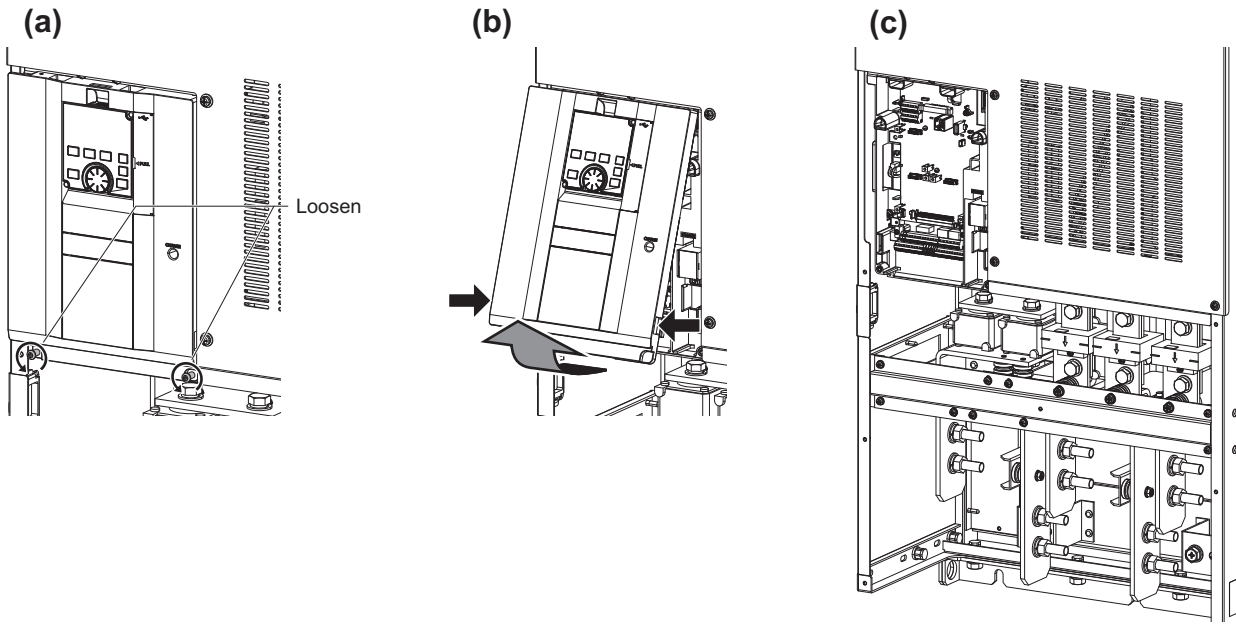


(b)



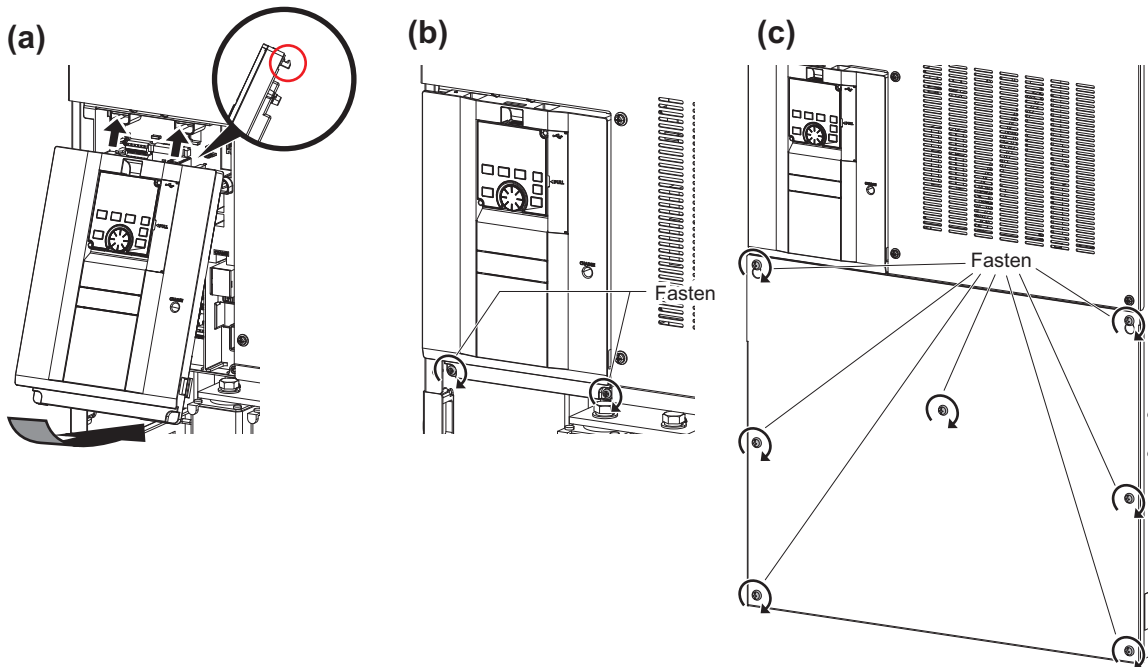
- (a) Remove the mounting screws to remove the front cover (lower side). (The number of the mounting screws differs by the capacity.)
- (b) With the front cover (lower side) removed, wiring of the main circuit terminals can be performed.

◆ Removal of the front cover (upper side)



- (a) With the front cover (lower side) removed, loosen the mounting screws on the front cover (upper side). These screws cannot be removed.
- (b) While holding the areas around the installation hooks on the sides of the front cover (upper side), pull out the front cover (upper side) using its upper side as a support.
- (c) With the front cover (upper side) removed, wiring of the control circuit and the RS-485 terminals, and installation of the plug-in option can be performed.

◆ Reinstallation of the front covers



- (a) Insert the upper hooks of the front cover (upper side) into the sockets of the inverter. Securely install the front cover (upper side) to the inverter by fixing the hooks on the sides of the cover into place.
- (b) Tighten the mounting screw at the lower part of the front cover (upper side).
- (c) Fasten the front cover (lower side) with the mounting screws. (The number of the mounting screws differs by the capacity.)

NOTE

- When installing the front cover (upper side), fit the connector of the operation panel securely along the guides of the PU connector.
- Fully make sure that the front covers are installed securely. Always tighten the mounting screws of the front covers.

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 to +50°C (non-freezing) <div style="text-align: right; margin-top: 10px;"> </div>
Surrounding air humidity	With circuit board coating (conforming to IEC60721-3-3 3C2/3S2) 95% RH or less (non-condensing) Without circuit board coating 90% RH or less (non-condensing)
Storage temperature	-20 to + 65°C*1
Atmosphere	Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
Altitude	Maximum 1,000 m *2
Vibration	2.9 m/s ² or less at 10 to 55 Hz (directions of X, Y, Z axes)

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

*2 For the installation at an altitude above 1000 m (up to 2500 m), consider a 3% reduction in the rated current per altitude increase of 500 m.

◆ Temperature

The permissible surrounding air temperature of the inverter is between -10°C and +50°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.

(a) Measures against high temperature

- Use a forced ventilation system or similar cooling system. (Refer to [page 20](#).)
- 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.

(b) 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.)

(c) 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 19](#).

◆ Humidity

Operate the inverter within the ambient air humidity of usually 45 to 90% (up to 95% with circuit board coating). 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 insulation distance defined in JEM1103 "Control Equipment Insulator" is humidity of 45 to 85%.

(a) 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.

(b) 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.

(c) 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 in (a).
- 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 20](#).)
- 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 above.

◆ 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 1000 m. For use at an altitude above 1,000 m (up to 2,500 m), derate the rated current 3% per 500 m.

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 up to 2.9 m/s^2 at 10 to 55 Hz frequency and 1 mm amplitude for the directions of X, Y, Z axes. 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

◆ Installing the heatsink inside the enclosure

The following tables show the amount of heat generated from the converter unit or the inverter of which the heatsink is installed inside the enclosure.

Converter FR-CC2-H□-P	Amount of heat generated (W)
400K	2745
450K	3060
500K	3420
560K	3960

Inverter FR-A842-□-P	Amount of heat generated (W)	
	LD	ND
400K	5832	5085
450K	6606	5850
500K	7767	6660

NOTE

- The amount of heat generated shown assumes that the output current is the inverter rated current.

◆ Protruding the heatsink through a panel

When the heatsink is protruded through a panel, the amount of heat generated by the inverter and converter unit is shown in the following tables. (For the details on protruding the heatsink through a panel, refer to [page 22](#).)

Converter FR-CC2-H□-P	Amount of heat generated (W)	
	Heatsink section (outside of enclosure)	Control section (inside of enclosure)
400K	1917	828
450K	2142	918
500K	2394	1026
560K	2772	1188

Inverter FR-A842-□-P	Amount of heat generated (W)			
	Heatsink section (outside of enclosure)		Control section (inside of enclosure)	
	LD	ND	LD	ND
400K	4077	3555	1755	1530
450K	4626	4095	1980	1755
500K	5436	4662	2331	1998

NOTE

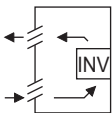
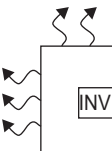
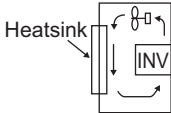
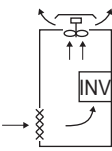
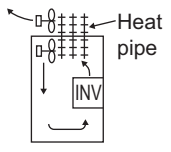
- The amount of heat generated shown assumes that the output current is the inverter rated current.

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.

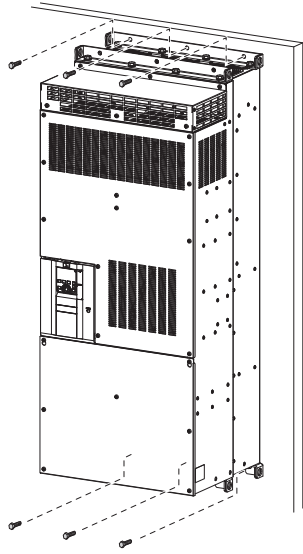
The cooling systems are classified as follows in terms of the cooling calculation method.

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

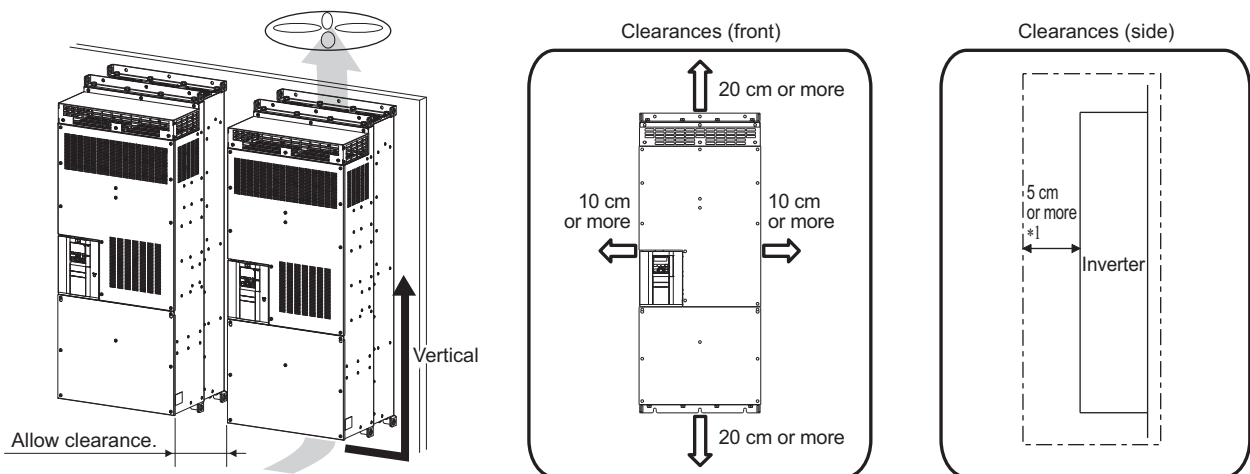
Cooling system		Enclosure structure	Comment
Natural cooling	Natural ventilation (enclosed ventilated type)		This system is low in cost and generally used, but the enclosure size increases as the inverter capacity increases. This system is for relatively small capacities.
	Natural ventilation (totally 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 cooling	Heatsink cooling		This system has restrictions on the heatsink 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 is a totally enclosed 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.



◆ 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

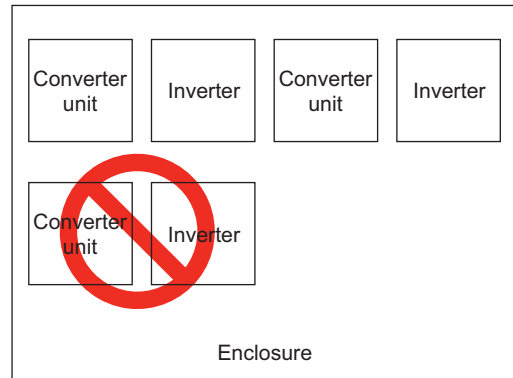
Heat is blown up from inside the inverter by the small fan built in the unit. Any equipment placed above the inverter should be heat resistant.

◆ Encasing multiple inverters and converter units

When multiple inverters and converter units are placed in the same enclosure, generally arrange them horizontally as shown in the figure on the right.

Do not place multiple products vertically. The exhaust air temperature of the inverter and the converter unit may be increased.

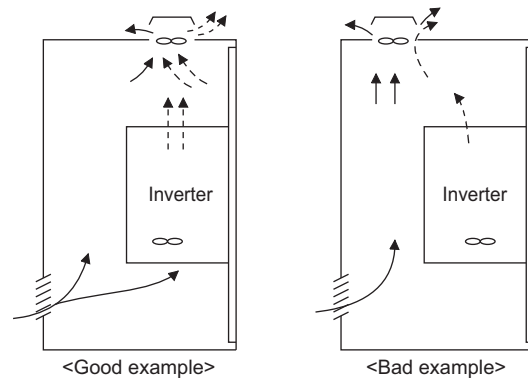
When mounting multiple inverters and converter units, fully take caution not to make the surrounding air temperature of the inverter and the converter unit higher than the permissible value by providing ventilation and increasing the enclosure size.



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

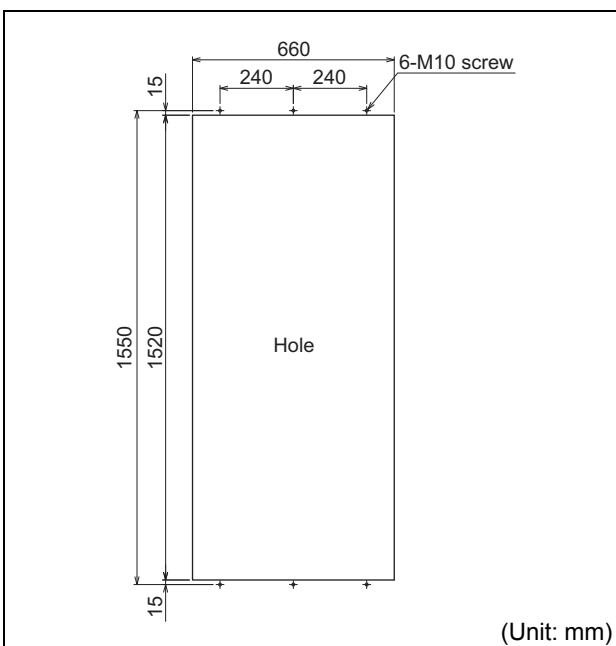
2.3.5 Protruding the heatsink

When encasing an inverter to an enclosure, the heat generated in the enclosure can be greatly reduced by protruding the heatsink of the inverter.

When installing the inverter in a compact enclosure, etc., this installation method is recommended.

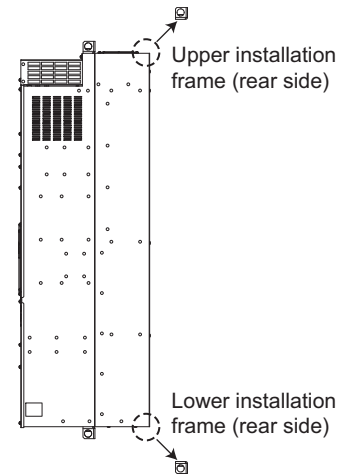
◆ Panel cutting

Cut the panel of the enclosure.



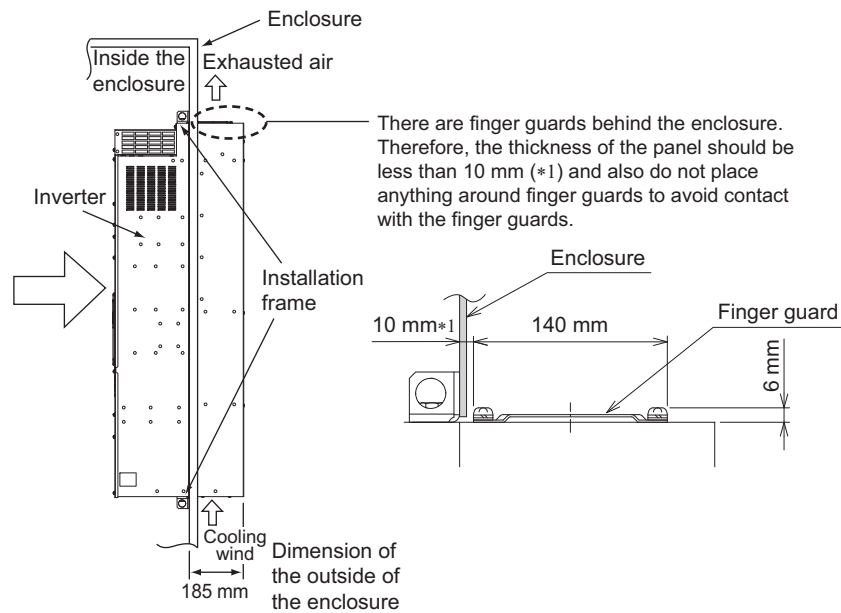
◆ Removal of the rear installation frame

Two installation frames are attached to each of the upper and lower parts of the inverter. Remove the rear side installation frame on the top and bottom of the inverter as shown on the right.



◆ Installation of the inverter

Push the inverter heatsink portion outside the enclosure and fix the enclosure and inverter with upper and lower installation frame.



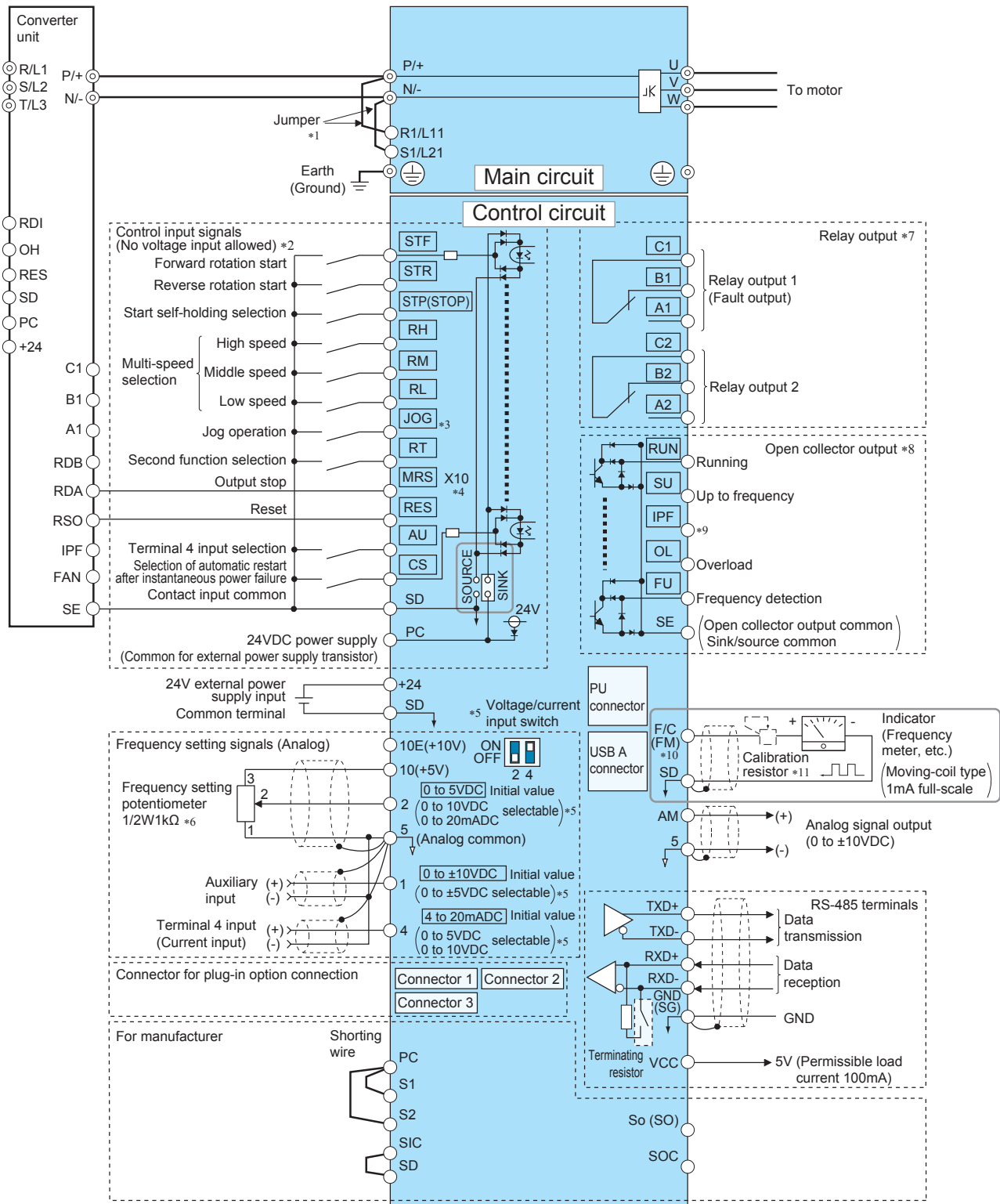
NOTE

- Having a cooling fan, the cooling section which comes out of the enclosure cannot be used in the environment of water drops, oil, mist, dust, etc.
- Be careful not to drop screws, dust etc. into the inverter and cooling fan section.

2.4 Terminal connection diagrams

◆FM type

- Sink logic
- ⊙ Main circuit terminal
- Control circuit terminal



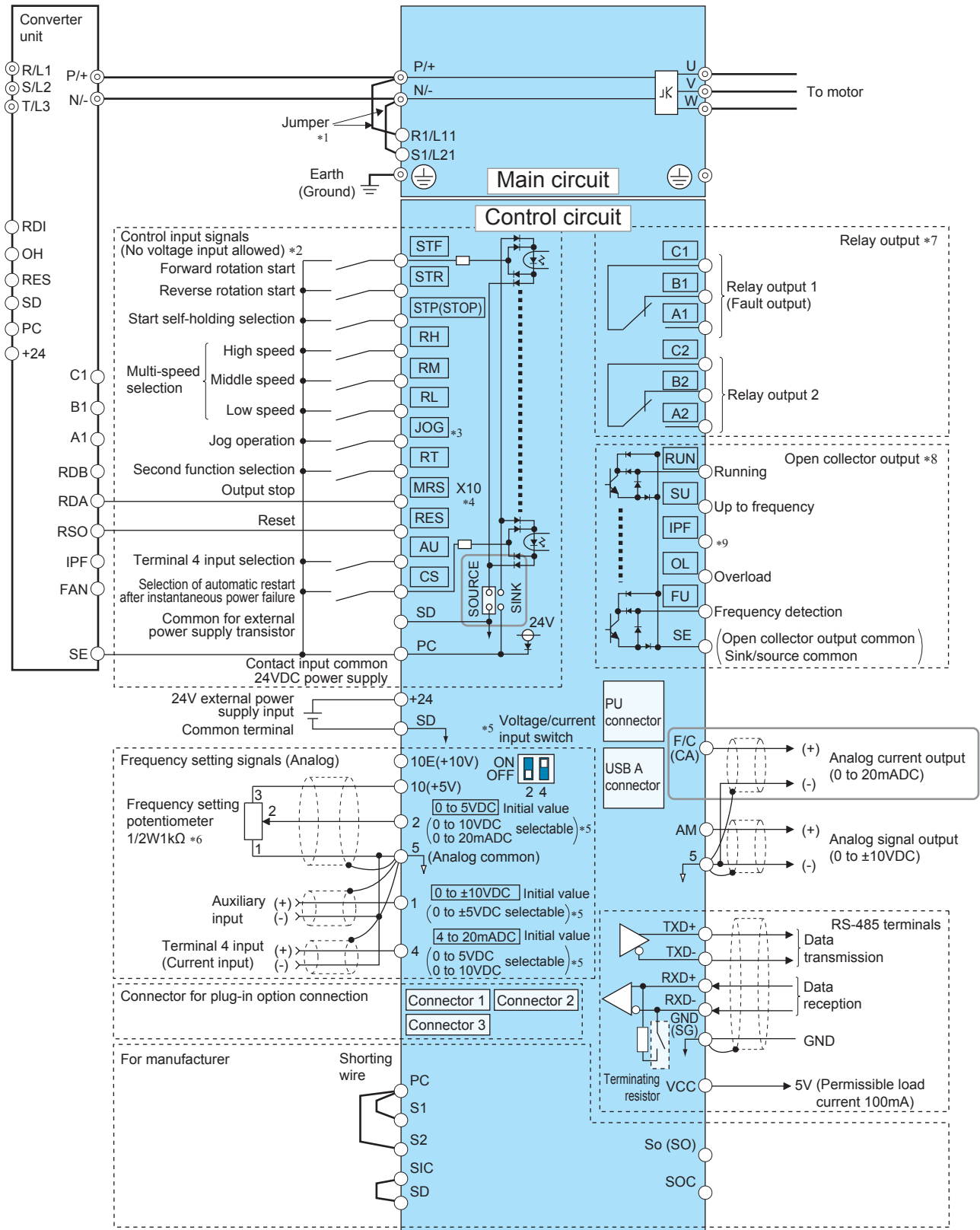
- *1 Terminals R1/L11 and S1/L21 are connected to terminals P/+ and N/- with a jumper respectively. When using separate power supply for the control circuit, remove the jumpers from R1/L11 and S1/L21.
- *2 The function of these terminals can be changed with the input terminal assignment (**Pr.178 to Pr.189**).
- *3 Terminal JOG is also used as the pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
- *4 The X10 signal (NC contact input specification) is assigned to 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 a voltage (0 to 5 V/0 to 10 V), set the voltage/current input switch OFF. To input a 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 k Ω when the frequency setting signal is changed frequently.
- *7 The function of these terminals can be changed with the output terminal assignment (**Pr.195, Pr.196**).
- *8 The function of these terminals can be changed with the output terminal assignment (**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.

NOTE

- For the system configuration examples for the parallel operation, refer to [page 28](#) and [30](#).
- To prevent a malfunction due to noise, keep the signal cables 10 cm or more away from the power cables. Also, separate the main circuit cables at the input side from the main circuit cables at the output side.
- After wiring, wire offcuts must not be left in the inverter.
Wire offcuts can cause an alarm, 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 voltage/current input switch correctly. Incorrect setting may cause a fault, failure or malfunction.

◆CA type

- Source logic
- ◎ Main circuit terminal
- Control circuit terminal



- *1 Terminals R1/L11 and S1/L21 are connected to terminals P/+ and N/- with a jumper respectively. When using separate power supply for the control circuit, remove the jumpers from R1/L11 and S1/L21.
- *2 The function of these terminals can be changed with the input terminal assignment (**Pr.178 to Pr.189**).
- *3 Terminal JOG is also used as the pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
- *4 The X10 signal (NC contact input specification) is assigned to 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 a voltage (0 to 5 V/0 to 10 V), set the voltage/current input switch OFF. To input a 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 k Ω when the frequency setting signal is changed frequently.
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- *8 The function of these terminals can be changed with the output terminal assignment (**Pr.190 to Pr.194**).
- *9 No function is assigned in the initial setting. Use **Pr.192** for function assignment.

NOTE

- For the system configuration examples for the parallel operation, refer to [page 28](#) and [30](#).
- To prevent a malfunction due to noise, keep the signal cables 10 cm or more away from the power cables. Also, separate the main circuit cables at the input side from the main circuit cables at the output side.
- After wiring, wire offcuts must not be left in the inverter.
Wire offcuts can cause an alarm, 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 voltage/current input switch correctly. Incorrect setting may cause a fault, failure or malfunction.

◆ System configuration (for operating two inverters in parallel)

- Install wiring of the RS-485 terminals in between the converter units and between the inverters as shown in the figure in [page 29](#). (For the details of wiring of the RS-485 terminals, refer to [page 50](#).)
- Install wiring in between the converter unit and the inverter used in a pair and between the pairs as shown in the diagram in [page 29](#). (For details of wiring between the converter units and the inverters, refer to [page 32](#).)
- Set the inverter **Pr.1001 Parallel operation selection** as shown in the table below. (For details of **Pr.1001**, refer to the Parallel Operation Function Manual.)

Inverter	Pr.1001 setting
Master station	200
Slave station	1 or 2

Parameter setting procedure

- 1** Install wiring of the RS-485 terminals in between the inverters.
 - 2** Set "1 or 2" in Pr.1001 of the slave inverter, and then reset the inverter.
 - 3** Set "200" in Pr.1001 of the master inverter, and then reset the inverter.
- After the wiring of the RS-485 terminals and the setting of **Pr.1001** on all inverters are completed, communication between the inverters starts automatically.

NOTE

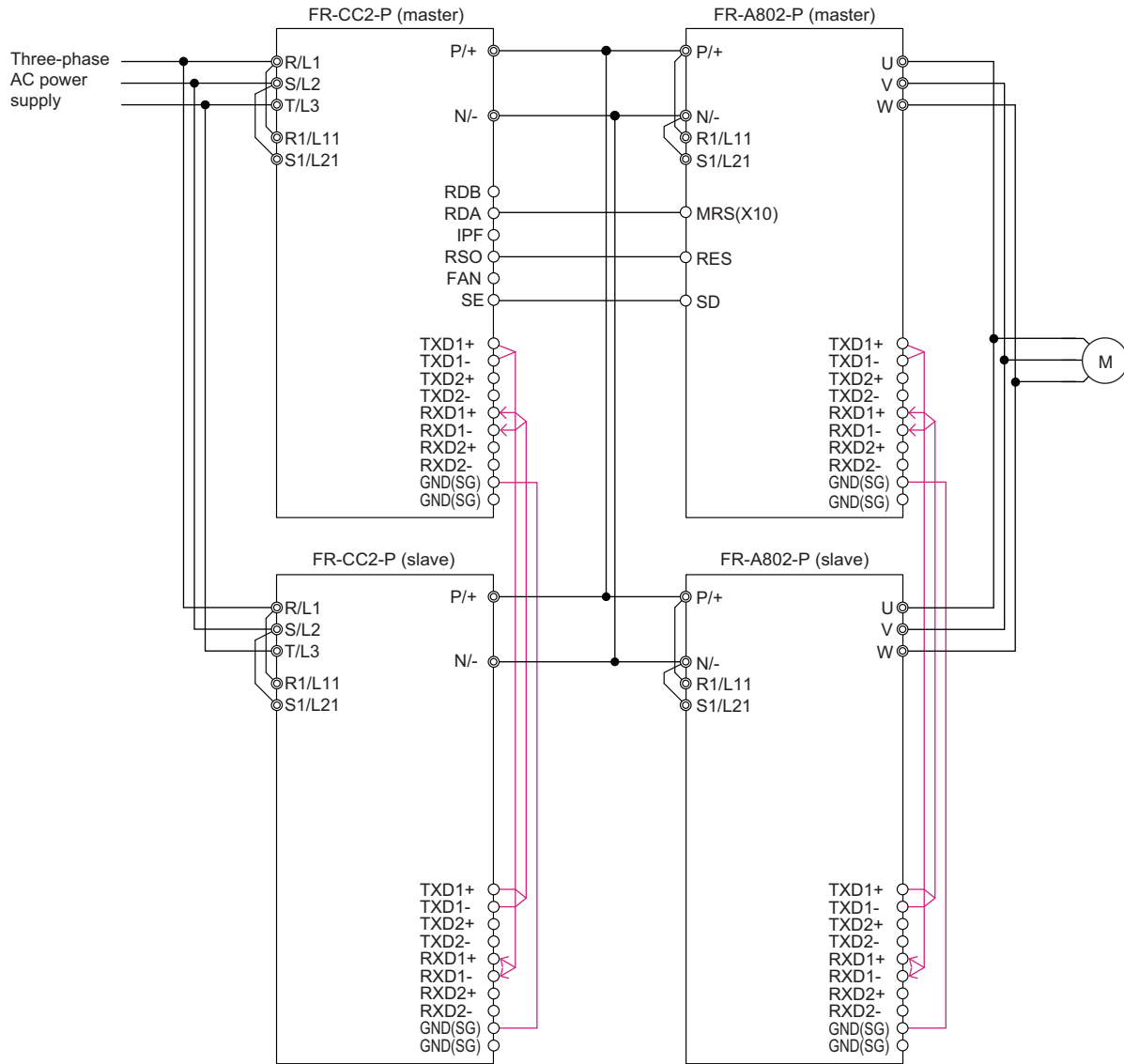
- Set up the slave inverter first before the master inverter by the **Pr.1001** setting and the inverter reset. Otherwise, an error may occur in communication between the inverters.
- For the inverters operated in parallel, the wires between the inverter and the motor must have the same length for the three phases. Otherwise, normal operation may not be possible.
- When the parameter setting procedure is completed, the Parallel operation ready (Y227) signal turns ON if the signal is preset to output. (For the details of the Y227 signal, refer to the Parallel Operation Function Manual.)



CAUTION

- Be sure to set Pr.1001 correctly. Operation with incorrect settings may damage the inverters.
- When connecting wiring between the inverter outputs (U, V, and W) and the motor, the phase sequence must be the same. Connect wiring between the master and slave inverter outputs with the correct phase sequence. Otherwise the inverter may be damaged.

- Terminal connection diagram for two inverters in parallel



◆ System configuration (for operating three inverters in parallel)

- Install wiring of the RS-485 terminals in between the converter units and between the inverters as shown in the figure in [page 31](#). (For the details of wiring of the RS-485 terminals, refer to [page 50](#).)
- Install wiring in between the converter unit and the inverter used in a pair and between the pairs as shown in the diagram in [page 31](#). (For details of wiring between the converter units and the inverters, refer to [page 32](#).)
- Set the inverter **Pr.1001** as shown in the table below. (For details of **Pr.1001**, refer to the Parallel Operation Function Manual.)

Inverter	Pr.1001 setting
Master station	300
Slave station 1	1
Slave station 2	2

Parameter setting procedure

- 1** Install wiring of the RS-485 terminals in between the inverters.
 - 2** Set "1" in Pr.1001 of the slave 1 inverter, and then reset the inverter.
 - 3** Set "2" in Pr.1001 of the slave 2 inverter, and then reset the inverter.
 - 4** Set "300" in Pr.1001 of the master inverter, and then reset the inverter.
- After the wiring of the RS-485 terminals and the setting of **Pr.1001** on all inverters are completed, communication between the inverters starts automatically.

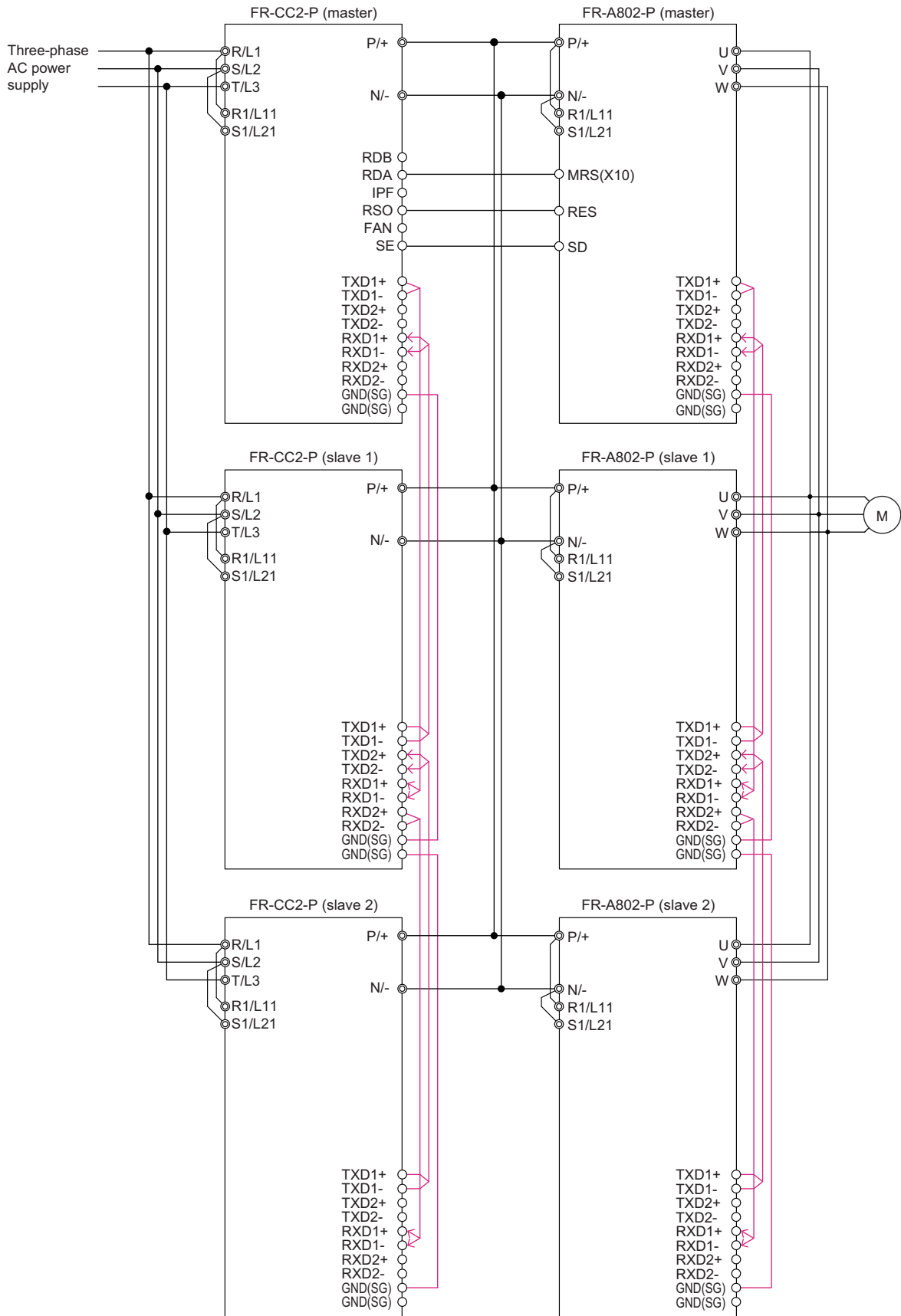
NOTE

- It is not important which order steps 2 and 3 are performed in.
- Set up the slave inverter first before the master inverter by the **Pr.1001** setting and the inverter reset. Otherwise, an error may occur in communication between the inverters.
- For the inverters operated in parallel, the wiring length for the three phases between each inverter and the motor must be the same. Otherwise, normal operation may not be possible.
- When the parameter setting procedure is completed, the Parallel operation ready (Y227) signal turns ON if the signal is preset to output. (For the details of the Y227 signal, refer to the Parallel Operation Function Manual.)

CAUTION

- Be sure to set Pr.1001 correctly. Operation with incorrect settings may damage the inverters.
- When connecting wiring between the inverter outputs (U, V, and W) and the motor, the phase sequence must be the same. Connect wiring between the master and slave inverter outputs with the correct phase sequence. Otherwise the inverter may be damaged.

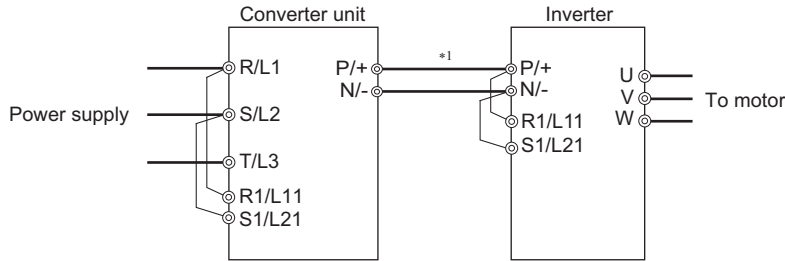
- Terminal connection diagram for three inverters in parallel



◆ Wiring between the converter units and the inverters

◆ Main circuit terminal

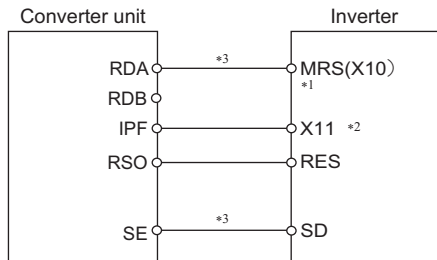
- Wire terminal P (+) on the converter unit to terminal P on the inverter, and do likewise for terminal N (-). Pair the masters or the slaves (1 with 1 or 2 with 2). Otherwise, the converter unit and the inverter may be damaged.
- Use cables of 50 m or shorter each to connect the converter unit and the inverter (for terminal P or N).
- For information about the gauge of cable for terminal P or N, refer to [page 35](#).



*1 Do not install an MCCB for terminal P or N. Ensure correct connection in polarity of terminals P and N; which may damage the inverter.

◆ Control circuit terminal


- Wiring both of control circuits in the master converter unit and the master inverter is required. Wire correctly to ensure the command transmission from the converter unit to the inverter. Otherwise, the converter unit and the inverter may be damaged.
- Use cables of 30 m or shorter each to wire the control circuits.




- *1 For the terminal used for the X10 signal input, set "10" in any of **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 be normally closed (NC). To change the contact state to normally open (NO), set **Pr.599** = "0".)
- *2 For the terminal used for the X11 signal input, set "11" in any of **Pr.178 to Pr.189 (Input terminal function selection)** to assign the function. **\$\$\$**The X11 signal is usable to store the inverter state at an instantaneous power failure occurred in communication operation in which the start command is transmitted only once (such as RS-485 communication) if the state storage is set to be enabled in advance.
- *3 It is mandatory to wire terminal RDA on the converter unit to terminal MRS (X10) on the inverter and to wire terminal SE on the converter unit to terminal SD (sink logic) on the inverter. Otherwise, the converter unit may be damaged.

2.5 Main circuit terminals

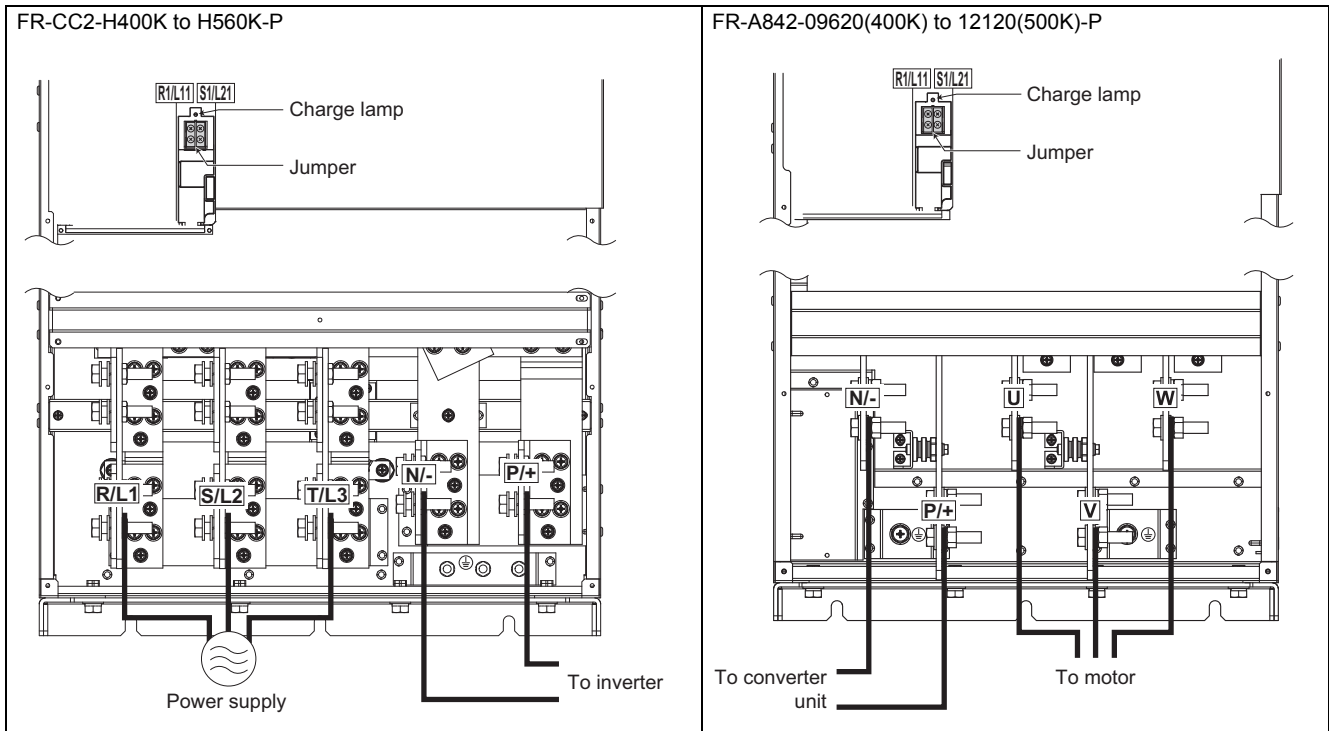
2.5.1 Details on the main circuit terminals of the inverter

Terminal symbol	Terminal name	Terminal function description	Refer to page
U, V, W	Inverter output	Connect these terminals to 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, remove the jumpers across terminals R1/L11 and S1/L21, and apply external power through these terminals. The power capacity necessary when separate power is supplied from R1/L11 and S1/L21 is 80 VA.	47
P/+, N/-	Converter unit connection	Install wiring in between the converter unit and between the inverter as shown in the terminal connection diagram. (Wire one terminal P to another terminal P, and do likewise for terminal N.)	29, 31
	Earth (ground)	For earthing (grounding) the inverter chassis. This must be earthed (grounded).	37

2.5.2 Details on the main circuit terminals of the converter unit

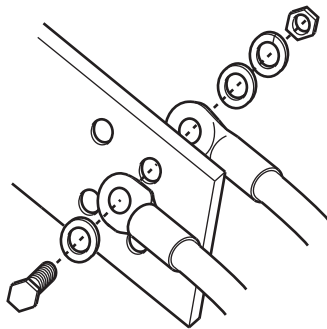
Terminal symbol	Terminal name	Terminal function description	Refer to page
R/L1, S/L2, T/L3	AC power input	Connect these terminals to the commercial power supply.	-
R1/L11, S1/L21	Power supply for the control circuit	Connected to the AC power supply terminals R/L1 and S/L2. To retain the fault display and fault output, remove the jumpers across terminals R/L1 and R1/L11 and across S/L2 and S1/L21, and supply external power to these terminals. The power capacity necessary when separate power is supplied from R1/L11 and S1/L21 is 80 VA.	47
P/+, N/-	Inverter connection	Install wiring in between the converter unit and between the inverter as shown in the terminal connection diagram. (Wire one terminal P to another terminal P, and do likewise for terminal N.)	29, 31
	Earth (ground)	For earthing (grounding) the converter unit chassis. This must be earthed (grounded).	37

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

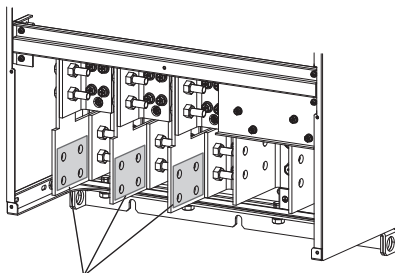


NOTE

- Make sure the power cables are connected to the R/L1, S/L2, and T/L3 of the converter unit. (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 the U, V, and W of the inverter. (The phases must be matched.)
- When wiring the main circuit conductor, tighten a nut from the right side of the conductor. When wiring two wires, place wires on both sides of the conductor. (Refer to the diagram below.) For wiring, use bolts (nuts) provided with the inverter.



- When wiring the main circuit conductor (R/L1, S/L2, T/L3) of the converter unit, use the bolts (nuts) for main circuit wiring, which are provided on the front side of the conductor.



Connect the cables here.

2.5.4 Applicable cables and wiring length

Select a recommended cable size to ensure that the voltage drop will be 2% or less.

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.

The following tables for cable selection are one example in the case of a cable of 20 m long used at 440 V power supply.

- Single converter unit

Converter model FR-CC2-[]-P	Terminal screw Size*4	Tightening Torque N·m	Crimp terminal	Cable gauge					
				HIV cables, etc. (mm ²)*1			AWG/MCM*2	PVC cables, etc. (mm ²)*3	
				R/L1, S/L2, T/L3	R/L1, S/L2, T/L3	P/+, N/-	Earthing (grounding) cable	R/L1, S/L2, T/L3	R/L1, S/L2, T/L3
H400K	M12 (M10)	46	C2-200	2×200	2×200	100	2×400	2×185	2×95
H450K	M12 (M10)	46	C2-250	2×250	2×250	100	2×500	2×240	2×120
H500K	M12 (M10)	46	C2-200	3×200	3×200	2×100	2×500	2×240	2×120
H560K	M12 (M10)	46	C2-200	3×200	3×200	2×100	3×350	3×185	2×150

- Single inverter (ND rating)

Inverter model FR-A842-[]-P	Terminal screw size*4	Tightening Torque N·m	Crimp terminal	Cable gauge					
				HIV cables, etc. (mm ²)*1			AWG/MCM*2	PVC cables, etc. (mm ²)*3	
				U, V, W	U, V, W	P/+, N/-	Earthing (grounding) cable	U, V, W	U, V, W
09620(400K)	M12 (M10)	46	C2-200	2×200	2×200	100	2×400	2×185	2×95
10940(450K)	M12 (M10)	46	C2-250	2×250	2×250	100	2×500	2×240	2×120
12120(500K)	M12 (M10)	46	C2-250	2×250	3×200	2×100	2×500	2×240	2×120

- Single inverter (LD rating)

Inverter model FR-A842-[]-P	Terminal screw size*4	Tightening Torque N·m	Crimp terminal	Cable gauge					
				HIV cables, etc. (mm ²)*1			AWG/MCM*2	PVC cables, etc. (mm ²)*3	
				U, V, W	U, V, W	P/+, N/-	Earthing (grounding) cable	U, V, W	U, V, W
09620(400K)	M12 (M10)	46	C2-250	2×250	2×250	100	2×500	2×240	2×120
10940(450K)	M12 (M10)	46	C2-250	2×250	3×200	2×100	2×500	2×240	2×120
12120(500K)	M12 (M10)	46	C2-200	3×200	3×200	2×100	3×350	3×185	2×150

*1 The gauge of the cable with the continuous maximum permissible temperature of 90°C or higher. (LMFC (heat resistant flexible cross-linked polyethylene insulated cable), etc.). It assumes a surrounding air temperature of 40°C or lower and in-enclosure wiring.

*2 The recommended cable size is that of the cable (THHN 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 for use mainly in the United States.)

*3 The 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 for use mainly in Europe.)

*4 The terminal screw size indicates the size of a terminal screw for R/L1, S/L2, T/L3, U, V, W, P/+, N/-, and a screw for earthing (grounding). 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 when the wiring distance is long or when it is desired to decrease the voltage drop (torque reduction) in the low speed range.

NOTE

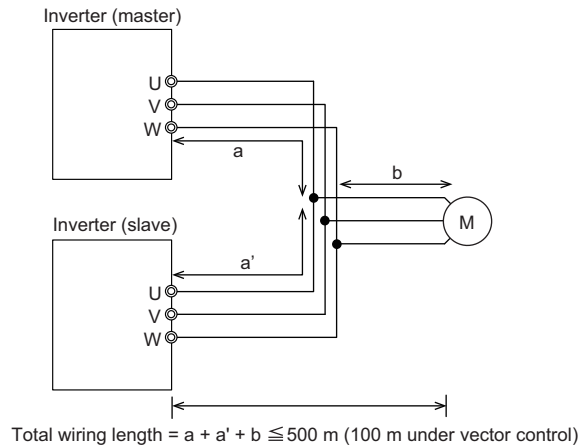
- Tighten the terminal screw to the specified torque.
A screw that has been tightened too loosely can cause a short circuit or malfunction.
A screw that has been tightened too tightly can cause a short circuit or malfunction due to the unit breakage.
- Use crimp terminals with insulation sleeves to wire the power supply and motor.

◆ Total wiring length

The total wiring length between the inverters in parallel connection and a motor must be 500 m or less. It is determined by calculating the sum of length of "a" (a cable from the master inverter to the node point), "a'" (a cable from each slave inverter to the node point), and "b" (a cable from the node point to the motor) in the figure. (It must be 100 m or less under Vector control.)

Furthermore, the cable length must be 10 to 30 m between each inverter and the node point (a/a').

Example for connecting two inverters in parallel



When driving a 400 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 400 V class inverter-driven insulation-enhanced motor.

NOTE

- Especially for long-distance wiring, the inverter may be affected by a charging current caused by the stray capacitances of the wiring, leading to a malfunction of the overcurrent protective function or a malfunction or fault of the equipment connected on the inverter output side.
- Refer to [page 73](#) to drive a 400 V class motor by an inverter.
- Contact your sales representative if a cable shorter than 10 m is intended to be used between the inverter and the node point.

2.5.5 Earthing (grounding) precautions

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

◆ Purpose of earthing (grounding)

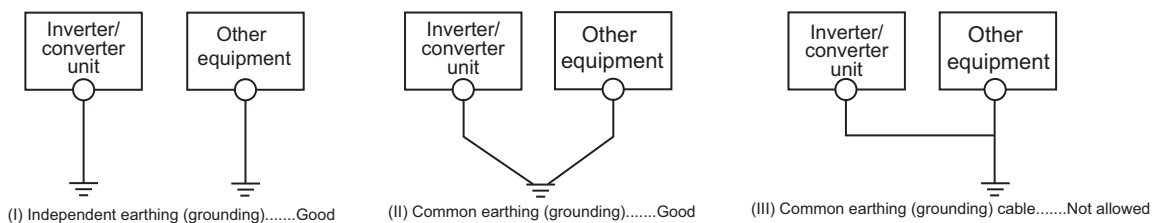
Generally, an electrical apparatus has an earth (ground) terminal, which must be connected to the ground before use. An electrical circuit is usually insulated by an insulating material and encased. However, it is impossible to manufacture an insulating material that can shut off a leakage current completely, 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, this earthing (grounding) is important to audio equipment, sensors, computers and other apparatuses that handle low-level signals or operate very fast.

◆ Earthing (grounding) methods and earthing (grounding) work

As described previously, earthing (grounding) is roughly classified into an electrical shock prevention type and a noise-influenced malfunction prevention type. Therefore, these two types should be clearly distinguished, and the following work must be done to prevent the leakage current having the inverter's high frequency components from entering the malfunction prevention type earthing (grounding):

- Whenever possible, use the independent earthing (grounding) for the inverter.
 - If independent earthing (grounding) (I) is not available, use (II) common earthing (grounding) in the figure below where the inverter is connected with the other equipment at an earthing (grounding) point. Do not use the other equipment's earthing (grounding) cable to earth (ground) the inverter as shown in (III).
- A leakage current containing many high frequency components flows into the earthing (grounding) cables of the inverter and peripheral devices. Because of this, the inverter must be earthed (grounded) separately from EMI-sensitive devices. In a high building, it may be effective to use the EMI prevention type earthing (grounding) connecting to an iron structure frame, and electric shock prevention type earthing (grounding) with the independent earthing (grounding) together.
 - Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes. (NEC section 250, IEC 536 class 1 and other applicable standards).
 - A neutral-point earthed (grounded) power supply in compliance with EN standard must be used.
 - use the thickest possible earthing (grounding) cable. The earthing (grounding) cable should be the size indicated in the table on [page 35](#).
 - 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 equipment sensitive to noises and run them in parallel in the minimum distance.




NOTE

- To be compliant with the EU Directive (Low Voltage Directive), refer to [page 106](#).

2.6 Control circuit

2.6.1 Details on the control circuit terminals of the inverter

The input signal function of the terminals in  can be selected by setting **Pr.178 to Pr.196 (I/O terminal function selection)**.

For the parameter details, refer to the FR-A800 Instruction Manual (Detailed).

◆ Input signal

Type	Terminal symbol	Terminal name	Terminal function description		Rated specification
Contact input	STF*4	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 When contacts are short-circuited: 4 to 6 mADC
	STR*4	Reverse rotation start	Turn ON the STR signal to start reverse rotation and turn it OFF to stop.		
	STOP*4	Start self-holding selection	Turn ON the STOP signal to self-hold the start signal.		
	RH*4 RM*4 RL*4	Multi-speed selection	Multi-speed can be selected according to the combination of RH, RM and RL signals.		
	JOG*4	Jog mode selection	Turn ON the JOG signal to enable JOG operation (initial setting) and turn ON the start signal (STF or STR) to start JOG operation.		
		Pulse train input	Terminal JOG is also used as the pulse train input terminal. To use as a pulse train input terminal, change the Pr.291 setting. (maximum input pulse: 100k pulses/s)		
	RT*4	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 When contacts are short-circuited: 4 to 6 mADC
	MRS (X10)*4	Output stop (Inverter operation enable)	Connect to terminal RDA of the converter unit. When the RDA signal is turned OFF, the inverter output is shut off. The X10 signal (NC contact) is assigned to terminal MRS in the initial setting. Use Pr.599 to change the specification to NO contact.		
	RES	Reset	Use this signal to reset a fault output provided when a protective function is activated. Turn ON the RES signal for 0.1s or longer, then turn it OFF. In the initial setting, reset is always enabled. By setting Pr.75 , reset can be enabled only at an inverter fault occurrence. The inverter recovers about 1 s after the reset is released.		
	AU	Terminal 4 input selection	The terminal 4 function is available only when the AU signal is ON. Turning ON the AU signal disables the terminal 2 function.		
	CS	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)*2	Common terminal for contact input terminal (sink logic) and terminal FM		
		External transistor common (source)*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 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)*2	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.		Power supply voltage range 19.2 to 28.8 VDC Permissible load current 100 mA	
	Contact input common (source)*3	Common terminal for contact input terminal (source logic).			
	24 VDC power supply common	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 in Pr.73 when connecting it to terminal 10E.	10 VDC ± 0.4 V Permissible load current 10 mA
	10			5 VDC ± 0.5 V 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).*1	When voltage is input: Input resistance 10 k Ω ± 1 k Ω Maximum permissible voltage 20 VDC
	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).*1 Use Pr.858 to switch terminal functions.	When current is input: Input resistance 245 Ω ± 5 Ω Permissible maximum current 30 mA
	1	Frequency setting auxiliary	Inputting 0 to ± 5 VDC or 0 to ± 10 VDC adds this signal to terminal 2 or 4 frequency setting signal. 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 k Ω ± 1 k Ω Permissible maximum voltage ± 20 VDC
	5	Frequency setting common	Common terminal for frequency setting signal (terminal 2, 1 or 4) and analog output terminal AM. Do not earth (ground).	—
Thermistor	10 2	PTC thermistor input	For receiving PTC thermistor outputs. When PTC thermistor is valid (Pr.561 \neq "9999"), terminal 2 is not available for frequency setting.	Applicable PTC thermistor specification Overheat detection resistance: 0.5 to 30 k Ω (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 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 voltage/current input switch ON (current input is selected) or a current with the switch OFF (voltage input is selected) could cause component damage of the inverter or analog circuits of output devices. (For the details, refer to the FR-A800 Instruction Manual (Detailed).)

*2 The sink logic is initially set for the FM-type inverter.

*3 The source logic is initially set for the CA-type inverter.

*4 For the slave inverter, the function is not available in the initial status.

2

◆ Output signal

Type	Terminal symbol	Terminal name	Terminal function description	Rated Specification
Relay	A1, B1, C1	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 Band 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	Relay output 2	1 changeover contact output	

Control circuit

Type	Terminal symbol	Terminal name	Terminal function description	Rated Specification
Open collector	RUN	Inverter running	Switched to LOW when the inverter output frequency is equal to or higher than the starting frequency (initial value 0.5 Hz). Switched to HIGH during stop or DC injection brake operation.	Permissible load 24 VDC (maximum 27 VDC) 0.1 A (The voltage drop is 2.8 V at maximum while the signal is ON.) LOW is when the open collector output transistor is ON (conducted). HIGH is when the transistor is OFF (not conducted).
	SU*3	Up to frequency	Switched to LOW when the output frequency is within the set frequency range $\pm 10\%$ (initial value). Switched to HIGH during acceleration/ deceleration and at a stop.	
	OL*3	Overload alarm	Switched to LOW when stall prevention is activated by the stall prevention function. Switched to HIGH when stall prevention is canceled.	
	IPF	Open collector output	No function is assigned in the initial setting. The function can be assigned setting Pr.192 .	
	FU*3	Frequency detection	Switched to LOW when the inverter output frequency is equal to or higher than the preset detection frequency, and to HIGH 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*1	For meter	Outputs a selected monitored item (such as output frequency) among several monitored items. The signal is not output during an inverter reset.	Output item: Output frequency (initial setting)
		NPN open collector output		This terminal can be used for open collector outputs by setting Pr.291 .
Analog	AM	Analog voltage output	The output signal is proportional to the magnitude of the corresponding monitoring 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)
	CA*2	Analog current output		Output signal 0 to 10 VDC, Permissible load current 1 mA (load impedance 10 k Ω or more) resolution 8 bits Load impedance 200 Ω to 450 Ω Output signal 0 to 20 mADC

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

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

*3 For the slave inverter, the function is not available in the initial status.


◆ Communication

Type	Terminal symbol	Terminal name	Terminal function description	
RS-485	—	PU connector	With the PU connector, communication can be made through RS-485. (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	
	RS-485 terminals	TXD+	Inverter transmission terminal	Two inverters in parallel connection have the RS-485 communication via the RS-485 terminals on each inverter. Total wiring length (sum of length of cables used between all inverters) per terminal: 5 m or less
		TXD-		
		RXD+	Inverter reception terminal	
		RXD-		
GND (SG)	Earthing (grounding)			
USB	—	USB A connector	A connector (receptacle) A USB memory device enables parameter copies and the trace function. Interface: Conforms to USB1.1 (USB2.0 fullspeed compatible) Transmission speed: 12 Mbps	

◆ Terminals for manufacturer setting

Terminal symbol	Terminal function description
S1	Terminals S1, S2, SIC, So (SO), and SOC are for manufacturer setting. Do not connect anything to these. Doing so may cause an inverter failure. Do not remove the shorting wires across terminals S1 and PC, terminals S2 and PC, and terminals SIC and SD. Removing either shorting wire disables the inverter operation.
S2	
SIC	
So (SO)	
SOC	

2.6.2 Details on the control circuit terminals of the converter unit

The input signal function of the terminals in  can be selected by setting **Pr.178, Pr.187, Pr.189 to Pr.195 (I/O terminal function selection)**.

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

◆ Input signal

Type	Terminal symbol	Terminal name	Terminal function description	Rated Specification
Contact input	RES	Reset	Use this signal to reset a fault output provided when a protective function is activated. Turn ON the RES signal for 0.1 s or longer, then turn it OFF. In the initial setting, reset is always enabled. By setting Pr.75 , reset can be set enabled only at fault occurrence of the converter unit. The inverter recovers about 1s after the reset is released.	Input resistance 4.7 kΩ Voltage when contacts are open: 21 to 27 VDC When contacts are short-circuited: 4 to 6 mADC
	OH	External thermal relay input	The external thermal relay input (OH) signal is used when using an external thermal relay or a 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	Contact input	No function is assigned in the initial setting. The function can be assigned by setting Pr.178 .	
	SD	Contact input common (sink)	Common terminal for 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 source 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 common	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

◆ Output signal

Type	Terminal symbol	Terminal name	Terminal function description	Rate Specification
Relay	A1, B1, C1	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 Band 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	Inverter operation enable (NO contact)	Switched to LOW when the converter unit operation is ready. Assign the signal to terminal MRS (X10) of the inverter. The inverter can be started when the RDA status is LOW.	Permissible load 24 VDC (maximum 27 VDC) 0.1 A (The voltage drop is 2.8 V at maximum while the signal is ON.) LOW is when the open collector output transistor is ON (conducted). HIGH is when the transistor is OFF (not conducted).
	RDB	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	Inverter reset	Switched to LOW when the converter is reset (RES-ON). Assign the signal to terminal RES of the inverter. The inverter is reset when it is connected with the RSO status LOW.	
	IPF	Instantaneous power failure	Switched to LOW when an instantaneous power failure is detected.	
	FAN	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 terminal SD (sink logic) or PC (source logic) of the inverter.	—

⚠ 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 terminal RDA of the master converter unit and terminal MRS (X10) of the master inverter, and terminal SE of the master converter unit and terminal SD (PC for source logic) of the master inverter. Not doing so may lead to damage of the converter unit.

2.6.3 Control logic (sink/source) change

Change the control logic of input signals as necessary.

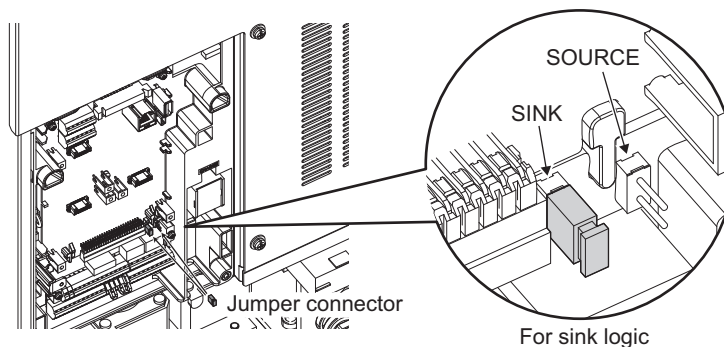
To change the control logic, change the jumper connector position on the control circuit board.

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 FM type inverter.

The control logic of input signals is initially set to the source logic (SOURCE) for the CA type inverter.

(The output signals may be used in either the sink or source logic independently of the jumper connector position.)



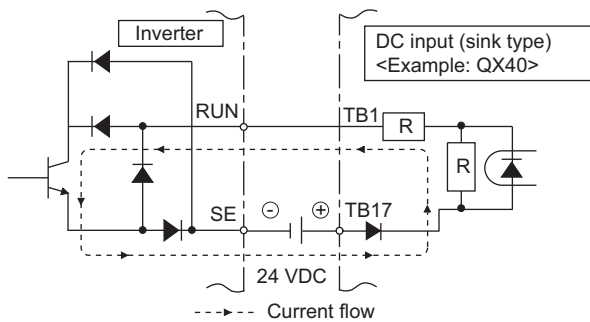
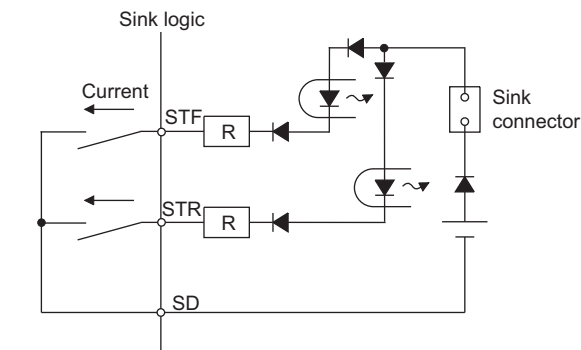
NOTE

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

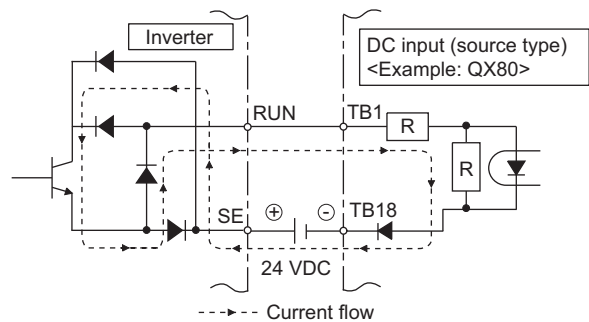
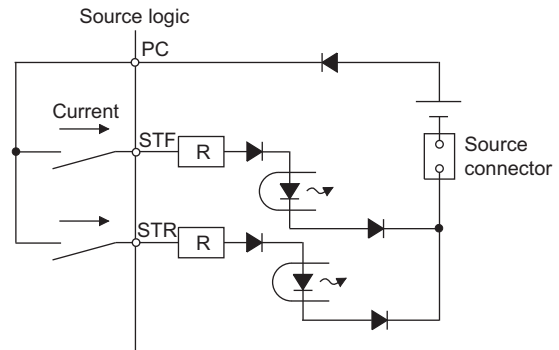
◆ Sink logic and source logic

- In the sink logic, a signal switches ON when a current flows 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 switches ON when a current flows 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



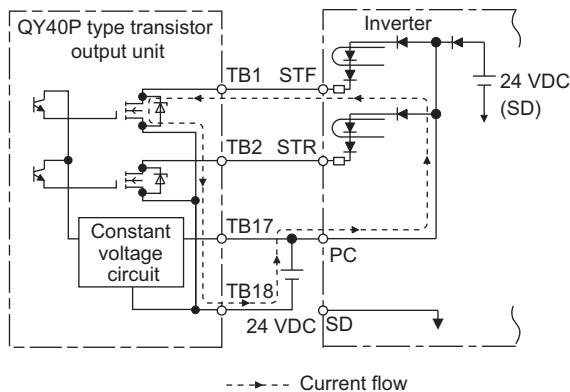
● Current flow concerning the input/output signal when source logic is selected



- When using an external power supply for transistor output

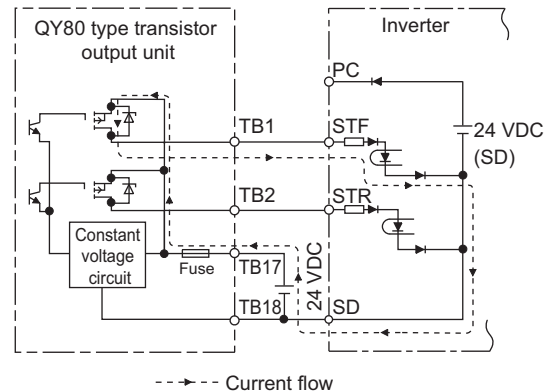
Sink logic

Use terminal PC as a common terminal, and perform wiring as shown below. (Do not connect terminal SD of the inverter with the terminal 0 V of 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.)



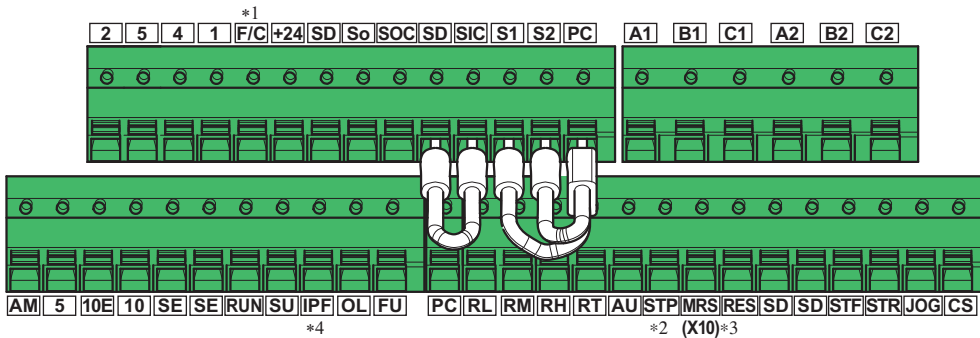
Source logic

Use terminal SD as a common terminal, and perform wiring as shown below. (Do not connect terminal PC of the inverter with terminal +24 V of 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 FM type, and as terminal CA for the CA type.
- *2 Represents the terminal STOP.
- *3 The X10 signal is assigned in the initial setting.
- *4 No signal 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.

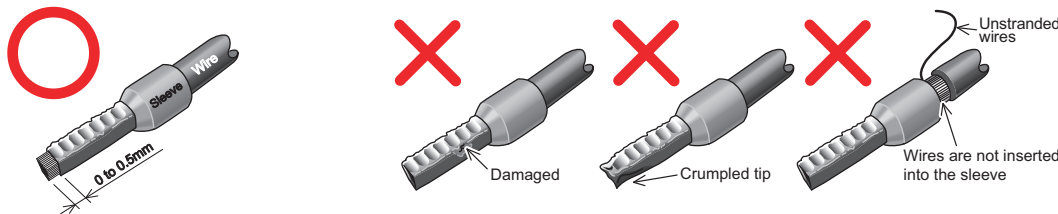
- (1) Strip off the sheath for the below length. If the length of the sheath peeled is too long, a short circuit may occur with neighboring wires. If the length is too short, wires might come off. Wire the stripped cable after twisting it to prevent it from becoming loose. In addition, do not solder it.

Cable sheath stripping length



- (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 May 2016)
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 (for two wires)	AI-TWIN 2 × 0, 75-10GY	-	-	

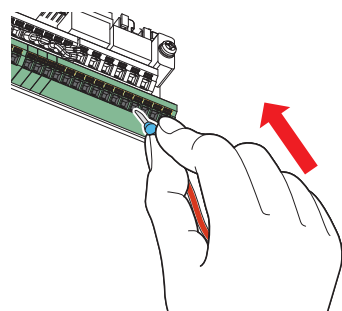
*1 A ferrule terminal with an insulation sleeve compatible with the MTW wire which has a thick wire insulation.

*2 Applicable for the terminals A1, B1, C1, A2, B2, and C2 only.

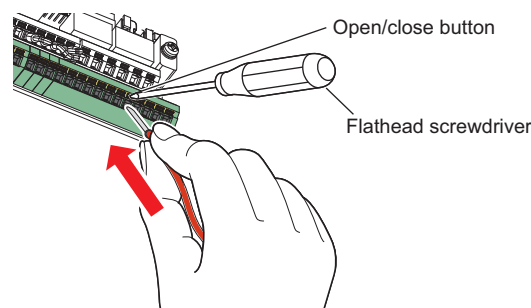
NICHIFU Co., Ltd.

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 a single wire or stranded wires without a blade terminal, push the open/close button all the way down with a flathead screwdriver, and insert the wire.

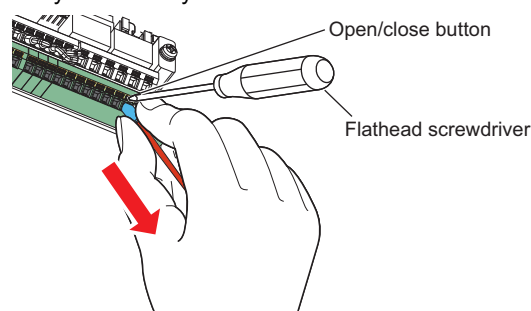


NOTE

- 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)

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

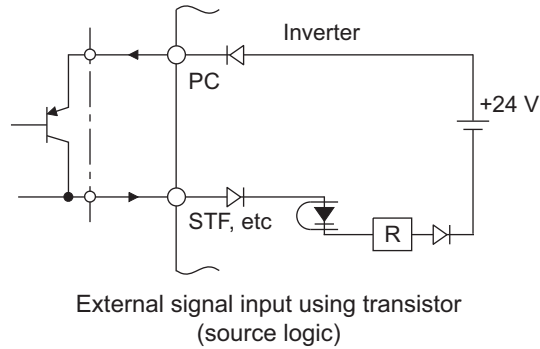
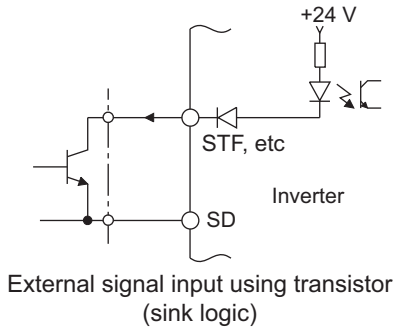
- Terminals SD (sink logic), PC (source logic), 5, and SE are common terminals (0 V) for I/O signals. (All common terminals are isolated from each other.) Do not earth (ground) these terminals. Avoid connecting the terminal SD (sink logic) with 5, the terminal PC (source logic) with 5, and the terminal SE with 5.
- In the sink logic, terminal SD is a common terminal for the contact input terminals (STF, STR, STOP, RH, RM, RL, JOG, RT, MRS, RES, AU, 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, 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 (2, 1 or 4) and the analog output terminals (AM, 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, 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.

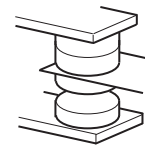
◆ Signal inputs by contactless switches

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

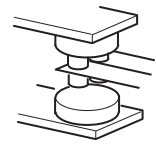


2.6.5 Wiring precautions

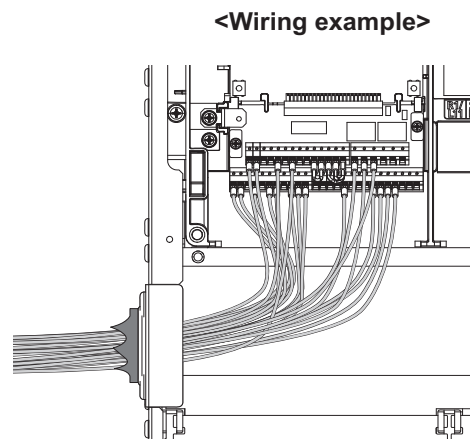
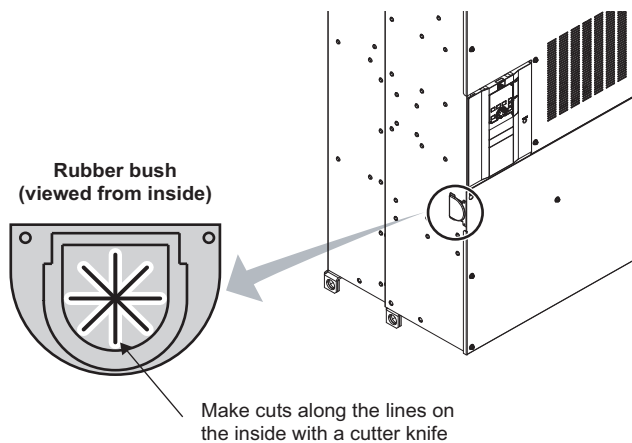
- It is recommended to use a cable of 0.75 mm² for the connection to the control circuit terminals.
 - The wiring length should be 30 m (200 m for the terminal FM) at the maximum.
 - Use two or more parallel micro-signal contacts or twin contacts to prevent contact faults when using contact inputs since the control circuit input signals are micro-currents.
 - To suppress EMI, use shielded or twisted cables for the control circuit terminals and run them away from the main 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 the 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.
- Make cuts in rubber bush of the inverter side and lead the wires through.



Micro signal contacts



Twin contacts



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)

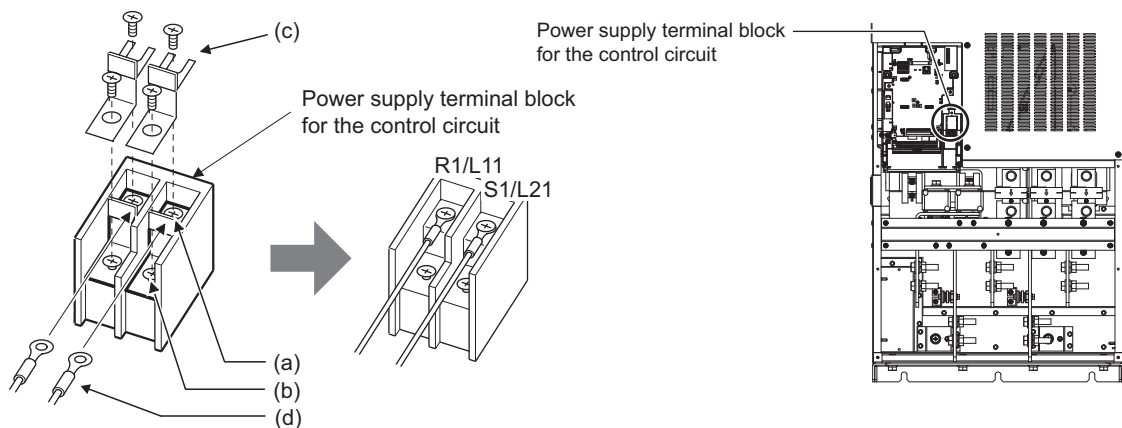
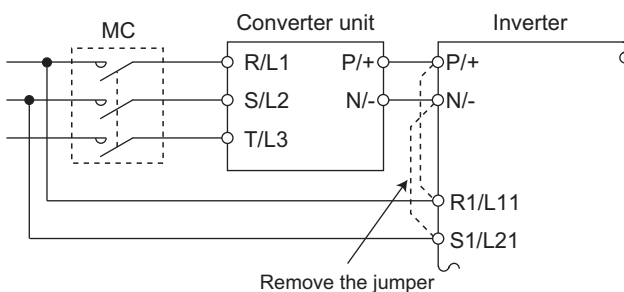
- Terminal screw size: M4
- Cable gauge: 0.75 mm² to 2 mm²
- Tightening torque: 1.5 N·m

◆ Connection method

When a fault occurs, opening of the electromagnetic contactor (MC) on the inverter power supply side results in power loss in the control circuit, disabling the fault output signal retention. Terminals R1/L11 and S1/L21 are provided to hold a fault signal. In this case, connect the power supply terminals R1/L11 and S1/L21 of the control circuit to the input side of the MC.

The terminals R1/L11 and S1/L21 are connected to the terminals P/+ and N/- with a jumper respectively. Do not connect the power cable to incorrect terminals. Doing so may damage the inverter.

<Connection diagram>



- Remove the upper screws.
- Remove the lower screws.
- Pull the jumper toward you to remove.
- 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 from terminals R1/L11 and S1/L21. The inverter may be damaged if the jumpers are not removed.
- The voltage should be the same as that of the main control circuit when the control circuit power is supplied from other than the input side of the MC.
- The power capacity necessary when separate power is supplied from R1/L11 and S1/L21 is 80 VA.
- If the main circuit power is switched OFF (for 0.1 s 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. The 24 V external power supply enables I/O terminal ON/OFF operation, operation panel displays, control functions, and communication during communication operation even during power-OFF of inverter's main circuit power supply. When the main circuit power supply is turned ON, the power supply changes from the 24 V external power supply to the main circuit power supply.

◆ Specification of the applied 24 V external power supply

Item	Rate Specification
Input voltage	DC23 to 25.5 V
Input current	1.4 A or lower

Commercially available products (as of February 2015)

Model	Manufacturer
S8JX-N05024C *1 Specifications: Capacity 50 W, output voltage 24 VDC, output current 2.1 A Installation method: Front installation with cover or S8VS-06024 *1 Specifications: Capacity 60 W, output voltage 24 VDC, output current 2.5 A Installation method: DIN rail installation	OMRON Corporation

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

◆ Starting and stopping the 24 V external power supply operation

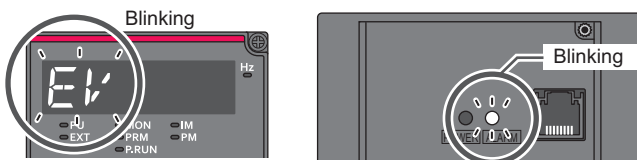
- Supplying 24 V external power while the main circuit power is OFF starts the 24 V external power supply operation. Likewise, turning OFF the main circuit power while supplying 24 V external power starts the 24 V external power supply operation.
- Turning ON the main circuit power stops the 24 V external 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 the 24 V external power supply operation, "EV" blinks on the operation panel. The alarm lamp also blinks. Thus, the 24 V external power supply operation can be confirmed even when the operation panel is removed.



- During the 24 V external power supply operation, the 24 V external power supply operation signal (EV) 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

- Faults history 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.
- During the 24 V external power supply operation, monitored items and signals related to inputs to main circuit power supply, such as 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

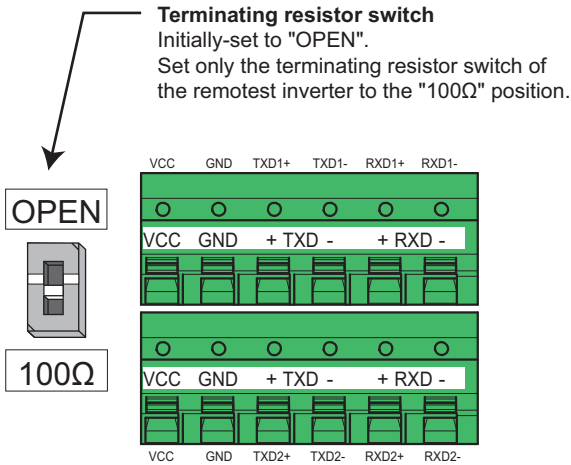
- Inrush current equal to or higher than the 24 V external power supply specification may flow at power-ON. Confirm that the power supply and other devices are not affected by the inrush current and the voltage drop caused by it. Depending on the power supply, the inrush current protection may be activated 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. Use the inverter after confirming that the input voltage of each converter unit 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.
- "E.SAF" or "E.P24" may appear when the start-up time of the 24 V power supply is too long (less than 1.5 V/s) in the 24 V external power supply operation.
- "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.

2.7 Communication connectors and terminals

2.7.1 RS-485 terminal block

Connecting between the RS-485 terminals of the master/slave inverters enables communication for the parallel operation. For wiring, refer to [page 51](#).

◆RS-485 terminal layout



Name	Description
RXD1+	Inverter receive +
RXD1-	Inverter receive -
RXD2+	Inverter receive + (for branch)
RXD2-	Inverter receive - (for branch)
TXD1+	Inverter send +
TXD1-	Inverter send -
TXD2+	Inverter send + (for branch)
TXD2-	Inverter send - (for branch)
VCC	5V Permissible load current 100 mA
GND	Earthing (grounding) (connected to terminal SD)

◆Connection of RS-485 terminals and wires

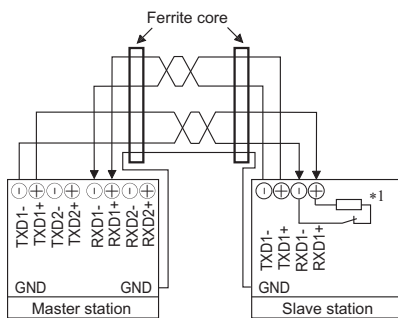
- Use a 4-pair twisted cable for each connection.
- The size of RS-485 terminal block is the same as the control circuit terminal block. Refer to [page 44](#) for the wiring method.

NOTE

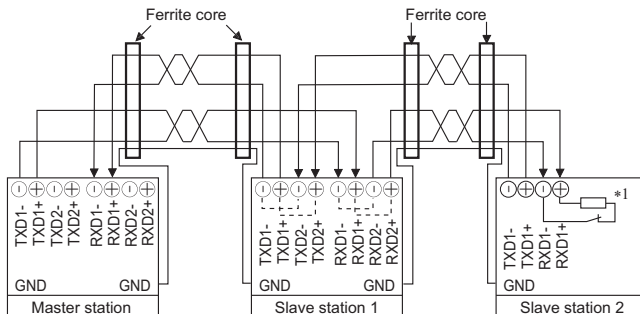
- The wiring length to the RS-485 terminals between the master/slave inverters should be within 5 m.
- To avoid malfunction, keep the RS-485 terminal wires away from the control circuit board.
- For wiring of the RS-485 terminals used with a plug-in option, lead the wires on the left side of the plug-in option.

◆ RS-485 terminal wiring method

- For operating two inverters in parallel



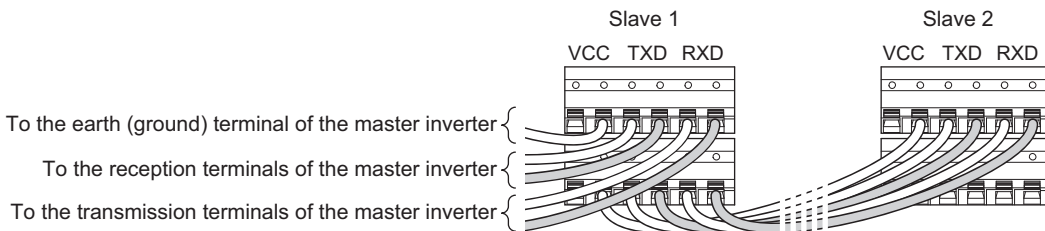
- For operating three inverters in parallel



*1 Set the terminating resistor switch to the 100 Ω side.

NOTE

- Refer to the diagrams above to connect the inverters with RS-485 cables. Wrap the cables together around each ferrite core (accessory of the inverter) once (two turns). Install each ferrite core on within 10 cm of the inverter.
- For branching, connect the wires as shown below.



2.7.2 PU connector

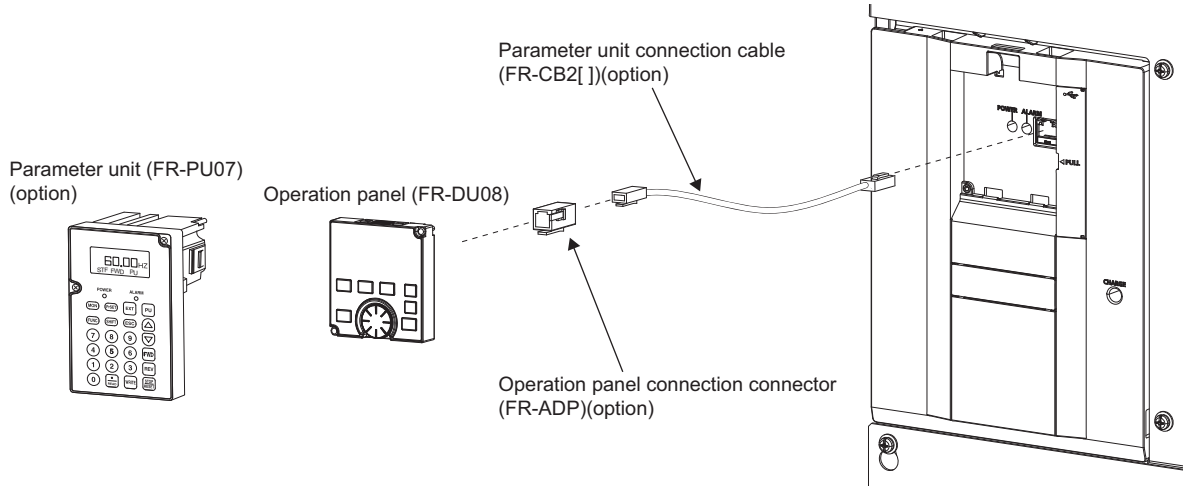
◆ Mounting the operation panel (FR-DU08) or parameter unit (FR-PU07) on the enclosure surface

- Having an operation panel (FR-DU08) or a parameter unit (FR-PU07) on the enclosure surface is convenient. With a connection cable, the operation panel (FR-DU08) or the parameter unit (FR-PU07) 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 install the operation panel (FR-DU08), the optional connector (FR-ADP) is required.)

Securely insert one end of the connection cable 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

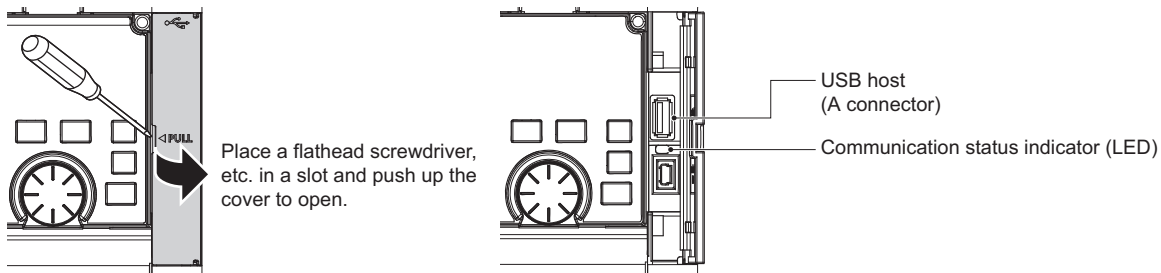
◆ Communication operation

- Using the PU connector 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 FR-A800 Instruction Manual (Detailed).)

2.7.3 USB connector



Interface		Conforms to USB1.1
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	<ul style="list-style-type: none"> • Copies the parameter setting 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	<ul style="list-style-type: none"> • The monitored data and output status of the signals can be saved in a USB memory device.
PLC function data copy	<ul style="list-style-type: none"> • 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.
Blinking rapidly	The USB memory device is being accessed. (Do not remove the USB memory device.)
Blinking slowly	Error in the USB connection.

- When a device such as a USB battery charger is connected to the USB connector and an excessive current (500 mA or more) flows, USB host error "UF" (UF warning) is displayed on the operation panel.
- If a UF warning occurs, disconnect the USB device and set **Pr.1049** = "1" to cancel the USB error. (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 details of usage, refer to the FR-A800 Instruction Manual (Detailed).

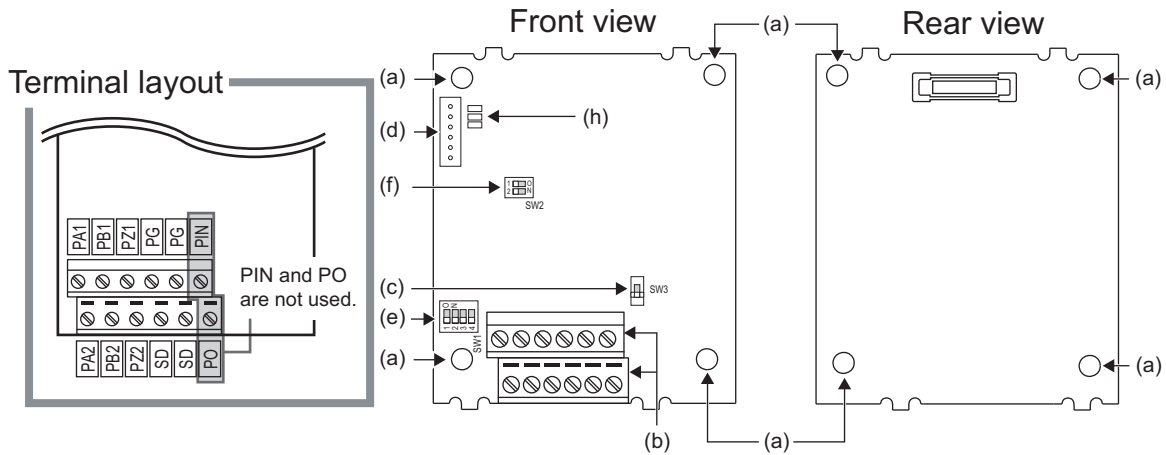
2.8 Connection of motor with encoder (Vector control)


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.

(The Vector control compatible options can be installed only to the master inverter.)

This section explains wiring for use of the FR-A8AP.

◆ Appearance and parts name of FR-A8AP



Symbol	Name	Description	Refer to page
a	Mounting hole	Used for installation to the inverter.	—
b	Terminal block	Connected with the encoder.	57
c	Encoder type selection switch (SW3)	Switches the encoder type (differential line driver/complementary).	55
d	CON2 connector	Used for extension	—
e	Terminating resistor selection switch (SW1)	Switches ON or OFF the internal terminating resistor.	55
f	Switch for manufacturer setting (SW2)	Do not change from the initially-set status. (Switches 1 and 2 are OFF )	—
g	Connector	Connected to the option connector of the inverter.	9
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 side) 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

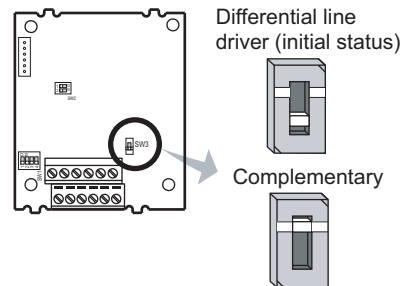
- When the encoder's output voltage differs from its input power supply voltage, the signal loss detection (E.ECT) may occur.
- Incorrect wiring or faulty setting to the encoder will cause a fault such as an overcurrent (E.OC[]) and an inverter overload (E.THT).
Correctly perform the encoder wiring and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

◆ Switches of 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.



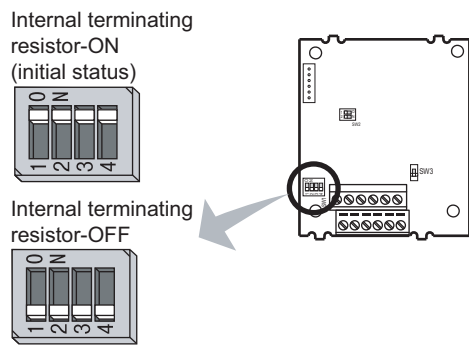
• Terminating resistor selection switch (SW1)

Selects ON/OFF of the internal terminating resistor.

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

ON: with internal terminating resistor (initial status)

OFF: without internal terminating resistor



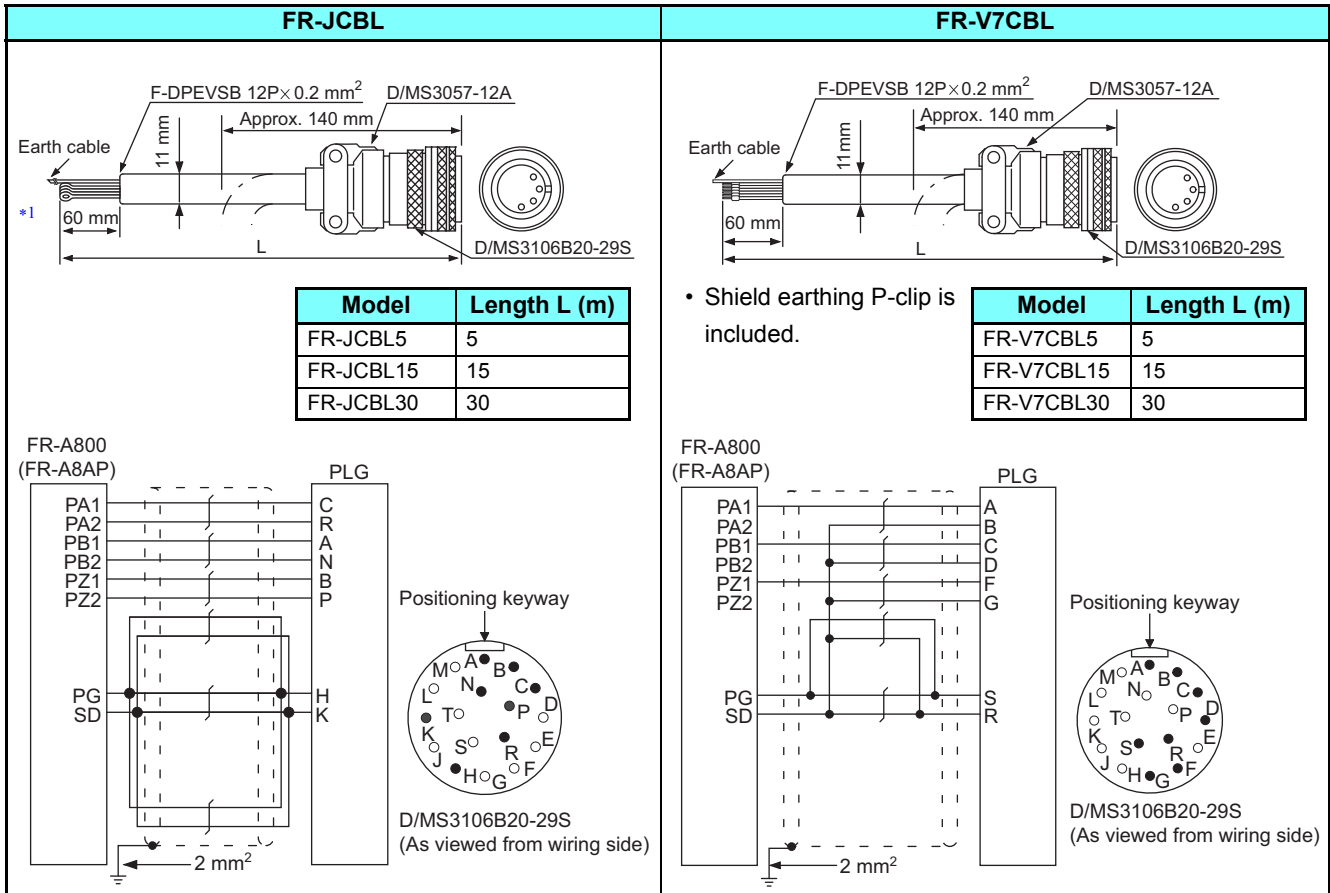
NOTE

- Set all switches to the same setting (ON/OFF).
- Set the switch "OFF" when sharing an encoder with another unit (NC (computerized numerical controller), etc.) having a terminating resistor under the differential line driver setting.
- Prepare an encoder's power supply (5 V/12 V/15 V/24 V) according to the encoder's output voltage. When the encoder output is the differential line driver type, only 5 V can be input.
- The SW2 switch is for manufacturer setting. Do not change the setting.

• Encoder specification

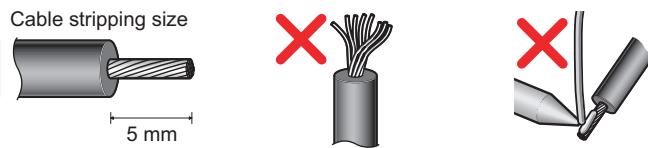
Item	Specification
Resolution	0 to 4096 pulses/rev (setting by Pr.369)
Power supply voltage	5 V, 12 V, 15 V, 24 V
Output signal form	A, B phases (90° phase shift) Z phase: 1 pulse/rev
Output circuit	Differential line driver or complementary

◆ Encoder cable



*1 As the terminal block of the FR-A8AP is an insertion type, cables need to be treated. (Refer to the following description.)

- 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 crimp 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 will 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 February 2016)
Phoenix Contact Co., Ltd.

Terminal screw size	Cable gauge (mm ²)	Ferrule terminal model		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 product number	Insulation cap product number	Crimping tool product number
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.

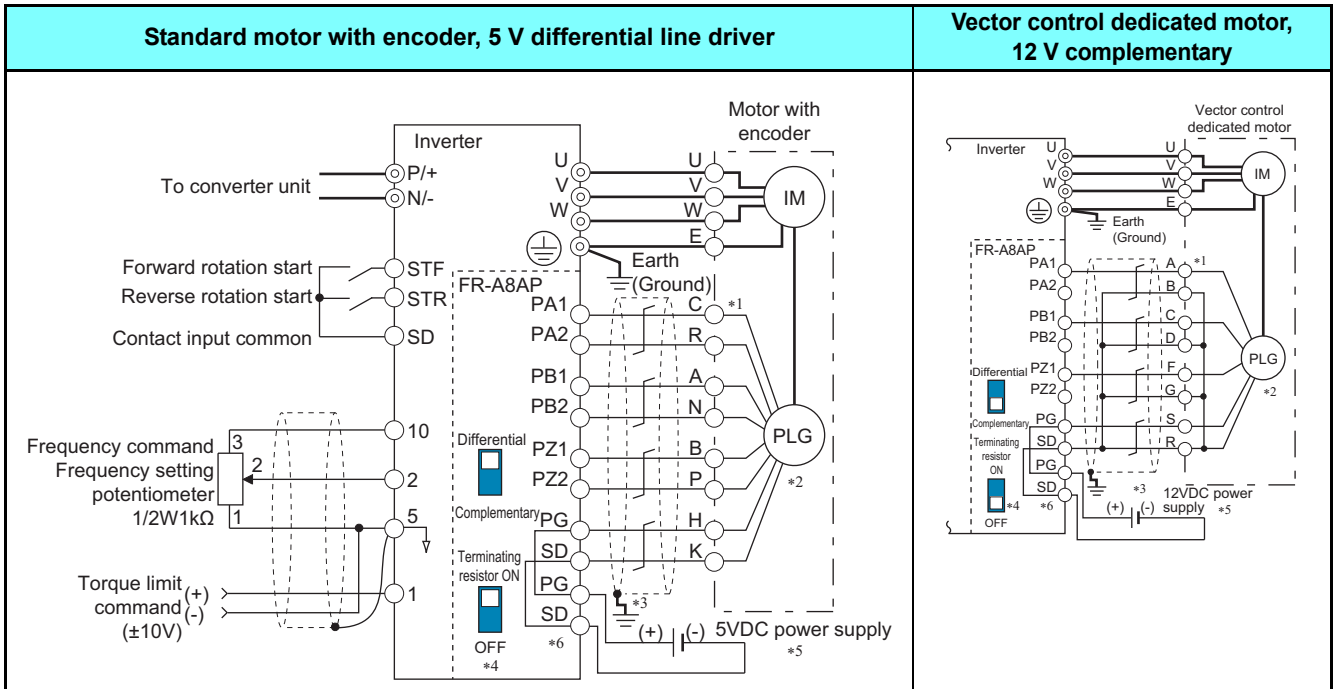


- Connection terminal compatibility table

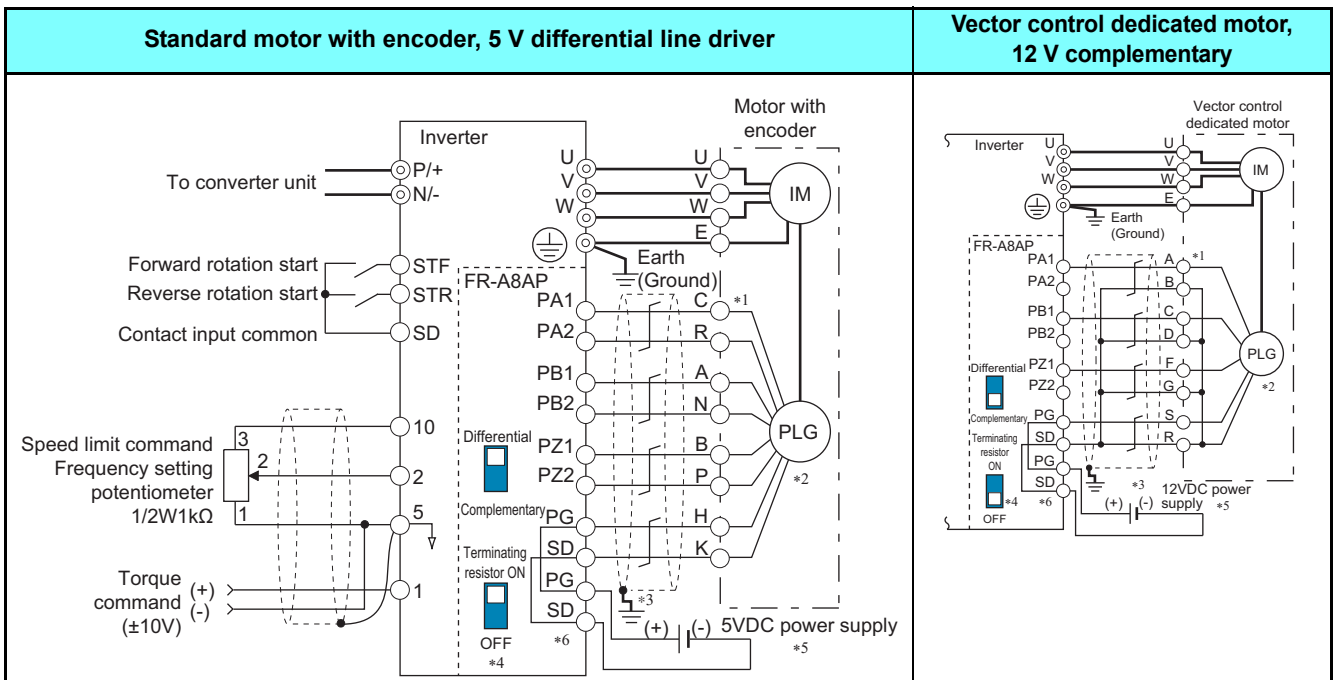
Encoder cable		FR-V7CBL	FR-JCBL
FR-A8AP terminal	PA1	PA	PA
	PA2	Do not connect anything to this.	PAR
	PB1	PB	PB
	PB2	Do not connect anything to this.	PBR
	PZ1	PZ	PZ
	PZ2	Do not connect anything to this.	PZR
	PG	PG	5E
	SD	SD	AG2

◆Wiring example

- Speed control



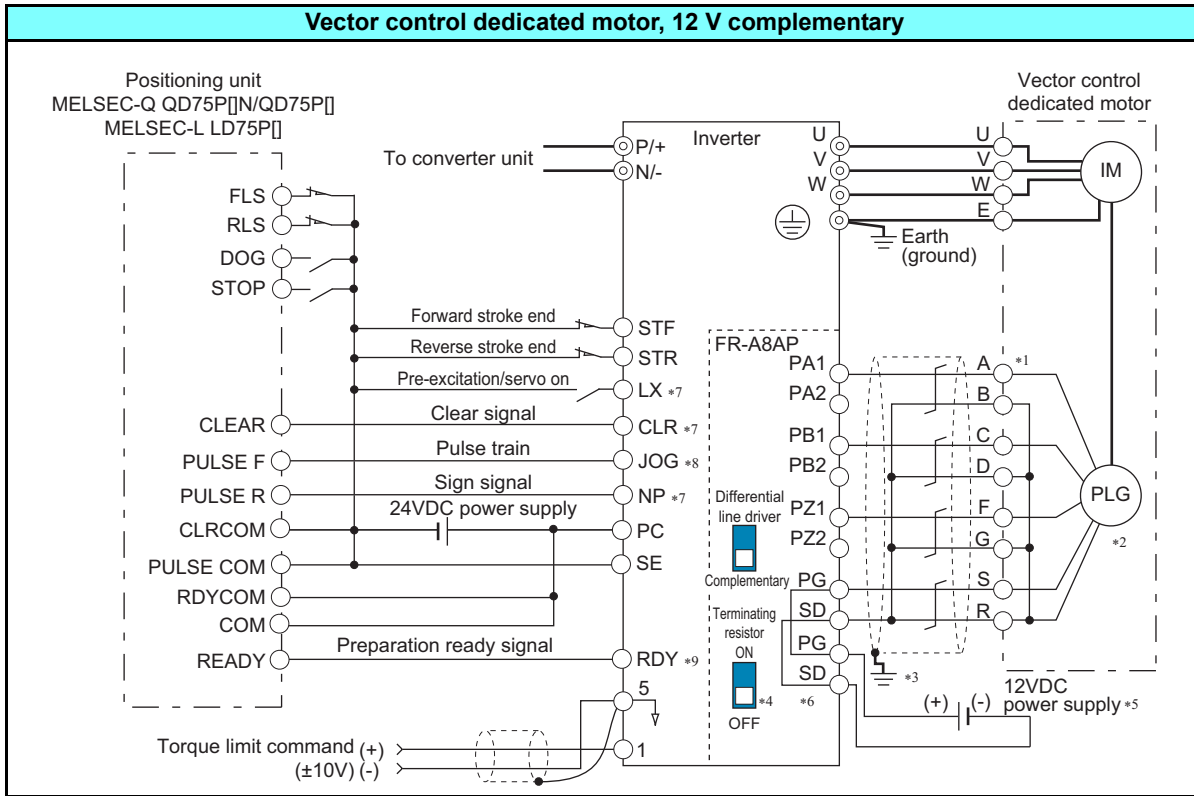
- Torque control



2

Connection of motor with encoder (Vector control)

- Position control

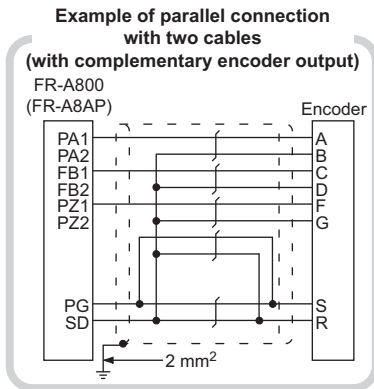


- *1 The pin number differs according to the encoder used.
Speed, control, torque control, and position control by pulse train input are available with or without the Z-phase being connected.
- *2 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio must be 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 59](#).)
- *4 For the complementary, set the terminating resistor selection switch to OFF position. (Refer to [page 55](#).)
- *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 the 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 57](#).
- *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 mm² or larger) to connect the FR-A8AP. For the wiring to the 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).

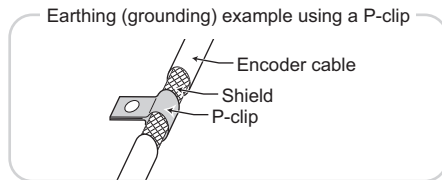


Wiring length	Parallel connection	Larger-size cable	
Within 10 m	At least two cables in parallel	Cable gauge 0.2 mm ²	
Within 20 m	At least four cables in parallel		0.4 mm ² or larger
Within 100 m*1	At least six cables in parallel		0.75 mm ² or larger
			1.25 mm ² or larger

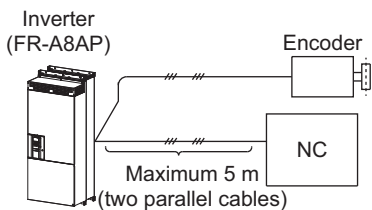
*1 When differential line driver is set and a wiring length is 30 m or more.

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 mm² gauge cables in parallel or a 1.25 mm² 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 P-clip or U-clip made of metal.



- When one encoder is shared between FR-A8AP and CNC (computerized numerical controller), its output signal should be connected as shown below. In this case, the wiring length between 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 56](#).
- 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.852, Pr.853)

- 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. 
				1	Set when using a motor for which forward rotation (encoder) is counterclockwise (CCW) viewed from the shaft. 
				100, 101	For manufacturer setting. Do not set.
369 C140	851 C240	Number of encoder pulses	1024	0 to 4096	Set the number of encoder pulses output. 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 a vector control compatible option to be used.

Item	FR-A8AP/FR-A8AL parameter	FR-A8TP parameter
Encoder rotation direction	Pr.359	Pr.852
Number of detector pulses	Pr.369	Pr.851

◆ Parameter settings for the motor under vector control

Motor name	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 FR-A800 Instruction Manual (Detailed))

*2 Set this parameter according to the motor.

3

PRECAUTIONS FOR USE OF THE INVERTER

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

3.1	Electro-magnetic interference (EMI) and leakage currents ..	62
3.2	Power supply harmonics	69
3.3	Power-OFF and magnetic contactor (MC)	72
3.4	Countermeasures against deterioration of the 400 V class motor insulation.....	73
3.5	Checklist before starting operation	74
3.6	Failsafe system which uses the inverter	77

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. Its value depends on the static capacitances, etc. Take the following countermeasures. To select the earth leakage circuit breaker, refer to its rated sensitivity current.

◆Line-to-earth (ground) leakage currents

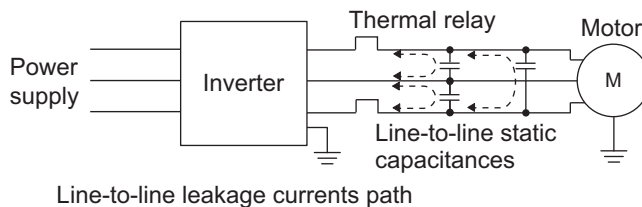
Leakage currents may flow not only into the inverter's own line but also into the other lines through the earthing (grounding) cable, etc. These leakage currents may cause unnecessary operation of the earth leakage relays.

●Countermeasures

- Use an earth leakage circuit breaker with a weak sensitivity in a high frequency range.
The output current of the inverter contains a high-frequency leakage current component, which gives relatively low impacts to human bodies. These leakage currents may trip an earth leakage circuit breaker or earth leakage relay unnecessarily.
- Minimize the line-to-earth stray capacitance.
Use the line-to-earth insulated with low dielectric constant material, and perform wiring to make the wiring length between the inverter and the motor to be as short as possible.
- To-earth (ground) leakage currents
 - Take caution as long wiring will increase the leakage current.
 - Increasing the motor capacity increases 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.



●Countermeasures

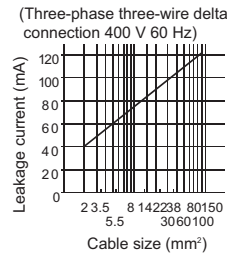
- Use **Pr.9 Electronic thermal O/L relay**.
- To ensure that the motor is protected against line-to-line leakage currents, it is recommended to use a temperature sensor to directly detect motor temperature.
- Increase the external thermal overload relay setting by the amount of the leakage current.
- Minimize the stray capacitance between the lines.
Use the cables insulated with low dielectric constant material, and perform wiring to make the wiring length between the inverter and the motor to be as short as possible.
- Installation and selection of the molded case circuit breaker
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 Mitsubishi earth leakage current breaker designed for harmonics and surge suppression.

◆ Selecting the rated sensitivity current for the earth leakage circuit breaker

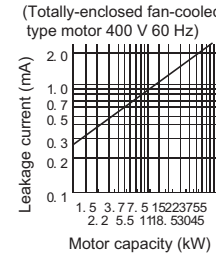
When using the earth leakage circuit breaker with the inverter circuit, select its rated sensitivity current as follows.

- Breaker designed for harmonic and surge suppression
Rated sensitivity current
 $I\Delta n \geq 10 \times (I_{g1} + I_{gn} + I_{gi} + I_{g2} + I_{gm})$
 - Standard breaker
Rated sensitivity current
 $I\Delta n \geq 10 \times \{I_{g1} + I_{gn} + I_{gi} + 3 \times (I_{g2} + I_{gm})\}$
- I_{g1}, I_{g2} : Leakage currents in wire path during commercial power supply operation
 I_{gn} : Leakage current of inverter input side noise filter
 I_{gm} : Leakage current of motor during commercial power supply operation
 I_{gi} : Leakage current of inverter unit
 (When the converter unit is connected, add the leakage current of converter unit.)

Example of leakage current per 1 km during the commercial power supply operation when the CV cable is routed in metal conduit

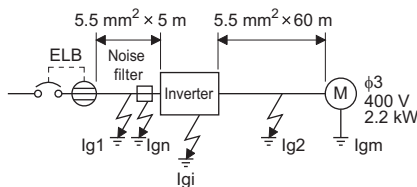


Leakage current example of three-phase induction motor during the commercial power supply operation



For "Δ" connection, the amount of leakage current is approx. 1/3 of the above value.

<Example>



- Selection example for the Δ connection of the 400 V class

Item	Breaker designed for harmonic and surge suppression	Standard breaker
Leakage current I_{g1} (mA)	$\frac{1}{3} \times 66 \times \frac{5 \text{ m}}{1000 \text{ m}} = 0.11$	
Leakage current I_{gn} (mA)	0 (without noise filter)	
Leakage current I_{gi} (mA)	1 (without EMC filter) For the leakage current of the inverter, refer to the following table.	
Leakage current I_{g2} (mA)	$\frac{1}{3} \times 66 \times \frac{60 \text{ m}}{1000 \text{ m}} = 1.32$	
Motor leakage current I_{gm} (mA)	0.36	
Total leakage current (mA)	2.79	6.15
Rated sensitivity current (mA) ($\geq I_g \times 10$)	30	100

- Leakage current per inverter / converter unit
400 V class (input power condition: 440 V / 60 Hz, power supply unbalance within 3%)

Inverter / converter unit	FR-A802-P (Separated converter type)	Converter unit FR-CC2-P	
		EMC filter	
Phase earthing (grounding)	2	ON	OFF
Earthed-neutral system	1	2	1

(mA)

NOTE

- Install the earth leakage circuit breaker (ELB) on the input side of the converter unit.
- In the Δ connection earthed-neutral system, the sensitivity current is blunt against a ground fault in the inverter output side. Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes. (NEC section 250, IEC 536 class 1 and other applicable standards)
- When the breaker is installed on the output side of the inverter, it may be unnecessarily operated by harmonics even if the effective value is within the rating.
In this case, do not install the breaker since the eddy current and hysteresis loss will increase, leading to temperature rise.
- The following models are standard breakers BV-C1, BC-V, NVB, NV-L, NV-G2N, NV-G3NA, NV-2F, earth leakage relay (except NV-ZHA), and NV with AA neutral wire open-phase protection.
The other models are designed for harmonic and surge suppression: NV-C/NV-S/MN series, NV30-FA, NV50-FA, BV-C2, earth leakage alarm breaker (NF-Z), NV-ZHA, and NV-H.
- For the motor leakage current, contact the motor manufacturer.

3.1.2 Countermeasures against inverter-generated EMI

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. Also, since the inverter chops outputs at high carrier frequency, that could generate electromagnetic noises. 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 techniques
 - 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.

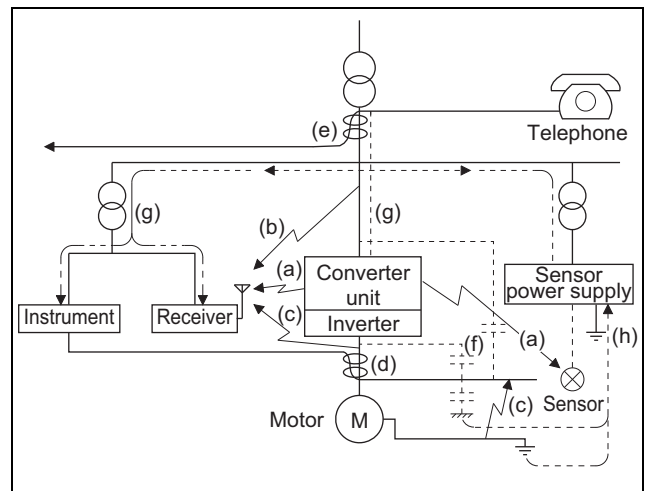
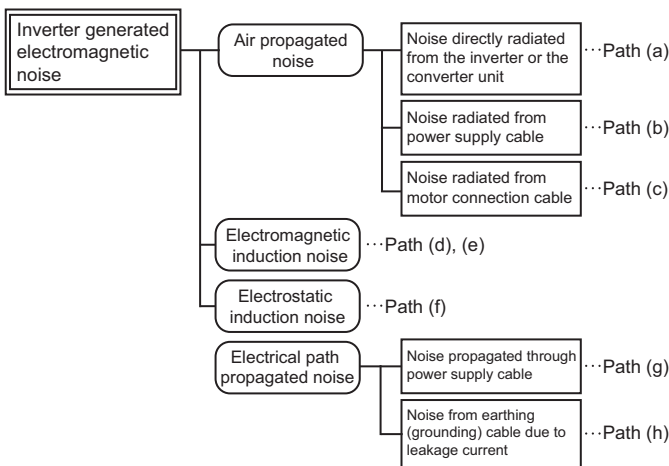
- Techniques to reduce electromagnetic noises that enter and cause a malfunction of the inverter or the converter unit (EMI countermeasures)

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 66) 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 to or converter unit 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.



Electro-magnetic interference (EMI) and leakage currents

Noise propagation path	Countermeasure
(a)(b)(c)	<p>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:</p> <ul style="list-style-type: none"> • 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 68.) • 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)	<p>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:</p> <ul style="list-style-type: none"> • 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)	<p>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:</p> <ul style="list-style-type: none"> • Set the EMC filter ON/OFF connector of the converter unit to the ON position. (Refer to page 68.) • Install the line noise filter to the power cables (output cables) of the inverter.
(h)	<p>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.</p>

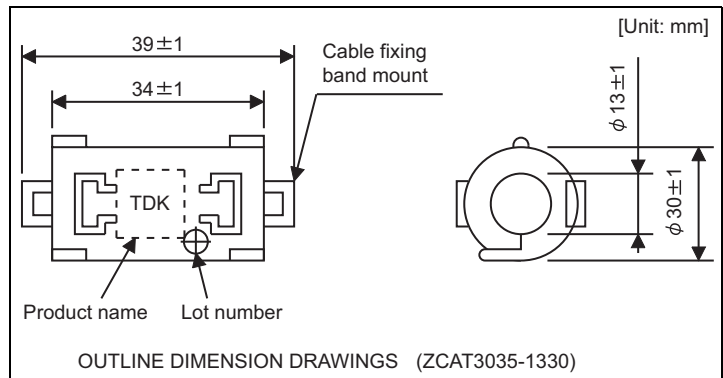
●Data line filter

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

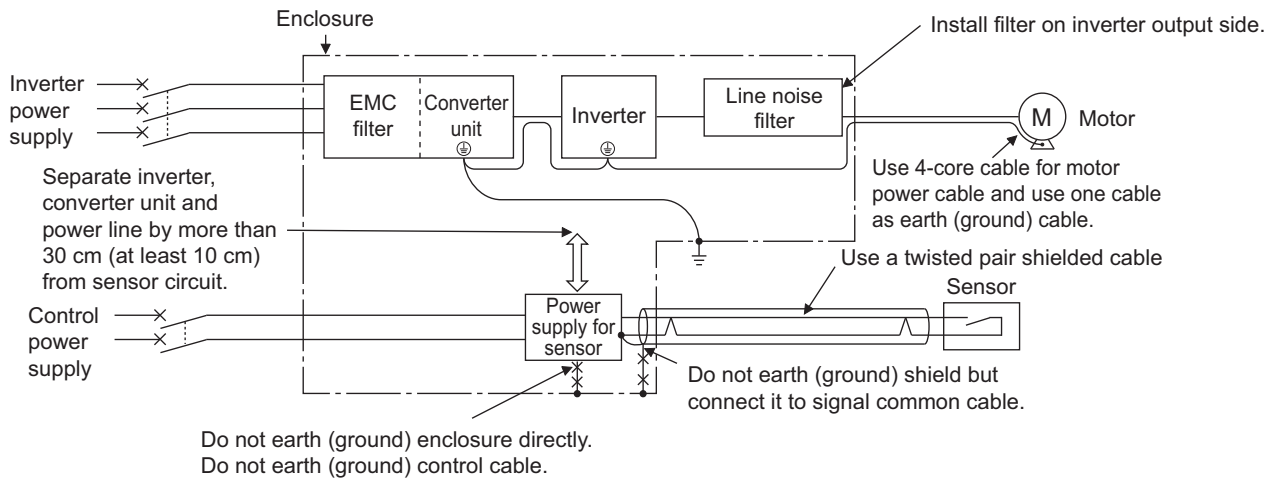
<Example> Data line filter: ZCAT3035-1330 (by TDK)
 ESD-SR-250 (by NEC TOKIN)
 Impedance (ZCAT3035-1330)

Impedance (Ω)	
10 to 100 MHz	100 to 500 MHz
80	150

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



●EMI countermeasure example



NOTE

- For compliance with the EU EMC Directive, refer to [page 106](#).

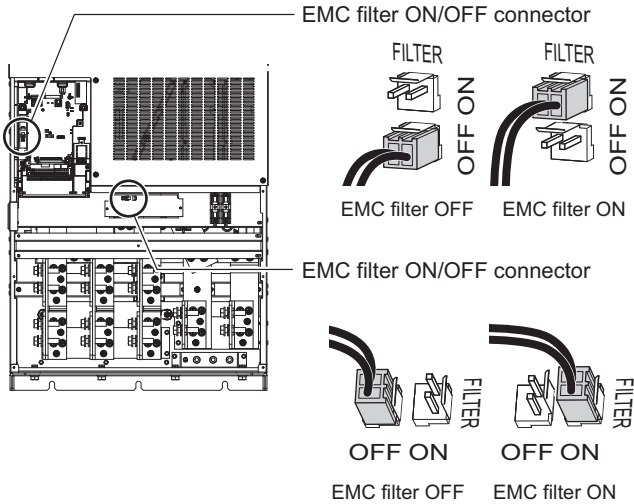
3.1.3 Converter unit built-in EMC filter

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.

Two EMC filter ON/OFF connectors are provided. The both connectors are initially set to the "disabled" (OFF) position.

To enable the EMC filters, fit both of the EMC filter ON/OFF connectors to the "enabled" (ON) position.

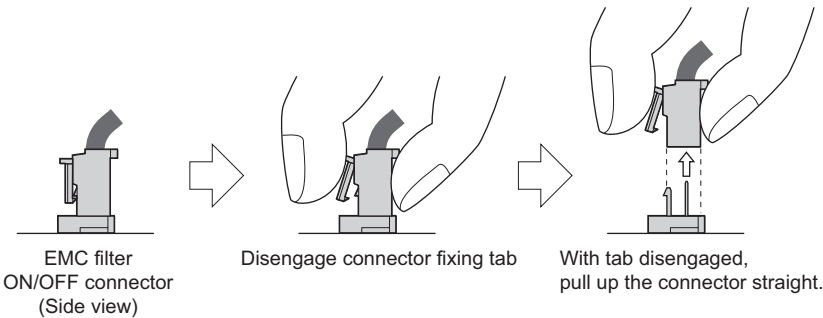


<How to enable or disable the filter>

- 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 tester 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 63](#).)

WARNING

- While the inverter 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.

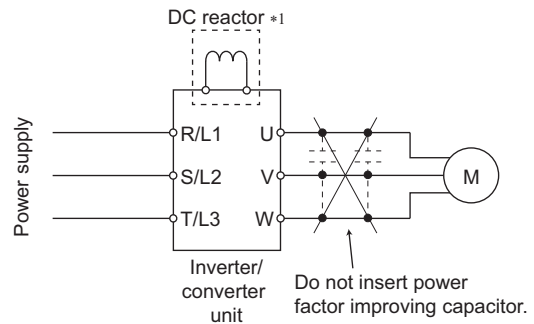
- The differences between harmonics and noises

Item	Harmonics	Noise
Frequency	Normally 40th to 50th degrees or less (3 kHz or less).	High frequency (several 10 kHz to 1 GHz order).
Environment	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 is equipped with the 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.

3.2.2 Harmonic Suppression Guidelines in Japan

Inverters have a converter section (rectifier circuit) and generate a harmonic current.

The Harmonic Suppression Guidelines was established to protect other consumers from these outgoing harmonic currents.

The three-phase 200 V input specifications 3.7 kW or lower were previously covered by "the Harmonic Suppression Guidelines for Household Appliances and General-purpose Products" and other models were covered by "the Harmonic Suppression Guidelines for Consumers Who Receive High Voltage or Special High Voltage". However, the transistorized inverter has been excluded from the target products covered by "the Harmonic Suppression Guidelines for Household Appliances and General-purpose Products" in January 2004 and "the Harmonic Suppression Guideline for Household Appliances and General-purpose Products" was repealed on September 6, 2004. All capacity and all models of general-purpose inverter used by specific consumers are now covered by "the Harmonic Suppression Guidelines for Consumers Who Receive High Voltage or Special High Voltage" (hereinafter referred to as "the Specific Consumer Guidelines").

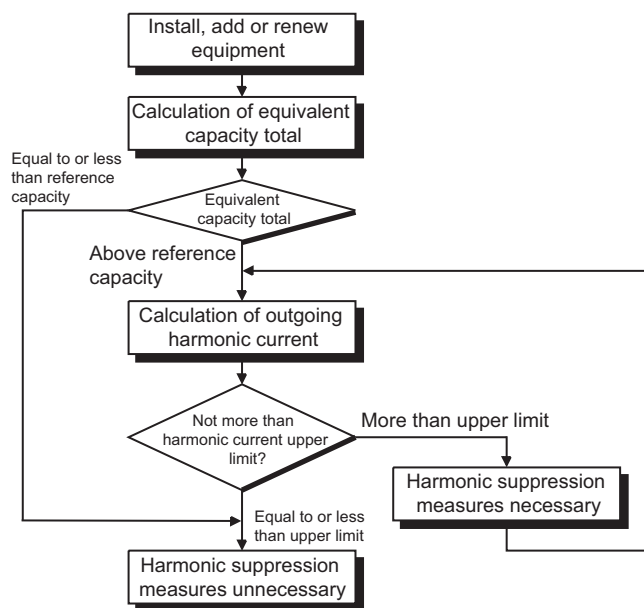
- "Specific Consumer Guidelines"

This guideline sets forth the maximum harmonic currents outgoing from a high-voltage or especially high-voltage receiving consumer who will install, add or renew harmonic generating equipment. If any of the maximum values is exceeded, this guideline requires that consumer to take certain suppression measures.

- Maximum Values of Outgoing Harmonic Currents per 1 kW Contract Power

Received power voltage	5th	7th	11th	13th	17th	19th	23rd	Over 23rd
6.6 kV	3.5	2.5	1.6	1.3	1.0	0.9	0.76	0.70
22 kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36
33 kV	1.2	0.86	0.55	0.46	0.35	0.32	0.26	0.24

◆ Application of the specific consumer guidelines



- Conversion factors

Classification	Circuit type		Conversion coefficient Ki
3	Three-phase bridge (Capacitor smoothing)	With reactor (DC side)	K33 = 1.8

- Equivalent Capacity Limits

Received power voltage	Reference capacity
6.6 kV	50 kVA
22/33 kV	300 kVA
66 kV or more	2000 kVA

- Harmonic content (Values of the fundamental current is 100%)

reactor	5th	7th	11th	13th	17th	19th	23rd	25th
Used (DC side)	30	13	8.4	5.0	4.7	3.2	3.0	2.2

- Calculation of equivalent capacity P0 of harmonic generating equipment

"Equivalent capacity" is the capacity of a 6-pulse converter converted from the capacity of consumer's harmonic generating equipment and is calculated by the following equation: If the sum of equivalent capacities is higher than the limit in (refer to [page 70](#)), harmonics must be calculated with the following procedure:

$$P0 = \sum (Ki \times Pi) \text{ [kVA]}$$

Ki: Conversion coefficient (Refer to [page 70](#))

Pi: Rated capacity*1 of harmonic generating equipment [kVA]

i: Number indicating the conversion circuit type

*1 Rated capacity: Determined by the capacity of the applied motor and found in Table 5. The rated capacity used here is used to calculate the generated harmonic amount and is different from the power supply capacity required for actual inverter drive.

- Calculation of outgoing harmonic current

Outgoing harmonic current = fundamental wave current (value converted from received power voltage) × operation ratio × harmonic content

- Operation ratio: Operation ratio = actual load factor × operation time ratio during 30 minutes
- Harmonic content: Found in [page 70](#).

- Rated capacities and outgoing harmonic currents of inverter-driven motors

Applicable motor (kW)	Fundamental wave current (A)	Fundamental wave current converted from 6.6 kV (mA)	Rated capacity (kVA)	Outgoing harmonic current converted from 6.6 kV (mA) (With a DC reactor, 100% operation ratio)							
	400 V			5th	7th	11th	13th	17th	19th	23rd	25th
75	123	7455	87.2	2237	969	626	373	350	239	224	164
90	147	8909	104	2673	1158	748	445	419	285	267	196
110	179	10848	127	3254	1410	911	542	510	347	325	239
132	216	13091	153	3927	1702	1100	655	615	419	393	288
160	258	15636	183	4691	2033	1313	782	735	500	469	344
220	355	21515	252	6455	2797	1807	1076	1011	688	645	473
250	403	24424	286	7327	3175	2052	1221	1148	782	733	537
280	450	27273	319	8182	3545	2291	1364	1282	873	818	600
315	506	30667	359	9200	3987	2576	1533	1441	981	920	675
355	571	34606	405	10382	4499	2907	1730	1627	1107	1038	761
400	643	38970	456	11691	5066	3274	1949	1832	1247	1169	857
450	723	43818	512	13146	5696	3681	2191	2060	1402	1315	964
500	804	48727	570	14618	6335	4093	2436	2290	1559	1462	1072
560	900	54545	638	16364	7091	4582	2727	2564	1746	1636	1200
630	1013	61394	718	18418	7981	5157	3070	2886	1965	1842	1351

- Determining if a countermeasure is required

A countermeasure for harmonics is required if the following condition is satisfied: outgoing harmonic current > maximum value per 1 kW contract power × contract power.

- Harmonic suppression techniques

Item	Description
Reactor installation	The converter unit is equipped with the DC reactor on its DC side, and outgoing harmonic current can be suppressed.
Installation of power factor improving capacitor	When used with a reactor connected in series, the power factor improving correction capacitor can absorb harmonic currents.
Transformer multi-phase operation	Use two transformers with a phase angle difference of 30° as in Λ - Δ and Δ - Δ combinations to provide an effect corresponding to 12 pulses, reducing low-degree harmonic currents.
Passive filter (AC filter)	A capacitor and a reactor are used together to reduce impedances at specific frequencies. Harmonic currents are expected to be absorbed greatly by using this technique.
Active filter (Active filter)	This filter detects the current in a circuit generating a harmonic current and generates a harmonic current equivalent to a difference between that current and a fundamental wave current to suppress the harmonic current at the detection point. Harmonic currents are expected to be absorbed greatly by using this technique.

3.3 Power-OFF 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 13](#) for selection.)

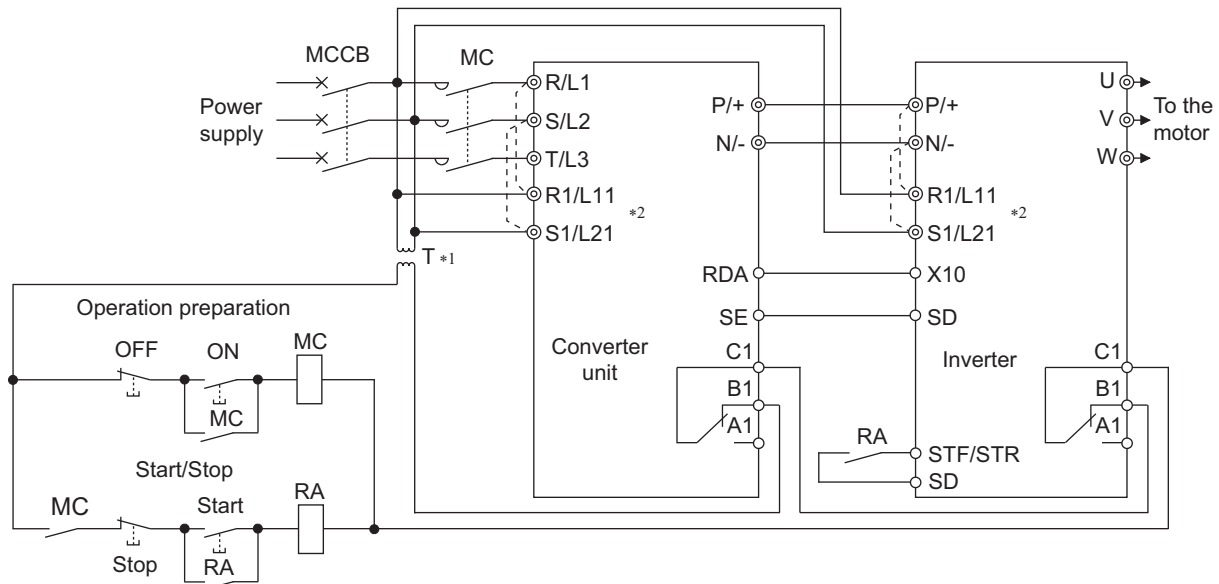
- To disconnect the inverter from the power supply at activation of a protective function or at malfunctioning of the driving system (emergency stop, etc.).
- To prevent any accident due to an automatic restart at power restoration after an inverter stop made by a power failure.
- To separate the inverter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

If using an MC for emergency stop during operation, select an MC regarding the converter unit input side current as JEM1038-AC-3 class rated current.

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/OFF the inverter start controlling terminals (STF, STR) to run/stop the inverter.
- Inverter start/stop circuit example

As shown below, always use the start signal (ON or OFF of STF(STR) signal) to make a start or stop.



*1 When the power supply is 400 V class, install a stepdown transformer.

*2 Connect the power supply terminals R1/L11, S1/L21 of the control circuit to the input side of the MC to hold an alarm signal when the inverter's protective circuit is activated. At this time, remove jumpers across terminals R1/L11 and S1/L21. (Refer to [page 47](#) 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**. (The commercial power supply operation is not available with vector control dedicated motors.)

NOTE

- Do not open or close the contactor while the inverter is running (outputting).

3.4 Countermeasures against deterioration of the 400 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 400 V class motor, the surge voltage may deteriorate the insulation. When the 400 V class motor is driven by the inverter, consider the following countermeasures:

- Countermeasures

For the 400 V class motor, use an insulation-enhanced motor.

Specifically,

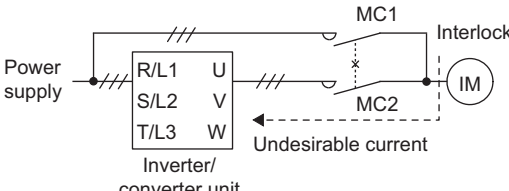
- Order a "400 V class inverter-driven insulation-enhanced motor".
- For the dedicated motor such as the constant-torque motor and low-vibration motor, use an "inverter-driven dedicated motor".

3.5 Checklist before starting operation

The FR-A800 series inverter and 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 (R/L1, S/L2, T/L3) and the motor (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.	34	
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 and 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.	35	
The total wiring length within the specified length.	Keep the total wiring length is within the specified length. Especially for long-distance wiring, the inverter may be affected by a charging current caused by the stray capacitances of the wiring, leading to a malfunction or fault of the equipment connected on the inverter output side. Pay attention to the total wiring length.	35	
Countermeasures are taken against EMI.	The input/output (main circuit) of the inverter and the converter unit includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the inverter and the converter unit. In such case, activate the EMC filter (turn ON the EMC filter ON/OFF connector) to minimize interference.	68	
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 built-in 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 on the output side of the inverter.*1 (This is effective regardless of the EMC filter ON/OFF connector setting.)	-	
On the inverter's output side, none of the power factor correction capacitor, surge suppressor, or radio noise filter is installed.	Doing so will cause the inverter output shutoff or the capacitor and surge suppressor to be damaged. 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 tester, etc.	-	
The inverter's output side has no short circuit or ground fault occurring.	• A short circuit or earth (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/OFF the inverter's start signals (STF, STR) to run/stop the inverter.	72	

Checkpoint	Countermeasure	Refer to page	Check by user
The voltage applied to the I/O signal circuits of the inverter and the converter unit is within the specifications.	Application of a voltage higher than the permissible voltage to the I/O signal circuits of the inverter and 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 the terminals 10E and 5.	38	
The converter unit and the inverter are correctly connected.	<ul style="list-style-type: none"> 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 for source logic) of the inverter. Not connecting these terminals may damage the converter unit. 	32	
The RS-485 terminals are correctly connected.	Always connect wiring to the RS-485 terminals of the master/slave inverters. If the RS-485 communication is not performed correctly, the parallel operation cannot be made.	50	
When using the electronic bypass operation, electrical and mechanical interlocks are provided between the electronic bypass contactors MC1 and MC2.	<p>When using a switching circuit as shown below, chattering due to mis-configured sequence or arc generated at switching may allow undesirable current to flow in and damage the inverter. Mis-wiring may also damage the inverter. (The commercial power supply operation is not available with vector control dedicated motors.)</p>  <p>When switching to the commercial power supply operation while a failure such as an output short circuit is occurring between the magnetic contactor MC2 and the motor, the damage may further spread. When a failure occurs between the MC2 and motor, make sure to provide a protection circuit, such as using the OH signal input.</p>	-	
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.	-	
When using the 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.)	54	
A magnetic contactor (MC) is installed on the converter unit's input side.	<p>On the converter unit's input side, connect an MC for the following purposes:</p> <ul style="list-style-type: none"> 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. <p>If using an MC for emergency stop during operation, select an MC regarding the converter unit input side current as JEM1038-AC-3 class rated current.</p>	72	
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.	72	
An EMI countermeasure is provided for the frequency setting signals.	<p>If electromagnetic noise generated from the inverter and the converter unit causes frequency setting signal to fluctuate and the motor rotation speed to be unstable when changing the motor speed with analog signals, the following countermeasures are effective:</p> <ul style="list-style-type: none"> 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 signal cables as far away as possible from power cables (inverter and converter I/O cables). Use shielded cables. Install a ferrite core on the signal cable (Example: ZCAT3035-1330 TDK). 	-	

Checklist before starting operation

Checkpoint	Countermeasure	Refer to page	Check by user
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 2 ranks).	-	
The specifications and rating match the system requirements.	Make sure that the specifications and rating match the system requirements.	-	

*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 is activated and outputs a fault signal. However, a 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.

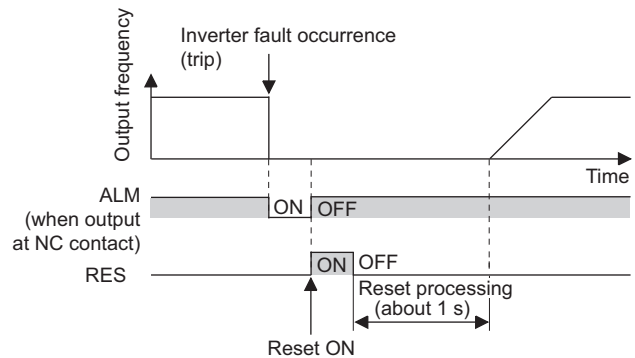
No.	Interlock method	Check method	Used signals
a	Inverter protective function operation	Operation check of an alarm contact. Circuit error detection by negative logic.	Fault (ALM) signal
b	Inverter operating status	Operation ready signal check.	Inverter operation ready (RY) signal
c	Inverter running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

(a) Checking by the output of the inverter fault signal

When the inverter's protective function is activated to shut off the inverter output, 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.)



(b) Checking the inverter operating status by the inverter operation ready completion signal

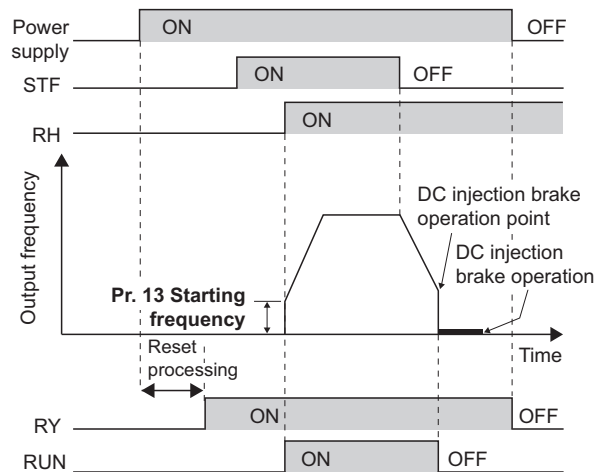
The Inverter operation ready (RY) signal is output when the inverter power is ON and the inverter becomes operative.

Check if the RY signal is output after powering ON the inverter.

(c) Checking the inverter operating status by the start signal input to the inverter and inverter running signal

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 Y12 signal is being output while inputting a start signal to the inverter. (The STF signal is a forward rotation signal, and STR is a reverse rotation signal.) 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.



Failsafe system which uses the inverter

- (d) Checking the motor operating status by the start signal input to the inverter and inverter output current detection signal
- The output current detection (Y12) signal is output when the inverter operates and current flows into the motor. Check if Y12 signal is being output while inputting a start signal to the inverter. (STF signal is a forward rotation signal, and STR is a reverse rotation signal.) The Y12 signal is initially set to be output at 150% rated inverter 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.

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

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

NOTE

- Changing the terminal assignment using **Pr.190 and Pr.196 (Output terminal function selection)** may affect the other functions. Set parameters after confirming the function of each terminal.
- For the details of the parameters and signals, refer to the FR-A800 Instruction Manual (Detailed).

◆ Backup method outside 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 signal will be output and the RUN signal will be kept ON because the inverter CPU is down.

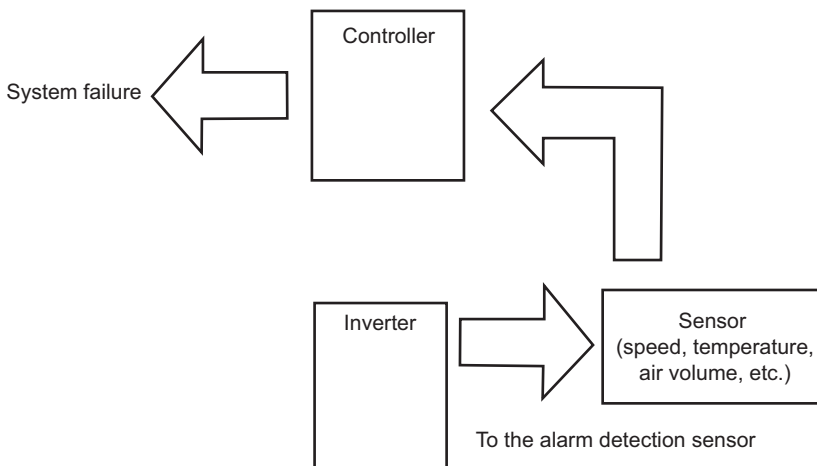
Provide a speed detector to detect the motor speed and current detector to detect the motor current and consider the backup system such as performing a check as below according to the level of importance of the system.

- (a) 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.

- (b) 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.



4 PROTECTIVE FUNCTIONS

This chapter explains the "PROTECTIVE FUNCTIONS" that operates in this product.

Always read the instructions before using the equipment.

4.1	Inverter fault and alarm indications	80
4.2	Reset method for the protective functions.....	80
4.3	Check and clear of the faults history	81
4.4	List of fault displays	83

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 below.

Displayed item	Description
Error message	A message regarding an operational fault and setting fault by the operation panel and parameter unit is displayed. 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	A protective function is activated to shut off the inverter output and output a Fault (ALM) signal.

NOTE

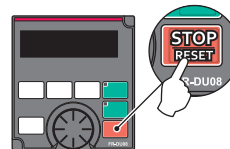
- For the details of fault displays and other malfunctions, refer to the FR-A800 Instruction Manual (Detailed).
- The past eight faults can be displayed on the operation panel. (Faults history) (For the operation, refer to [page 81](#).)

4.2 Reset method for the protective functions

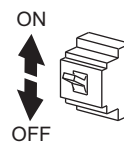
Reset the inverter by performing any of the following operations. Note that the accumulated heat value of the electronic thermal relay function is cleared (erased) by resetting the inverter.

The inverter recovers about 1 s after the reset is released.

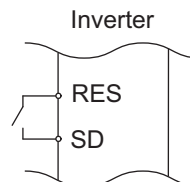
- On the operation panel, press the STOP/RESET key to reset the inverter.
(This may only be performed when a fault occurs.)



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



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



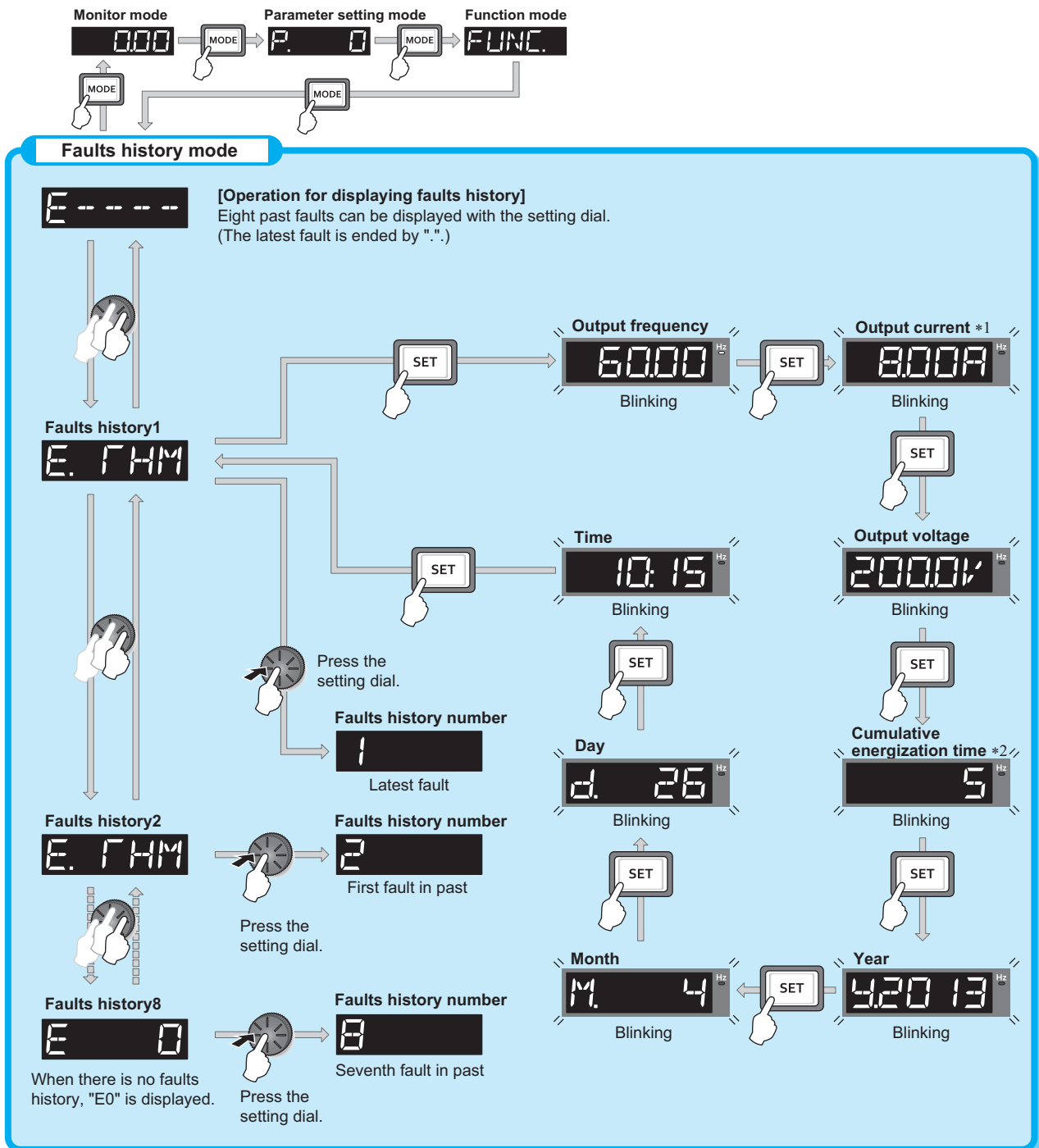
NOTE

- 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 faults history

The operation panel stores the fault indications which appears when a protective function is activated to display the fault record for the past eight faults. (Faults history)

◆ Check for the faults history



*1 When an overcurrent trip occurs by an instantaneous overcurrent, the monitored current value saved in the faults 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.









◆ Faults history clearing procedure



POINT

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

Operation

1.	Screen at power-ON The monitor display appears.
Parameter setting mode	
2.	Press  to choose the parameter setting mode. (The parameter number read previously appears.)
Selecting the parameter number	
3.	Turn  until "Err.CL" (faults history clear) appears. Press  to read the present set value. "1" (initial value) appears.
Faults history clear	
Turn  to change the set value to "1". Press  to start clear.	
"1" and "Err.CL" blink alternately after parameters are cleared.	
4.	<ul style="list-style-type: none">• Turn  to read another parameter.• Press  to show the setting again.• Press  twice to show the next parameter.

4.4 List of fault displays

Availability of the protective function for the master and the slave during the parallel operation are as follows.

○ indicates that the protective function is enabled. × indicates that the protective function is disabled.

For the details of each protective function, refer to the Instruction Manual (Detailed) of the FR-A800 or the Parallel Operation Function Manual.

Operation panel indication		Name	Master station	Slave station	
Error message	HOLD	HOLD	Operation panel lock	○	○
	LOCD	LOCD	Password locked	○	○
	Er 1 to Er 4 Er 8	Er1 to Er4 Er8	Parameter write error	○	○
	rE 1 to rE 4 rE 6 to rE 8	rE1 to rE4 rE6 to rE8	Copy operation error	○	○
	Err.	Err.	Error	○	○
	Warning	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 (output during speed limit)	○	×
CF		CF	Continuous operation during communication fault	○	×
CP		CP	Parameter copy	○	○
SA		SA	Safety stop	○	○
MF 1 to MF 3		MT1 to MT3	Maintenance timer 1 to 3	○	○
UF		UF	USB host error	○	○
HP 1		HP1	Home position return setting error	○	×
HP 2	HP2	Home position return uncompleted	○	×	
Alarm	FN	FN	Fan alarm	○	○
Fault	E. OC 1	E.OC1	Overcurrent trip during acceleration	○	×
	E. OC 2	E.OC2	Overcurrent trip during constant speed	○	×
	E. OC 3	E.OC3	Overcurrent trip during deceleration or stop	○	×
	E. OCT	E.OCT	Overcurrent trip	×	○
	E. OV 1	E.OV1	Regenerative overvoltage trip during acceleration	○	×
	E. OV 2	E.OV2	Regenerative overvoltage trip during constant speed	○	×
	E. OV 3	E.OV3	Regenerative overvoltage trip during deceleration or stop	○	×
	E. OVT	E.OVT	Overvoltage trip	×	○
	E. THF	E.THT	Inverter overload trip (electronic thermal relay function)	○	○
	E. THM	E.THM	Motor overload trip (electronic thermal relay function)	○	×
	E. FIN	E.FIN	Heatsink overheat	○	○

List of fault displays

Operation panel indication		Name	Master station	Slave station
E. OLT	E.OLT	Stall prevention stop	○	×
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. OP1 to E. OP3	E.OP1 to E.OP3	Communication option fault	○	○
E. 16 to E. 20	E.16 to E.20	User definition error by the PLC function	○	○
E. PA1	E.PA1	Parallel operation slave 1 fault	○	×
E. PA2	E.PA2	Parallel operation slave 2 fault	○	×
E. PE	E.PE	Parameter storage device fault	○	○
E. PUE	E.PUE	PU disconnection	○	○
E. PE2	E.PE2	Parameter storage device fault	○	○
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 / RS-485 terminals power supply short circuit	○	○
E. P24	E.P24	24 VDC power fault	○	○
E. CDO	E.CDO	Abnormal output current detection	○	×
E. SER	E.SER	Communication fault (inverter)	○	○
E. AIE	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. MB1 to E. MB7	E.MB1 to E.MB7	Brake sequence fault	○	×
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	○	×

Fault

Operation panel indication		Name	Master station	Slave station	
Others	E-----	E----	Faults history	<input type="radio"/>	<input type="radio"/>
	EV	EV	24 V external power supply operation	<input type="radio"/>	<input type="radio"/>
	Rd	RD	Backup in progress	<input type="radio"/>	<input type="radio"/>
	WR	WR	Restoration in progress	<input type="radio"/>	<input type="radio"/>
	SLV.1	SLV.1	Parallel operation slave 1	<input checked="" type="radio"/>	<input type="radio"/>
	SLV.2	SLV.2	Parallel operation slave 2	<input checked="" type="radio"/>	<input type="radio"/>

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

MEMO

5 PRECAUTIONS FOR MAINTENANCE AND INSPECTION

This chapter explains the "PRECAUTIONS FOR MAINTENANCE AND INSPECTION" for this product.

Always read the instructions before using the equipment.

5.1	Inspection item.....	88
5.2	Measurement of main circuit voltages, currents and powers	94

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, and then make sure that the voltage across the main circuit terminals P/+ and N/- of the inverter is not more than 30 VDC using a tester, etc.

5.1 Inspection item

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 35](#).)
- Check the conductors and insulating materials for corrosion and damage.
- Measure the insulation resistance.
- Check and change the cooling fan and relay.

5.1.3 Daily and periodic inspection

Area of inspection	Inspection item	Description	Inspection interval		Corrective action at fault occurrence	Check by the 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 voltages and control voltages are normal.*2	○		Inspect the power supply.		
Main circuit	General	(1) Check with megger (across main circuit terminals and earth (ground) terminal).		○	Contact the manufacturer.		
		(2) Check for loose screws and bolts.		○	Retighten.		
		(3) Check for overheat traces on the parts.		○	Contact the manufacturer.		
		(4) Check for stain.		○	Clean.		
	Conductors, cables	(1) Check conductors for distortion.		○	Contact the manufacturer.		
		(2) 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	(1) Check for liquid leakage.		○	Contact the manufacturer.			
	(2) Check for safety valve projection and bulge.		○	Contact the manufacturer.			
	(3) Judge by visual check		○				
Relay/contacter	Check that the operation is normal and no chattering sound is heard.		○	Contact the manufacturer.			
Control circuit, protective circuit	Operation check	(1) Check that the output voltages across phases are balanced while operating the inverter alone.		○	Contact the manufacturer.		
		(2) Check that no fault is found in protective and display circuits in a sequence protective operation test.		○	Contact the manufacturer.		
	Components check	Overall	(1) Check for unusual odor and discoloration.		○	Stop the equipment and contact the manufacturer.	
		(2) Check for serious rust development.		○	Contact the manufacturer.		
Aluminum electrolytic capacitor	(1) Check for liquid leakage in a capacitor and deformation trace.		○	Contact the manufacturer.			
	(2) Visual check and judge by the life check of the control circuit capacitor. (Refer to the FR-A800 Instruction Manual (Detailed)).		○				
Cooling system	Cooling fan	(1) Check for unusual vibration and noise.	○		Replace the fan.		
		(2) Check for loose screws and bolts.		○	Fix with the fan cover fixing screws		
(3) Check for stain.			○	Clean.			
	Heatsink	(1) Check for clogging.		○	Clean.		
(2) Check for stain.			○	Clean.			
Display	Indication	(1) Check that display is normal.	○		Contact the manufacturer.		
	(2) Check for stain.		○	Clean.			
	Meter	Check that reading is normal.	○		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.

5.1.4 Checking the inverter and converter modules

◆Preparation

- Disconnect the external power supply cables (R/L1, S/L2, T/L3) and motor cables (U, V, W). (The cables between the inverter and the converter unit, between the inverters, and between the converter units does not need to be removed.)
- Prepare a tester. (For the resistance measurement, use the 100 Ω range.)

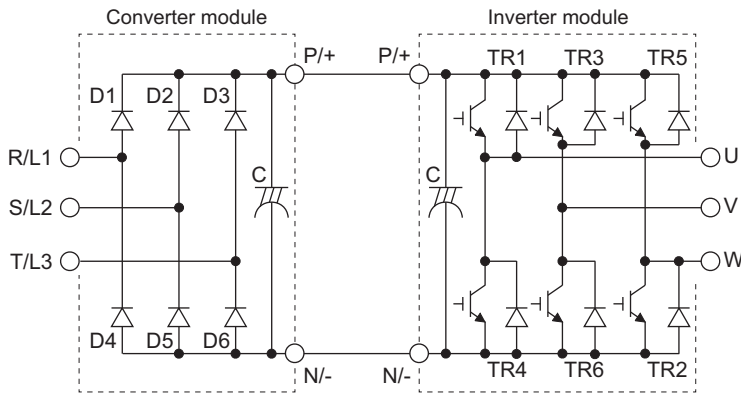
◆Checking method

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. If all measured values are almost the same, although these values are not constant depending on the module type and tester type, the modules are without fault.

◆Module device numbers and terminals to be checked



		Tester polarity		Result		Tester polarity		Result
		⊕	⊖			⊕	⊖	
Converter module	D1	R/L1, P/+		Discontinuity	D4	R/L1, N/-		Continuity
		P/+ R/L1,		Continuity		N/- R/L1,		Discontinuity
	D2	S/L2, P/+		Discontinuity	D5	S/L2, N/-		Continuity
		P/+ S/L2,		Continuity		N/- S/L2,		Discontinuity
	D3	T/L3 P/+		Discontinuity	D6	T/L3 N/-		Continuity
		P/+ T/L3		Continuity		N/- T/L3		Discontinuity
Inverter module	TR1	U P/+		Discontinuity	TR4	U N/-		Continuity
		P/+ U		Continuity		N/- U		Discontinuity
	TR3	V P/+		Discontinuity	TR6	V N/-		Continuity
		P/+ V		Continuity		N/- V		Discontinuity
	TR5	W P/+		Discontinuity	TR2	W N/-		Continuity
		P/+ W		Continuity		N/- W		Discontinuity

(Assumes the use of an analog meter.)

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 and parameter unit 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 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.

The life warning output can be used as a guideline for life judgment.

Parts	Judgment level
Control circuit capacitor	Estimated remaining life 10%
Cooling fan	Approx. less than 1700 r/min

NOTE

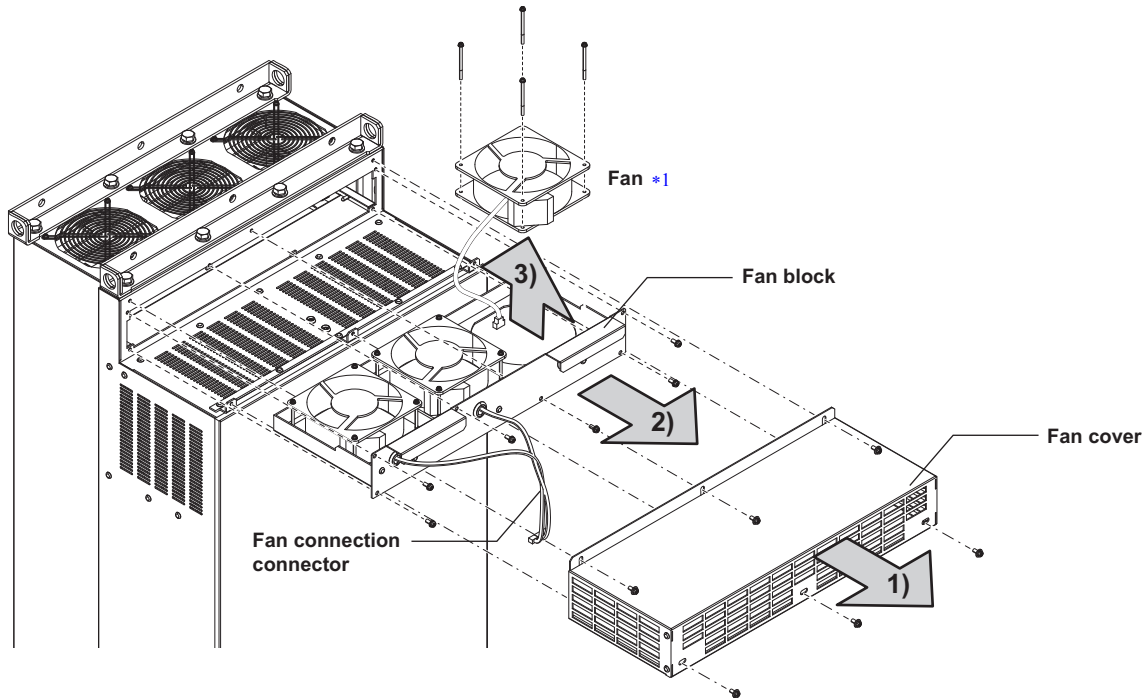
- Refer to the FR-A800 Instruction Manual (Detailed) to perform the life check of the inverter parts.

◆ 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

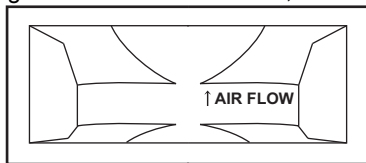
- 1) Remove the fan cover fixing screws, and remove the fan cover.
- 2) Disconnect the fan connector and remove the fan block.
- 3) Remove the fan fixing screws, and remove the fan.



*1 The number of cooling fans differs according to the inverter capacity.

◆ Reinstallation

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



<Fan side face>

- 2) For reconnection of the fan, refer to the above figure.

NOTE

- Installing the fan in the opposite direction of air flow can cause the inverter life to be shorter.
- Prevent the cable from being caught when installing a fan.
- Switch the power OFF before replacing fans. Since the inverter circuits are charged with voltage even after power OFF, replace fans only when the inverter cover is on the inverter to prevent an electric shock accident.

◆Smoothing capacitors

A large-capacity aluminum electrolytic capacitor is used for smoothing in the main circuit DC section, and an aluminum electrolytic capacitor is used for stabilizing the control power in the control circuit. Their characteristics are deteriorated by the adverse effects of ripple currents, etc. The replacement intervals greatly vary with the surrounding air temperature and operating conditions. When the inverter is operated in air-conditioned, normal environment conditions, replace the capacitors about every 10 years.

The appearance criteria for inspection are as follows:

- Case: Check the side and bottom faces for expansion.
- Sealing plate: Check for remarkable warp and extreme crack.
- Check for external crack, discoloration, liquid leakage, etc. Judge that the capacitor has reached its life when the measured capacitance of the capacitor reduced below 80% of the rating.

NOTE

- The inverter diagnoses the control circuit capacitor by itself and can judge its life. (Refer to the FR-A800 Instruction Manual (Detailed))

◆Relays

- To prevent a contact fault, etc., relays must be replaced according to the cumulative number of switching times (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. (After installing a new control terminal block, set up the control logic for input signals with the jumper connector (control logic selector). (Refer to [page 42.](#)))

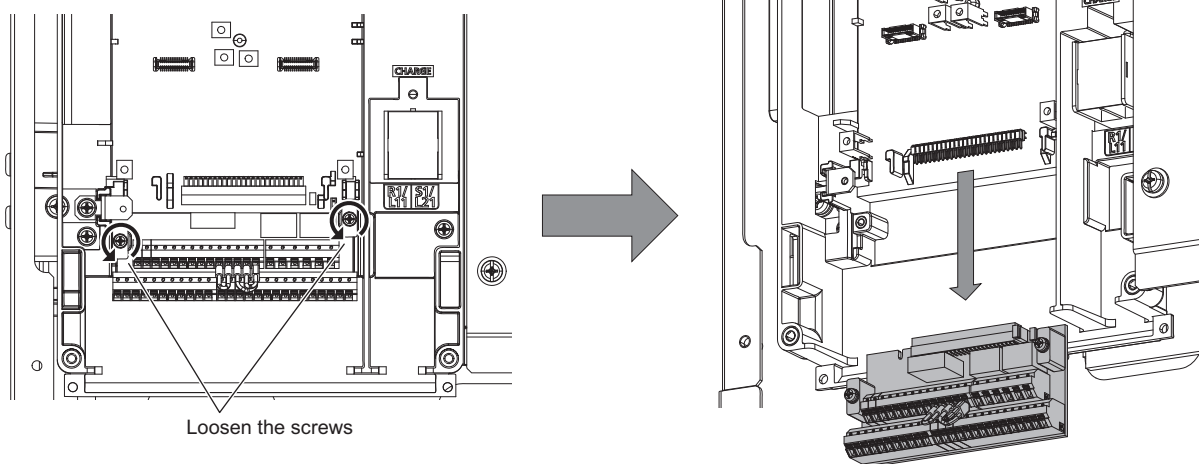
◆Main circuit fuse

A fuse is used inside the inverter. The replacement intervals vary with the surrounding air temperature and operating conditions. When the converter unit is operated in air-conditioned, normal environment conditions, replace the capacitors about every 10 years.

5.1.7 Inverter replacement

The inverter can be replaced with the control circuit wiring kept connected.

- 1) Loosen the two mounting 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 inverter replacement, switch power OFF, wait for at least 10 minutes, and then check the voltage with a tester and such to ensure safety.

5.2 Measurement of main circuit voltages, currents and powers

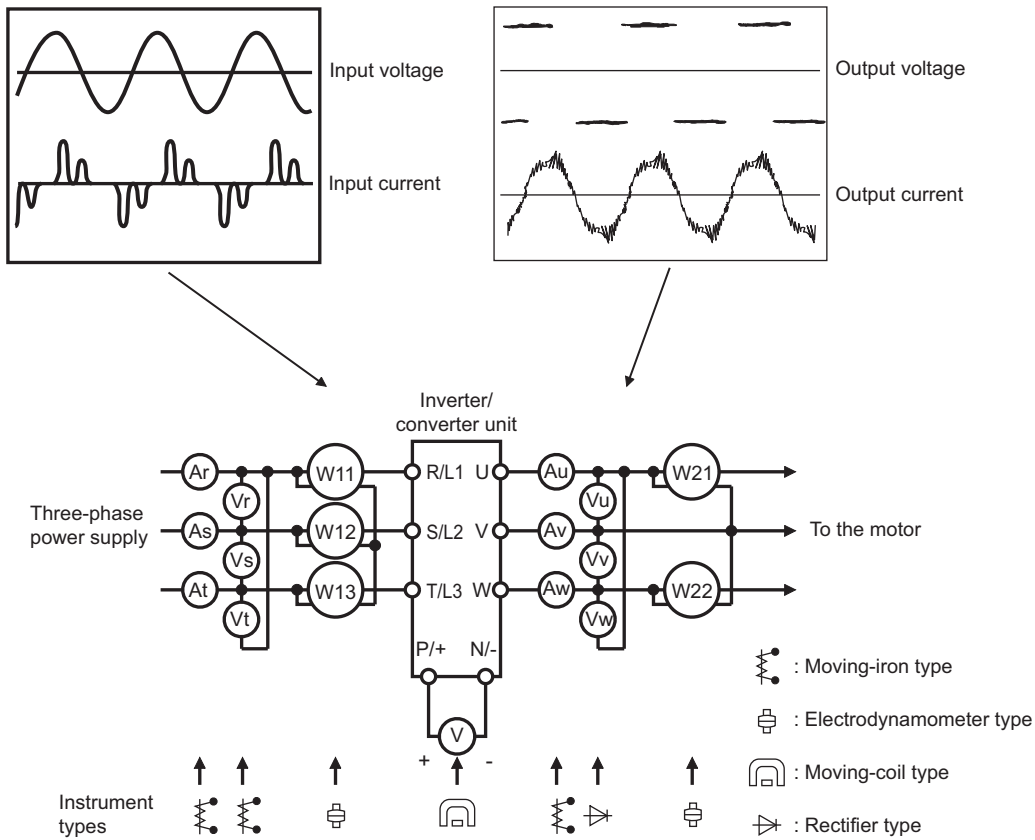
Since the voltages and currents on the inverter power supply and output sides include harmonics, measurement data depends on the instruments used and circuits measured.

When instruments for commercial frequency are used for measurement, measure the following circuits with the instruments given on the next page.

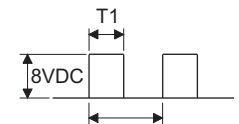
NOTE

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

◆ Examples of measuring points and instruments



◆ Measuring points and instruments

	Item	Measuring point	Measuring instrument	Remarks (reference measured value)	
Converter unit	Power supply voltage V1	Across R/L1 and S/L2, S/L2 and T/L3, T/L3 and R/L1	Moving-iron type AC voltmeter*3	Commercial power supply Within permissible AC voltage fluctuation (Refer to page 100.)	
	Power supply side current I1	R/L1, S/L2, T/L3 line current	Moving-iron type AC ammeter*3		
	Power supply side power P1	R/L1, S/L2, T/L3 and Across R/L1 and S/L2, S/L2 and T/L3, T/L3 and R/L1	Digital power meter (for inverter) or electrodynamic type single-phase wattmeter	P1 = W11 + W12 + W13 (3-wattmeter method)	
	Power supply side power factor Pf1	Calculate after measuring power supply voltage, power supply side current and power supply side power. $Pf_1 = \frac{P_1}{\sqrt{3}V_1 \times I_1} \times 100\%$			
	Converter output	Across P/+ and N/-	Moving-coil type (such as tester)	Inverter LED is lit. 1.35 × V1	
	Operation enable signal External thermal relay signal Reset signal	Across RDI, OH, RES(+) and SD (for sink logic)	Moving-coil type (tester and such may be used.) (internal resistance 50 kΩ or more)	When open 20 to 30 VDC ON voltage: 1 V or less	"SD" is common
	Alarm signal	Across A1 and C1 Across B1 and C1	Moving-coil type (such as tester)	Continuity check*2 [Normal] [Fault] Across A1 and C1 Discontinuity Continuity Across B1 and C1 Continuity Discontinuity	
Inverter	Output side voltage V2	Across U and V, V and W, and W and U	Rectifier type AC voltage meter*1*3 (moving-iron type cannot measure.)	Difference between the phases is within 1% of the maximum output voltage.	
	Output side current I2	U, V and W line currents	Moving-iron type AC ammeter*3	Difference between the phases is 10% or lower of the rated inverter current.	
	Output side power P2	U, V, W and across U and V, V and W	Digital power meter (for inverter) or electrodynamic type single-phase wattmeter	P2 = W21 + W22 2-wattmeter method (or 3-wattmeter method)	
	Output side power factor Pf2	Calculate in similar manner to power supply side power factor. $Pf_2 = \frac{P_2}{\sqrt{3}V_2 \times I_2} \times 100\%$			
	Frequency setting signal	Across 2, 4(+) and 5	Moving-coil type (tester and such may be used.) (internal resistance 50 kΩ or more)	0 to 10 VDC, 4 to 20 mA	"5" is common
		Across 1(+) and 5		0 to ±5 VDC and 0 to ±10 VDC	
	Frequency setting power supply	Across 10(+) and 5		5.2 VDC	
		Across 10E(+) and 5		10 VDC	
		Across AM(+) and 5		Approximately 10 VDC at maximum frequency (without frequency meter)	"SD" is common
		Across CA(+) and 5		Approximately 20 mADC at maximum frequency	
Frequency meter signal	Across FM(+) and SD	Approximately 5 VDC at maximum frequency (without frequency meter)		"SD" is common	
		 <p>Pulse width T1: Adjust with C0 (Pr.900). Pulse cycle T2: Set with Pr.55. (frequency monitor only)</p>			
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)	When open 20 to 30 VDC ON voltage: 1 V or less			
Fault signal	Across A1 and C1 Across B1 and C1	Moving-coil type (such as tester)		Continuity check*2 [Normal] [Fault] Across A1 and C1 Discontinuity Continuity Across B1 and C1 Continuity Discontinuity	

Measurement of main circuit voltages, currents and powers

- *1 Use an FFT to measure the output voltage accurately. A tester or general measuring instrument cannot measure accurately.
- *2 When the setting of **Pr.195 ABC1 terminal function selection** is the positive logic
- *3 A digital power meter (designed for inverter) can also be used to measure.

5.2.1 Measurement of powers

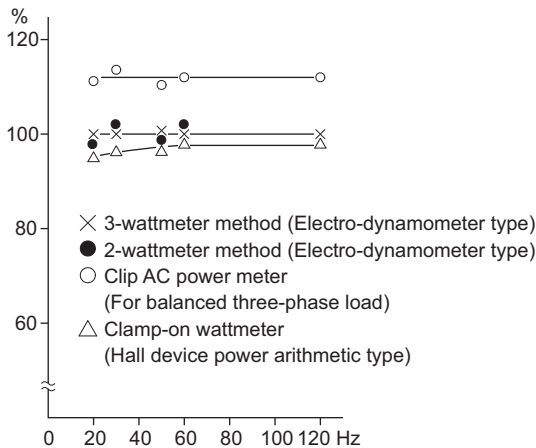
Use a digital power meter (for inverter) for the input side of the converter unit and the output side of the inverter. Alternatively, measure using electrodynamic type single-phase wattmeters for the input side of the converter unit and output side of the inverter in two-wattmeter or three-wattmeter method. As the current is liable to be imbalanced especially in the input side, it is recommended to use the three-wattmeter method.

Examples of measured value differences produced by different measuring meters are shown below.

An error will be produced by difference between measuring instruments, e.g. power calculation type and two- or three-wattmeter type three-phase wattmeter. When a CT is used in the current measuring side or when the meter contains a PT on the voltage measurement side, an error will also be produced due to the frequency characteristics of the CT and PT.

[Measurement conditions]

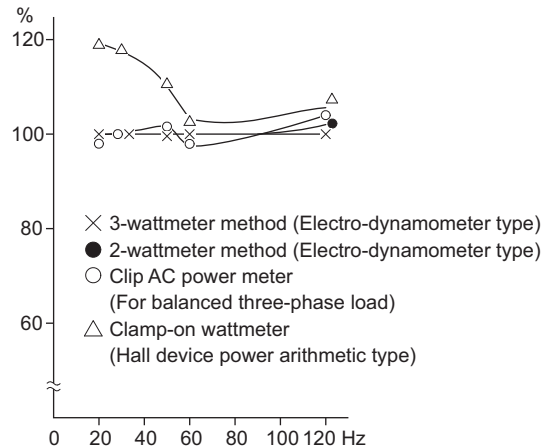
Constant output of 60 Hz or more frequency with a constant-torque (100%). The value obtained by the 3-wattmeter method with a 4-pole 3.7 kW induction motor is assumed to be 100%.



Example of measuring inverter input power

[Measurement conditions]

Constant output of 60 Hz or more frequency with a constant-torque (100%). The value obtained by the 3-wattmeter method with a 4-pole 3.7 kW induction motor is assumed to be 100%.



Example of measuring inverter output power

5.2.2 Measurement of voltages and use of PT

◆ Converter unit input side

As the input side voltage has a sine wave and it is extremely small in distortion, accurate measurement can be made with an ordinary AC meter.

◆ Inverter output side

Since the output side voltage has a PWM-controlled rectangular wave, always use a rectifier type voltmeter. A needle type tester cannot be used to measure the output side voltage as it indicates a value much greater than the actual value. A moving-iron type meter indicates an effective value which includes harmonics and therefore the value is larger than that of the fundamental wave. The value monitored on the operation panel is the inverter-controlled voltage itself. Hence, that value is accurate and it is recommended to monitor values (analog output) using the operation panel.

◆ PT

No PT can be used in the output side of the inverter. Use a direct-reading meter. (A PT can be used in the input side of the converter unit.)

5.2.3 Measurement of currents

Use moving-iron type meter on the input side of the converter unit and the output side of the inverter.

Since current on the converter unit input side tends to be unbalanced, measurement of three phases is recommended.

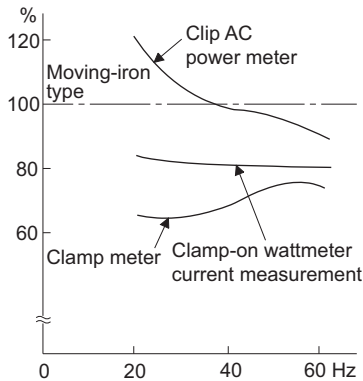
Correct value cannot be obtained by measuring only one or two phases. On the other hand, the unbalanced ratio of each phase of the output side current should be within 10%.

When a clamp ammeter is used, always use an effective value detection type. A mean value detection type produces a large error and may indicate an extremely smaller value than the actual value. The value monitored on the operation panel is accurate if the output frequency varies, and it is recommended to monitor values (provide analog output) using the operation panel.

Examples of measured value differences produced by different measuring meters are shown below.

[Measurement conditions]

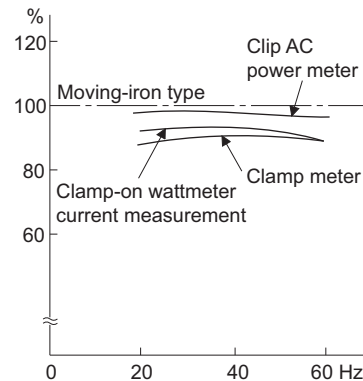
Indicated value of the moving-iron type ammeter is 100%.



Example of measuring converter unit input current

[Measurement conditions]

Indicated value of the moving-iron type ammeter is 100%.



Example of measuring inverter output current

5.2.4 Use of CT and transducer

A CT may be used in both the input side of the converter unit and the output side of the inverter. Use the one with the largest possible VA ability because an error will increase if the frequency gets lower.

When using a transducer, use the effective value calculation type which is immune to harmonics.

5.2.5 Example of measuring converter unit input power factor

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

$$\begin{aligned} \text{Total power factor of the converter unit} &= \frac{\text{Effective power}}{\text{Apparent power}} \\ &= \frac{\text{Three-phase input power found by the 3-wattmeter method}}{\sqrt{3} \times V (\text{power supply voltage}) \times I (\text{input current effective value})} \end{aligned}$$

5.2.6 Measurement of converter output voltage (across terminals P and N)

The output voltage of the converter is output across terminals P and N and can be measured with a moving-coil type meter (tester). Although the voltage varies according to the power supply voltage, approximately 540 to 600 V is output when no load is connected and voltage decreases during driving load operation.

When energy is regenerated from the motor during deceleration, for example, the converter output voltage rises to nearly 800 to 900 V maximum.

5.2.7 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 of the inverter. This pulse train output can be counted by a frequency counter, or a meter (moving-coil type voltmeter) can be used to read the mean value of the pulse train output voltage. When a meter 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 (Detailed).

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 of the inverter. Measure the current using an ammeter or tester.

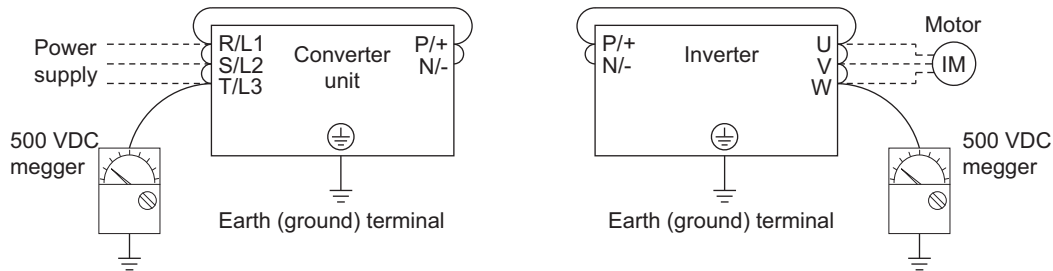
For detailed specifications of the analog current output terminal CA, refer to the FR-A800 Instruction Manual (Detailed).

5.2.8 Insulation resistance test using megger

- For the inverter and the converter unit, conduct the insulation resistance test on the main circuit only as shown below 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 (high resistance range) and do not use the megger or buzzer.



5.2.9 Pressure test

Do not conduct a pressure test. Deterioration may occur.

6 SPECIFICATIONS

This chapter explains the "SPECIFICATIONS" of this product.
Always read the instructions before using the equipment.

6.1	Inverter rating.....	100
6.2	Common specifications	101
6.3	Outline dimension drawings.....	103

6.1 Inverter rating

Model FR-A842-[]-P		Two in parallel			Three in parallel			
		400K	450K	500K	400K	450K	500K	
		09620	10940	12120	09620	10940	12120	
Applicable motor capacity (kW)	LD	710	800	900	1065	1200	1350	
	ND (initial setting)	630	710	800	945	1065	1200	
Output	Rated capacity (kVA) *1	LD	1056	1173	1334	1584	1759	2002
		ND (initial setting)	939	1056	1173	1409	1584	1759
	Rated current (A)*2	LD	1386	1539	1750	2078	2309	2626
		ND (initial setting)	1232	1386	1539	1848	2078	2309
	Overload current rating*3	LD	120% 60 s, 150% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C					
		ND (initial setting)	150% 60 s, 200% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C					
Rated voltage*4		Three-phase 380 to 500 V						
Regenerative braking torque*5 (When the converter unit is used)	Maximum brake torque	10% torque/continuous						
Input power	DC power supply voltage		430 to 780 VDC					
	Control power supply auxiliary input		Single phase 380 to 500 V 50/60 Hz*6					
	Permissible control power supply auxiliary input fluctuation		Frequency ±5%, voltage ±10%					
Protective structure (IEC 60529)*7		Open type (IP00)						
Cooling system		Forced air cooling						
Approx. mass (kg)*8		486	486	486	729	729	729	

- *1 The rated output capacity indicated assumes that the output voltage is 440 V.
- *2 Total output current of the inverters operated in parallel
- *3 The % value of the overload current rating indicated 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.
- *4 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 $\sqrt{2}$.
- *5 ND rating reference value
- *6 For the power voltage exceeding 480 V, set **Pr.977 Input voltage mode selection**. (For details, refer to the FR-A800 Instruction Manual (Detailed).)
- *7 FR-DU08: IP40 (except for the PU connector section)
- *8 Total mass of the inverters operated in parallel

6.2 Common specifications

Control specifications	Control method		Soft-PWM control, PWM control (selectable among V/F control, Advanced magnetic flux vector control, Real sensorless vector control), and vector control ¹
	Output frequency range		0.2 to 120 Hz
	Frequency setting resolution	Analog input	0.015 Hz/60 Hz (terminal 2, 4: 0 to 10 V/12 bits) 0.03 Hz/60 Hz (0 to 5 V/11 bits or 0 to 20 mA/approx. 11 bits for terminals 2 and 4, 0 to ±10 V/12 bits for terminal 1) 0.06 Hz/60 Hz (0 to ±5 V/11 bits for terminal 1)
		Digital input	0.01 Hz
	Frequency accuracy	Analog input	Within ±0.2% of the max. output frequency (25°C ±10°C)
		Digital input	Within 0.01% of the set output frequency
	Voltage/frequency characteristics		Base frequency can be set from 0 to 120 Hz. Constant-torque/variable-torque pattern or adjustable 5 points V/F can be selected.
	Starting torque		LD rating: 150% 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 (LD rating: 0 to 150%, 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 specifications	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) are available. Terminal 1: -10 to +10 V, -5 to 5 V are available.
		Digital input	Input using the setting dial of the operation panel or parameter unit Four-digit BCD or 16-bit binary (when used with option FR-A8AX)
	Start signal		Forward and reverse rotation or start signal automatic self-holding input (3-wire input) can be selected.
	Input signals (twelve terminals)		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 input signal can be changed using Pr.178 to Pr.189 (Input terminal function selection) .
	Pulse train input		100 kpps
	Operational functions		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, forward/reverse rotation prevention, operation mode selection, slip compensation, droop control, load torque high-speed frequency control, speed smoothing control, traverse, applied motor selection, gain tuning, RS-485 communication, PID control, PID pre-charge function, easy dancer control, cooling fan operation selection, stop selection (deceleration stop/coasting), 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, vibration control
	Output signal		
	Open collector output (five terminals)		Inverter running, Up to frequency, Overload warning, Output frequency detection, Fault The output signal can be changed using Pr.190 to Pr.196 (Output terminal function selection) .
	Relay output (two terminals)		Fault codes of the inverter can be output (4 bits) from the open collector.
	Pulse train output		50 kpps
Indication	For meter	Pulse train output (FM type)	Max. 2.4 kHz: one terminal (output frequency) The monitored item can be changed using Pr.54 FM/CA terminal function selection .
		Current output (CA type)	Max. 20 mADC: one terminal (output current) The monitored item can be changed using Pr.54 FM/CA terminal function selection .
		Voltage output	Max. 10 VDC: one terminal (output voltage) The monitored item can be changed using Pr.158 AM terminal function selection .
	Operation panel (FR-DU08)	Operating status	Output frequency, output current, output voltage, frequency setting value The monitored item can be changed using Pr.52 Operation panel main monitor selection .
Fault record		Fault record is displayed when a fault occurs. Past 8 fault records and the conditions immediately before the fault (output voltage/current/frequency/cumulative energization time/year/month/date/time) are saved.	
Protective/warning function	Protective function		Overcurrent trip during acceleration, Overcurrent trip during constant speed, Overcurrent trip during deceleration or stop, Overcurrent trip, Regenerative overvoltage trip during acceleration, Regenerative overvoltage trip during constant speed, Regenerative overvoltage trip during deceleration or stop, Overvoltage trip, Inverter overload trip (electronic thermal relay function), Motor overload trip (electronic thermal relay function), Heatsink overheat, Stall prevention stop, 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, PU disconnection ⁵ , Parameter storage device fault, CPU fault, Operation panel power supply short circuit / RS-485 terminals power supply short circuit, 24 VDC power fault, Abnormal output current detection ⁵ , Communication fault (inverter), Analog input fault, USB communication fault, Overspeed occurrence ⁵ , Speed deviation excess detection ¹ ⁵ , Signal loss detection ¹ ⁵ , Excessive position fault ¹ ⁵ , Brake sequence fault ⁵ , 4 mA input fault ⁵ , Pre-charge fault ⁵ , PID signal fault ⁵ , Opposite rotation deceleration fault ⁵ , Internal circuit fault
	Warning function		Fan alarm, Stall prevention (overcurrent), Stall prevention (overvoltage), Electronic thermal relay function pre-alarm, PU stop, Speed limit indication (output during speed limit) ⁵ , Parameter copy, Maintenance timer 1 to 3 ⁵ , USB host error, Home position return setting error ¹ ⁵ , Home position return uncompleted ¹ 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 ⁵

Common specifications

Environment	Surrounding air temperature	-10°C to +50°C (non-freezing)
	Surrounding air humidity	95% RH or less (non-condensing) (With circuit board coating (conforming to IEC60721-3-3 3C2/3S2)) 90% RH or less (non-condensing) (Without circuit board coating)
	Storage temperature*3	-20°C to +65°C
	Atmosphere	Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt, etc.)
	Altitude/vibration	Maximum 1000 m, 2.9 m/s ² or less*4 at 10 to 55 Hz (directions of X, Y, Z axes)

*1 Available only when a vector control compatible option is mounted.

*2 In the initial setting, it is limited to 150% by the torque limit level.

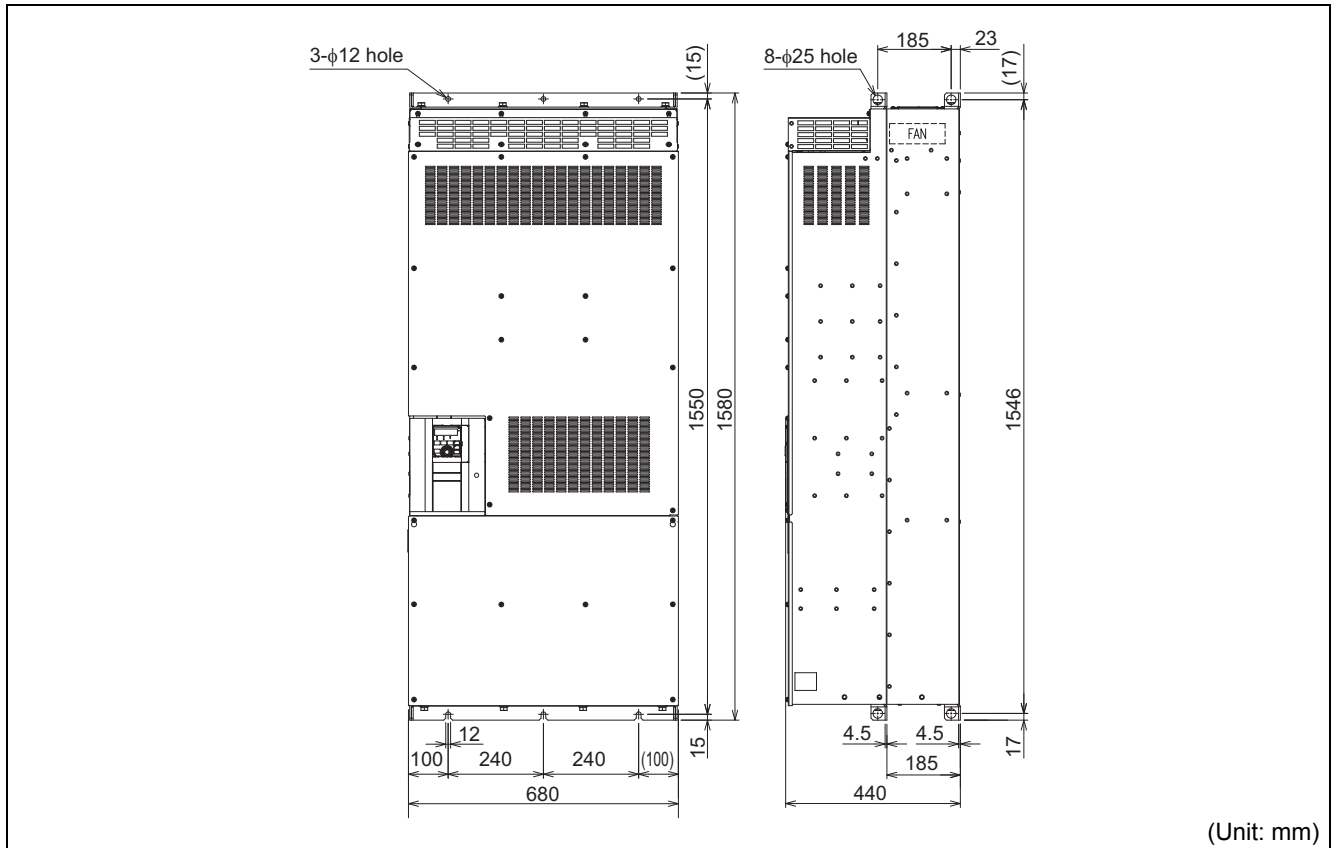
*3 Temperature applicable for a short time, e.g. in transit.

*4 For the installation at an altitude above 1000 m (up to 2500 m), consider a 3% reduction in the rated current per altitude increase of 500 m.

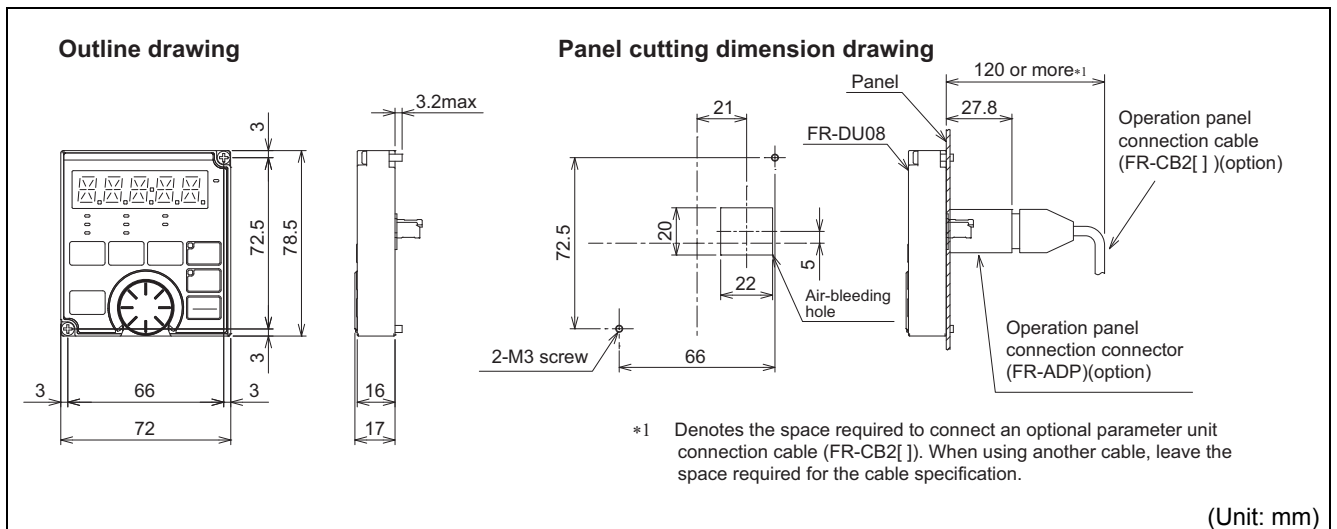
*5 This protective function is not available in the initial status.

6.3 Outline dimension drawings

FR-A842-09620(400K), 10940(450K), 12120(500K)-P



Operation panel (FR-DU08)



MEMO



APPENDIX

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

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Appendix 2 Instructions for UL and cUL	109
Appendix 3 Instructions for EAC	111
Appendix 4 Restricted Use of Hazardous Substances in Electronic and Electrical Products	112

Appendix 1 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.

Company name: Mitsubishi Electric Europe B.V.

Address: Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

- Note

We declare that this inverter conforms with the EMC Directive in industrial environments and affix the CE marking on the inverter. When using the inverter in a residential area, take appropriate measures and ensure the conformity of the inverter used in the residential area.

◆ EMC Directive

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

- EMC Directive 2004/108/EC
- Standard(s): EN61800-3:2004 (Second environment / PDS Category "C3")
- Please ensure you chose the right inverter for the intended environment.
- 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

Set the EMC filter valid and install the inverter and perform wiring according to the following instructions.

- The converter unit is equipped with an EMC filter. Enable the EMC filter. (For details, refer to [page 68](#).)
- Connect the inverter and the converter unit to an earthed power supply.
- Install a motor and a control cable written in the EMC Installation Manual (BCN-A21041-204) and Technical News (MF-S-138) according to the instruction.
- Confirm that the inverter and the converter unit conform with the EMC Directive as the industrial drives application for final installation.

◆ Low Voltage Directive

We have self-confirmed our inverters as products compliant to the Low Voltage Directive (Conforming standard EN 61800-5-1) and affix the CE marking on the inverters.

◆ Outline of instructions

- Do not use an earth leakage current 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 35](#) under the following conditions.
 - Surrounding air temperature 40°C maximum
 If conditions are different from above, select appropriate wire according to EN60204 Appendix C TABLE 5.
- 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 35](#).
- 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 (RDC) or residual current monitor (RDM), connect a type B RCD or RCM to the power supply side.
- Use the inverter under the conditions of overvoltage category II (usable regardless of the earth (ground) condition of the power supply), overvoltage category III (usable with the earthed-neutral system power supply, 400 V class only) and pollution degree 2 or lower specified in IEC60664.
 - 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 type and size set forth in EN60204 Appendix C.
- 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 24](#) are safely isolated from the main circuit.
- Environment (For the detail, refer to [page 17](#).)

	During operation	In storage	During transportation
Surrounding air temperature	-10 to +40°C	-20 to +65°C	-20 to +65°C
Ambient humidity	95%RH or less	95%RH or less	95%RH or less
Maximum altitude	2500 m	2500 m	10000 m

◆ Wiring protection

Class T, Class J, Class CC, or Class L fuse must be provided.

FR-CC2-[]-P	H400K	H450K	H500K	H560K
Rated fuse voltage (V)	500 V or more			
Fuse maximum allowable rating (A) *1	1350	1500	1800	1800

*1 Maximum allowable rating by US National Electrical Code. Exact size must be chosen for each installation.

◆ Short circuit ratings

Suitable For Use in A Circuit Capable of Delivering Not More Than 100 kA rms Symmetrical Amperes, 500 V Maximum.

◆ Rated specifications per inverter

The following table shows the rated specifications per inverter. (For the rated specifications for operating two or three inverters in parallel, refer to [page 100](#).)

Model FR-A842-[J-P		400K	450K	500K
		09620	10940	12120
Applicable motor capacity (kW)*1	LD	360	400	450
	ND (initial setting)	320	360	400
Output	Rated capacity (kVA)*2	LD	470	528
		ND (initial setting)	417	470
	Rated current (A)	LD	692.8	769.6
		ND (initial setting)	616	692.8
	Overload current rating*3	LD	120% 60 s, 150% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C	
		ND (initial setting)	150% 60 s, 200% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C	
Rated voltage*4		Three-phase 380 to 500 V		
Input power	DC power supply voltage	430 to 780 VDC		
	Control power supply auxiliary input	Single phase 380 to 500 V 50/60 Hz*6		
	Permissible control power supply auxiliary input fluctuation	Frequency ±5%, voltage ±10%		
Protective structure (IEC 60529)*5		Open type (IP00)		
Approx. mass (kg)		243	243	243

*1 The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.

*2 The rated output capacity indicated assumes that the output voltage is 440 V.

*3 The % value of the overload current rating indicated 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.

*4 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 $\sqrt{2}$.

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

*6 For the power voltage exceeding 480 V, set **Pr.977 Input voltage mode selection**. (For details, refer to the FR-A800 Instruction Manual (Detailed).)

Appendix 2 Instructions for UL and cUL

(Standard to comply with: UL 508C, CSA C22.2 No.14)

◆ 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.

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.

◆ Installation

The FR-A802 inverters with the below types of converter unit 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 17.](#))

◆ Wiring protection

For installation in the United States, Class T, Class J, Class CC, or Class L fuse must be provided, in accordance with the National Electrical Code and any applicable local codes.

For installation in Canada, Class T, Class J, Class CC, or Class L fuse must be provided, in accordance with the Canadian Electrical Code and any applicable local codes.

FR-CC2-[]-P	H400K	H450K	H500K	H560K
Rated fuse voltage (V)	500 V or more			
Fuse maximum allowable rating (A) *1	1350	1500	1800	1800

*1 Maximum allowable rating by US National Electrical Code. Exact size must be chosen for each installation.

◆ Wiring to the power supply and the motor

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 crimping terminals. Crimp the crimping terminals with the crimping tool recommended by the terminal manufacturer.

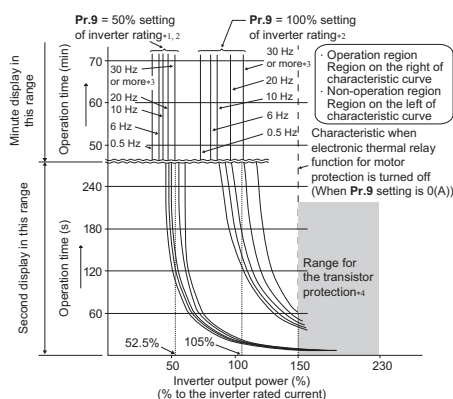
◆ Short circuit ratings

Suitable For Use in A Circuit Capable of Delivering Not More Than 100 kA rms Symmetrical Amperes, 500 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**.

Operation characteristics of electronic thermal relay function



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

- Mitsubishi constant-torque motor

- (1) Set one of "1", "13" to "16" in **Pr.71**. (This setting will enable the 100% constant-torque characteristic in the low-speed range.)
- (2) Set the rated current of the motor in **Pr.9**.

- *1 When a value 50% of the inverter rated output current (current value) is set in **Pr.9**
- *2 The % value denotes the percentage to the rated inverter current. It is not the percentage to the rated motor current.
- *3 When you set the electronic thermal relay function dedicated to the Mitsubishi constant-torque motor, this characteristic curve applies to operation at 6 Hz or higher.
- *4 Transistor protection is activated depending on the temperature of the heatsink. 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 relay function is reset by inverter power reset and reset signal input. Avoid unnecessary reset and power-OFF.
- When the inverter is used to drive a multi-pole motor or a dedicated motor, install an external thermal relay (OCR) between the inverter and the motor. Note that the current indicated on the motor rating plate is affected by the line-to-line leakage current (refer to the FR-A800 Instruction Manual (Detailed)) when selecting the setting for an external thermal relay.
- 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 an electronic thermal O/L relay. Use an external thermal relay.
- Motor over temperature sensing is not provided by the drive.

◆ Rated specifications per inverter

The following table shows the rated specifications per inverter. (For the rated specifications for operating two or three inverters in parallel, refer to [page 100](#).)

Model FR-A842-[]-P		400K	450K	500K
		09620	10940	12120
Applicable motor capacity (kW)*1	LD	360	400	450
	ND (initial setting)	320	360	400
Output	Rated capacity (kVA)*2	LD	470	528
		ND (initial setting)	417	470
Output	Rated current (A)	LD	692.8	769.6
		ND (initial setting)	616	692.8
Output	Overload current rating*3	LD	120% 60 s, 150% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C	
		ND (initial setting)	150% 60 s, 200% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C	
Rated voltage*4		Three-phase 380 to 500 V		
Input power	DC power supply voltage	430 to 780 VDC		
	Control power supply auxiliary input	Single phase 380 to 500 V 50/60 Hz*6		
	Permissible control power supply auxiliary input fluctuation	Frequency ±5%, voltage ±10%		
Protective structure (IEC 60529)*5		Open type (IP00)		
Approx. mass (kg)		243	243	243

- *1 The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.
- *2 The rated output capacity indicated assumes that the output voltage is 440 V.
- *3 The % value of the overload current rating indicated 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.
- *4 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 $\sqrt{2}$.
- *5 FR-DU08: IP40 (except for the PU connector section)
- *6 For the power voltage exceeding 480 V, set **Pr.977 Input voltage mode selection**. (For details, refer to the FR-A800 Instruction Manual (Detailed).)

Appendix 3 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 8](#).)

Example: MADE IN JAPAN

- Manufactured year and month

Check the SERIAL number indicated on the rating plate of the product. (Refer to [page 8](#).)

- 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

Appendix 4 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。

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 shall not be liable for compensation to:

- (1) Damages caused by any cause found not to be the responsibility of Mitsubishi.
- (2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products.
- (3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi 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 copies of the manuals related to this product.

◆ Before using the enclosed CD-ROM

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- Warranty

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



- 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	Specifications
OS	Microsoft® Windows Vista®, Windows® 7, Windows® 8, Windows® 8.1 or Windows® 10
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	800×600 dots 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 a personal computer and place the enclosed CD-ROM in the CD-ROM drive.
 - Step 2. The main window automatically opens by the web browser.
 - Step 3. Choose your language from a language select menu.
 - Step 4. Click a manual you want to read in the "INSTRUCTION MANUAL" list.
 - Step 5. PDF manual you clicked opens.
- Manual opening of the enclosed CD-ROM
 - Step 1. Start a personal computer and place the enclosed CD-ROM in the CD-ROM drive.
 - Step 2. Open "index.html" file in the enclosed CD-ROM.
 - Step 3. The main window opens by the web browser. Follow the instructions from Step 3 of "How to read instruction manuals".
- PDF data of the instruction manual are stored in "MANUAL" folder on the enclosed CD-ROM.

MEMO

REVISIONS

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

Print Date	*Manual Number	Revision
Nov. 2016	IB(NA)-0600651ENG-A	First edition

⚠ For Maximum Safety

- Mitsubishi inverters are not designed or manufactured to be used in equipment or systems in situations that can affect or endanger human life.
- When considering this product for operation in special applications such as machinery or systems used in passenger transportation, medical, aerospace, atomic power, electric power, or submarine repeating applications, please contact your nearest Mitsubishi sales representative.
- Although this product was manufactured under conditions of strict quality control, you are strongly advised to install safety devices to prevent serious accidents when it is used in facilities where breakdowns of the product are likely to cause a serious accident.
- Please do not use this product for loads other than three-phase induction motors.

mitsubishi electric corporation
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