MITSUBISHI ELECTRIC

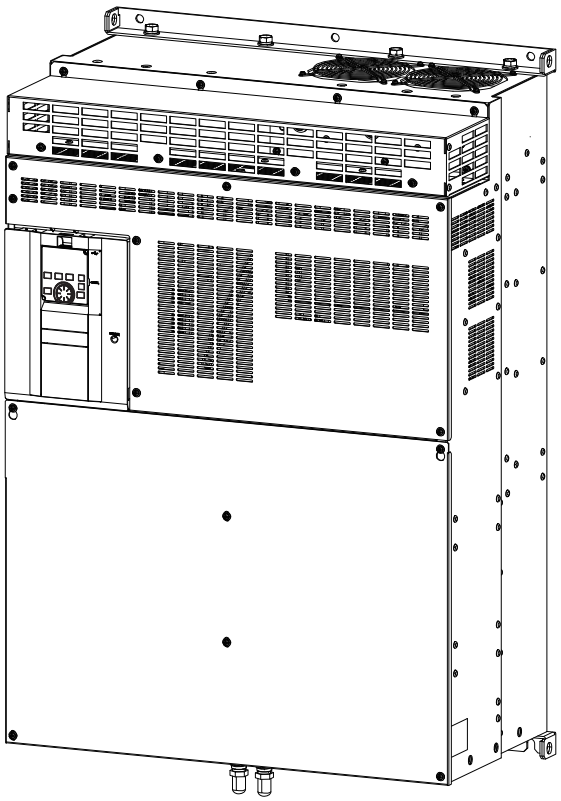
INVERTER

A800 Plus

FR-A840-LC (LIQUID COOLED TYPE) INSTRUCTION MANUAL (HARDWARE)

High functionality and high performance

FR-A840-03250(110K) to 06830(280K)-LC



INTRODUCTION 1

INSTALLATION AND WIRING 2

PRECAUTIONS FOR USE OF THE INVERTER 3

PRECAUTIONS FOR MAINTENANCE AND INSPECTION 4

SPECIFICATIONS 5

Thank you for choosing Mitsubishi Electric inverter.
This Instruction Manual describes handling and cautions about the hardware, such as installation and wiring, for the FR-A840-LC (liquid cooled type).
Information about the software, such as basic operations and parameters, is described in the Instruction Manual (Detailed) and the Safety Stop Function Instruction Manual. For details on Ethernet communication, refer to the Ethernet Function Manual. In addition to this manual, read these instruction manuals carefully to ensure proper use. Do not use this product until you have a full knowledge of this product mechanism, safety information and instructions.
The manuals can be downloaded in PDF form from the Mitsubishi Electric FA Global Website.
Please forward this Instruction Manual to the end user.
https://www.MitsubishiElectric.com/fa/products/drv/inv/support/a800/a800lc.html

Safety instructions

Do not attempt to install, operate, maintain or inspect this product until you have read the Instruction Manuals and appended documents carefully. Do not use this product until you have a full knowledge of this product mechanism, safety information and instructions.
Installation, operation, maintenance and inspection must be performed by qualified personnel. Here, qualified personnel means a person who meets all the following conditions:
• A person who possesses a certification in regard with electric appliance handling, or person took a proper engineering training. Such training may be available at your local Mitsubishi Electric office. Contact your local sales office for schedules and locations.
• A person who can access operating manuals for the protective devices (for example, light curtain) connected to the safety control system, or a person who has read these manuals thoroughly and familiarized themselves with the protective devices.

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

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

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

◆ Electric shock prevention

⚠WARNING

- Do not remove the front cover or the wiring cover while the power of this product is ON, and do not run this product with the front cover or the wiring cover removed as the exposed high voltage terminals or the charging part of the circuitry can be touched. Otherwise you may get an electric shock.
- Even if power is OFF, do not remove the front cover except for wiring or periodic inspection as the inside of this product is charged. Otherwise you may get an electric shock.
- Before wiring or inspection, check that the LED display of the operation panel is OFF. Any person who is involved in wiring or inspection shall wait for 10 minutes or longer after the power supply has been cut off, and check that there are no residual voltage using a tester or the like. The capacitor is charged with high voltage for some time after power OFF, and it is dangerous.
- This product must be earthed (grounded). Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code (NEC section 250, IEC 61140 class 1 and other applicable standards).
- Any person who is involved in wiring or inspection of this product shall be fully competent to do the work.
- This product body must be installed before wiring. Otherwise you may get an electric shock or be injured.
- Setting dial and key operations must be performed with dry hands to prevent an electric shock. Otherwise, electric shock may result.
- 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 as it is dangerous.
- Do not touch the printed circuit board or handle the cables with wet hands. Otherwise you may get an electric shock.
- Before wiring or inspection for a PM motor, confirm that the PM motor is stopped as a PM motor is a synchronous motor with high-performance magnets embedded inside and high-voltage is generated at the motor terminals while the motor is running even after the power of this product is turned OFF. In an application, such as fan and blower, that the motor may be driven by the load, connect a low-voltage manual contactor at the output side of this product and keep it open during wiring and inspection of this product. Otherwise you may get an electric shock.
- Never touch the motor terminals, etc. right after powering OFF as the DC voltage is applied to the motor for 1 second at powering OFF if the main circuit capacitor capacity is measured. Doing so may cause an electric shock.

◆ **Fire prevention**

⚠CAUTION

- This product must be installed on a nonflammable wall without any through holes so that nobody touches the heatsink, etc. on the rear side of this product. Installing it on or near flammable material may cause a fire.
- If this product has become faulty, the product power must be switched OFF. A continuous flow of large current may cause a fire.
- Do not connect a resistor directly to the DC terminals P/+ and N/-. Doing so could cause a fire.
- Be sure to perform daily and periodic inspections as specified in the Instruction Manual. If this 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 as 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 this product as it will be extremely hot. Touching these devices may cause a burn.
- As some sections on this product such as the coolant or piping port can be heated to high temperatures during operation or while the cooling system does not yet work fully, do not touch the product until it becomes certain that the product temperature is within a safe range. Touching these devices may cause a burn.

◆ **Additional instructions**

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

⚠ CAUTION

Transportation and installation

- Any person who is opening a package using a sharp object, such as a knife or cutter, must wear gloves to prevent injuries caused by the edge of the sharp object.
- This product must be transported in correct method that corresponds to the weight. Failure to do so may lead to injuries.
- Do not stand or place any heavy object on this product.
- Do not stack the boxes containing this product higher than the number recommended.
- When carrying this product, do not hold it by the front cover. Doing so may cause a fall or failure of the product.
- During installation, caution must be taken not to drop this product as doing so may cause injuries.
- This product must be installed on the surface that withstands the weight of the product.
- Do not install this product on a hot surface.
- The installing orientation of this product must be correct.
- This product must be installed on a strong surface securely with screws so that it does not drop.
- Do not install or operate this product if it is damaged or has parts missing.
- Foreign conductive objects must be prevented from entering this product. That includes screws and metal fragments or other flammable substance such as oil.
- As this product is a precision instrument, do not drop or subject it to impact.
- The surrounding air temperature must be between -10 and +50°C (non-freezing). Otherwise this product may be damaged.
- The ambient humidity must be 95% RH or less (non-condensing) for this product. Otherwise the product may be damaged. (Refer to page 19 for details.)
- Use the specified coolant for cooling the liquid cooled type product (FR-[ ]-LC). Otherwise the product may be damaged.
- The temporary storage temperature (applicable to a short limited time such as a transportation time) must be between -20 and +65°C. Otherwise this product may be damaged.
- This product must be used indoors (without corrosive gas, flammable gas, oil mist, dust and dirt). Otherwise the product may be damaged.
- This product must be used at an altitude of 2000 m or less, with 2.9 m/s^2 or less vibration at 10 to 55 Hz (directions of X, Y, Z axes). Otherwise the product may be damaged. (For the installation at an altitude above 1000 m, consider a 3% reduction in the rated current per 500 m increase in altitude.)
- If halogen-based materials (fluorine, chlorine, bromine, iodine, etc.), included in fumigants to sterilize or disinfect wooden packages, infiltrate into this product, the product may be damaged. Prevent residual fumigant components from being infiltrated into the product when packaging, or use an alternative sterilization or disinfection method (heat disinfection, etc.). Note that sterilization or disinfection of wooden package should be performed before packing the product.

⚠ CAUTION

Wiring

- Do not install a power factor correction capacitor, surge absorber, or radio noise filter on the output side of this product. Doing so may be overheated or burn out.
- The output of this product (output terminals U, V, W) must be correctly connected to a motor. Otherwise the motor rotates inversely.
- Even after the power of this product is turned OFF, a PM motor is running for a while and the output terminals U, V, and W of this product wired to the PM motor hold high voltages all that while. Before wiring other terminals, be sure that the PM motor is stopped. Otherwise you may get an electric shock.
- Never connect a PM motor to the commercial power supply. Applying the commercial power to the input terminals (U, V, W) on a PM motor will burn the PM motor. The PM motor must be applied a power from this product with the output terminals (U, V, W).

Test operation

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

⚠ WARNING

Usage

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

⚠ CAUTION

Usage

- The electronic thermal O/L relay function may not be enough for protection of a motor from overheating. It is recommended to install an external thermal relay or a PTC thermistor for overheat protection.
- Do not use a magnetic contactor on the input side of this product for frequent starting/stopping of this product. Otherwise the life of the product decreases.
- Use a noise filter or other means to minimize the electromagnetic interference with other electronic equipment used nearby this product.
- Appropriate measures must be taken to suppress harmonics. Otherwise harmonics in power systems generated from this product may heat/damage a power factor correction capacitor or a generator.
- For a 400 V class motor driven by this product, use an insulation-enhanced motor, or take measures to suppress surge voltage.
- As all parameters return to their initial values after Parameter clear or All parameter clear is performed, the needed parameters for this product operation must be set again before the operation is started.
- This product can be easily set for high-speed operation. Therefore, consider all things related to the operation such as the performance of a motor and equipment in a system before the setting change.
- The stop state of this product by the product's brake function (DC injection brake function) cannot be held. Install a device to apply brakes to a motor or equipment in a system for safety.
- Before running this product which have been stored and not been operated for a long period, perform an inspection and a test operation.
- To avoid damage to this product due to static electricity, static electricity in your body must be discharged before you touch this product.
- Only one PM motor can be connected to a single unit of this product.
- A PM motor must be used under PM sensorless vector control. Do not use a synchronous motor, induction motor, or synchronous induction motor.
- Do not connect a PM motor to this product at a setting for the induction motor control (initial setting). Do not connect an induction motor to this product at a setting for PM motor control. Doing so will cause a failure.
- As a process of starting a PM motor, turn ON the power of this product first, and then close the contactor on the output side of this product.
- To maintain the security (confidentiality, integrity, and availability) of the inverter and the system against unauthorized access, DoS*1 attacks, computer viruses, and other cyberattacks from external devices via network, take appropriate measures such as firewalls, virtual private networks (VPNs), and antivirus solutions. We shall have no responsibility or liability for any problems involving inverter trouble and system trouble by DoS attacks, unauthorized access, computer viruses, and other cyberattacks.
- Depending on the Ethernet network environment, this product may not operate as intended due to delays or disconnection in communication. Carefully consider the conditions on site and safety for this product.

Emergency stop

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

Maintenance, inspection and parts replacement

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

Disposal

- This product must be treated as industrial waste.

*1 DoS: A denial-of-service (DoS) attack disrupts services by overloading systems or exploiting vulnerabilities, resulting in a denial-of-service (DoS) state.

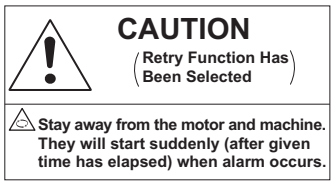
General instruction

- For clarity purpose, illustrations in this Instruction Manual may be drawn with covers or safety guards removed. Ensure all covers and safety guards are properly installed prior to starting operation. For details on the PM motor, refer to the Instruction Manual of the PM motor.

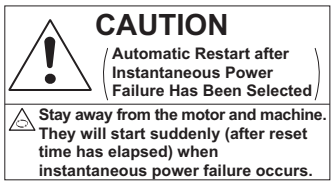
Application of caution labels

Caution labels are used to ensure safety during use of Mitsubishi Electric inverters.
Apply the following labels to the inverter if the "retry function" and/or "automatic restart after instantaneous power failure" have been enabled.

- For the retry function

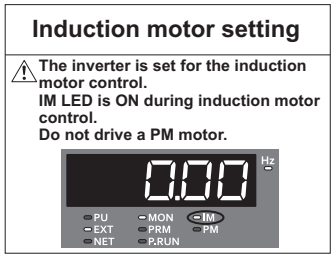


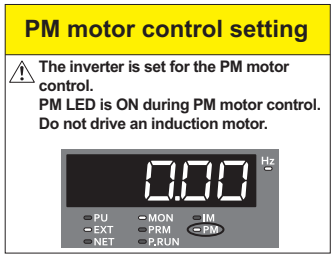
- For automatic restart after instantaneous power failure



Application of motor control labels

Apply the following labels to the inverter to avoid connecting motors not intended for a particular motor control setting.





CONTENTS

1 INTRODUCTION 7

1.1 Product checking and accessories 8

1.2 Component names 9

1.3 About the related manuals 11

2 INSTALLATION AND WIRING 13

2.1 Peripheral devices 14

2.1.1 Inverter and peripheral devices ... 14
2.1.2 Peripheral devices ... 16

2.2 Removal and reinstallation of the operation panel or the front cover 17

2.3 Installation of the inverter and enclosure design 19

2.3.1 Inverter installation environment ... 19
2.3.2 Cooling system types for inverter enclosure ... 22
2.3.3 Inverter installation ... 23
2.3.4 Protruding the heatsink through a panel ... 24

2.4 Terminal connection diagrams 27

2.5 Main circuit terminals / piping port 35

2.5.1 Descriptions of the main circuit terminals / piping ports ... 35
2.5.2 Terminal layout of the main circuit terminals and wiring of power supply / motor ... 36
2.5.3 Piping the cooling system and the drainage pipe ... 36
2.5.4 Applicable cables and the wiring length ... 37
2.5.5 Earthing (grounding) precautions ... 39
2.5.6 Piping and coolant for the cooling system and the drainage pipe ... 40

2.6 Control circuit 46

2.6.1 Details on the control circuit terminals ... 46
2.6.2 Control logic (sink/source) change ... 50
2.6.3 Wiring of control circuit ... 52
2.6.4 Wiring precautions ... 54
2.6.5 When using separate power supplies for the control circuit and the main circuit ... 55
2.6.6 When supplying 24 V external power to the control circuit ... 56
2.6.7 Safety stop function ... 58

2.7 Communication connectors and terminals 60

2.7.1 PU connector ... 60
2.7.2 USB connector ... 61
2.7.3 RS-485 terminal block (RS-485 model) ... 62
2.7.4 Ethernet port (Ethernet model) ... 63

2.8 Connection of motor with encoder (vector control) 64

2.9 Parameter settings for a motor with encoder 70

2.10 Connection of stand-alone option units 71

2.10.1 Connection of the brake unit (FR-BU2) ... 71
2.10.2 Connection of the high power factor converter (FR-HC2) ... 72
2.10.3 Connection of the DC reactor (FR-HEL) ... 73

2.11 Installing a communication option 74

3 PRECAUTIONS FOR USE OF THE INVERTER 75

3.1 Electro-magnetic interference (EMI) and leakage currents 76
3.1.1 Leakage currents and countermeasures 76
3.1.2 Countermeasures against inverter-generated EMI 77
3.1.3 Built-in EMC filter 79

3.2 Power supply harmonics 80
3.2.1 Power supply harmonics 80

3.3 Power-OFF and magnetic contactor (MC) 81

3.4 Countermeasures against deterioration of the 400 V class motor insulation 82

3.5 Checklist before starting operation 83

3.6 Failsafe system which uses the inverter 86

4 PRECAUTIONS FOR MAINTENANCE AND INSPECTION 89

4.1 Inspection item 90
4.1.1 Daily inspection 90
4.1.2 Periodic inspection 90
4.1.3 Daily and periodic inspection 91
4.1.4 Continuity test of the inverter and converter modules 93
4.1.5 Cleaning 93
4.1.6 Replacement of parts 94
4.1.7 Removal and reinstallation of the control circuit terminal block 97

4.2 Measurement of main circuit voltages, currents, and powers 99
4.2.1 Measurement of powers 102
4.2.2 Measurement of voltages and use of PT 102
4.2.3 Measurement of currents 103
4.2.4 Use of CT and transducer 103
4.2.5 Measurement of inverter input power factor 103
4.2.6 Measurement of converter output voltage (across terminals P and N) 103
4.2.7 Measurement of inverter output frequency 104
4.2.8 Insulation resistance test using megger 104
4.2.9 Withstand voltage test 104

5 SPECIFICATIONS 105

5.1 Inverter rating 106

5.2 Common specifications 107

5.3 Inverter outline dimensions 109

APPENDIX 111

Appendix 1 Instructions for compliance with the EU Directives 112
Appendix 2 Instructions for UL and cUL 115
Appendix 3 Instructions for EAC 117
Appendix 4 Restricted Use of Hazardous Substances in Electronic and Electrical Products 118
Appendix 5 Referenced Standard (Requirement of Chinese standardized law) 118
Appendix 6 Compliance with the UK certification scheme 119
Appendix 7 Compliance with the EU ErP Directive (Ecodesign Directive) 119

1 INTRODUCTION

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

1.1 Product checking and accessories 8
1.2 Component names 9
1.3 About the related manuals 11

<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 Electric inverter FR-A800 Plus series (liquid cooled type)
FR-A800-E	Mitsubishi Electric FR-A800 liquid cooled inverter (Plus series) Ethernet model
Ethernet board	Ethernet communication board (FR-A8ETH)
Vector control compatible option	FR-A8AP/FR-A8AL/FR-A8APR/FR-A8APS (plug-in option)/ FR-A8TP (control terminal option)
Pr.	Parameter number (Number assigned to function)
PU operation	Operation using the PU (operation panel/parameter unit)
External operation	Operation using the control circuit signals
Combined operation	Combined operation using the PU (operation panel/parameter unit) and External operation

<Trademarks>

• All company and product names herein are the trademarks and registered trademarks of their respective owners.

<Notes on descriptions in this Instruction Manual>

• Connection diagrams in this Instruction Manual appear with the control logic of the input terminals as sink logic, unless otherwise specified. (For the control logic, refer to page 50.)

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.

●Inverter model

Symbol	Voltage class
4	400 V class

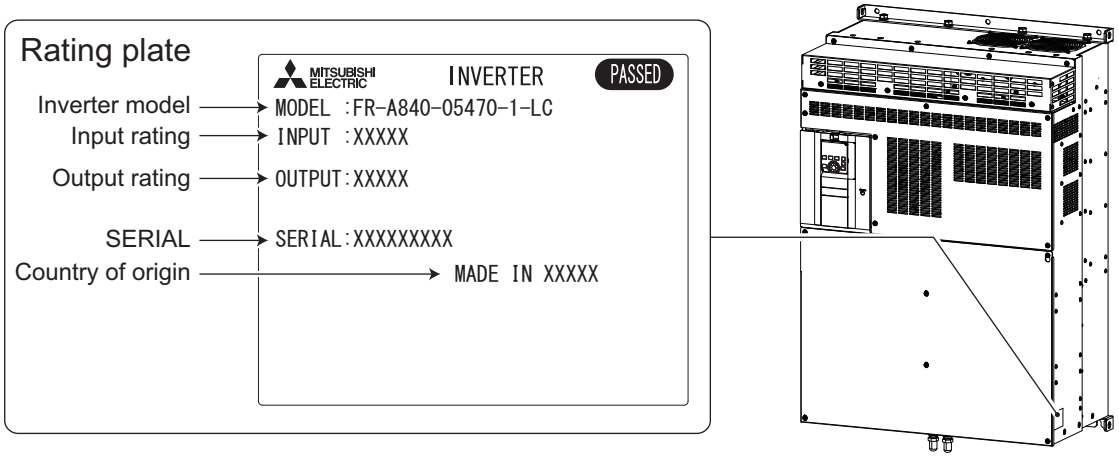
Symbol	Description
03250 to 06830	Inverter SLD rated current (A)
110K to 280K	Inverter ND rated capacity (kW)

Symbol	Type*1	Communication
1	FM	RS-485
2	CA	
E1	FM	Ethernet
E2	CA	

FR-A840-05470-1-□LC

Symbol	Circuit board coating*2	Plated conductor
None	Without	Without
60	With	Without
06	With	With

Symbol	Function
LC	Liquid cooled type



*1 Specification differs by the type. Major differences are shown in the table below.

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 mADC)) Terminal AM (analog voltage output (0 to ±10 VDC))	ON	Source logic	50 Hz	8888 (95% of the power supply voltage)

*2 Conforming to IEC60721-3-3:1994 3C2/3S2

NOTE

- In this Instruction Manual, the inverter model name consists of the applicable motor capacity and the rated current.
  (Example) FR-A840-05470(220K)

● How to read the SERIAL number

Rating plate example

□ ○ ○ ○○○○○○

Symbol Year Month Control number

SERIAL

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

● Accessory

- Eyebolt for hanging the inverter

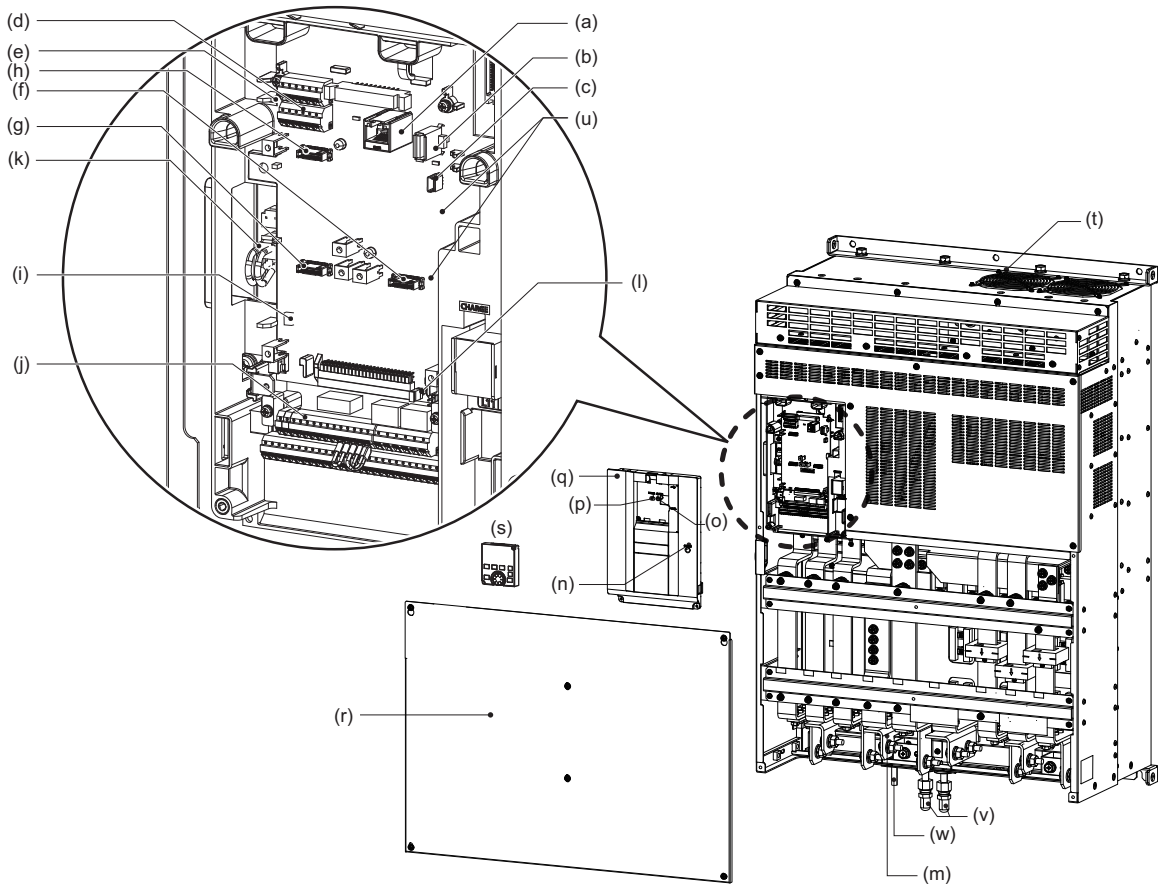
Capacity	Eyebolt size	Quantity
FR-A840-04320(160K) to FR-A840-04810(185K)	M10	2
FR-A840-05470(220K) to FR-A840-06830(280K)	M12	2



1.2 Component names

Component names are shown below.

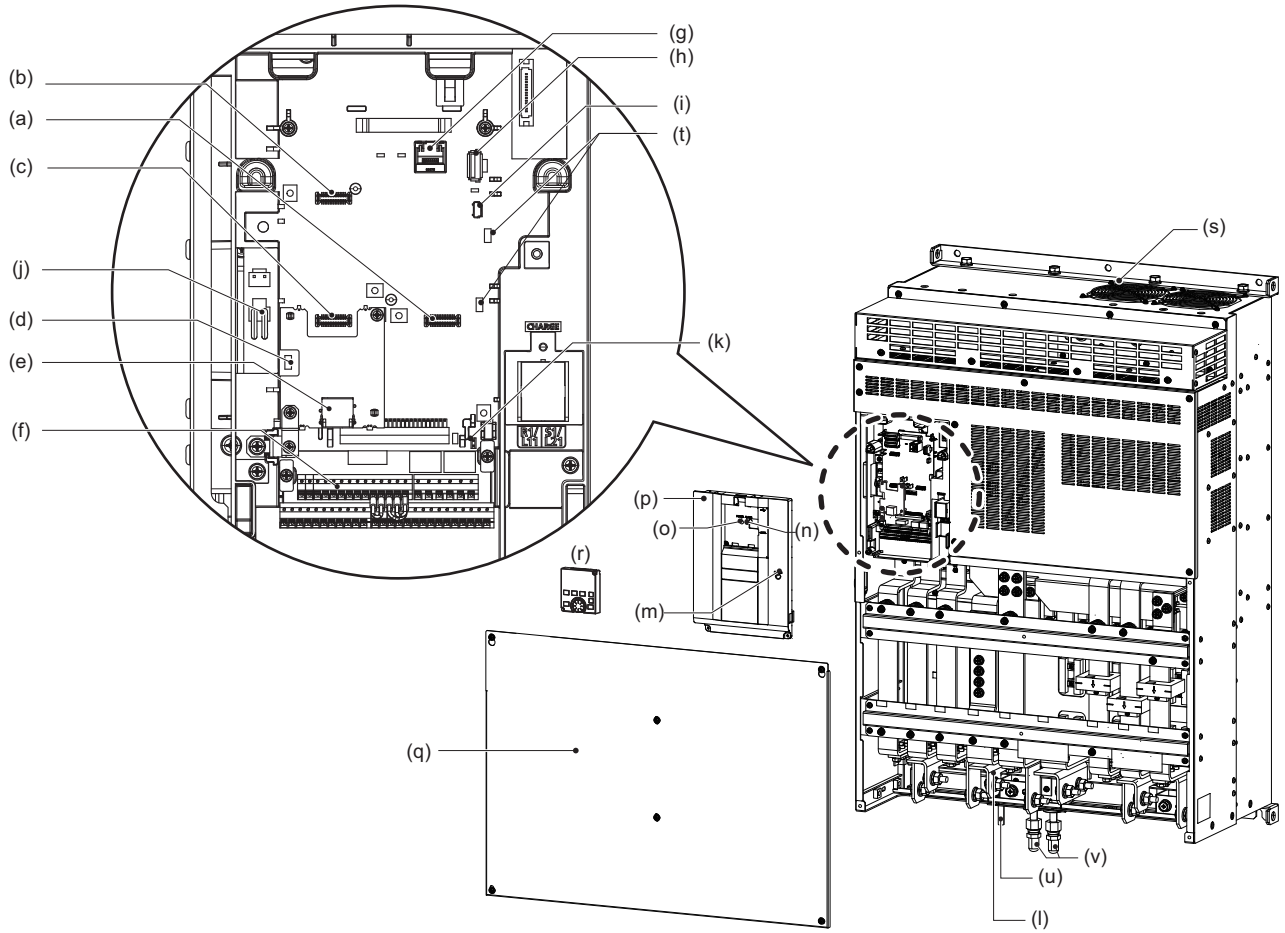
◆RS-485 model



Symbol	Name	Description	Refer to page
(a)	PU connector	Connects the operation panel or the parameter unit. This connector also enables the RS-485 communication.	60
(b)	USB A connector	Connects a USB memory device.	61
(c)	USB mini B connector	Connects a personal computer and enables communication with FR Configurator2.	61
(d)	RS-485 terminals	Enables RS-485, MODBUS RTU communication.	62
(e)	Terminating resistor selection switch (SW1)	Select whether or not to use the terminating resistor for RS-485 communication.	62
(f)	Plug-in option connector1	Connects a plug-in option or a communication option.	Instruction Manual of the option
(g)	Plug-in option connector2		
(h)	Plug-in option connector3		
(i)	Voltage/current input switch (SW2)	Selects between voltage and current for the terminal 2 and 4 inputs.	*1
(j)	Control circuit terminal block	Connects cables for the control circuit.	46
(k)	EMC filter ON/OFF connector	Turns ON/OFF the EMC filter.	79
(l)	Control logic switchover jumper connector	Switch the control logic of input signals as necessary.	50
(m)	Main circuit terminal block	Connects cables for the main circuit.	35
(n)	Charge lamp	Stays ON while the power is supplied to the main circuit.	36
(o)	Alarm lamp	Turns ON when the protective function of the inverter is activated.	36
(p)	Power lamp	Stays ON while the power is supplied to the control circuit (R1/L11, S1/L21).	36
(q)	Upper front cover	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.	17
(r)	Lower front cover	Remove this cover for wiring.	17
(s)	Operation panel (FR-DU08)	Operates and monitors the inverter.	60
(t)	Cooling fan	Cools the inverter.	95
(u)	Switches for manufacturer setting (SW3 and SW4)	Do not change the initial setting (OFF ).	–
(v)	Piping port	Remove the protective cap to connect the pipes for coolant.	36
(w)	Drainage port	Used for discharging water leakage. Connect the drainage pipe.	36

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

◆Ethernet model



Symbol	Name	Description	Refer to page
(a)	Plug-in option connector1	Connects a plug-in option or a communication option.	Instruction Manual of the option
(b)	Plug-in option connector3		
(c)	Plug-in option connector2	The connector 2 cannot be used because the Ethernet board is installed in the initial status. The Ethernet board must be removed to install a plug-in option to the connector 2. (However, Ethernet communication is disabled in that case.)	63
(d)	Voltage/current input switch (SW2)	Selects between voltage and current for the terminal 2 and 4 inputs.	*1
(e)	Ethernet communication connector	Connect the Ethernet dedicated cable for connection to the network.	63
(f)	Control circuit terminal block	Connects cables for the control circuit.	46
(g)	PU connector	Connects the operation panel or the parameter unit. This connector also enables the RS-485 communication.	60
(h)	USB A connector	Connects a USB memory device.	61
(i)	USB mini B connector	Connects a personal computer and enables communication with FR Configurator2.	61
(j)	EMC filter ON/OFF connector	Turns ON/OFF the EMC filter.	79
(k)	Control logic switchover jumper connector	Switch the control logic of input signals as necessary.	50
(l)	Main circuit terminal block	Connects cables for the main circuit.	35
(m)	Charge lamp	Stays ON while the power is supplied to the main circuit.	36
(n)	Alarm lamp	Turns ON when the protective function of the inverter is activated.	36
(o)	Power lamp	Stays ON while the power is supplied to the control circuit (R1/L11, S1/L21).	36
(p)	Upper front cover	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.	17
(q)	Lower front cover	Remove this cover for wiring.	17
(r)	Operation panel (FR-DU08)	Operates and monitors the inverter.	60
(s)	Cooling fan	Cools the inverter.	95
(t)	Switches for manufacturer setting (SW3 and SW4)	Do not change the initial setting (OFF ).	–
(u)	Piping port	Remove the protective cap to connect the pipes for coolant.	36
(v)	Drainage port	Used for discharging water leakage. Connect the drainage pipe.	36

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

1.3 About the related manuals

The manuals related to FR-A840-LC are shown below.

Manual name	Manual number
FR-A800 Instruction Manual (Detailed)	IB-0600503ENG
Ethernet Function Manual	IB-0600628ENG
FR Configurator2 Instruction Manual	IB-0600516ENG
FR-A800/F800 PLC Function Programming Manual	IB-0600492ENG
FR-A800-LC Safety stop function instruction manual	BCN-A23228-015

MEMO

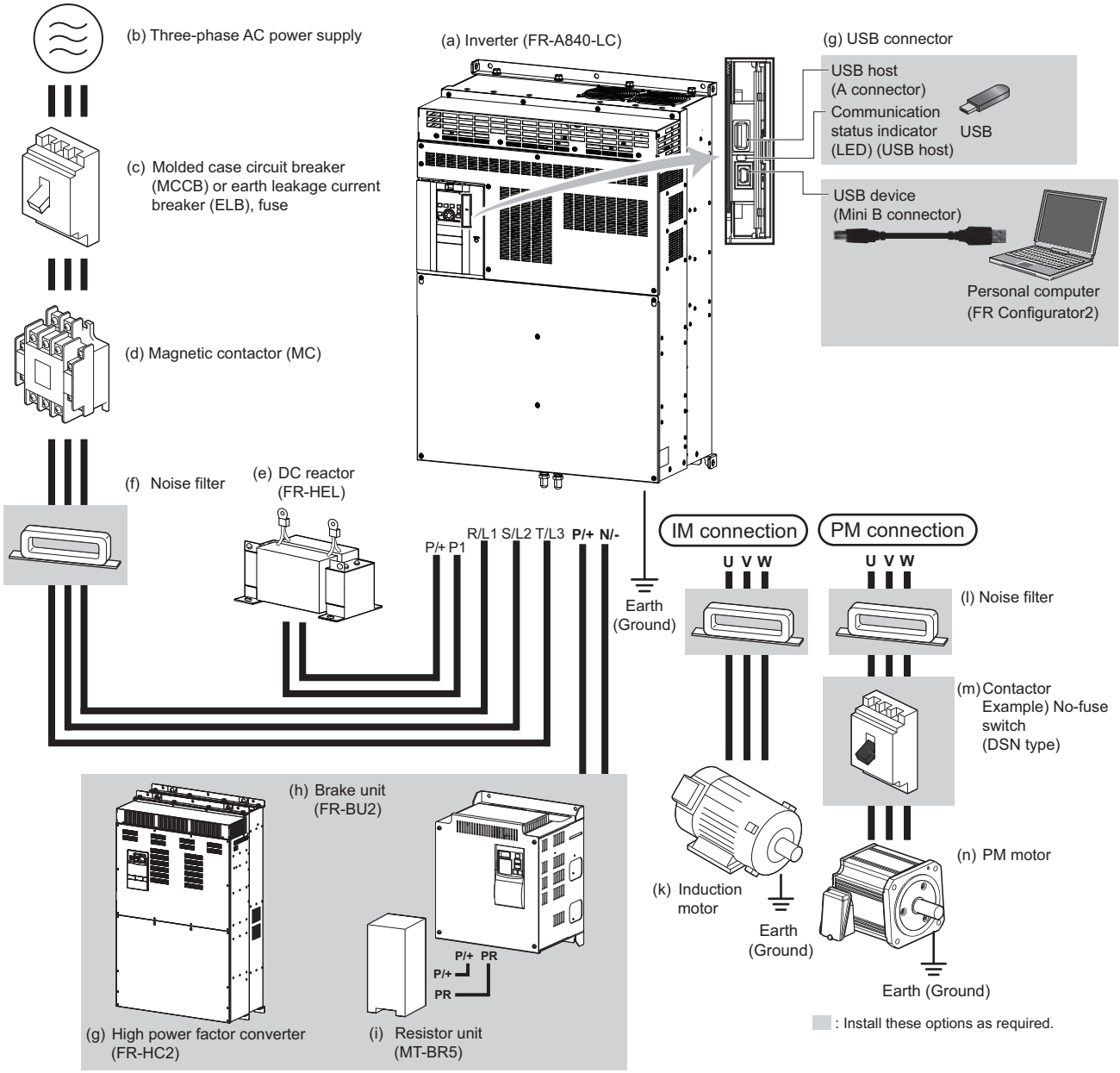
2 INSTALLATION AND WIRING

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

2.1 Peripheral devices 14
2.2 Removal and reinstallation of the operation panel or the front cover 17
2.3 Installation of the inverter and enclosure design 19
2.4 Terminal connection diagrams 27
2.5 Main circuit terminals / piping port 35
2.6 Control circuit 46
2.7 Communication connectors and terminals 60
2.8 Connection of motor with encoder (vector control) 64
2.9 Parameter settings for a motor with encoder 70
2.10 Connection of stand-alone option units 71
2.11 Installing a communication option 74

2.1 Peripheral devices

2.1.1 Inverter and peripheral devices



NOTE

- To prevent an electric shock, always earth (ground) the motor and inverter.
- Do not install a power factor correction capacitor or surge suppressor or capacitor type filter on the inverter's output side. Doing so will cause the inverter to trip 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 includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the inverter. In this case, activating the EMC filter may minimize interference. (Refer to page 79.)
- For details of options and peripheral devices, refer to the respective Instruction Manual.
- A PM motor cannot be driven by the commercial power supply.
- A PM motor is a motor with permanent magnets embedded inside. High voltage is generated at the motor terminals while the motor is running. Before closing the contactor at the output side, make sure that the inverter power is ON and the motor is stopped.

Symbol	Name	Overview	Refer to page
(a)	Inverter (FR-A840-LC)	The life of the inverter 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. The control signal lines must be kept fully away from the main circuit lines to protect them from noise. The built-in EMC filter can reduce the noise.	19 27 79
(b)	Three-phase AC power supply	Must be within the permissible power supply specifications of the inverter.	106
(c)	Molded case circuit breaker (MCCB), earth leakage circuit breaker (ELB), or fuse	Must be selected carefully since an inrush current flows in the inverter at power ON.	16
(d)	Magnetic contactor (MC)	Install this to ensure safety. Do not use this to start and stop the inverter. Doing so will shorten the life of the inverter.	81
(e)	DC reactor (FR-HEL)	Install this to suppress harmonics and to improve the power factor. Select a DC reactor according to the applied motor capacity, and always keep it connected.	73
(f)	Noise filter	Suppresses the noise radiated from the power supply side of the inverter.	77
(g)	High power factor converter (FR-HC2)	Suppresses the power supply harmonics significantly. Install this as required.	72
(h)	Brake unit (FR-BU2)	Allows the inverter to provide the optimal regenerative braking capability. Install this as required.	71
(i)	Resistor unit (MT-BR5)		
(j)	USB connection	A USB (Ver. 1.1) cable connects the inverter with a personal computer. A USB memory device enables parameter copies and the trace function.	61
(k)	Noise filter	Install this to reduce the electromagnetic noise generated from the inverter.	77
(l)	Induction motor	Connect a squirrel-cage induction motor.	—
(m)	Contactor Example) No-fuse switch (DSN type)	Connect this for an application where a PM motor is driven by the load even while the inverter power is OFF. Do not open or close the contactor while the inverter is running (outputting).	—
(n)	PM motor	Use the specified motor. A PM motor cannot be driven by the commercial power supply.	—

2.1.2 Peripheral devices

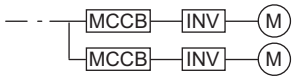
Check the model of the inverter you purchased. Appropriate peripheral devices must be selected according to the capacity. Refer to the table below to prepare appropriate peripheral devices.

◆ND rating (Pr.570 Multiple rating setting = "2")

Motor output (kW)*1	Applicable inverter model	Molded case circuit breaker (MCCB)*2 or earth leakage circuit breaker (ELB) (NF, NV type)	Input-side magnetic contactor*3
110	FR-A840-03250(110K)-LC	225A	S-N180
132	FR-A840-03610(132K)-LC	350A	S-N220
160	FR-A840-04320(160K)-LC	400A	S-N300
185	FR-A840-04810(185K)-LC	400A	S-N300
220	FR-A840-05470(220K)-LC	500A	S-N400
250	FR-A840-06100(250K)-LC	600A	S-N600
280	FR-A840-06830(280K)-LC	600A	S-N600

*1 Assumes the use of a 4-pole standard motor with the power supply voltage of 400 VAC 50 Hz.

*2 Select an MCCB according to the power supply capacity.
Install one MCCB per inverter.
(For the use in the United States or Canada, refer to page 115 to select the appropriate fuse.)



*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.

NOTE

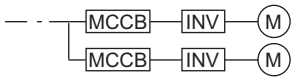
- When the inverter capacity is larger than the motor capacity, select an MCCB and a magnetic contactor according to the inverter model, and select cables and reactors according to the motor output.
- When the breaker on the inverter's input side trips, check for the wiring fault (short circuit), damage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

◆LD rating (Pr.570 Multiple rating setting = "1")

Motor output (kW)*1	Applicable inverter model	Molded case circuit breaker (MCCB)*2 or earth leakage circuit breaker (ELB) (NF, NV type)	Input-side magnetic contactor*3
132	FR-A840-03250(110K)-LC	350A	S-N220
160	FR-A840-03610(132K)-LC	400A	S-N300
185	FR-A840-04320(160K)-LC	400A	S-N300
220	FR-A840-04810(185K)-LC	500A	S-N400
250	FR-A840-05470(220K)-LC	600A	S-N600
280	FR-A840-06100(250K)-LC	600A	S-N600
315	FR-A840-06830(280K)-LC	800A	S-N800

*1 Assumes the use of a 4-pole standard motor with the power supply voltage of 400 VAC 50 Hz.

*2 Select an MCCB according to the power supply capacity.
Install one MCCB per inverter.
(For the use in the United States or Canada, refer to page 115 to select the appropriate fuse.)



*3 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.

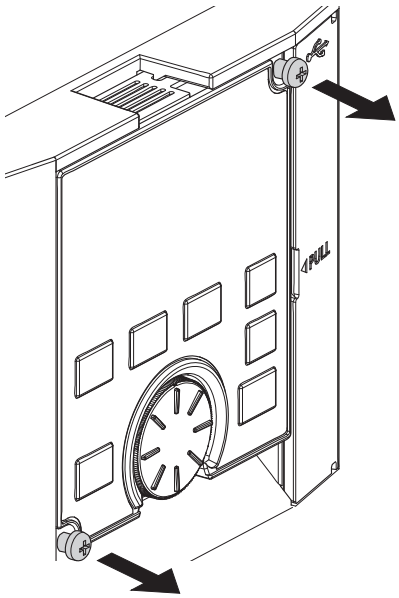
NOTE

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

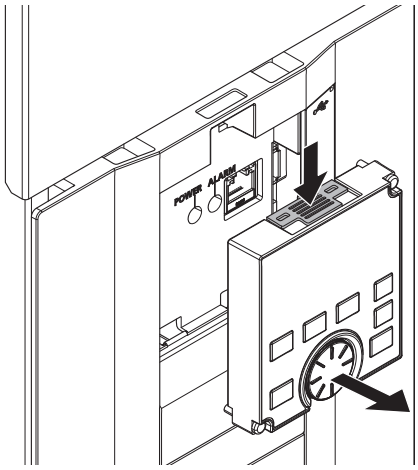
2.2 Removal and reinstallation of the operation panel or the front cover

◆Removal and reinstallation of the operation panel

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

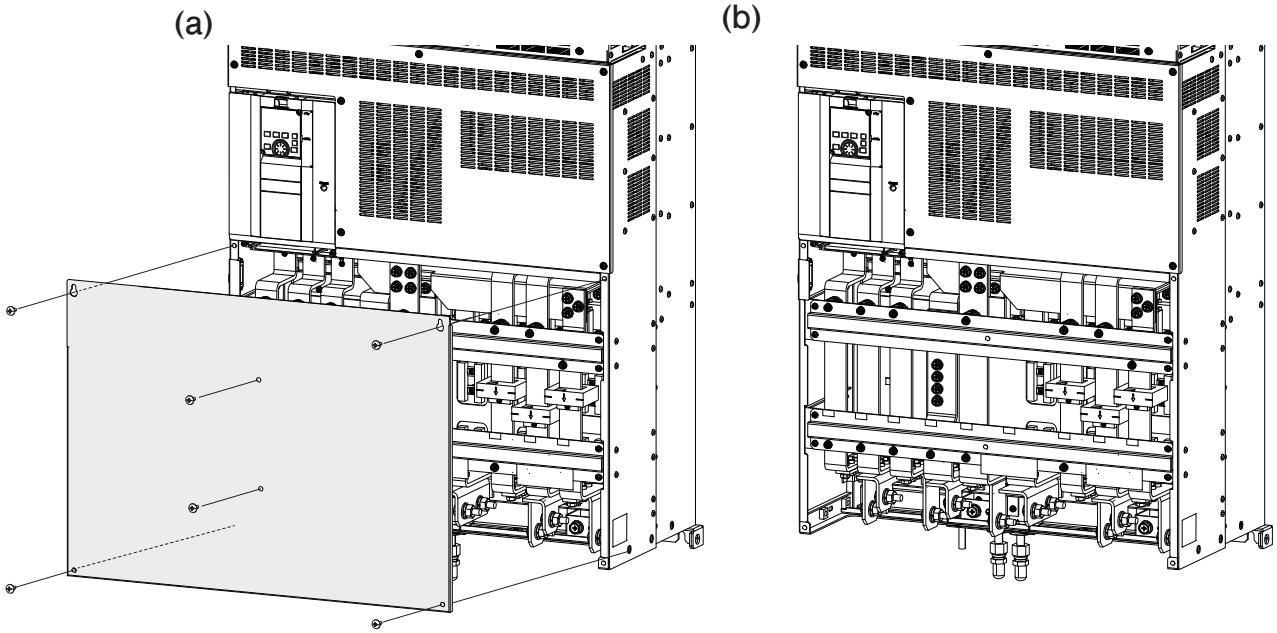


- Press the upper edge of the operation panel while pulling out the operation panel.



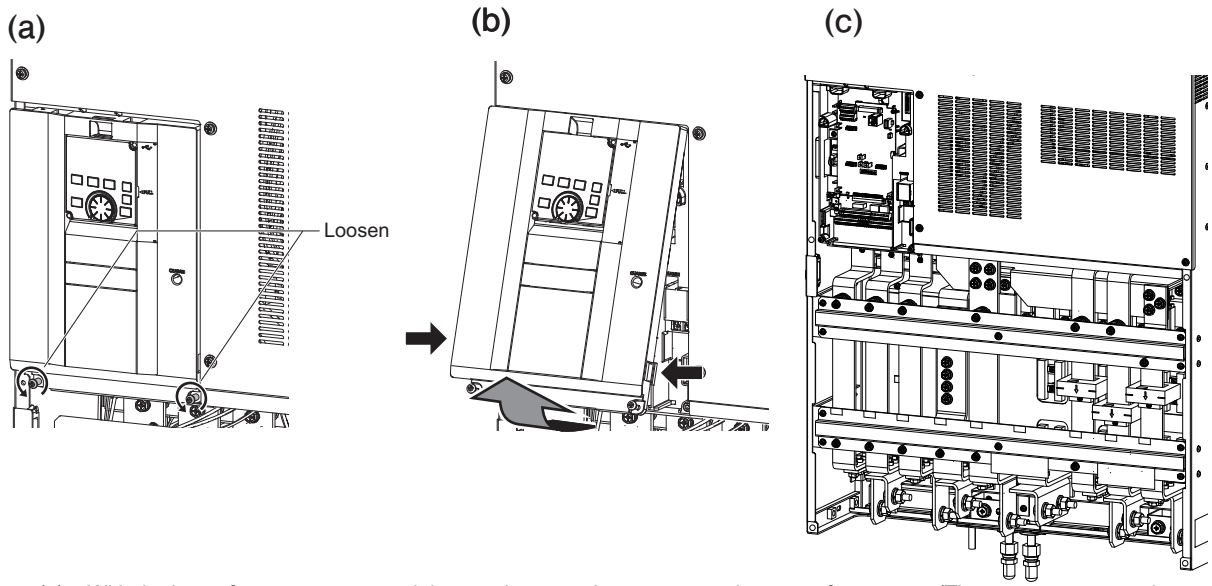
To reinstall the operation panel, align its connector on the back with the PU connector of the inverter, and insert the operation panel. After confirming that the operation panel is fit securely, tighten the screws. (Tightening torque: 0.40 to 0.45 N·m)

◆Removal of the lower front cover



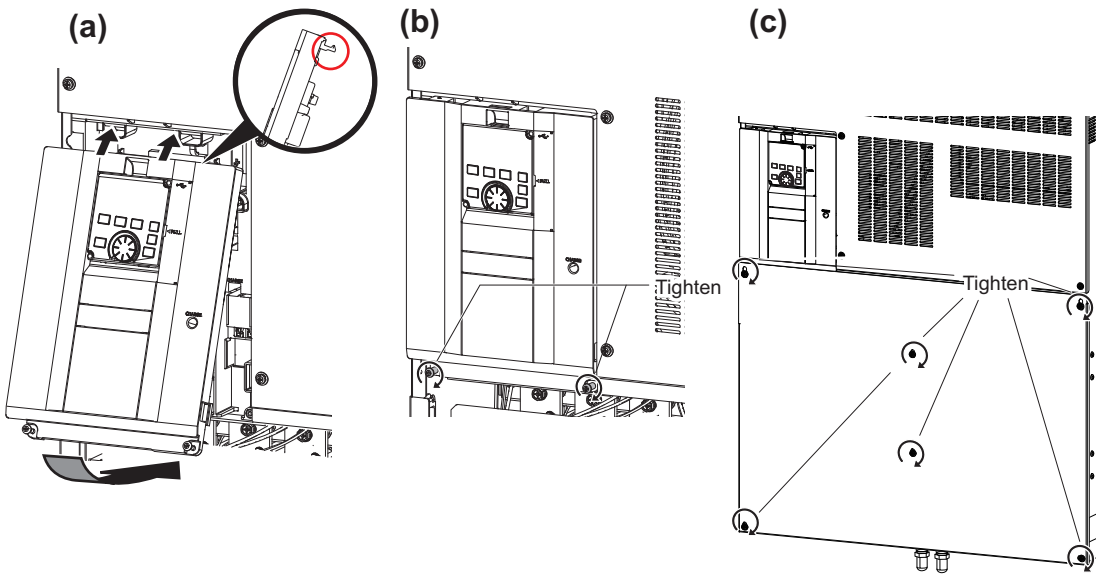
(a) When the mounting screws are removed, the lower front cover can be removed.
(b) With the lower front cover removed, wiring of the main circuit terminals can be performed.

◆Removal of the upper front cover



(a) With the lower front cover removed, loosen the mounting screws on the upper front cover. (These screws cannot be removed.)
(b) Holding the areas around the installation hooks on the sides of the upper front cover, pull out the cover using its upper side as a support.
(c) With the upper front cover removed, wiring of 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 upper front cover into the sockets of the inverter.
Securely install the upper front cover to the inverter by fixing the hooks on the sides of the cover into place.
(b) Tighten the mounting screw(s) at the lower part of the upper front cover.
(c) Fasten the lower front cover with the mounting screws.

NOTE

• 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

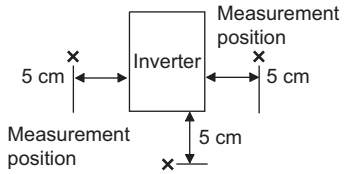
When designing or manufacturing an inverter enclosure, determine the structure, size, and device layout of the enclosure by fully considering the conditions such as heat generation of the contained devices and the operating environment. An inverter unit uses many semiconductor devices. To ensure higher 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	LD, ND (initial setting)		-10 to +50°C (non-freezing)*1
Ambient humidity			With circuit board coating (conforming to IEC60721-3-3:1994 3C2/3S2): 95% RH or less (noncondensing), Without circuit board coating: 90% RH or less (non-condensing)
Coolant	Coolant temperature		1 to 40°C (non-freezing)
	Coolant flow rate *2	FR-A840-03250(110K), 03610(132K)	3.0 to 3.7 L/min
		FR-A840-04320(160K) to 06830(280K)	6.0 to 7.5 L/min
	Maximum permissible pressure		300 kPa
Storage temperature*3			-20 to +65°C
Atmosphere			Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
Altitude			2000 m or less*4
Vibration			2.9 m/s^2 or less at 10 to 55 Hz (directions of X, Y, Z axes)



*1 Condensation may occur depending on the humidity and the coolant temperature. Adjust the humidity and the coolant temperature to prevent condensation.

*2 Under normal condition, keep the flow rate between 3.2 and 3.5 L/min for the FR-A840-03610(132K) or lower and between 6.5 and 7.0 L/min for the FR-A840-04320(160K) or higher.

*3 Temperature applicable for a short time, e.g. in transit.
To store the inverter after the coolant has passed through the pipes, fill the pipes with coolant sufficiently enough, that it contains antifreezing agent to prevent corrosion. Or fill the pipes with nitrogen gas after the inside of the pipes is fully dried. If any moisture remains inside the pipes, it may react with oxygen in the air to form corrosion.

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

◆Temperature

The permissible surrounding air temperature of the inverter is between -10°C and +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 22.)
- 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.)
- When the coolant temperature is higher than the surrounding air temperature, let the coolant circulate.

(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 42.

◆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.)
- When the coolant temperature is lower than the surrounding air temperature, do not let the coolant circulate while the inverter is stopped.

◆Coolant flow rate

Under normal condition, keep the flow rate between 3.1 and 3.5 L/min for the FR-A840-03610(132K) or lower and between 6.5 and 7.0 L/min for the FR-A840-04320(160K) or higher. When the inverter is continuously operated at the flow rate more than the maximum specifications (3.7 L/min for the FR-A840-03610(132K) or lower, 7.5 L/min for the FR-A840-04320(160K) or higher), copper pipes may corrode or leak, resulting in damage of the inverter. On the contrary, when the inverter is continuously operated at the flow rate less than the minimum specifications (2.9 L/min for the FR-A840-03610(132K) or lower, 6.0 L/min for the FR-A840-04320(160K) or higher), impurities may deposit and degrade the cooling performance, resulting in corrosion of the pipes or inverter failures.

The internal pressure loss and the internal head according to the flow rate of coolant are as follows.

FR-A840-03610(132K) or lower

Flow rate [L/min]	Internal pressure loss [kPa]	Internal head [kPa]
3.0	8.5	3.3
3.2	9.5	3.3
3.5	11.2	3.3
3.7	12.4	3.3

FR-A840-04320(160K), FR-A840-04810(185K)

Flow rate [L/min]	Internal pressure loss [kPa]	Internal head [kPa]
6.0	6.3	4.7
6.5	7.3	4.7
7.0	8.4	4.7
7.5	9.5	4.7

FR-A840-05470(220K) or higher

Flow rate [L/min]	Internal pressure loss [kPa]	Internal head [kPa]
6.0	11.0	8.3
6.5	12.7	8.3
7.0	14.5	8.3
7.5	16.5	8.3

◆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.

Countermeasures

- Place the inverter in a totally enclosed enclosure.
  Take measures if the in-enclosure temperature rises. (Refer to page 22.)
- Purge air.
  Pump clean air from outside to make the in-enclosure air pressure higher than the outside air pressure.

◆Corrosive gas, salt damage

If the inverter is exposed to corrosive gas or to salt near a beach, the printed board patterns and parts will corrode or the relays and switches will result in poor contact.
In such places, take the measures given in the previous paragraph.

◆Explosive, flammable gases

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

◆High altitude

Use the inverter at an altitude of within 2000 m. For use at an altitude above 1000 m, consider a 3% reduction in the rated current per 500 m increase in altitude.
If it is used at a higher place, it is likely that thin air will reduce the cooling effect and low air pressure will deteriorate dielectric strength.

◆Vibration, impact

The vibration resistance of the inverter is 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 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.

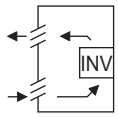
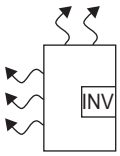
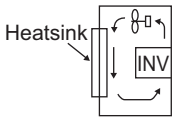
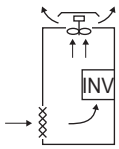
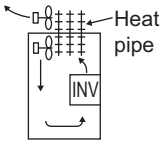
The cooling systems are classified as follows in terms of the cooling calculation method.

(a) Cooling by natural heat dissipation from the enclosure surface (totally enclosed type)

(b) Cooling by heatsink (aluminum fin, etc.)

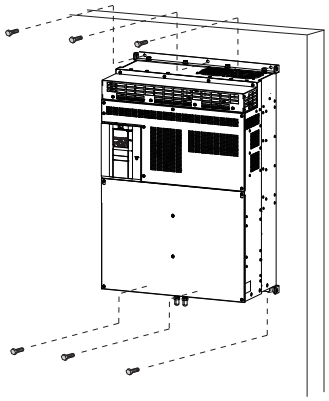
(c) Cooling by ventilation (forced ventilation type, pipe ventilation type)

(d) Cooling by heat exchanger or cooler (heat pipe, cooler, etc.)

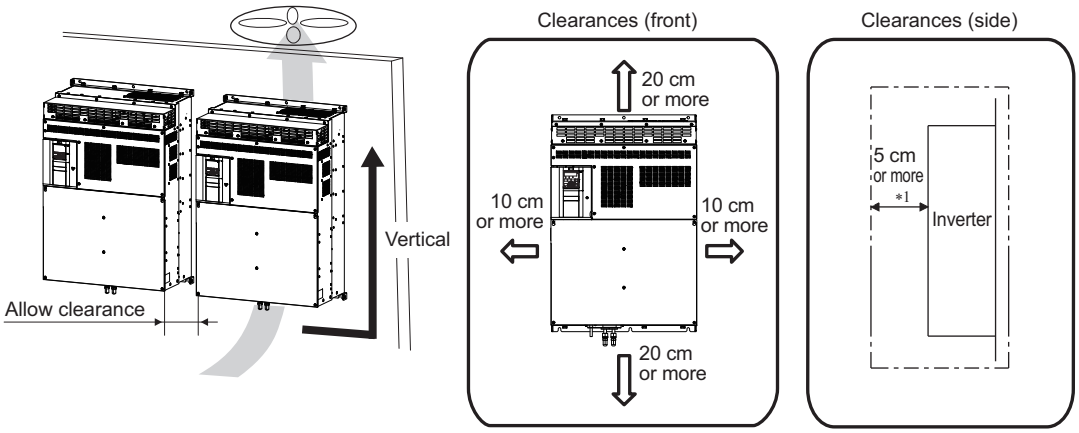
Cooling system		Enclosure structure	Comment
Natural	Natural ventilation (enclosed type / open type)		This system is low in cost and generally used, but the enclosure size increases as the inverter capacity increases. This system is for relatively small capacities.
	Natural ventilation (totally enclosed type)		Being a totally enclosed type, this system is the most appropriate for hostile environment having dust, dirt, oil mist, etc. The enclosure size increases depending on the inverter capacity.
Forced air	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.

2.3.3 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, 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.
- When designing or building an enclosure for the inverter, carefully consider influencing factors such as heat generation of the contained devices and the operating environment.



*1 For replacing the cooling fan, 30 cm of space is necessary in front of the inverter. Refer to page 95 for fan replacement.

◆ Installation orientation of the inverter

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

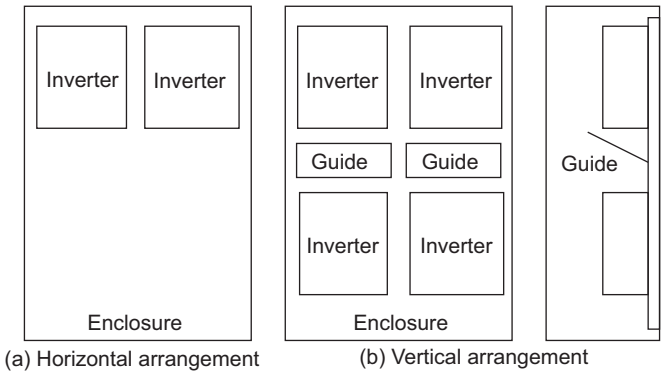
◆Above the inverter

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

◆Arrangement of multiple inverters

When multiple inverters are placed in the same enclosure, generally arrange them horizontally as shown in the right figure (a). When it is inevitable to arrange them vertically to minimize space, take such measures as to provide guides since heat from the bottom inverters can increase the temperatures in the top inverters, causing inverter failures.

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

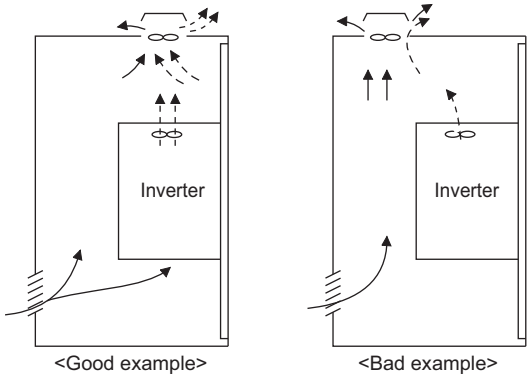


(a) Horizontal arrangement (b) Vertical arrangement

Arrangement of multiple inverters

◆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

2.3.4 Protruding the heatsink through a panel

For separating the electric wiring section and the coolant piping section, this installation method is recommended.

◆Using the panel through attachment (FR-A8CN)

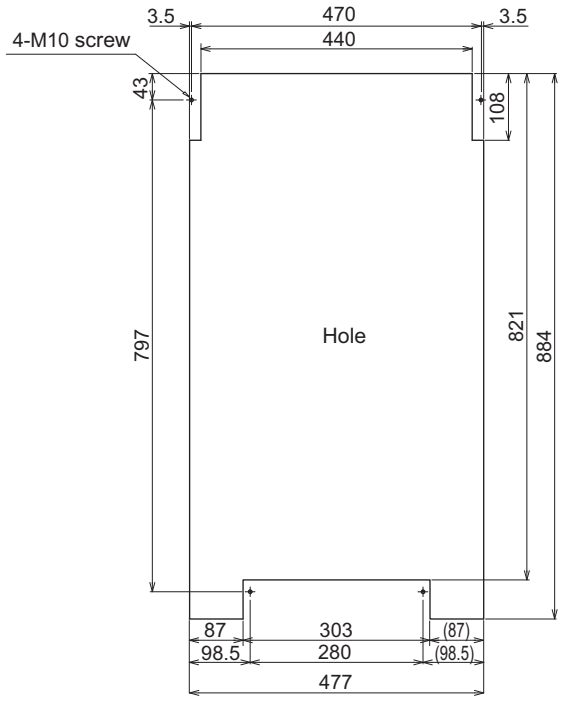
For the FR-A840-03250(110K) or FR-A840-03610(132K), its heatsink can be protruded using the panel through attachment (FR-A8CN). (For FR-A840-04320(160K) or higher, the attachment is not required to protrude its heatsink.)
For the enclosure cut dimensions and the installation procedure of the panel through attachment (FR-A8CN) to the inverter, refer to the Instruction Manual of the FR-A8CN.

◆ Heatsink protrusion

◆ Panel cutting

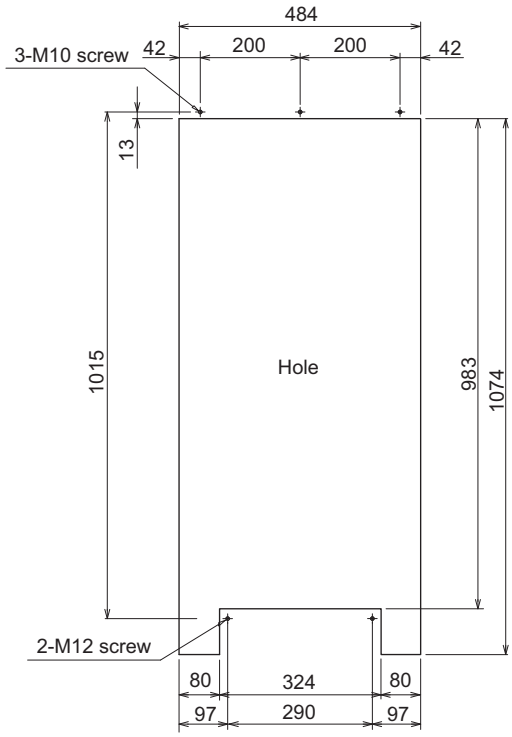
Cut the panel of the enclosure according to the inverter capacity.

FR-A840-03250(110K), 03610(132K)-LC



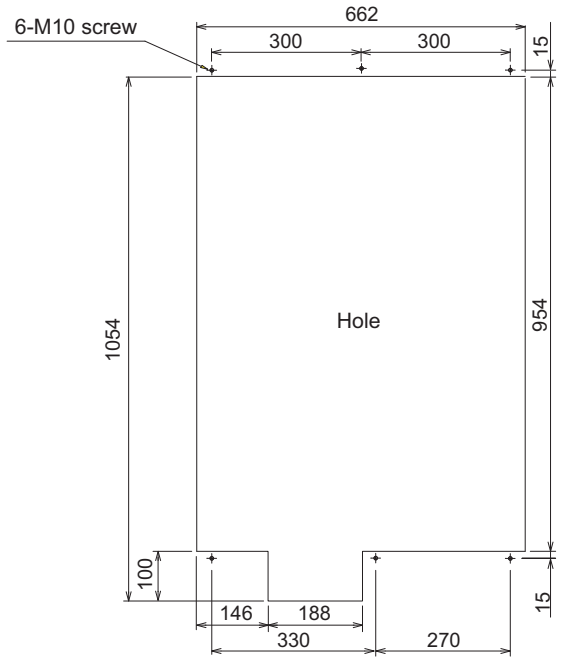
(Unit: mm)

FR-A840-04320(160K), 04810(185K)-LC



(Unit: mm)

FR-A840-05470(220K), 06100(250K), 06830(280K)-LC

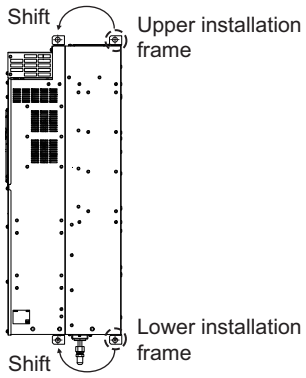


(Unit: mm)

2

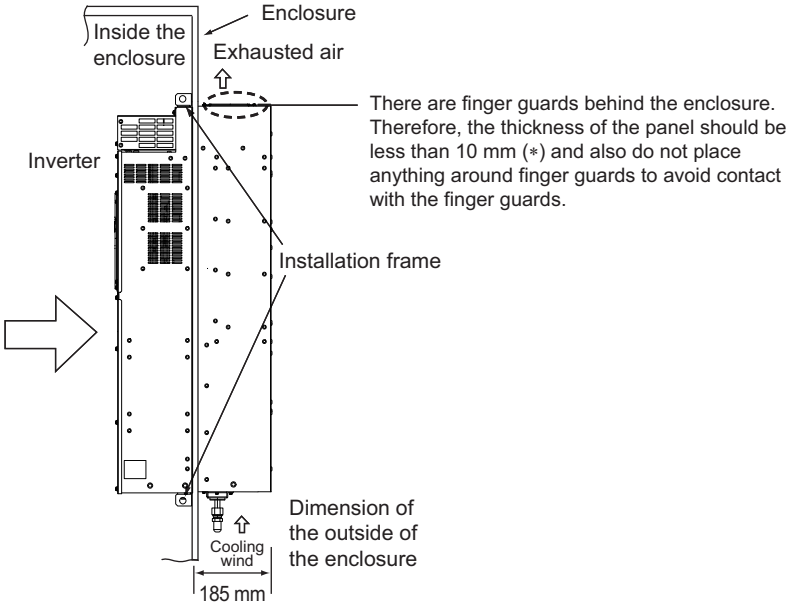
◆Shift and removal of a rear side installation frame

One installation frame is attached to each of the upper and lower parts of the inverter. Change the position of the rear side installation frame on the upper and lower sides of the inverter to the front side as shown on the right. When changing the installation frames, make sure that the installation orientation is correct.



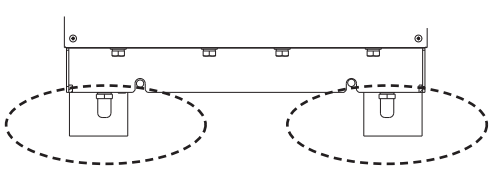
◆Installation of the inverter

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

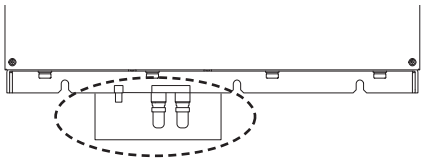


NOTE

- 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.
- The cutout hole on the enclosure is uncovered, which makes enough room to allow the piping and the drainage ports pass through out the enclosure. Fill the hole with something to cover it for complete separation between inside and outside of the enclosure.



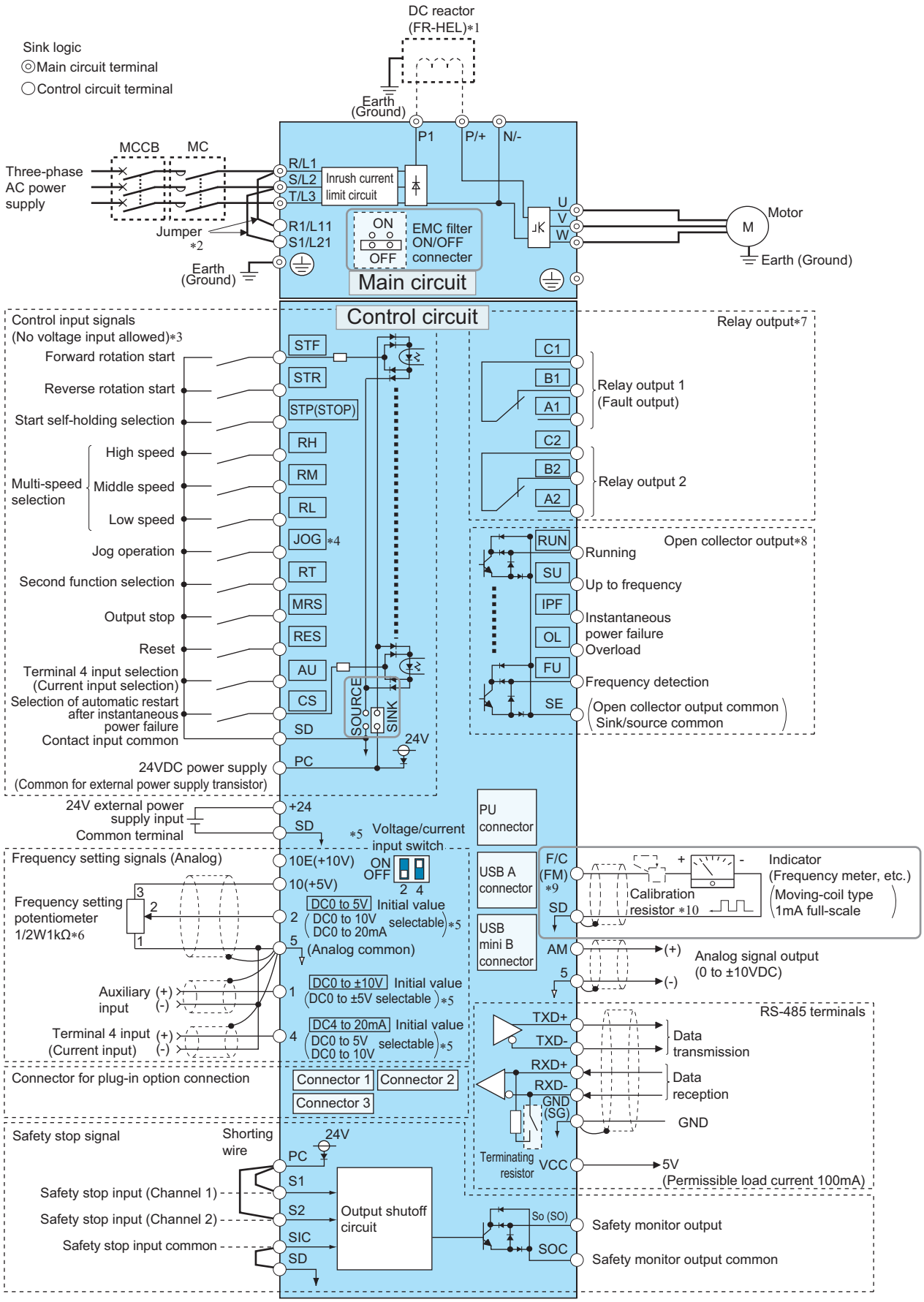
FR-A840-03250(110K) to FR-A840-04810(185K)



FR-A840-05470(220K) to FR-A840-06830(280K)

2.4 Terminal connection diagrams

◆FM type (RS-485 model)

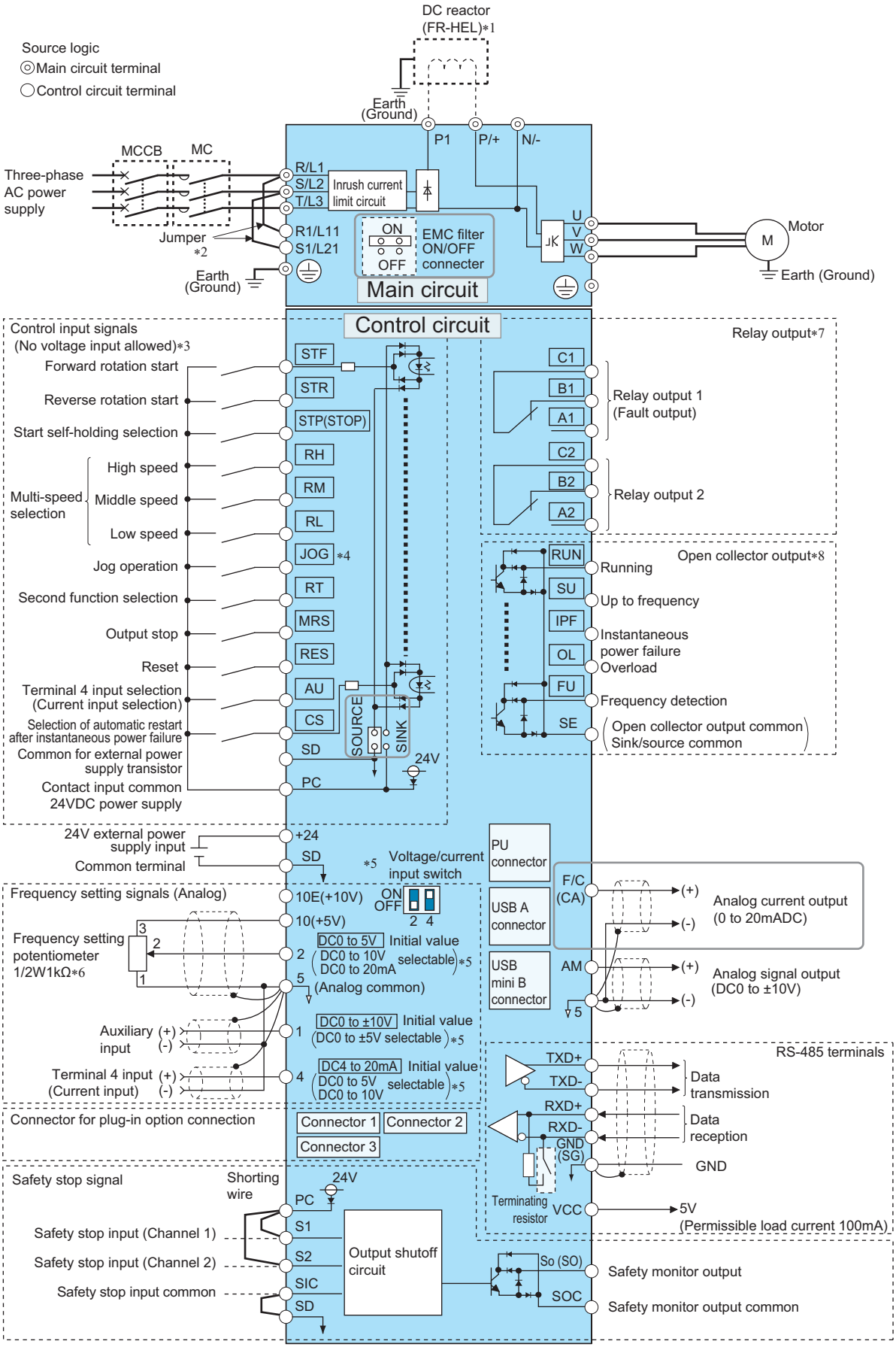


∗1 Always connect a DC reactor (FR-HEL), which is available as an option. (To select a DC reactor, refer to page 106, and select one according to the applicable motor capacity.)
∗2 When using separate power supply for the control circuit, remove the jumper between R1/L11 and S1/L21.
∗3 The function of these terminals can be changed with the input terminal assignment **(Pr.178 to Pr.189)**.
∗4 Terminal JOG is also used as a pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
∗5 Terminal input specifications can be changed by analog input specification switchover **(Pr.73, Pr.267)**. To input a voltage, set the voltage/current input switch OFF. To input a current, set the voltage/current input switch ON. Terminals 10 and 2 are also used as a PTC input terminal. (**Pr.561**)
∗6 It is recommended to use 2 W 1 kΩ when the frequency setting signal is changed frequently.
∗7 The function of these terminals can be changed 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 The terminal FM can be used to output pulse trains as open collector output by setting **Pr.291**.
∗10 Not required when calibrating the scale with the operation panel.

NOTE

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

◆CA type (RS-485 model)

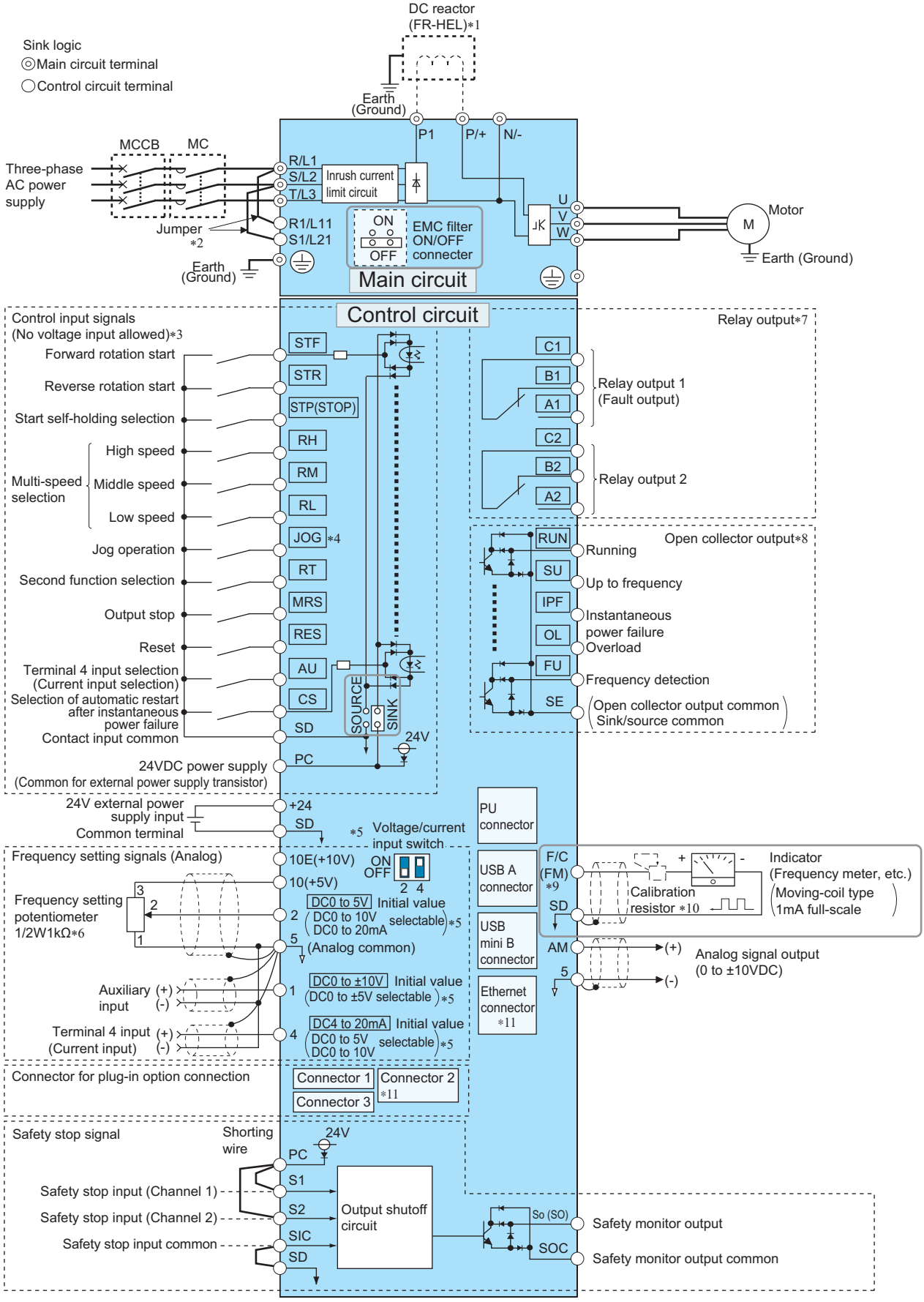


∗1 Always connect a DC reactor (FR-HEL), which is available as an option. (To select a DC reactor, refer to page 106, and select one according to the applicable motor capacity.)
∗2 When using separate power supply for the control circuit, remove the jumper between R1/L11 and S1/L21.
∗3 The function of these terminals can be changed with the input terminal assignment **(Pr.178 to Pr.189)**.
∗4 Terminal JOG is also used as a pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
∗5 Terminal input specifications can be changed by analog input specification switchover **(Pr.73, Pr.267)**. To input a voltage, set the voltage/current input switch OFF. To input a current, set the voltage/current input switch ON. Terminals 10 and 2 are also used as a PTC input terminal. **(Pr.561)**
∗6 It is recommended to use 2 W 1 kΩ when the frequency setting signal is changed frequently.
∗7 The function of these terminals can be changed 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)**.

NOTE

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

◆FM type (Ethernet model)

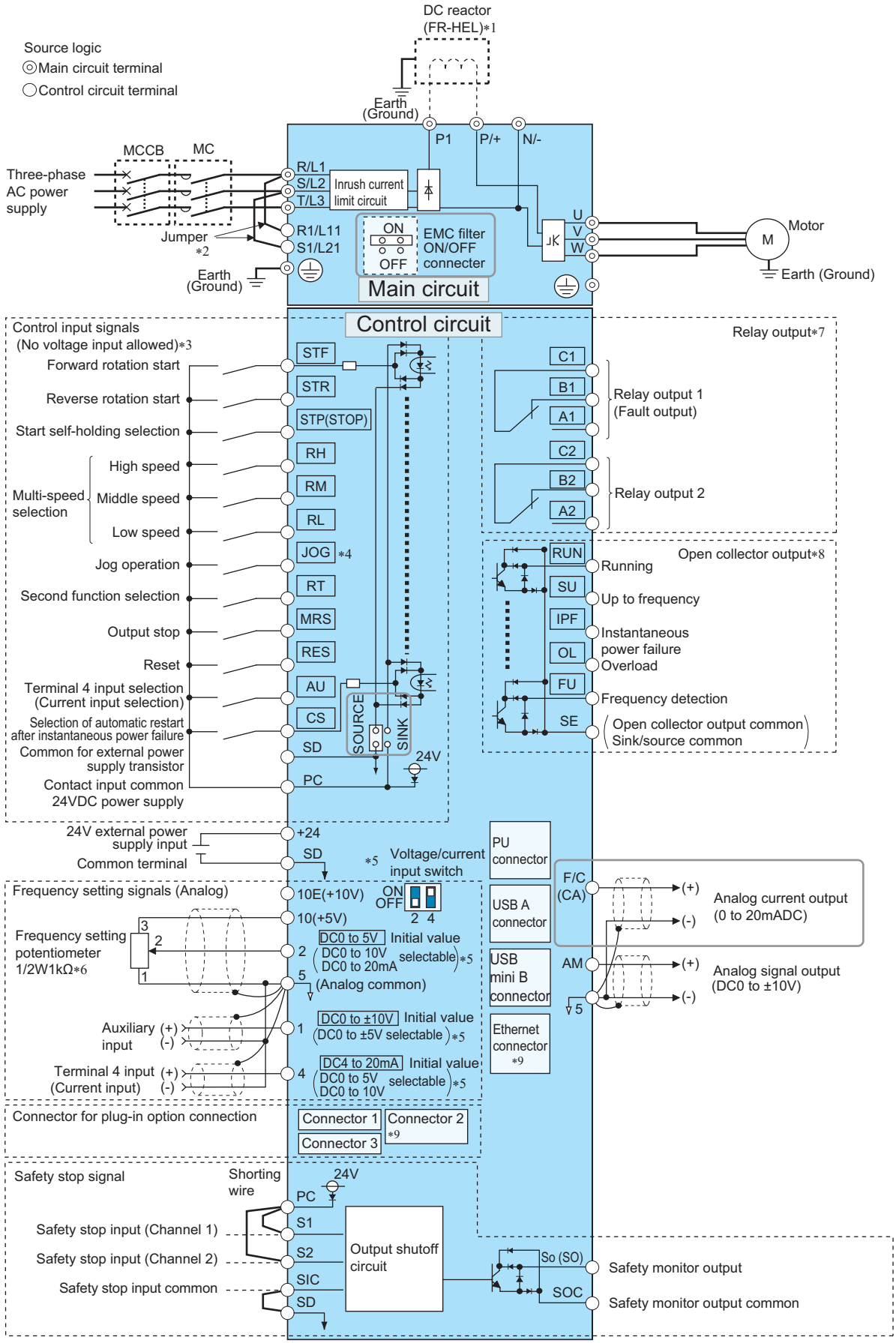


∗1 Always connect a DC reactor (FR-HEL), which is available as an option. (To select a DC reactor, refer to page 106, and select one according to the applicable motor capacity.)
∗2 When using separate power supply for the control circuit, remove the jumper between R1/L11 and S1/L21.
∗3 The function of these terminals can be changed with the input terminal assignment **(Pr.178 to Pr.189)**.
∗4 Terminal JOG is also used as a pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
∗5 Terminal input specifications can be changed by analog input specification switchover **(Pr.73, Pr.267)**. To input a voltage, set the voltage/current input switch OFF. To input a current, set the voltage/current input switch ON. Terminals 10 and 2 are also used as a PTC input terminal. (**Pr.561**)
∗6 It is recommended to use 2 W 1 kΩ when the frequency setting signal is changed frequently.
∗7 The function of these terminals can be changed 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 The terminal FM can be used to output pulse trains as open collector output by setting **Pr.291**.
∗10 Not required when calibrating the scale with the operation panel.
∗11 The option connector 2 cannot be used because the Ethernet board is installed in the initial status. The Ethernet board must be removed to install a plug-in option to the option connector 2. (However, Ethernet communication is disabled in that case.)

NOTE

- To prevent a malfunction due to noise, keep the signal cables 10 cm or more away from the power cables. Also, 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.
- For the parameter details, refer to the Instruction Manual (Detailed).

◆CA type (Ethernet model)



∗1 Always connect a DC reactor (FR-HEL), which is available as an option. (To select a DC reactor, refer to page 106, and select one according to the applicable motor capacity.)
∗2 When using separate power supply for the control circuit, remove the jumper between R1/L11 and S1/L21.
∗3 The function of these terminals can be changed with the input terminal assignment **(Pr.178 to Pr.189)**.
∗4 Terminal JOG is also used as a pulse train input terminal. Use **Pr.291** to choose JOG or pulse.
∗5 Terminal input specifications can be changed by analog input specification switchover **(Pr.73, Pr.267)**. To input a voltage, set the voltage/current input switch OFF. To input a current, set the voltage/current input switch ON. Terminals 10 and 2 are also used as a PTC input terminal. **(Pr.561)**
∗6 It is recommended to use 2 W 1 kΩ when the frequency setting signal is changed frequently.
∗7 The function of these terminals can be changed 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 The option connector 2 cannot be used because the Ethernet board is installed in the initial status. The Ethernet board must be removed to install a plug-in option to the option connector 2. (However, Ethernet communication is disabled in that case.)

NOTE

- To prevent a malfunction due to noise, keep the signal cables 10 cm or more away from the power cables. Also, 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.
- For the parameter details, refer to the Instruction Manual (Detailed).

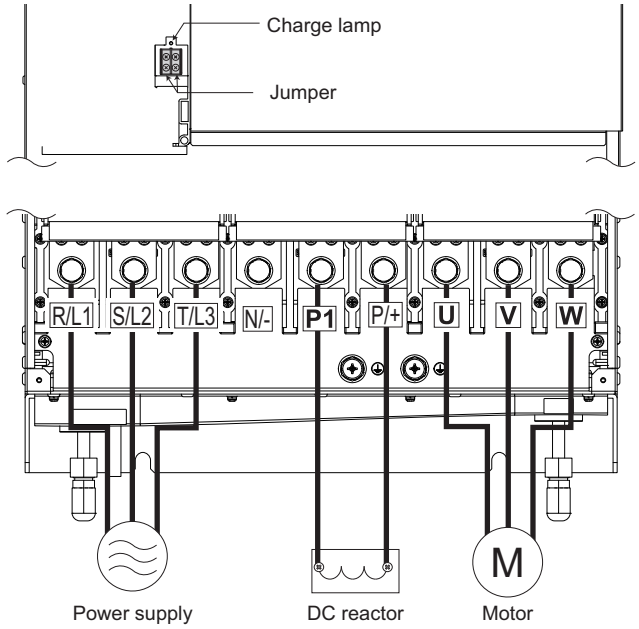
2.5 Main circuit terminals / piping port

2.5.1 Descriptions of the main circuit terminals / piping ports

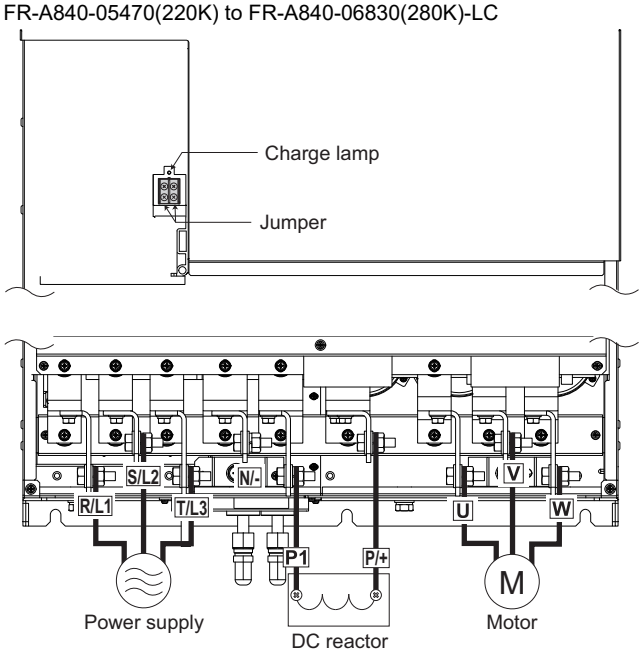
Terminal/ port symbol	Terminal/port name	Terminal/port function description	Refer to page
R/L1, S/L2, T/L3	AC power input	Connect these terminals to the commercial power supply. Do not connect anything to these terminals when using the high power factor converter (FR-HC2).	—
U, V, W	Inverter output	Connect these terminals to a three-phase squirrel cage motor or a PM motor.	—
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.	55
P/+, P1	DC reactor connection	Always connect a DC reactor, which is available as an option.	73
N/-	Keep this open.		
⏚	Earth (ground)	For earthing (grounding) the inverter chassis. This must be earthed (grounded).	39
LI, LO	Cooling system connection	Connect the cooling system.	36
D	Drainage pipe connection	Connect the drainage pipe.	36

2.5.2 Terminal layout of the main circuit terminals and wiring of power supply / motor

FR-A840-03250(110K) to FR-A840-04810(185K)-LC

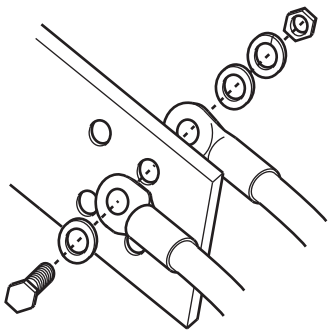


FR-A840-05470(220K) to FR-A840-06830(280K)-LC



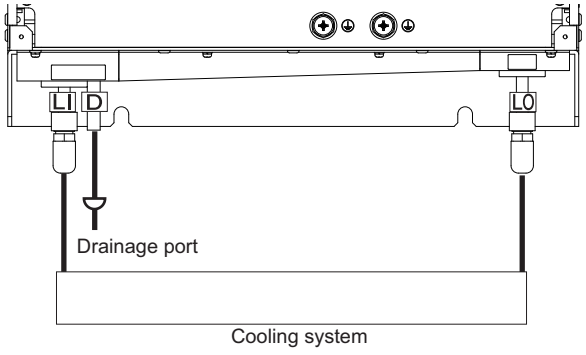
NOTE

- Make sure the power cables are connected to the R/L1, S/L2, and T/L3. (Phase need not be matched.) Never connect the power cable to the U, V, and W of the inverter. Doing so will damage the inverter.
- Connect the motor to U, V, and W. The phase need to be matched.
- When wiring the inverter 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 drawing on the right.) For wiring, use bolts (nuts) provided with the inverter.

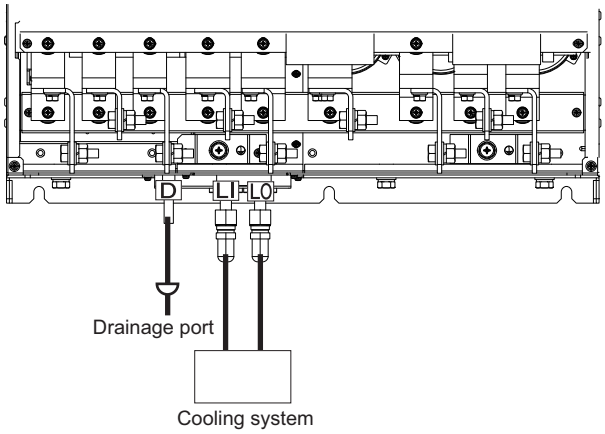


2.5.3 Piping the cooling system and the drainage pipe

FR-A840-03250(110K) to FR-A840-04810(185K)-LC



FR-A840-05470(220K) to FR-A840-06830(280K)-LC



2.5.4 Applicable cables and the 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 wires will cause the motor torque to decrease especially at a low speed.
The following table indicates a selection example for the wiring length of 20 m.

• 400 V class (440 V input power supply (with 150% rated current for one minute))

Applicable inverter model FR-A840-[ ]-LC	Terminal screw size*4	Tightening torque N·m	Crimp terminal		Cable gauge								
					MLFC cables, etc. (mm^2)*1				AWG/MCM*2		PVC cables, etc. (mm^2)*3		
			R/L1, S/L2, T/L3	U, V, W	R/L1, S/L2, T/L3	U, V, W	P/+, P1	Earthing (grounding) cable	R/L1, S/L2, T/L3	U, V, W	R/L1, S/L2, T/L3	U, V, W	Earthing (grounding) cable
03250(110K)	M10	26.5	80-10	80-10	80	80	80	38	3/0	3/0	70	70	35
03610(132K)	M10	26.5	100-10	100-10	100	100	100	38	4/0	4/0	95	95	50
04320(160K)	M12(M10)	46	150-12	150-12	125	150	150	38	250	250	120	120	70
04810(185K)	M12(M10)	46	150-12	150-12	150	150	150	38	300	300	150	150	95
05470(220K)	M12(M10)	46	100-12	100-12	2×100	2×100	2×100	60	2×4/0	2×4/0	2×95	2×95	95
06100(250K)	M12(M10)	46	100-12	100-12	2×100	2×100	2×100	60	2×4/0	2×4/0	2×95	2×95	95
06830(280K)	M12(M10)	46	150-12	150-12	2×125	2×125	2×125	60	2×250	2×250	2×120	2×120	125

*1 It is 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 50°C or lower and in-enclosure wiring.
*2 It is the gauge of a cable with the continuous maximum permissible temperature of 90°C (THHN cable). It assumes a surrounding air temperature of 40°C or lower and in-enclosure wiring. (For the use in the United States or Canada, refer to page 115.)
*3 It is the gauge of a cable with the continuous maximum permissible temperature of 90°C (XLPE cable). 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 terminal screw for R/L1, S/L2, T/L3, U, V, W, P/+, N/-, and P1.
The size of earthing (grounding) screws for the FR-A840-04320(160K) or higher 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.

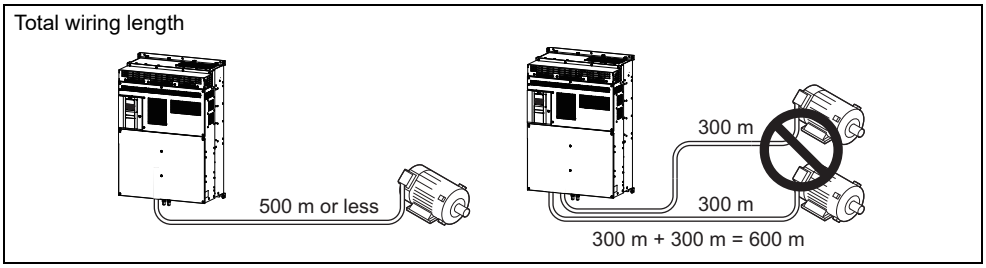
NOTE

- The selection example is for the ND or LD rating.
- 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

◆With induction motor

Connect one or more induction motors within the total wiring length 500 m. (The wiring length should be 100 m or shorter under vector control.)



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, take one of the following measures.

- Use a "400 V class inverter-driven insulation-enhanced motor". When the wiring length exceeds 100 m, set "4" (4 kHz) or less in **Pr.72 PWM frequency selection**.
- Connect a sine wave filter (MT-BSL/BSC) at the output side of the inverter.

◆With PM motor

The wiring length should be 100 m or shorter when connecting a PM motor.

Use one PM motor for one inverter. Multiple PM motors cannot be connected to an inverter.

When the wiring length exceeds 50 m for the motor driven by an inverter under PM sensorless vector control, set "9" (6 kHz) or less in **Pr.72 PWM frequency selection**.

NOTE

- Especially for long-distance wiring, the inverter may be affected by a charging current caused by stray capacitances of the wiring, leading to an activation of the overcurrent protection, malfunction of the fast-response current limit operation, or even to an inverter failure. It may also cause a malfunction or fault of the equipment connected ON the inverter output side. If the fast-response current limit function malfunctions, disable this function. (**Pr.156 Stall prevention operation selection**, refer to the Instruction Manual (Detailed).)
- A surge voltage suppression filter (FR-BMF-H) can be used under V/F control and Advanced magnetic flux vector control. A sine wave filter (MT-BSL/BSC) can be used under V/F control. Do not use the filters under different control methods.
- For the details of **Pr.72 PWM frequency selection**, refer to the Instruction Manual (Detailed).
- Refer to **page 82** to drive a 400 V class motor by an inverter.
- The carrier frequency is limited during PM sensorless vector control. (Refer to the Instruction Manual (Detailed).)

2.5.5 Earthing (grounding) precautions

- Always earth (ground) the motor and inverter.

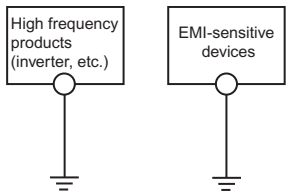
◆Purpose of earthing (grounding)

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 EMI-sensitive equipment that handle low-level signals or operate very fast such as audio equipment, sensors, computers.

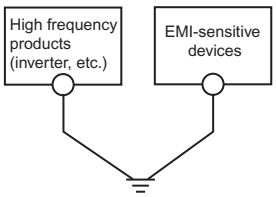
◆Earthing (grounding) system to be established

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

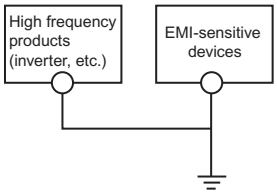
- Make the separate earth (ground) connection (I) for high frequency products such as the inverter from any other devices (EMI-sensitive devices described above) wherever possible.
  Establishing adequate common (single-point) earth (ground) system (II) shown in the following figure is allowed only in cases where the separate earth (ground) system (I) is not feasible. Do not make inadequate common (single-point) earth (ground) connection (III)
  As leakage 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 its iron structure frames as earthing (grounding) electrode for EMI prevention in order to separate from the earth (ground) system for electric shock prevention.
- Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes. (NEC section 250, IEC 61140 class 1 and other applicable standards).
- Use the thickest possible earthing (grounding) cable. The earthing (grounding) cable should be equal to the size indicated in the table on page 37.
- The earthing (grounding) point should be as close as possible to the inverter, and the earth (ground) wire length should be as short as possible.
- Run the earthing (grounding) cable as far away as possible from the I/O wiring of the EMI-sensitive devices and run them in parallel in the minimum distance.



(I) Separate earthing (grounding): Good



(II) Common (single-point) earthing (grounding): OK



(III) Inadequate common (single-point) earthing (grounding): Bad

NOTE

- To be compliant with the EU Directive (Low Voltage Directive), refer to page 112.

2.5.6 Piping and coolant for the cooling system and the drainage pipe

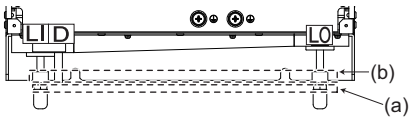
◆Piping connection

Connection port			Recommended pipes	
Port type	Material	Port symbol	Material	Size
Piping port	Brass (C3604BD)	LI, LO	Main material (inner layer): ETFE (Tetrafluoride based fluorine resin) (Tetrafluoroethylene and ethylene copolymer)*1 Reinforcement: Polyester yarn	Inside diameter: 12 mm, outside diameter: 18 mm
			Phosphorus deoxidized copper (C1220)	Inside diameter: 10.7 mm, outside diameter: 12.7 mm
Drainage port	Carbon steel (SGP)	D	Main material: Soft PVC Reinforcement: Polyester yarn	Inside diameter: 12 mm, outside diameter: 18 mm

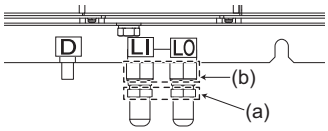
*1 For piping, fix each pipe securely with a binder to prevent fluid leakage.

- Before piping, remove a protective cap from each port.
- For piping, use sealing tape around each pipe joint to prevent fluid leakage. For connecting the joint, make sure to fix the section (a) shown in the figure. Do not fix the section (b). When the section (b) is fixed for connecting the joint, water leakage may occur.

FR-A840-03250(110K) to 04810(185K)

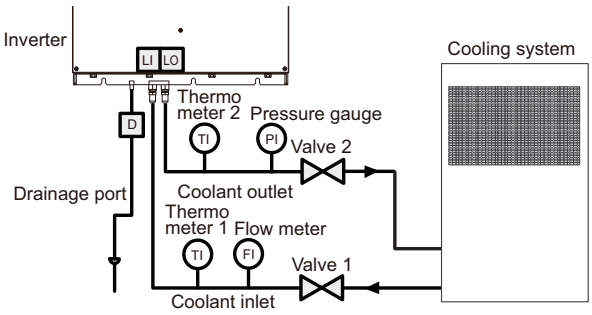


FR-A840-05470(220K) to 06830(280K)



	Screw type	Recommended tightening torque	Pipe diameter
Piping port	3/8R	23 N·m	—
Drainage port	—	—	Outside diameter: 10.5 mm

- Do not splash water on the port symbol (LI/LO/D) stickers during piping. Wet stickers may come unstuck. Wipe the stickers dry immediately if they get wet.
- Refer to the inverter installation environment (page 19) to connect the cooling system appropriately so that the flow rate, temperature, and pressure of the coolant will be kept within the specified range.
- Attach a flow meter or a flow switch at the inlet of coolant to monitor the flow rate. When the inverter is operated continuously with the flow rate less than the specified rate, impurities or other deposits may deposit. When the flow rate exceeds the specified rate, corrosion of internal piping may proceed more rapidly.
- Place thermometers at the inlet and the outlet of coolant to monitor the fluid temperature. When the temperature exceeds the specified temperature, corrosion of internal piping may proceed more rapidly.
- Place a pressure gauge at the outlet of coolant to monitor the pressure. When the applied pressure exceeds the specified pressure, water may leak out from the joint section or the pipes may be broken.
- Place valves at the inlet and the outlet of coolant in the piping. Use the valves for flow rate regulation during installation or replacement.
- Do not permit residual air in the pipes for piping joint.



◆Selection of the coolant

For corrosion prevention of the internal piping, use a coolant with the specifications in the following table.
Even if the values meet the specifications, also check that the value of bicarbonate ion exceeds the value of sulphate ion.
(When using running water, check the contents of water against the specifications.)

Item	Circulating water	Supply water
PH	7.0 to 8.0	7.0 to 8.0
Electrical conductivity	30 mS/m or less	30 mS/m or less
Chloride ion	50 mg/L or less	50 mg/L or less
Sulphate ion	50 mg/L or less	50 mg/L or less
Acid consumption	50 mg/L or less	50 mg/L or less
Total hardness	70 mg/L or less	70 mg/L or less
Calcium hardness	50 mg/L or less	50 mg/L or less
Ionic silica	30 mg/L or less	30 mg/L or less
Iron	1.0 mg/L or less	0.3 mg/L or less
Copper	1.0 mg/L or less	0.1 mg/L or less
Sulfide ion	Should not be detected	Should not be detected
Ammonium ion	0.3 mg/L	0.1 mg/L
Residual chlorine	0.25 mg/L or less	0.3 mg/L or less
Free carbon dioxide	0.4 mg/L or less	4.0 mg/L or less

NOTE

- Copper (C1220) is used for the inverter internal piping. Select an appropriate cooling system and a coolant to prevent corrosion.

◆Coolant temperature

The lowest temperature of the coolant differs depending on the surrounding air temperature and relative humidity of the inverter as shown in the following table.

Surrounding air temperature (°C)	Relative humidity (RH) (%)									
	95	90	80	70	60	50	40	30	20	10
50	Not applicable					38°C	33°C	29°C	22°C	13°C
45	Not applicable			39°C	36°C	33°C	29°C	24°C	18°C	9°C
40	40°C	39°C	37°C	34°C	32°C	28°C	25°C	20°C	14°C	5°C
35	35°C	34°C	32°C	30°C	27°C	24°C	20°C	16°C	10°C	1°C
30	30°C	29°C	27°C	25°C	22°C	19°C	16°C	11°C	6°C	1°C
25	25°C	24°C	22°C	20°C	18°C	15°C	11°C	7°C	2°C	1°C
20	20°C	19°C	17°C	15°C	13°C	10°C	7°C	3°C	1°C	1°C
15	15°C	14°C	12°C	10°C	8°C	6°C	2°C	1°C	1°C	1°C
10	10°C	9°C	8°C	6°C	3°C	1°C	1°C	1°C	1°C	1°C
5	5°C	4°C	3°C	1°C	1°C	1°C	1°C	1°C	1°C	1°C
0	1°C	1°C	1°C	1°C	1°C	1°C	1°C	1°C	1°C	1°C

When the coolant temperature becomes lower than the temperature specified in the table, condensation may occur inside the inverter and the inverter may be damaged. When condensation occurs, take the following countermeasures.

- When the coolant temperature is higher than the surrounding air temperature, let the coolant circulate.
- When the coolant temperature is lower than the surrounding air temperature, do not let the coolant circulate while the inverter is stopped.
- Install a dehumidifier or other appropriate device inside the enclosure of the inverter.

◆Amount of heat generated by the inverter

The following table shows the amount of heat generated in the liquid cooling and the air cooling sections of the inverter not connected with the cooling system. (The amount of heat generated shown assumes the following conditions: output current of the inverter rated current, power supply voltage of 440 V (400 V class), and carrier frequency of 2 kHz. The amount of heat shown is that generated from the inverter alone (not including that generated from the DC reactor).
Select the cooling system considering the following amount of heat.

Model FR-A840-[]-LC		03250	03610	04320	04810	05470	06100	06830
		110K	132K	160K	185K	220K	250K	280K
Total amount of heat	ND rating	2300	2800	3450	3850	4500	5050	5850
	LD rating	2800	3600	3800	4650	5050	5850	6600
Amount of heat in liquid cooling section	ND rating	2070	2550	3150	3530	4110	4640	5420
	LD rating	2550	3320	3480	4300	4640	5420	6090
Amount of heat in air cooling section	ND rating	230	250	300	320	390	410	430
	LD rating	250	280	320	350	410	430	510

(Unit: W)

◆Function specifications

(1) Low flow rate input warning

The warning is displayed according to the status of the signal input to the inverter input terminal from the flow switch attached at the inlet of coolant.

Input signal	Name	Description	Remarks
X31	Flow switch input 1	Signal status according to the flow rate. Low flow rate: ON (conductive) High flow rate: OFF (not conductive)	Set "31" in any of **Pr.178 to Pr.189** to enable the function. When multiple flow switches are used and any of the switches outputs the X31 signal, the Y216 signal is output.
X41	Flow switch input 2	Signal status according to the flow rate. Low flow rate: OFF (not conductive) High flow rate: ON (conductive)	Set "41" in any of **Pr.178 to Pr.189** to enable the function. When multiple flow switches are used and any of the switches stops outputting the X41 signal, the Y216 signal is output.

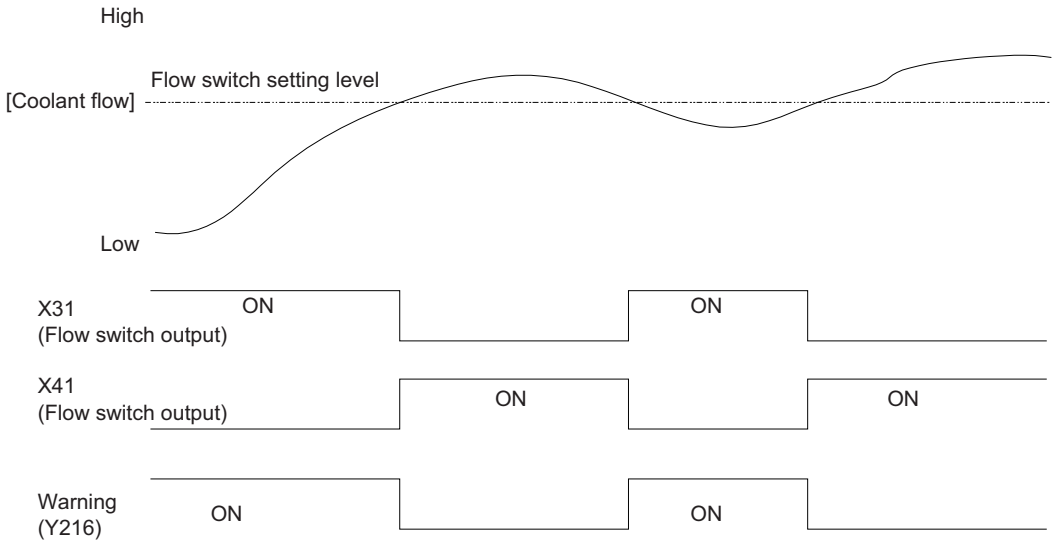
Output signal	Name	Description	Remarks
Y216	Low flow rate input warning	Low flow rate: ON High flow rate: OFF	Set "216 (positive logic) or 316 (negative logic)" in any of **Pr.190 to Pr.196** to output the Y216 signal.

• Warning output operation

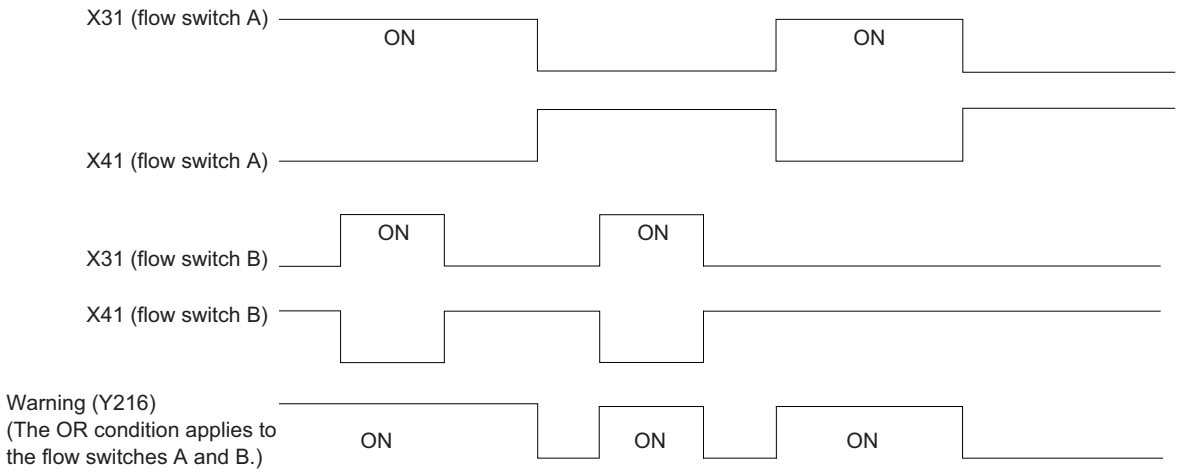
Flow rate condition (input signal)	Warning (output signal) status	FR-DU08 display
Low	ON	The "FL" warning is displayed.
High	OFF	The warning is OFF.

[Example] Warning output when the incoming coolant flow rate becomes low

- When a single flow switch is used and the X31 signal or the X41 signal is used for the switch, the status of the signals is as follows.
  The Y216 signal turns ON when the X31 signal turns ON.
  The Y216 signal turns ON when the X41 signal turns OFF.



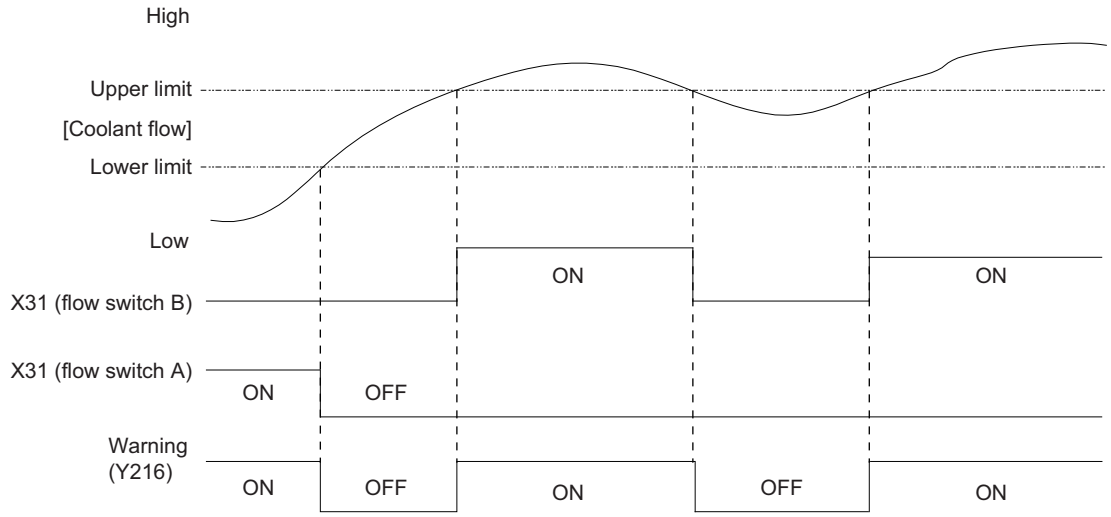
- When multiple flow switches are used and the X31 signal or the X41 signal is used for each of the switches, the status of the signals is as follows.
  When any of the X31 signals is ON or any of the X41 signals is OFF, the Y216 signal is ON.



2

[Example of advanced application] Warning output when the incoming coolant flow rate is beyond the upper/lower limit

- In this example, the upper and lower limits are placed on the coolant flow rate. The X31 signal turns ON when the flow rate becomes lower than the lower limit at the flow switch A, and the X31 signal is set to turn ON when the flow rate becomes higher than the upper limit at the flow switch B. The Y216 signal turns ON when the flow rate exceeds or falls below the limits. The status of the signals is as follows.
  The Y216 signal turns ON when the X31 signal for the flow switch A turns ON (the flow rate falls below the lower limit).
  The Y216 signal turns ON when the X31 signal for the flow switch B turns ON (the flow rate exceeds the upper limit).



NOTE

- The output signal Y216 is retained after inverter reset.
- When multiple input signals are used, the operation is as follows.
  - Multiple X31 signals: When any of the terminals turns ON, the warning is output.
  - Multiple X41 signals: When any of the terminals turns OFF, the warning is output.
  - X31 and X41 signals: When any of the X31 signals is ON or any of the X41 signals is OFF, the Y216 signal is ON and the warning is output.

(2) Multiple rating setting

Two rating types of different rated current and permissible load can be selected. For the parameter initial values and setting ranges changed after the multiple rating setting, refer to the Instruction Manual (Detailed) of the FR-A800 inverter.

Pr.	Name	Initial value	Setting range	Description
570 (E301)	**Multiple rating setting**	2	1	LD rating
			2	ND rating

◆Addition/change of fault indication

• Warning

Operation panel indication	FL	FL
Name	Low flow rate input warning	
Description	The warning is displayed according to the status of the signal input to the inverter input terminal from the flow switch attached at the inlet of coolant.	
Check point	Check if the flow rate decreases. Check for malfunction of the flow switch.	
Corrective action	• Keep the flow rate within the rated flow rate range. • Check the flow switch operation.	

• Fault

Operation panel indication	E.IPF	E. 1 PF
Name	Instantaneous power failure	
Description	If a power failure (inverter input shut-off) occurs and lasts for longer than 10 ms, the instantaneous power failure protective function is activated to trip the inverter in order to prevent the control circuit from malfunctioning. If a power failure persists for 100 ms or longer, the fault output is not provided, and the inverter restarts if the start signal is ON upon power restoration. (The inverter continues operating if an instantaneous power failure is within 10 ms.) In some operating status (depending on the load magnitude, acceleration/deceleration time setting, etc.), overcurrent or other protection may be activated upon power restoration. When instantaneous power failure protection is activated, the IPF signal is output.	
Check point	Find the cause of the instantaneous power failure occurrence.	
Corrective action	• Recover from the instantaneous power failure condition. • Prepare a backup power supply in case of an instantaneous power failure. • Set the function of automatic restart after instantaneous power failure (**Pr.57**).	

Operation panel indication	E.IAH	E. 1 AH
Name	Abnormal internal temperature	
Description	If the operation continues for 15 minutes or more while the fan alarm is output (while the indication "FN" appears), the inverter trips.	
Check point	Check if the cooling fan stops due to a fault.	
Corrective action	Replace the cooling fan.	

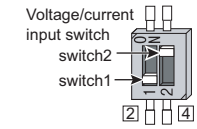
2.6 Control circuit

2.6.1 Details on the control circuit terminals

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 Instruction Manual (Detailed).

◆Input signal

Type	Terminal symbol	Terminal name	Terminal function description		Rated specification
Contact input	STF	Forward rotation start	Turn ON the STF signal to start forward rotation and turn it OFF to stop.	When the STF and STR signals are turned ON simultaneously, the stop command is given.	Input resistance: 4.7 kΩ Voltage when contacts are open: 21 to 27 VDC Current when contacts are short-circuited: 4 to 6 mADC
	STR	Reverse rotation start	Turn ON the STR signal to start reverse rotation and turn it OFF to stop.		
	STP (STOP)	Start self-holding selection	Turn ON the STP (STOP) signal to self-hold the start signal.		
	RH, RM, RL	Multi-speed selection	Multi-speed can be selected according to the combination of RH, RM and RL signals.		
	JOG	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 a pulse train input terminal. To use as a pulse train input terminal, change the **Pr.291** setting. (maximum input pulse: 100k pulses/s)		Input resistance: 2 kΩ Current when contacts are short-circuited: 8 to 13 mADC
	RT	Second function selection	Turn ON the RT signal to enable the second function. When the second function such as "second torque boost" and "second V/F (base frequency)" is set, turning ON the RT signal enables the selected function.		Input resistance: 4.7 kΩ Voltage when contacts are open: 21 to 27 VDC Current when contacts are short-circuited: 4 to 6 mADC
	MRS	Output stop	Turn ON the MRS signal (20 ms or more) to stop the inverter output. Use this signal to shut off the inverter output when stopping the motor with an electromagnetic brake.		
	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 set always-enabled. By setting **Pr.75**, reset can be set enabled only at 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 turned ON. Turning the AU signal ON makes terminal 2 invalid.		
	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 for this operation. In the initial setting, a restart is disabled.		
	SD	Contact input common (sink)*2	Common terminal for the contact input terminal (sink logic), 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 sink logic to avoid malfunction by undesirable currents.		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	Can be used as a 24 VDC 0.1 A power supply.		

Type	Terminal symbol	Terminal name	Terminal function description	Rated specification
Frequency setting	10E	Frequency setting power supply	When connecting the frequency setting potentiometer at an initial status, connect it to terminal 10. Change the input specifications of terminal 2 using **Pr.73** when connecting it to terminal 10E.	10 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	For voltage input, input resistance: 10 ±1 kΩ, maximum permissible voltage: 20 VDC. For current input, input resistance: 245 ±5 Ω, permissible maximum current: 30 mA. 
	4	Frequency setting (current)	Inputting 4 to 20 mADC (or 0 to 5 V, 0 to 10 V) provides the maximum output frequency at 20 mA and makes input and output proportional. This input signal is valid only when the AU signal is ON (terminal 2 input is invalid). Use **Pr.267** to switch among input 4 to 20 mA (initial setting), 0 to 5 VDC, and 0 to 10 VDC. Set the voltage/current input switch in the OFF position to select voltage input (0 to 5 V / 0 to 10 V).*1 Use **Pr.858** to switch terminal functions.	
	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 ±1 kΩ 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, CA. Do not earth (ground).	—
Thermistor	10 2	PTC thermistor input	For receiving PTC thermistor outputs. When PTC thermistor is valid (**Pr.561** ≠ "9999"), terminal 2 is not available for frequency setting.	Applicable PTC thermistor specification Overheat detection resistance: 0.5 to 30 kΩ (Set by **Pr.561**)
External 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 Instruction Manual (Detailed).)

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

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

◆Output signal

Type	Terminal symbol	Terminal name	Terminal function description		Rated specification
Relay	A1, B1, C1	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		
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.) The open collector transistor is ON (conductive) in LOW state. The transistor is OFF (not conductive) in HIGH state.
	SU	Up to frequency	Switched to LOW when the output frequency is within the set frequency range ±10% (initial value). Switched to HIGH during acceleration/ deceleration and at a stop.	Fault code (4 bits) output.	
	OL	Overload warning	Switched to LOW when stall prevention is activated by the stall prevention function. Switched to HIGH when stall prevention is canceled.		
	IPF	Instantaneous power failure	Switched to LOW when an instantaneous power failure occurs or when the undervoltage protection is activated.		
	FU	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. 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. (Refer to the Instruction Manual (Function).)	Output item: Output frequency (initial setting)	Permissible load current: 2 mA For full scale 1440 pulses/s
		NPN open collector output		This terminal can be used for open collector outputs by setting **Pr.291**.	Maximum output pulse: 50k pulses/s Permissible load current: 80 mA
Analog	AM	Analog voltage output		Output item: Output frequency (initial setting)	Output signal: 0 to ±10 VDC, Permissible load current: 1 mA (load impedance 10 kΩ or more) Resolution: 8 bits
	CA *2	Analog current output			Load impedance: 200 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.

◆Communication

Type	Terminal symbol		Terminal name	Terminal function description	
Ethernet (Ethernet model)	—		Ethernet connector	Communication can be made via Ethernet. Category: 100BASE-TX/10BASE-T Data transmission speed: 100 Mbps (100BASE-TX) / 10 Mbps (10BASE-T) Transmission method: Baseband Maximum segment length: 100 m between the hub and the inverter Number of cascade connection stages: Up to 2 (100BASE-TX) / up to 4 (10BASE-T) Interface: RJ-45 Number of interfaces available: 1 IP version: IPv4	
RS-485	—		PU connector	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 Transmission speed: 4800 to 115200 bps Wiring length: 500 m	
	RS-485 terminals (RS-485 model)	TXD+	Inverter transmission terminal	The RS-485 terminals enables the communication by RS-485. Conforming standard: EIA-485 (RS-485) Transmission format: Multidrop link Transmission speed: 300 to 115200 bps Overall length: 500 m	
		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 full-speed compatible) Transmission speed: 12 Mbps
			USB B connector	Mini B connector (receptacle) Establish the connection with a personal computer via this USB connector to configure the inverter setting, monitor and test the inverter operation.	

◆Safety stop signal

Terminal symbol	Terminal name	Terminal function description	Rated specification	Refer to page
S1	Safety stop input (Channel 1)	Terminals S1 and S2 are used for the safety stop input signal for the safety relay module. Terminals S1 and S2 are used at the same time (dual channel). Inverter output is shutoff by shortening/opening between terminals S1 and SIC, or between S2 and SIC. In the initial status, terminals S1 and S2 are shorted with terminal PC by shorting wires. Terminal SIC is shorted with terminal SD. Remove the shorting wires and connect the safety relay module when using the safety stop function.	Input resistance 4.7 kΩ Input current 4 to 6 mADC (with 24 VDC input)	58
S2	Safety stop input (Channel 2)			
SIC	Safety stop input terminal common	Common terminal for terminals S1 and S2.	—	
So (SO)	Safety monitor output (open collector output)	Indicates the safety stop input signal status. Switched to LOW when the status is other than the internal safety circuit failure. Switched to HIGH during the internal safety circuit failure status. (LOW is when the open collector output transistor is ON (conducted). HIGH is when the transistor is OFF (not conducted).) Refer to the Safety Stop Function Instruction Manual when the signal is switched to HIGH while both terminals S1 and S2 are open. (Please contact your sales representative for the manual.)	Permissible load 24 VDC (27 VDC at maximum), 0.1 A (The voltage drop is 3.4 V at maximum while the signal is ON.)	
SOC	Safety monitor output terminal common	Common terminal for terminal So (SO).	—	

2.6.2 Control logic (sink/source) change

Change the control logic of input signals as necessary.

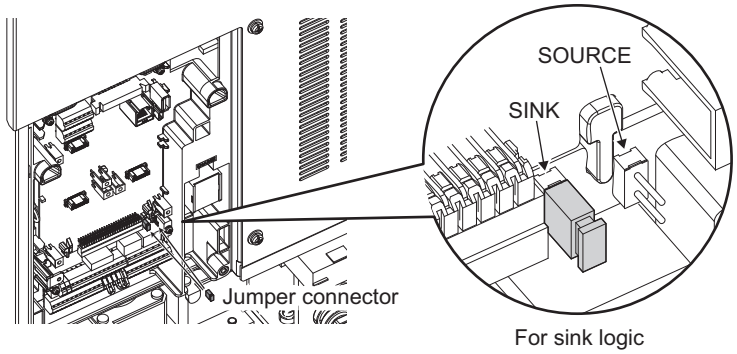
To change the control logic, change the jumper connector position on the control circuit board.

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.

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

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



For sink logic

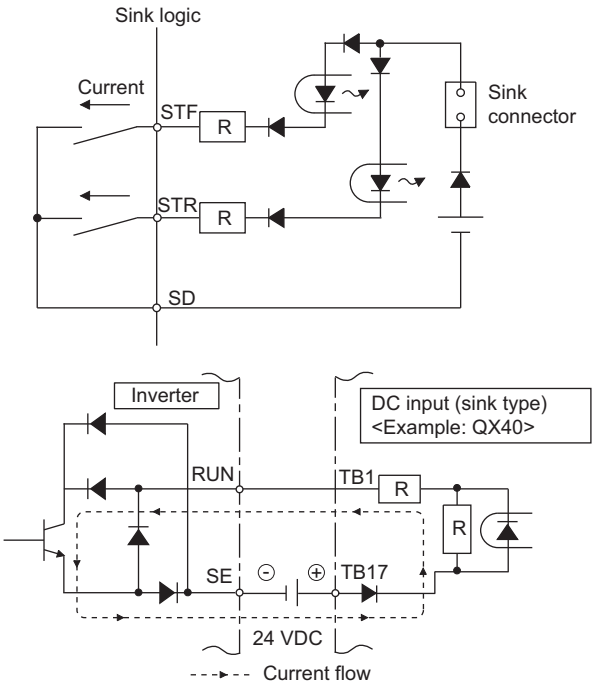
NOTE

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

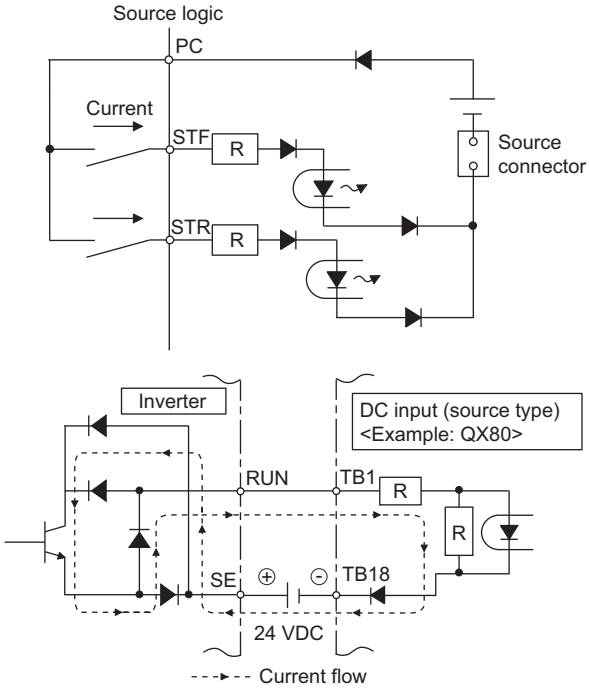
◆Sink logic and source logic

- 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



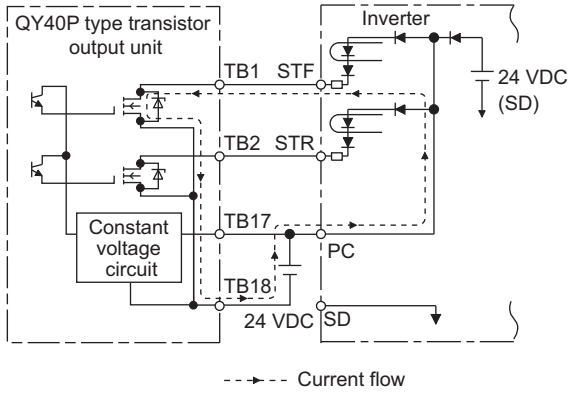
●Current flow concerning the input/output signal when source logic is selected



- When using an external power supply for transistor output

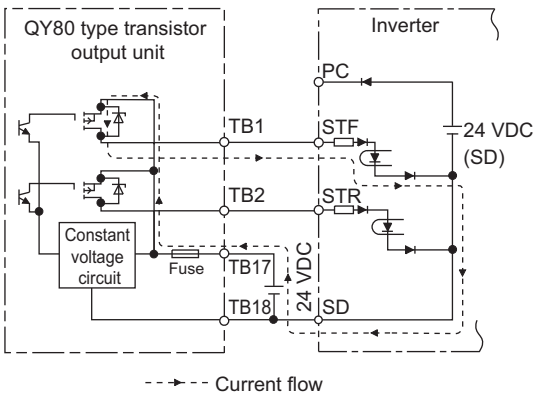
Sink logic

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

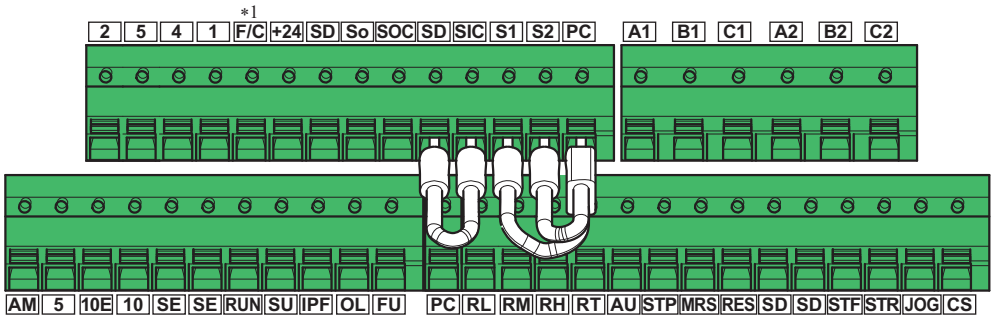
Use terminal SD as a common terminal, and perform wiring as shown below. (Do not connect terminal PC of the inverter with terminal +24 V of the external power supply. When using terminals PC-SD as a 24 VDC power supply, do not install an external power supply in parallel with the inverter. Doing so may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



2.6.3 Wiring of control circuit

◆Control circuit terminal layout

• Recommended cable gauge: 0.3 to 0.75 mm^2



*1 This terminal operates as the terminal FM for the FM type, and as the terminal CA for the CA type.

◆Wiring method

• Wiring connection

Use crimp terminals and stripped wire for the control circuit wiring. For single wire, the stripped wire can be used without crimp terminal.

Connect the end of wires (crimp terminal or stranded wire) to the terminal block.

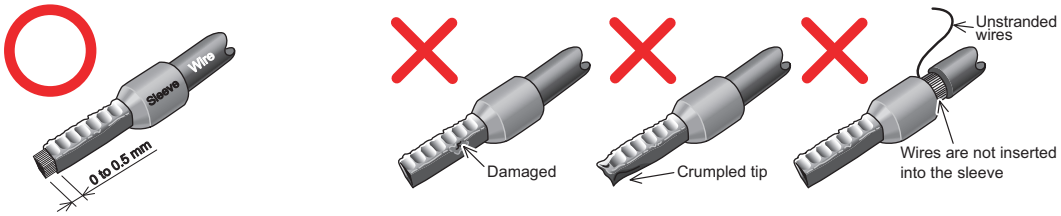
(1) Strip the signal wires as shown below. If too much of the wire is stripped, a short circuit may occur with neighboring wires. If not enough of the wire is stripped, wires may become loose and fall out. Twist the stripped end of wires to prevent them from fraying. Do not solder them.



(2) Use appropriate crimp terminals (ferrules, blade terminals, etc.).

Insert the wire into a crimp terminal, making sure that 0 to 0.5 mm of the wire protrudes from the end of the sleeve.

Check the condition of the crimp terminals after crimping. Do not use the crimp terminals of which the crimping is inappropriate, or the face is damaged.



• Crimp terminals commercially available (as of April 2023)

Phoenix Contact GmbH & Co. KG

Wire gauge (mm^2)	Ferrule part No.			Crimping tool model No.
	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	—	—	

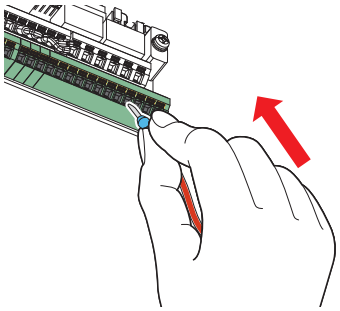
*1 A ferrule with an insulation sleeve compatible with the MTW wire which has a thick wire insulation.

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

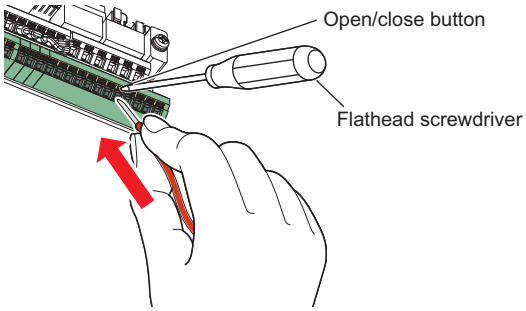
NICHIFU Co., Ltd.

Wire gauge (mm^2)	Blade terminal part No.	Insulation part No.	Crimping tool model No.
0.3 to 0.75	BT 0.75-11	VC 0.75	NH 69

(3) Insert each wire into the terminal.



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

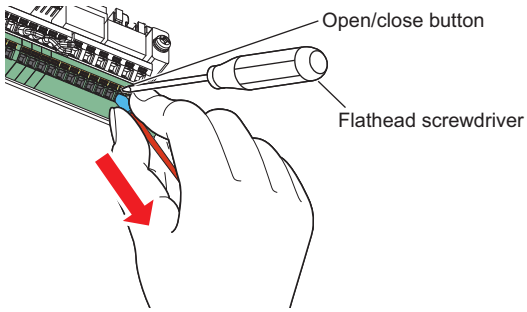


NOTE

- When using stranded wires without a crimp terminal, twist enough to avoid short circuit with a neighboring 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 April 2023)

Product	Model	Manufacturer
Screwdriver	SZF 0- 0,4 × 2,5	Phoenix Contact GmbH & Co. KG

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

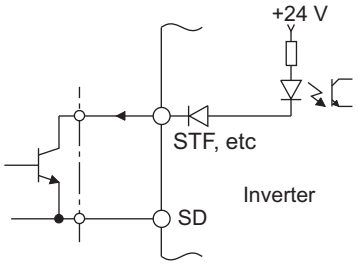
◆Common terminals of the control circuit (SD, PC, 5, SE)

- Terminals SD (sink logic), PC (source logic), 5, and SE are common terminals (0V) for I/O signals. (All common terminals are isolated from each other.) Do not earth (ground) these terminals. Avoid connecting terminal SD (sink logic) with 5, terminal PC (source logic) with 5, and terminal SE with 5.
- In the sink logic, terminal SD is a common terminal for the contact input terminals (STF, STR, STP (STOP), RH, RM, RL, JOG, RT, MRS, RES, AU, CS) and the pulse train output terminal (FM*1). The open collector circuit is isolated from the internal control circuit by photocoupler.
- In the source logic, terminal PC is a common terminal for the contact input terminals (STF, STR, STP (STOP), RH, RM, RL, JOG, RT, MRS, RES, AU, CS). The open collector circuit is isolated from the internal control circuit by photocoupler.
- Terminal 5 is a common terminal for the frequency setting terminals (2, 1 or 4) and the analog output terminals (AM, CA*2). Use a shielded or twisted cable to protect the terminal against malfunction caused by external noise.
- 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.

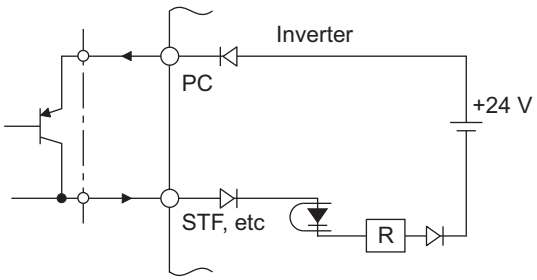
*1 Terminal FM is provided in the FM-type inverter.
*2 Terminal CA is provided in the CA-type inverter.

◆Signal inputs by contactless switches

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



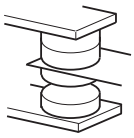
External signal input using transistor (sink logic)



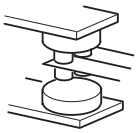
External signal input using transistor (source logic)

2.6.4 Wiring precautions

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

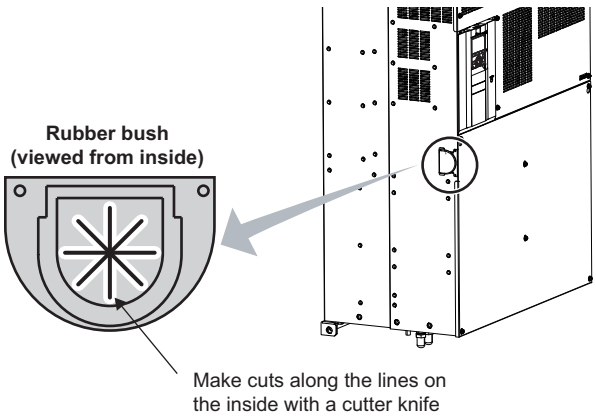


Micro signal contacts

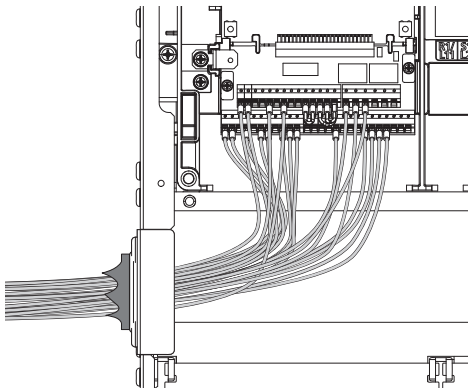


Twin contacts

- To suppress EMI, use shielded or twisted cables for the control circuit terminals and run them away from the main and power circuits (including the 200 V relay sequence circuit). For the cables connected to the control circuit terminals, connect their shields to the common terminal of the connected control circuit terminal. When connecting an external power supply to terminal PC, however, connect the shield of the power supply cable to the negative side of the external power supply. Do not directly earth (ground) the shield to the enclosure, etc.
- Always apply a voltage to the fault output terminals (A1, B1, C1, A2, B2, C2) via a relay coil, lamp, etc.
- Do not install an external power source in parallel with the internal 24 VDC power source (connected to terminals PC and SD) to use them together.
- 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.



<Wiring example>



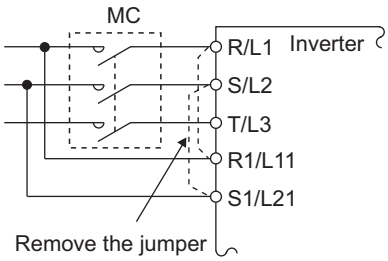
2.6.5 When using separate power supplies for the control circuit and the main circuit

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

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

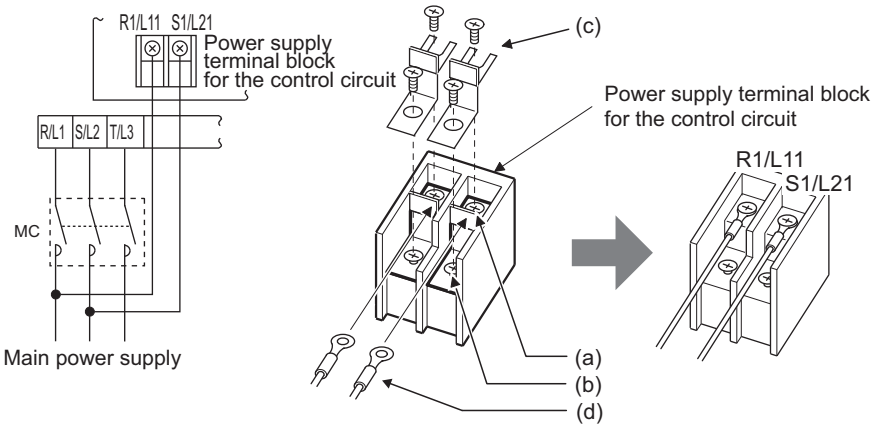
◆Connection method

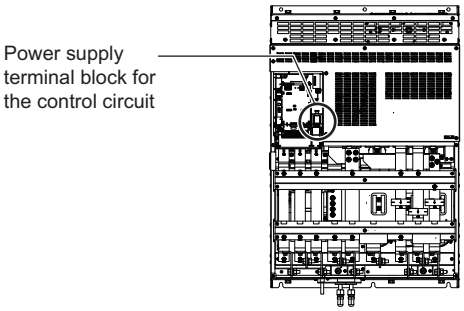
<Connection diagram>



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.
Do not connect the power cable to incorrect terminals. Doing so may damage the inverter.

(a) Remove the upper screws.
(b) Remove the lower screws.
(c) Pull the jumper toward you to remove.
(d) Connect the separate power supply cable for the control circuit to the upper terminals (R1/L11, S1/L21).





NOTE

- When using separate power supplies, always remove the jumpers across terminals R/L1 and R1/L11 and across S/L2 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.

2.6.6 When supplying 24 V external power to the control circuit

Connect the 24 V external power supply across terminals +24 and SD to enable I/O terminal ON/OFF operation, operation panel displays, operations of the operation panel, or communication during communication operation even at power-OFF state of inverter's main circuit power supply. When the main circuit power supply is turned ON, the power supply changes from the 24 V external power supply to the main circuit power supply.

◆Specification of the applicable 24 V external power supply

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

Commercially available products (as of April 2023)

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

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

◆Starting and stopping the 24 V external power supply operation

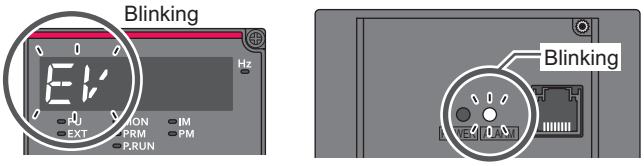
- Supplying 24 V external power while the main circuit power is OFF starts the 24 V external power supply operation. Likewise, turning OFF the main circuit power while supplying 24 V external power starts the 24 V external power supply operation.
- Turning ON the main circuit power stops the 24 V external 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 (EV) signal is output. To use the EV signal, set "68 (positive logic) or 168 (negative logic)" in one of **Pr.190 to Pr.196 (Output terminal function selection)** to assign function to an output terminal.

◆Operation while the 24 V external power is supplied

- Fault 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, converter output voltage, and IPF signal, are invalid.
- The safety stop function is invalid during the 24 V external power supply operation.
- The faults, 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.
- If the power supply changes from the main circuit power supply to the 24 V external power supply while measuring the main circuit capacitor's life, the measurement completes after the power supply changes back to the main circuit power supply (**Pr.259** = "3").
- The output data is retained when "1 or 11" is set in **Pr.495 Remote output selection**.

NOTE

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

2.6.7 Safety stop function

◆Function description

The terminals related to the safety stop function are shown below.

Terminal symbol	Terminal function description	
S1*1	For input of the safety stop channel 1.	Between S1 and SIC, S2 and SIC Open: In safety stop mode Short: Other than the safety stop mode.
S2*1	For input of the safety stop channel 2.	
SIC*1	Common terminal for S1 and S2.	
So (SO)	Outputs when an alarm or failure is detected. The signal is output when no internal safety circuit failure*2 exists.	OFF: Internal safety circuit failure*2 ON: No internal safety circuit failure*2
SOC	Open collector output (terminal So (SO)) common	

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

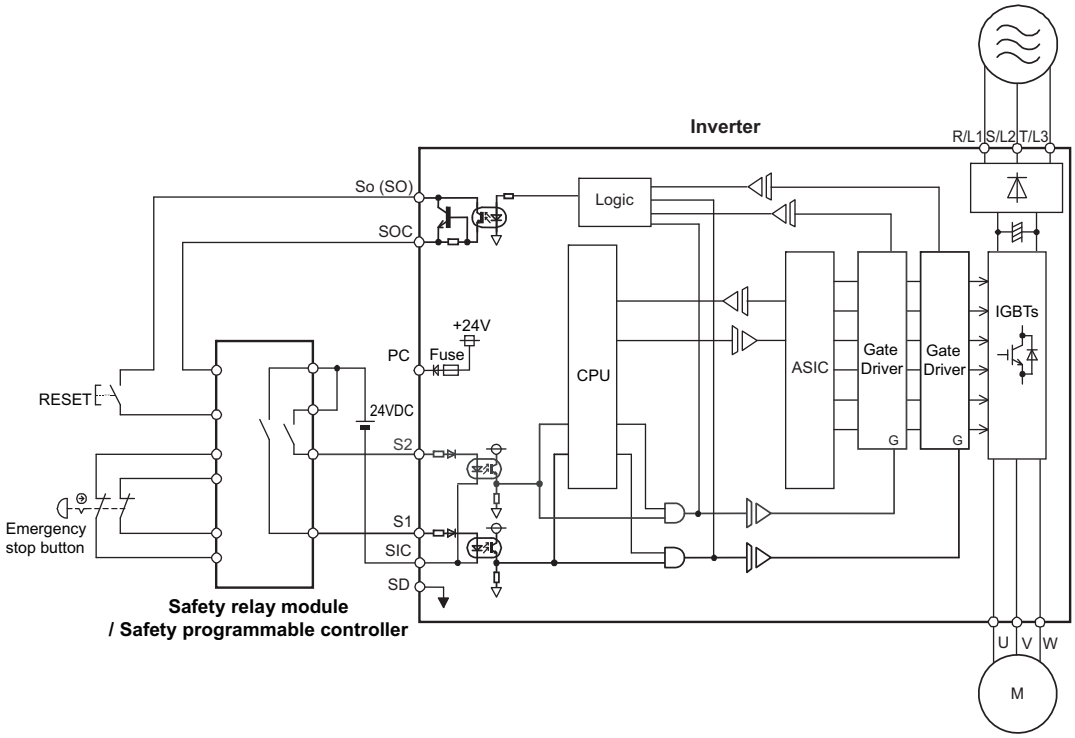
*2 At an internal safety circuit failure, the operation panel displays one of the faults shown on the next page.

NOTE

- Use terminal So (SO) to output a fault and to prevent restarting of the inverter. The signal cannot be used as safety stop input terminal to other devices.

◆Connection diagram

To prevent automatic restart after a fault occurrence, connect the reset button of a safety relay module or a safety programmable controller across terminals So (SO) and SOC. The reset button acts as the feedback input for the safety relay module or the safety programmable controller.



◆Safety stop function operation

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

*1 ON: The transistor is conducted. OFF: The transistor is not conducted.

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

*3 If any of the protective functions shown in the following table is activated, terminal So (SO) and the SAFE signal turn OFF.

Fault record	Operation panel indication
Option fault	E.OPT
Communication option fault	E.OP1 to E.OP3
Parameter storage device fault	E.PE
Retry count excess	E.RET
Parameter storage device fault	E.PE2
Internal storage device fault	E.PE6
Operation panel power supply short circuit/ RS-485 terminals power supply short circuit	E.CTE
24 VDC power fault	E.P24
Safety circuit fault	E.SAF
Overspeed occurrence	E.OS

Fault record	Operation panel indication
Speed deviation excess detection	E.OSD
Signal loss detection	E.ECT
Excessive position fault	E.OD
Encoder signal loss for orientation	E.ECA
Brake sequence fault	E.MB1 to E.MB7
CPU fault	E.CPU
	E.5 to E.7
Encoder phase fault	E.EP
Magnetic pole position unknown	E.MP
Internal circuit fault	E.13

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

*5 SA is displayed when terminals S1 and S2 are identified as OFF due to the internal safety circuit failure.

*6 If another fault occurs at the same time as E.SAF, the other fault can be displayed.

*7 If another warning occurs at the same time as SA, the other warning can be displayed.

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

*9 For SAFE signal, refer to the following table and assign the function by **Pr.190 to Pr.196 (Output terminal function selection)**.

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

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

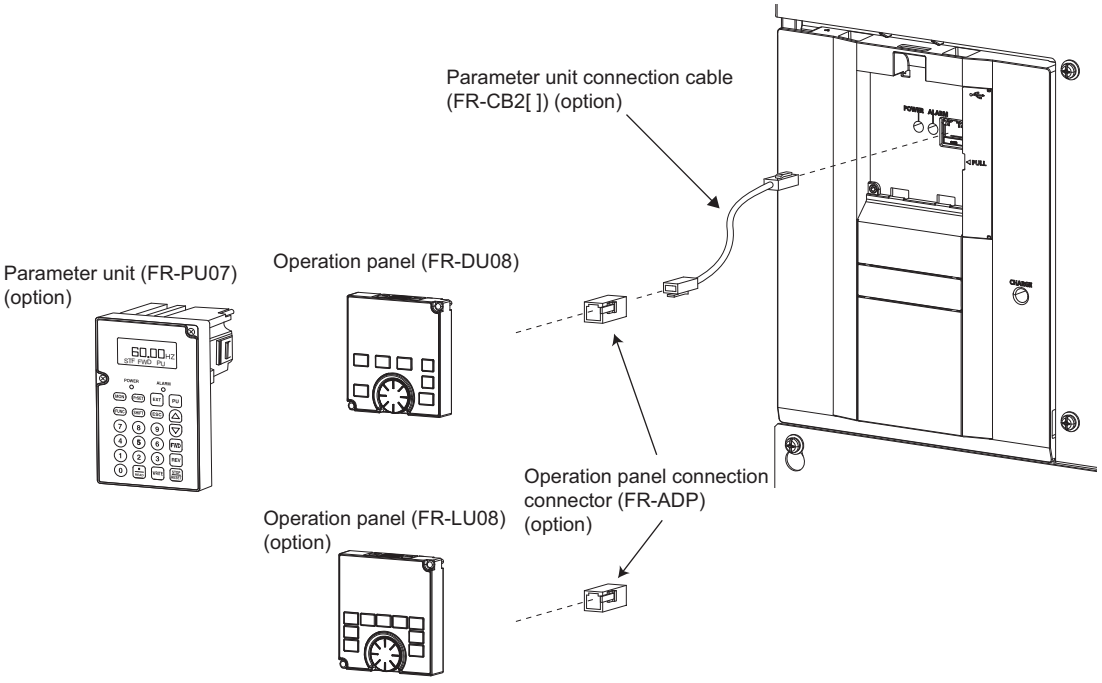
For more details, refer to the Safety Stop Function Instruction Manual.

2.7 Communication connectors and terminals

2.7.1 PU connector

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

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



NOTE

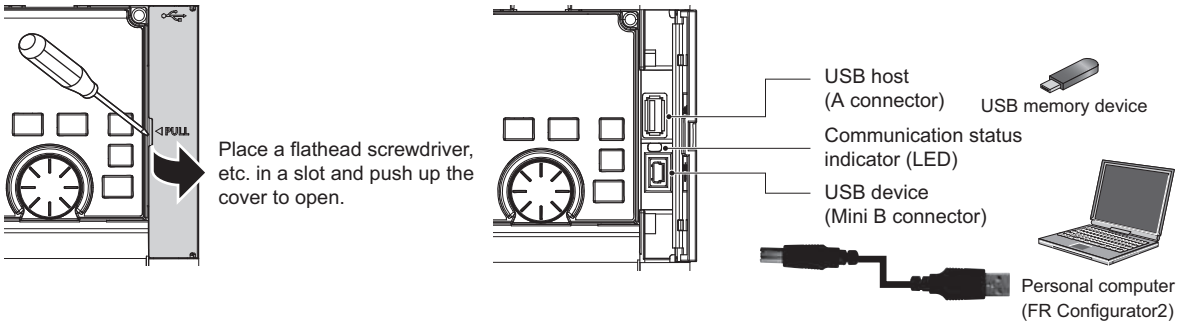
• Refer to the following table when fabricating the cable on the user side. Keep the total cable length within 20 m.

Name	Remarks
Communication cable	Cable compliant with EIA-568 (such as 10BASE-T cable)

◆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 the details, refer to the Instruction Manual (Detailed).

2.7.2 USB connector



◆USB host communication

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	• 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. • The parameter setting data copied in the USB memory device can be saved in a personal computer and edited in FR Configurator 2.
Trace	• The monitored data and output status of the signals can be saved in a USB memory device. • The saved data can be imported to FR Configurator2 to diagnose the operating status of the inverter.
PLC function data copy	• This function copies the PLC function project data to a USB memory device when the PLC function is used. • The PLC function project data copied in the USB memory device can be copied to other inverters. • This function is useful in backing up the parameter setting and for allowing multiple inverters to operate by the same sequence programs.

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

LED display status	Operating status
OFF	No USB connection.
ON	The communication is established between the inverter and the USB device.
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 warning) is displayed on the operation panel.
- When the UF warning appears, the USB error can be canceled by removing the USB device and setting **Pr.1049** = "1". (The UF warning can also be canceled by resetting the inverter power or resetting with the RES signal.)

NOTE

- Do not connect devices other than a USB memory device to the inverter.
- If a USB device is connected to the inverter via a USB hub, the inverter cannot recognize the USB memory device properly.

◆USB device communication

The inverter can be connected to a personal computer with a USB (Ver. 1.1) cable.
Parameter setting and monitoring can be performed by FR Configurator 2.

Interface	Conforms to USB1.1
Transmission speed	12 Mbps
Wiring length	Maximum 5 m
Connector	USB mini B connector (receptacle)
Power supply	Self-powered

NOTE

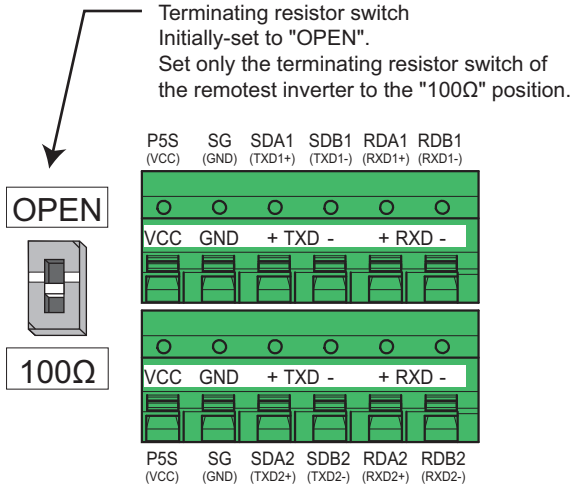
- For the details of FR Configurator2, refer to the Instruction Manual of FR Configurator2.

2.7.3 RS-485 terminal block (RS-485 model)

◆Communication operation

Conforming standard	EIA-485 (RS-485)
Transmission format	Multidrop link
Communication speed	maximum 115200 bps
Overall length	500 m
Connection cable	Twisted pair cable (4 pairs)

The RS-485 terminals enable 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) and MODBUS RTU protocol. For the details, refer to the Instruction Manual (Detailed).



2.7.4 Ethernet port (Ethernet model)

◆Ethernet communication specifications

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

◆Connection cable

Use Ethernet cables compliant with the following standards.

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

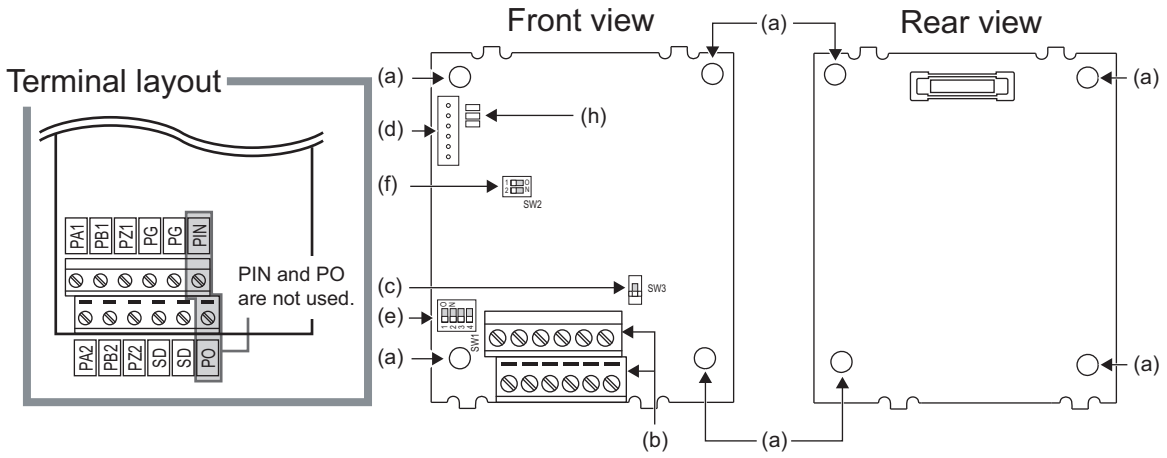
◆Hub

Use a hub that supports transmission speed of the Ethernet.

2.8 Connection of motor with encoder (vector control)

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

◆Appearance and parts name of the FR-A8AP



Symbol	Name	Description	Refer to page
a	Mounting hole	Used for installation to the inverter.	—
b	Terminal block	Connected with the encoder.	67
c	Encoder type selection switch (SW3)	Switches the encoder type (differential line driver/complementary).	65
d	CON2 connector	Used for extension	—
e	Terminating resistor selection switch (SW1)	Switches ON or OFF the internal terminating resistor.	65
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.	—

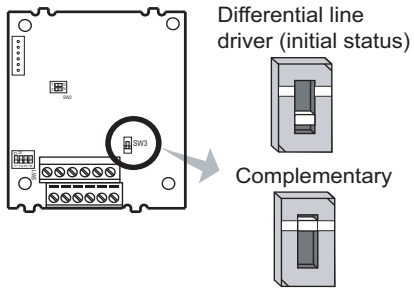
◆Terminals of the FR-A8AP

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

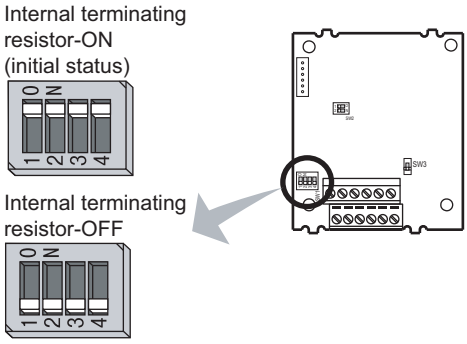
- When the encoder's output voltage differs from its input power supply voltage, the signal loss detection (E.ECT) may occur.
- Incorrect wiring or faulty setting to the encoder will cause a fault such as an overcurrent (E.OC[ ]) and an inverter overload (E.THT). Correctly perform the encoder wiring 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.
- The SW2 switch is for manufacturer setting. Do not change the setting.

- Encoder specification

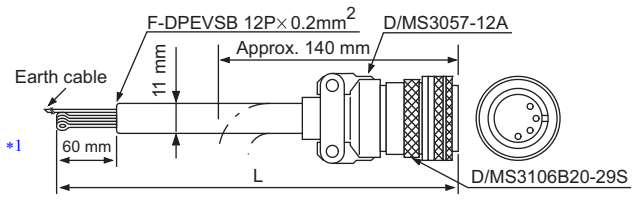
Item	Specification
Resolution	0 to 4096 Pulse/Rev (setting by **Pr. 369**)
Power supply voltage	5 V, 10 V, 15 V, 24 V
Output signal form	A, B phases (90° phase shift) Z phase: 1 pulse/rev
Output circuit	Differential line driver or complementary

NOTE

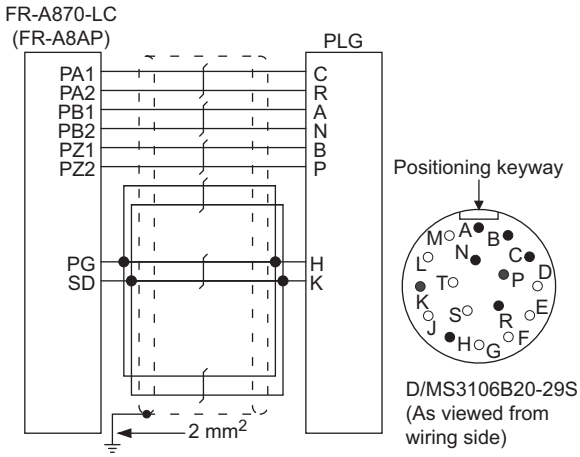
- Prepare an encoder's power supply (5 V/12 V/15 V/24 V) according to the encoder's output voltage. When the encoder output is the differential line driver type, only 5 V can be input.
- When the control terminal option FR-A8TP is installed, 24 V power supply can be provided from the FR-A8TP.

◆Encoder cable

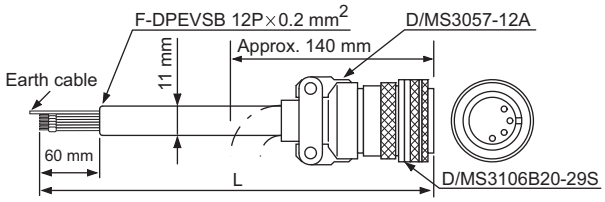
FR-JCBL



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

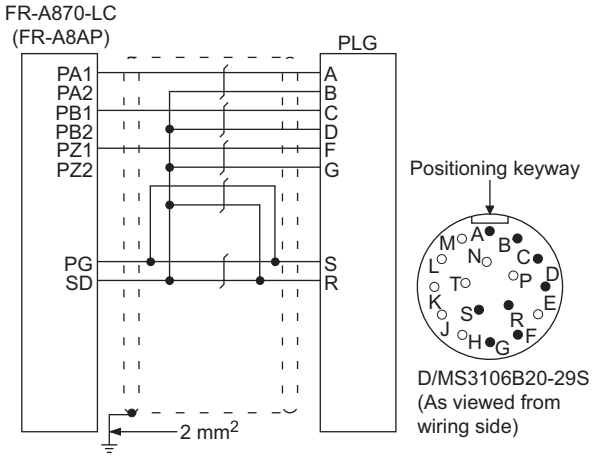


FR-V7CBL



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

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



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

- When using an encoder cable (FR-JCBL, FR-V5CBL, etc.) dedicated to the conventional motor, cut the crimp terminal of the encoder cable and strip wires to make wires' ends exposed.
  Also, treat the shielding wires of the shielded twisted pair cable to ensure that they will not contact conductive areas.
  Twist the stripped end of wires to prevent them from fraying. Do not solder them.



NOTE

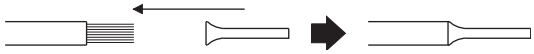
- Information on crimp terminals
  Commercially available products (as of April 2023)
  Phoenix Contact GmbH & Co. KG.

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

- When using the crimp terminal without insulation sleeve, make sure that the twisted stripped end does not come out of the terminal.



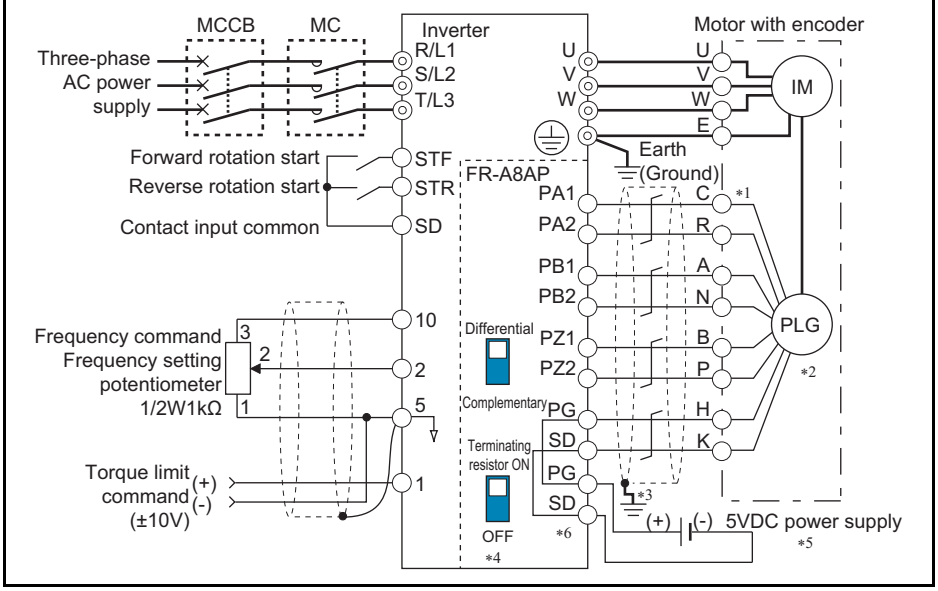
• Connection terminal compatibility table

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

◆Wiring example

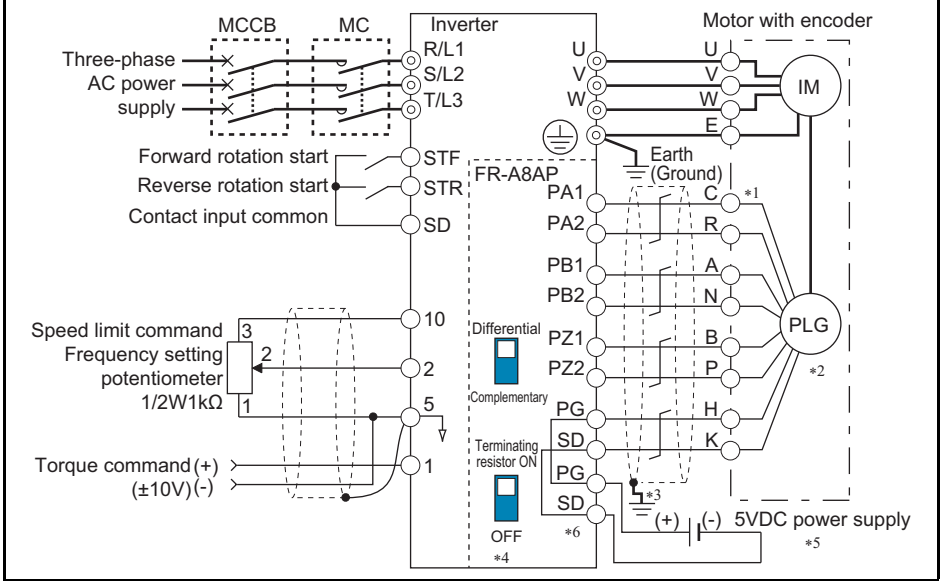
• Speed control

Standard motor with encoder, 5 V differential line driver



• Torque control

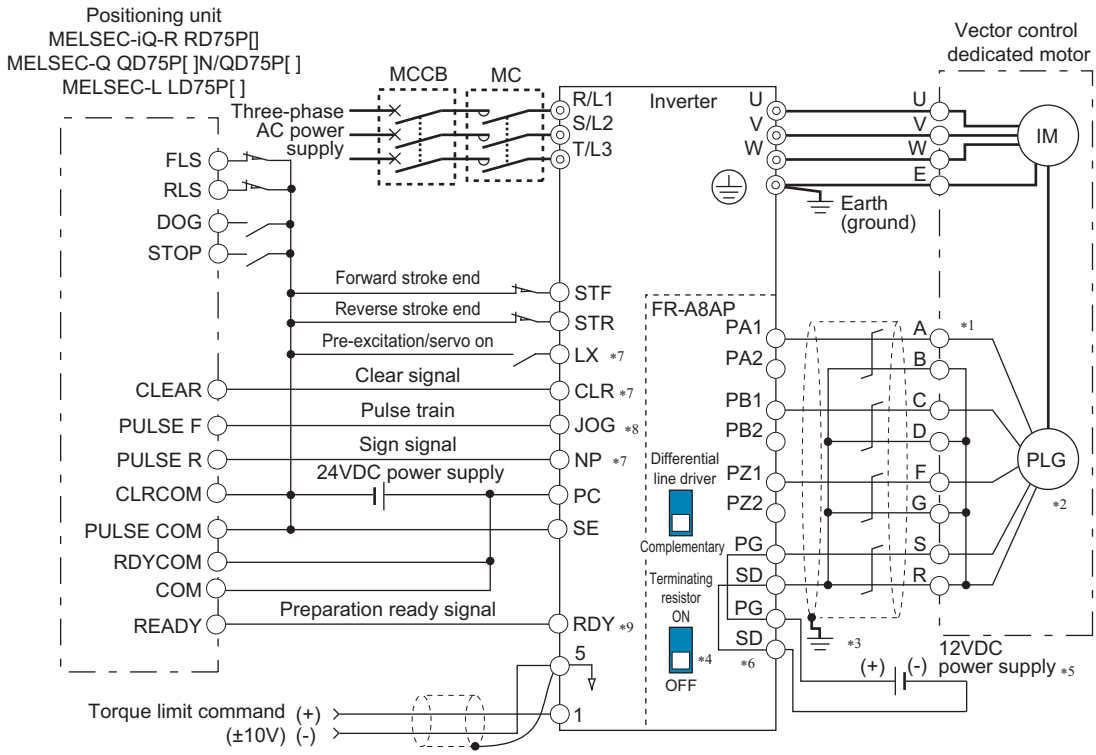
Standard motor with encoder, 5 V differential line driver



Connection of motor with encoder (vector control)

• Position control

Vector control dedicated motor, 12 V complementary



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

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

*3 Earth (ground) the shield of the encoder cable to the enclosure using a tool such as a P-clip. (Refer to **page 69**.)

*4 For the complementary, set the terminating resistor selection switch to OFF position. (Refer to **page 65**.)

*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 across PG and SD.

*6 For terminal compatibility of the FR-JCBL, FR-V7CBL, and FR-A8AP, refer to **page 67**.

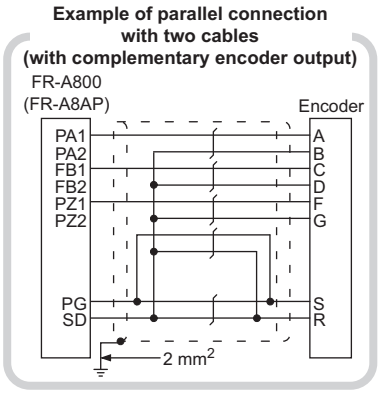
*7 Assign the function using **Pr.178 to Pr.184, Pr.187 to Pr.189 (Input terminal function selection)**.

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

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

◆Instructions for encoder cable wiring

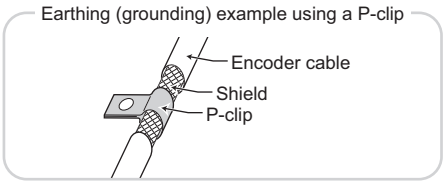
- Use shielded twisted pair cables (0.2 mm^2 or larger) to connect the FR-A8AP. For the wiring to terminals PG and SD, use several cables in parallel or use a thick cable, according to the wiring length.
  To protect the cables from noise, run them away from any source of noise (such as the main circuit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



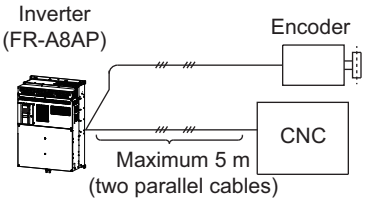
Wiring length	Parallel connection		Larger-size cable
Within 10 m	At least two cables in parallel	Cable gauge 0.2 mm^2	0.4 mm^2 or larger
Within 20 m	At least four cables in parallel		0.75 mm^2 or larger
Within 100 m*1	At least six cables in parallel		1.25 mm^2 or larger

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

- To reduce noise of the encoder cable, earth (ground) the encoder's shielded cable to the enclosure (as close as possible to the inverter) with a 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 66.
- 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)

• Set the encoder specifications.

Pr.		Name	Initial value	Setting range	Description	
359 C141	852 C241	Encoder rotation direction	1	0	Set when using a motor for which forward rotation (encoder) is clockwise (CW) viewed from the shaft 	Set for the operation at 120 Hz or less.
				100		Set for the operation at a frequency higher than 120 Hz.
				1	Set when using a motor for which forward rotation (encoder) is counterclockwise (CCW) viewed from the shaft 	Set for the operation at 120 Hz or less.
				101		Set for the operation at a frequency higher than 120 Hz.
369 C140	851 C240	Number of encoder pulses	1024	0 to 4096	Set the number of encoder pulses 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/ FR-A8APA parameter	FR-A8APR parameter	FR-A8APS parameter	FR-A8TP parameter
Encoder/Resolver rotation direction	**Pr.359**			**Pr.852**
Number of detector pulses	**Pr.369**	— (fixed 1024 pulses)	— (Obtained via communication from the encoder)	**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 Instruction Manual (Detailed).)

*2 Set this parameter according to the motor.

2.10 Connection of stand-alone option units

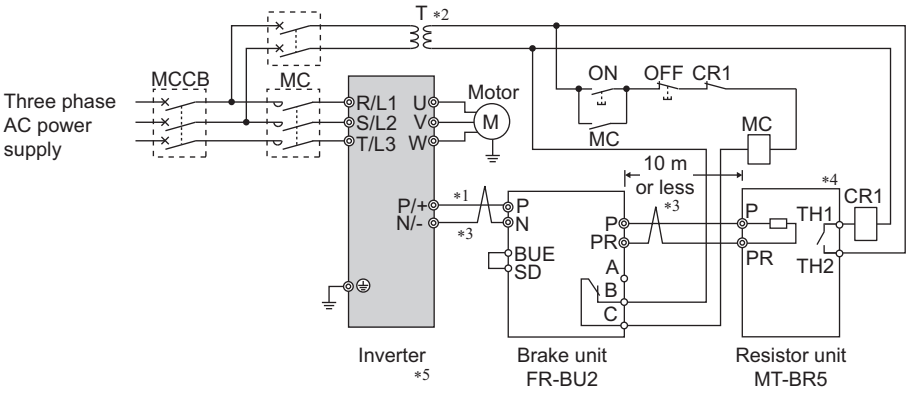
The inverter accepts a variety of stand-alone option units as required.
Incorrect connection will cause inverter damage or accident. Connect and operate the option unit carefully in accordance with the corresponding option unit manual.

2.10.1 Connection of the brake unit (FR-BU2)

Connect the brake unit (FR-BU2(H)) as shown below to improve the braking capability during deceleration.

◆Connection example with the MT-BR5 type resistor unit

After wiring securely, set **Pr.30 Regenerative function selection** = "1" and **Pr.70 Special regenerative brake duty** = "0 (initial value)".
Set **Pr.0 Brake mode selection** = "2" in the brake unit FR-BU2.



*1 When wiring, make sure to match the terminal symbol (P/+, N/-) at the inverter side and at the brake unit (FR-BU2) side. (Incorrect connection will damage the inverter and brake unit.)
*2 When the power supply is 400 V class, install a stepdown transformer.
*3 The wiring distance between the inverter and brake unit (FR-BU2), and between the brake unit (FR-BU2) and resistor unit (MT-BR5) must be within 5 m. Even when the wire is twisted, the cable length must be within 10 m.
*4 The contact between TH1 and TH2 is open in the normal status and is closed at a fault.
*5 The CN8 connector used with the MT-BU5 type brake unit is not used.

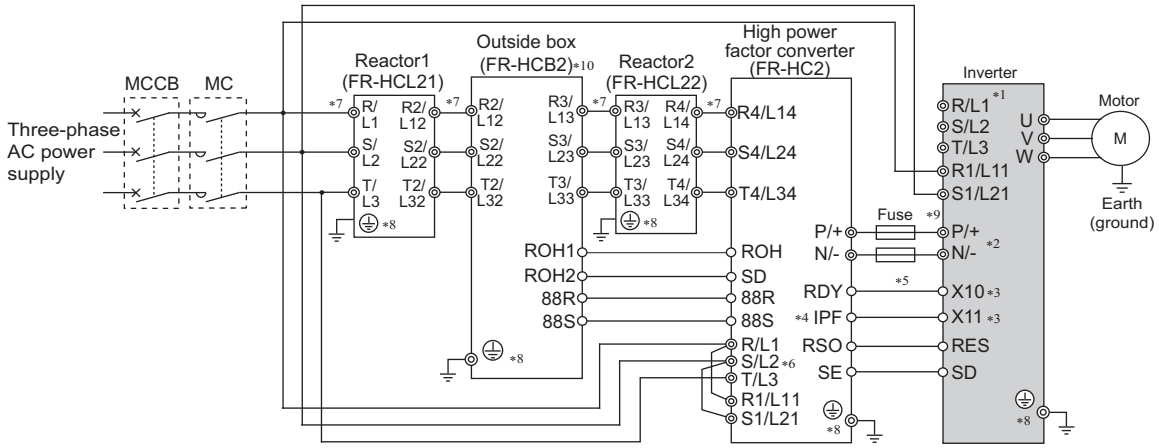
NOTE

- The stall prevention (overvoltage), oL, does not occur while **Pr.30 Regenerative function selection** = "1" and **Pr.70 Special regenerative brake duty** = 0% (initial value). (Refer to the Instruction Manual (Detailed).)

2.10.2 Connection of the high power factor converter (FR-HC2)

When connecting the high power factor converter (FR-HC2) to suppress power harmonics, perform wiring securely as shown below. Incorrect connection will damage the high power factor converter and the inverter.

After making sure that the wiring is correct, set "rated motor voltage" in **Pr.19 Base frequency voltage** (under V/F control) or **Pr.83 Rated motor voltage** (under other that V/F control) and "2" in **Pr.30 Regenerative function selection**.



*1 Remove jumpers between terminal R/L1 and R1/L11 as well as between S/L2 and S1/L21, and connect the power supply for the control circuit to terminals R1/L11 and S1/L21. Do not connect anything to power input terminals (R/L1, S/L2, T/L3). Incorrect connection will damage the inverter. (E.OPT (option fault) will occur. (Refer to the Instruction Manual (Detailed).))

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

*3 Use **Pr.178 to Pr.189 (Input terminal function selection)** to assign the terminals used for the X10 (X11) signal. (Refer to the Instruction Manual (Detailed).)
For RS-485 or any other communication where the start command is only transmitted once, use the X11 signal to save the operation mode at the time of an instantaneous power failure.

*4 Assign the IPF signal to an FR-HC2 terminal. (Refer to the Instruction Manual of the FR-HC2.)

*5 Always connect the FR-HC2 terminal RDY to a terminal where the X10 signal or MRS signal is assigned in the inverter. Always connect the FR-HC2 terminal SE to the inverter terminal SD. Not connecting these terminals may damage the FR-HC2.

*6 Always connect the R/L1, S/L2, and T/L3 terminals of the FR-HC2 to the power supply. Operating the inverter without connecting them will damage the FR-HC2.

*7 Do not install an MCCB or MC between the reactor 1 terminals (R/L1, S/L2, T/L3) and the FR-HC2 terminals (R4/L14, S4/L24, T4/L34). It will not operate properly.

*8 Securely perform grounding (earthing) by using the grounding (earthing) terminal.

*9 Installation of a fuse is recommended. (Refer to the Instruction Manual of the FR-HC2.)

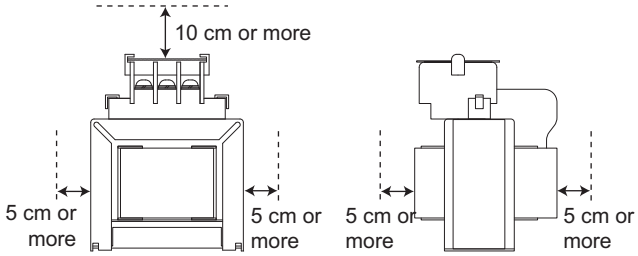
*10 Outside box is not available for the FR-HC2-H280K or higher. Connect filter capacitors, inrush current limit resistors, and magnetic contactors. (Refer to the Instruction Manual of the FR-HC2.)

NOTE

- The voltage phases of terminals R/L1, S/L2, and T/L3 and the voltage phases of terminals R4/L14, S4/L24, and T4/L34 must be matched.
- The control logic (sink logic/source logic) of the high power factor converter and the inverter must be matched. (Refer to **page 50**.)
- Do not connect a DC reactor (FR-HEL) to the inverter when the FR-HC2 is connected.

2.10.3 Connection of the DC reactor (FR-HEL)

- Always connect a DC reactor, which is selected according to the applied motor capacity.
- Keep the surrounding air temperature within the permissible range (-10 to +50°C). Keep enough clearance around the reactor because it heats up. (Take 10 cm or more clearance on top and 5 cm or more on left and right.)



- Connect the DC reactor (FR-HEL) across terminals P/+ and P1.
- Since the DC reactor (FR-HEL) is electrically connected to the enclosure through mounting screws, the DC reactor is earthed (grounded) by being securely installed to the enclosure. If the DC reactor is not earthed (grounded) securely enough, use an earth (ground) terminal to perform additional earthing (grounding). (Refer to the Instruction Manual of the FR-HEL.)

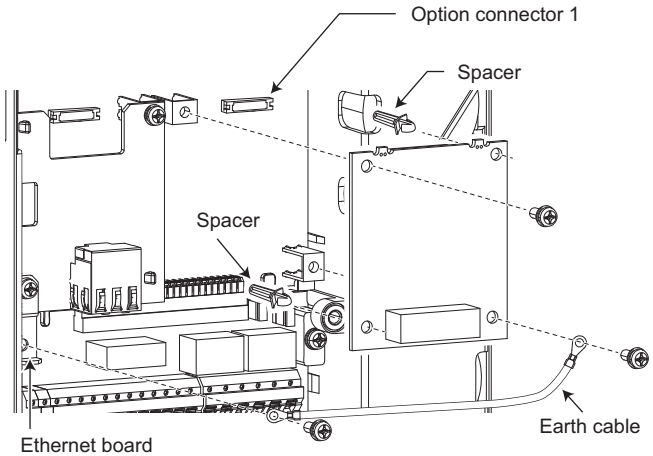
NOTE

- The wiring distance must be within 5 m.
- As a reference, the cable gauge for the connection must be equal to or larger than that of the power supply cables (R/L1, S/L2, T/L3) and the earthing (grounding) cable. (Refer to page 37.)
- Incorrect connection will cause inverter damage or accident. Connect and operate the FR-HEL carefully in accordance with the its Instruction Manual.

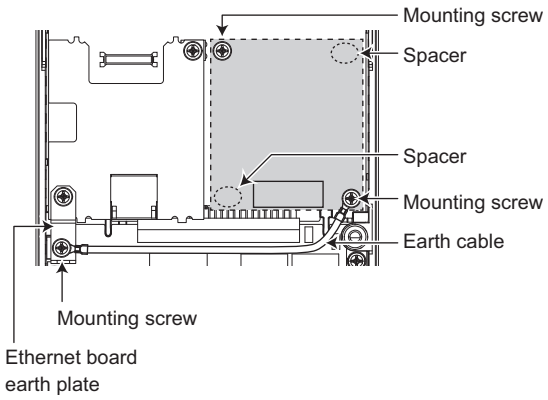
2.11 Installing a communication option

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

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



Example of FR-A8NC



NOTE

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

3 PRECAUTIONS FOR USE OF THE INVERTER

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

3.1 Electro-magnetic interference (EMI) and leakage currents ..76
3.2 Power supply harmonics 80
3.3 Power-OFF and magnetic contactor (MC) 81
3.4 Countermeasures against deterioration of the 400 V class motor insulation.....82
3.5 Checklist before starting operation 83
3.6 Failsafe system which uses the inverter 86

3.1 Electro-magnetic interference (EMI) and leakage currents

3.1.1 Leakage currents and countermeasures

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

◆To-earth (ground) leakage currents

Leakage currents may flow not only into the power system of the inverter but also into the other power systems through the earthing (grounding) cable, etc. These leakage currents may operate earth leakage circuit breakers and earth leakage relays unnecessarily.

●Suppression technique

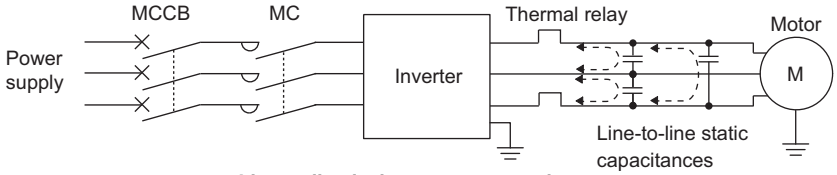
- If the carrier frequency setting is high, decrease the **Pr.72 PWM frequency selection** setting.
  Note that motor noise increases. Selecting **Pr.240 Soft-PWM operation selection** makes the sound inoffensive.
- By using earth leakage circuit breakers designed to suppress harmonics and surge voltage in the power system of the inverter and other devices, operation can be performed with the carrier frequency kept high (with low noise).

●To-earth (ground) leakage currents

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



Line-to-line leakage currents path

●Precautions

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

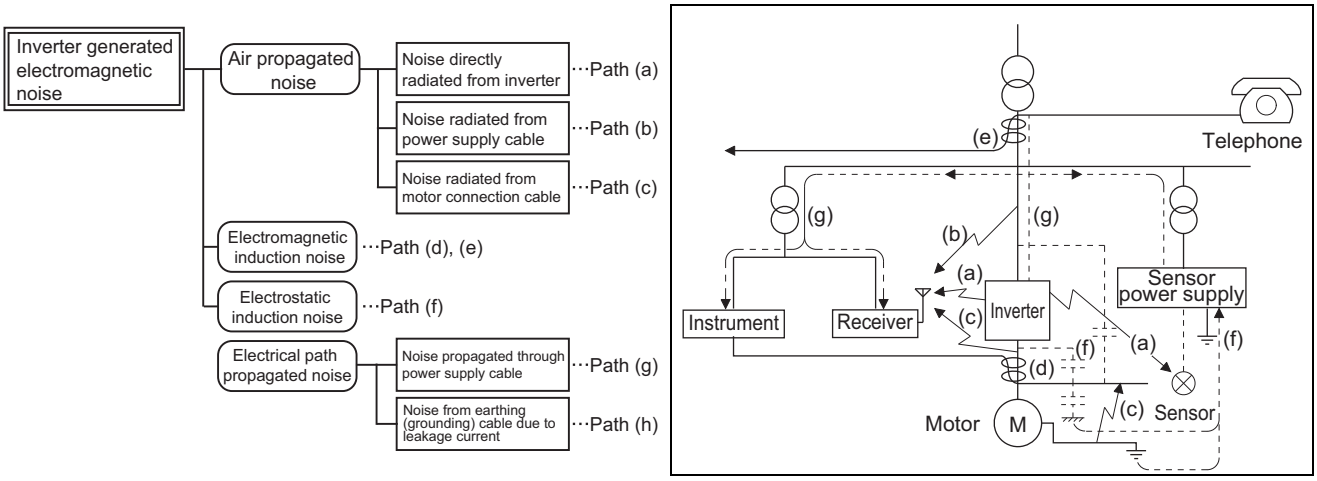
●Installation and selection of the molded case circuit breaker

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 earth leakage current breaker designed for harmonics and surge suppression.

3.1.2 Countermeasures against inverter-generated EMI

Some electromagnetic noises enter the inverter to cause the inverter malfunction, and others are radiated by the inverter to cause the peripheral devices to malfunction. Though the inverter 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 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, motor, etc. at one point.
- Techniques to reduce electromagnetic noises that enter and cause a malfunction of the inverter (EMI countermeasures)
  When devices that generate many electromagnetic noises (which use magnetic contactors, electromagnetic brakes, many relays, for example) are installed near the inverter and the inverter 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 78**) 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 cause the peripheral devices to malfunction (EMI countermeasures)
  Inverter-generated noises are largely classified into those radiated by the cables connected to the inverter and inverter main circuits (I/O), those electromagnetically and electrostatically induced to the signal cables of the peripheral devices close to the main circuit power supply, and those transmitted through the power supply cables.



Noise propagation path	Countermeasure
(a)(b)(c)	When devices that handle low-level signals and are liable to malfunction due to electromagnetic noises, e.g. instruments, receivers and sensors, are contained in the enclosure that contains the inverter or when their signal cables are run near the inverter, the devices may malfunction due to by air-propagated electromagnetic noises. The following countermeasures must be taken: • Install easily affected devices as far away as possible from the inverter. • Run easily affected signal cables as far away as possible from the inverter and its I/O cables. • Do not run the signal cables and power cables (inverter I/O cables) in parallel with each other and do not bundle them. • Set the EMC filter ON/OFF connector of the inverter to the ON position. (Refer to **page 79**.) • Inserting a line noise filter into the output suppresses the radiated noise from the cables. • Use shielded cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
(d)(e)(f)	When the signal cables are run in parallel with or bundled with the power cables, magnetic and static induction noises may be propagated to the signal cables to cause malfunction of the devices and the following countermeasures must be taken: • Install easily affected devices as far away as possible from the inverter. • Run easily affected signal cables as far away as possible from the inverter and its I/O cables. • Do not run the signal cables and power cables (inverter I/O cables) in parallel with each other and do not bundle them. • Use shielded cables as signal cables and power cables and run them in individual metal conduits to produce further effects.
(g)	When the peripheral devices use the power system of the inverter, its generated noises may flow back through the power supply cables to cause malfunction of the devices and the following countermeasures must be taken: • Set the EMC filter ON/OFF connector of the inverter to the ON position. (Refer to **page 79**.) • Install the line noise filter to the power cables (output cables) of the inverter.
(h)	When a closed loop circuit is formed by connecting the peripheral device wiring to the inverter, leakage currents may flow through the earthing (grounding) cable of the inverter to cause the device to malfunction. In that case, disconnecting the earthing (grounding) cable from the device may stop the malfunction of the device.

●Data line filter

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

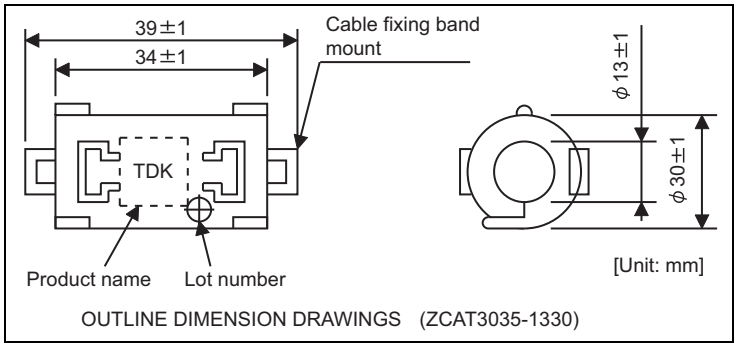
<Example> Data line filter : ZCAT3035-1330 (by TDK)

: ESD-SR-250 (by TOKIN)

Impedance (ZCAT3035-1330)

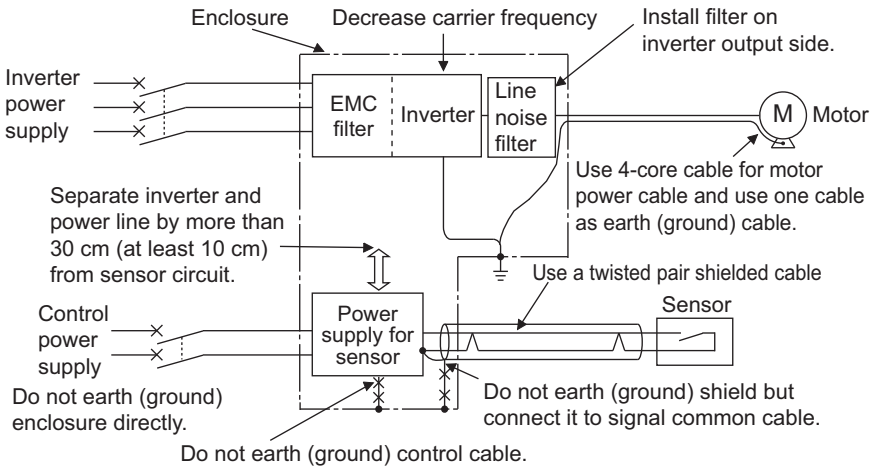
Impedance (Ω)	
10 to 100 MHz	100 to 500 MHz
80	150

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



OUTLINE DIMENSION DRAWINGS (ZCAT3035-1330)

●EMI countermeasure example

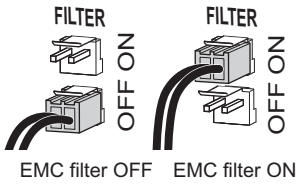


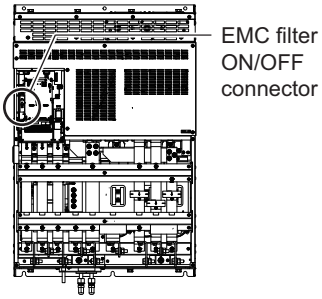
NOTE

- For compliance with the EU EMC Directive, refer to page 112.

3.1.3 Built-in EMC filter

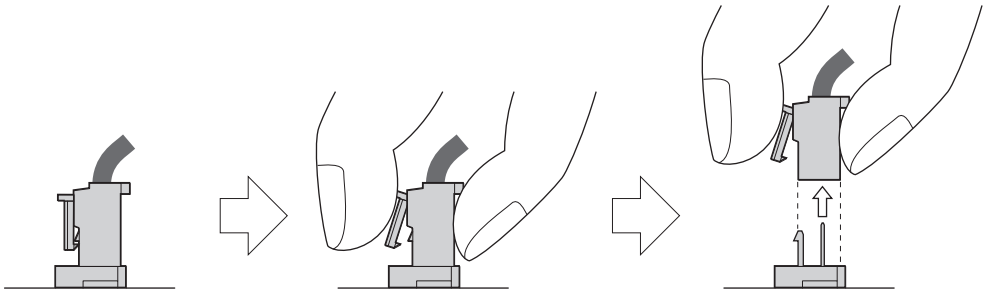
This inverter is equipped with a built-in EMC filter (capacitive filter) and a common mode choke.
These filters are effective in reducing air-propagated noise on the input side of the inverter.
To enable the EMC filter, fit the EMC filter ON/OFF connector to the ON position. The FM type is initially set to "disabled" (OFF), and the CA type to "enabled" (ON).





<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 77.)

WARNING

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

3.2 Power supply harmonics

3.2.1 Power supply harmonics

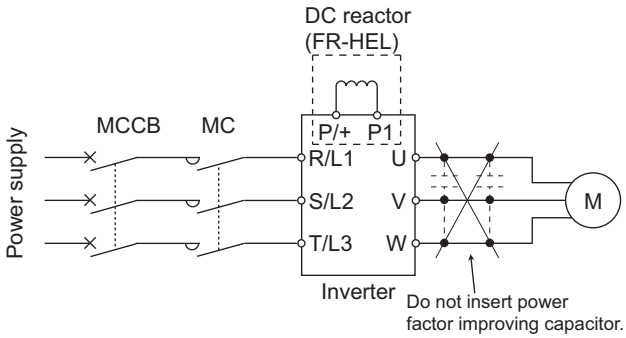
The inverter may generate power supply harmonics from its converter circuit to affect the power generator, power factor correction capacitor etc. Power supply harmonics are different from noise and leakage currents in source, frequency band and transmission path. Take the following countermeasure suppression 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).
Location	To-electric channel, power impedance.	To-space, distance, wiring path,
Quantitative understanding	Theoretical calculation possible.	Random occurrence, quantitative grasping difficult.
Generated amount	Nearly proportional to the load capacity.	Changes with the current variation ratio. (Gets larger as switching speed increases.)
Affected equipment immunity	Specified by standards per equipment.	Different depending on maker's equipment specifications.
Countermeasure	Provide a reactor.	Increase distance.

• Countermeasures

The harmonic current generated from the inverter to the input side differs according to various conditions such as the wiring impedance, whether a reactor is used or not, and output frequency and output current on the load side.
For the output frequency and output current, we understand that this should be calculated in the conditions under the rated load at the maximum operating frequency.



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. For power factor improvement, install a reactor on the inverter in the DC circuit.

3.3 Power-OFF and magnetic contactor (MC)

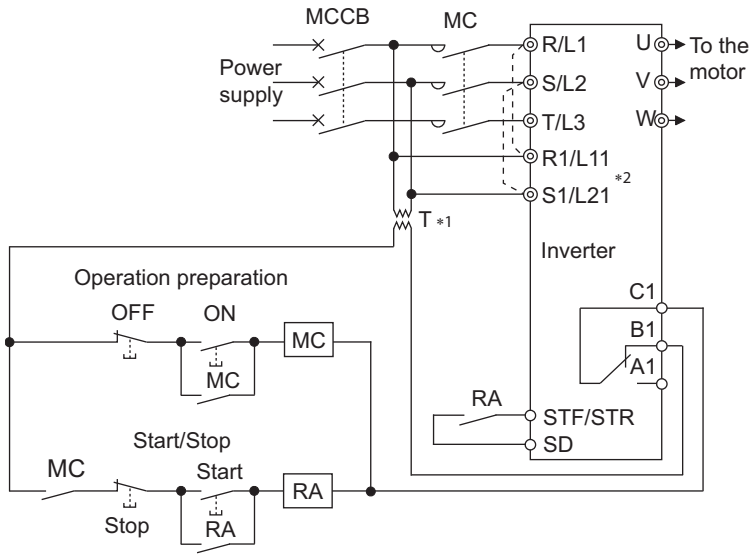
◆Inverter input side magnetic contactor (MC)

On the inverter input side, it is recommended to provide an MC for the following purposes:
(Refer to page 16 for selection.)

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

NOTE

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



- Inverter start/stop circuit example

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

*1 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 R/L1 and R1/L11 and S/L2 and S1/L21. (Refer to page 55 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 electronic bypass function of **Pr.135 to Pr.139** (refer to the Instruction Manual (Function)).

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

It is recommended to take one of the following countermeasures:

• Rectifying the motor insulation and limiting the PWM carrier frequency according to the wiring length
  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".
  - Set **Pr.72 PWM frequency selection** as indicated below according to the wiring length.

	Wiring length
	Longer than 100 m
Pr.72 PWM frequency selection	4 (4 kHz) or lower

• Suppressing the surge voltage on the inverter side
  - Connect the sine wave filter (MT-BSL/BSC) to the output side.

NOTE

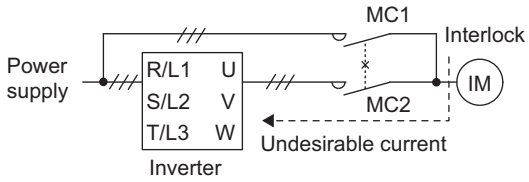
- For the details of **Pr.72 PWM frequency selection**, refer to the Instruction Manual (Detailed). (When using an optional sine wave filter (MT-BSL/BSC), set "25" (2.5 kHz) in **Pr.72**.)
- For the details of the sine wave filter (MT-BSL/BSC), refer to the Instruction Manual of each option.
- A sine wave filter (MT-BSL/BSC) can be used under V/F control. Do not use the filters under different control modes.
- The carrier frequency is limited during PM sensorless vector control. (Refer to the Instruction Manual (Detailed).)

3.5 Checklist before starting operation

The FR-A800 series inverter is a highly reliable product, but incorrect peripheral circuit making or operation/handling method may shorten the product life or damage the product.
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.	35	
No wire offcuts are left from the time of wiring.	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.	-	
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, the voltage drop in the main circuit will cause the motor torque to decrease especially during the output of a low frequency.	37	
The total wiring length is within the specified length.	Keep the total wiring length within the specified length. In long distance wiring, charging currents due to stray capacitance in the wiring may degrade the fast-response current limit operation or cause the equipment on the inverter's output side to malfunction. Pay attention to the total wiring length.	37	
Countermeasures are taken against EMI.	The input/output (main circuit) of the inverter includes high frequency components, which may interfere with the communication devices (such as AM radios) used near the inverter. In such case, activate the EMC filter (turn ON the EMC filter ON/OFF connector) to minimize interference.	79	
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, there is no power factor correction capacitor, surge suppressor, or radio noise filter installed.	Such installation will cause the inverter to trip 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 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 a 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, make sure to check the motor insulation resistance, etc.	-	

Checklist before starting operation

Checkpoint	Countermeasure	Refer to page	Check by user
The circuit is not configured to use the inverter's input-side magnetic contactor to start/stop the inverter frequently.	Since repeated inrush currents at power ON will shorten the life of the converter circuit, 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.	81	
The voltage applied to the inverter I/O signal circuits is within the specifications.	Application of a voltage higher than the permissible voltage to the inverter I/O signal circuits or opposite polarity may damage the I/O devices. Especially check the wiring to prevent the speed setting potentiometer from being connected incorrectly to short circuit terminals 10E and 5.	46	
When using the electronic bypass operation, electrical and mechanical interlocks are provided between the electronic bypass contactors MC1 and MC2.	When using a switching circuit as shown below, chattering due to 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 nor with PM motors.)  If switching to the commercial power supply operation while a failure such as an output short circuit has occurred between the magnetic contactor MC2 and the motor, the damage may further spread. If a failure has occurred between the MC2 and the motor, a protection circuit such as using the OH signal input must be provided.	-	
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 inverter'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 vector control, the encoder is properly installed.	The encoder must be directly connected to a motor shaft without any backlash. (Real sensorless vector control, PM sensorless vector control do not require an encoder.)	64	
A magnetic contactor (MC) is installed on the inverter's input side.	On the inverter's input side, connect an MC for the following purposes: • 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 inverter input side current as JEM1038-AC-3 class rated current.	81	
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.	81	
When using a PM motor, a low-voltage manual contactor is installed on the inverter's output side.	When a failure occurs between the MC2 and motor, make sure to provide a protection circuit, such as using the OH signal input. In an application, such as fan and blower, where the motor is driven by the load, a low-voltage manual contactor must be connected at the inverter's output side, and wiring and inspection must be performed while the contactor is open. Otherwise you may get an electric shock.	81	
An EMI countermeasure is provided for the frequency setting signals.	If electromagnetic noise generated from the inverter 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: • Do not run the signal cables and power cables (inverter 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 I/O cables). • Use shielded cables. • Install a ferrite core on the signal cable (Example: ZCAT3035-1330 by TDK).	77	

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 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. For an induction motor, use an inverter of a higher capacity (up to two ranks). For a PM motor, use an inverter and PM motor of higher capacities.	-	
The specifications and rating match the system requirements.	Make sure that the specifications and rating match the system requirements.	106	

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

3.6 Failsafe system which uses the inverter

When a fault is detected by the protective function, the protective function activates 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.

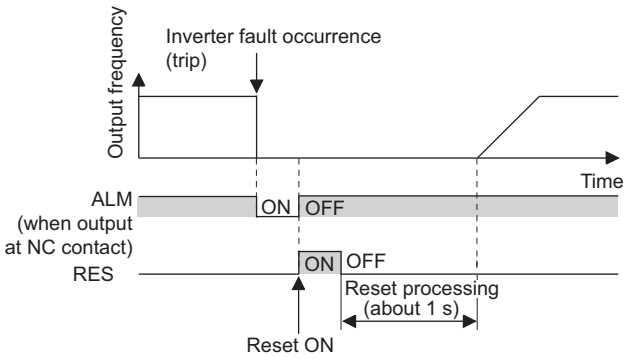
No.	Interlock method	Check method	Used signals
a	Inverter protective function operation	Operation check of an alarm contact. Circuit error detection by negative logic.	Fault (ALM) signal
b	Inverter operating status	Operation ready signal check.	Inverter operation ready (RY) signal
c	Inverter running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

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

When the inverter's protective function activates and the inverter trips, 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.)



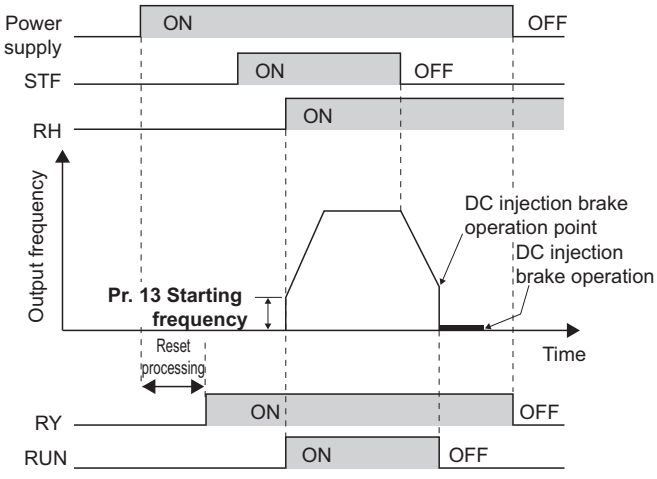
(b) Checking the inverter operating status by the inverter operation ready completion signal

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 RUN signal is being output while inputting a start signal to the inverter. (The STF signal is a forward rotation signal, and the 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.



(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 currents flows into the motor. 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 the STR is a reverse rotation signal.) The Y12 signal is initially set to be output at 150% inverter rated current. Adjust the level to around 20% using no load current of the motor as reference with **Pr.150 Output current detection level**.

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

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 on the parameters and signals, refer to the 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, when the inverter CPU fails, even if the interlock is provided using the inverter Fault signal, start signal and RUN signal, there is a case where a Fault signal is not output and RUN signal is kept output even if an inverter fault occurs.

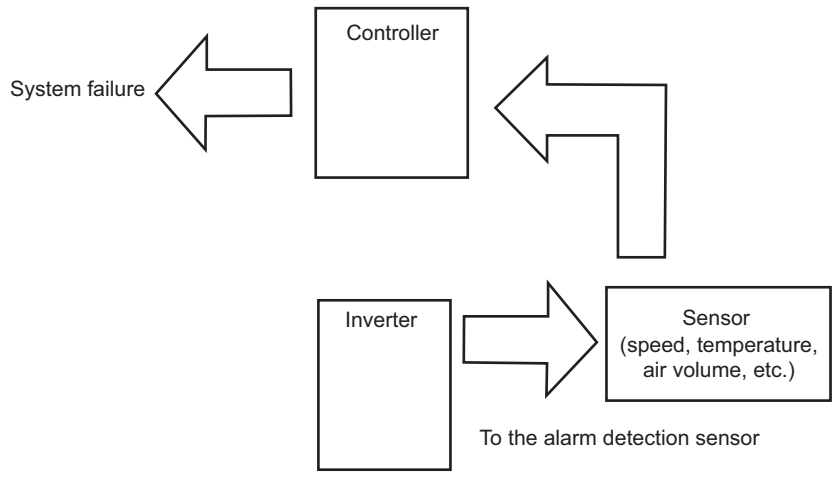
Provide a speed detector to detect the motor speed and current detector to detect the motor current and consider the backup system such as performing a check as below according to the level of importance of the system.

(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.



MEMO

4 PRECAUTIONS FOR MAINTENANCE AND INSPECTION

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

4.1 Inspection item.....90
4.2 Measurement of main circuit voltages, currents, and powers .99

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.

4.1 Inspection item

4.1.1 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

4.1.2 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 37**.)
- Check the conductors and insulating materials for corrosion and damage.
- Measure the insulation resistance.
- Check and change the cooling fan and relay.

NOTE

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

4.1.3 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.	O		Improve the environment.	
	Overall unit	Check for unusual vibration and noise.	O		Check fault location and retighten.	
		Check for dirt, oil, and other foreign material.*1	O		Clean.	
	Power supply voltage	Check that the main circuit voltages and control voltages are normal.*2	O		Inspect the power supply.	
Main circuit	General	(1)Check with megger (across main circuit terminals and earth (ground) terminal).		O	Contact the manufacturer.	
		(2)Check for loose screws and bolts.		O	Retighten.	
		(3)Check for overheat traces on the parts.		O	Contact the manufacturer.	
		(4)Check for stain.		O	Clean.	
	Conductors, cables	(1)Check conductors for distortion.		O	Contact the manufacturer.	
		(2)Check cable sheaths for breakage and deterioration (crack, discoloration, etc.).		O	Contact the manufacturer.	
	Transformer/ reactor	Check for unusual odor and abnormal increase of whining sound.	O		Stop the equipment and contact the manufacturer.	
	Terminal block	Check for a damage.		O	Stop the equipment and contact the manufacturer.	
	Smoothing aluminum electrolytic capacitor	(1)Check for liquid leakage.		O	Contact the manufacturer.	
		(2)Check for safety valve projection and bulge.		O	Contact the manufacturer.	
		(3)Visual check and judge by the life check of the main circuit capacitor. (Refer to page 94.)		O		
	Relay/contactor	Check that the operation is normal and no chattering sound is heard.		O	Contact the manufacturer.	
	Resistor	(1)Check for crack in resistor insulation.		O	Contact the manufacturer.	
		(2)Check for a break in the cable.		O	Contact the manufacturer.	
Control circuit, protective circuit	Operation check	(1)Check that the output voltages across phases are balanced while operating the inverter alone.		O	Contact the manufacturer.	
		(2)Check that no fault is found in protective and display circuits in a sequence protective operation test.		O	Contact the manufacturer.	
	Components check: Overall	(1)Check for unusual odor and discoloration.		O	Stop the equipment and contact the manufacturer.	
		(2)Check for serious rust development.		O	Contact the manufacturer.	
	Components check: Aluminum electrolytic capacitor	(1)Check for liquid leakage in a capacitor and deformation trace.		O	Contact the manufacturer.	
		(2)Visual check and judge by the life check of the control circuit capacitor. (Refer to page 94.)		O		
Cooling system	Cooling fan	(1)Check for unusual vibration and noise.	O		Replace the fan.	
		(2)Check for loose screws and bolts.		O	Fix with the fan cover fixing screws	
		(3)Check for stain.		O	Clean.	
	Heatsink	(1)Check for clogging.		O	Clean.	
		(2)Check for stain.		O	Clean.	
Coolant pipe	Joint	Check for liquid leakage.	O		Check fault location (joint or hose bind) and retighten.	

Inspection item

Area of inspection	Inspection item	Description	Inspection interval		Corrective action at fault occurrence	Check by the user
			Daily	Periodic *3		
Coolant cooling system	Water quality	Check for problems with water quality.		O	Improve the water quality. Contact the manufacturer.	
Display	Indication	(1)Check that display is normal. (2)Check for stain.	O	O	Contact the manufacturer. Clean.	
	Meter	Check that reading is normal.	O		Stop the equipment and contact the manufacturer.	
Load motor	Operation check	Check for vibration and abnormal increase in operation noise.	O		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 a capacitor without delay.

4.1.4 Continuity test of the inverter and converter modules

◆Preparation

- Disconnect the external power cables from terminals R/L1, S/L2, and T/L3, and motor cables from terminals U, V, and W.
- Prepare a continuity tester. (For the resistance measurement, use the 100 Ω range.)

◆Checking method

Change the polarity of the tester alternately at a semiconductor device (transistor) on an electrical path between two terminals among the inverter main circuit terminals R/L1, S/L2, T/L3, U, V, W, P/+ and N/- to check the electric continuity.

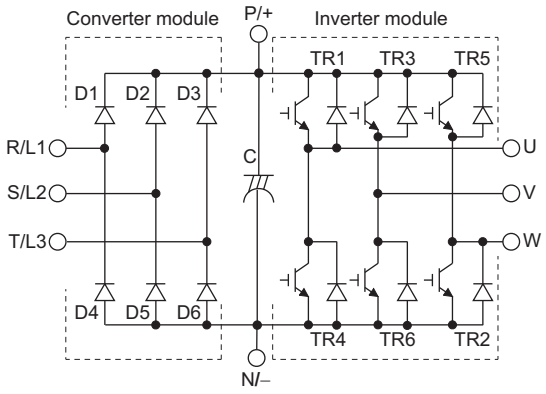
NOTE

- 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.

◆Device number and target terminal on each module

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

(Assumes the use of an analog meter.)



4.1.5 Cleaning

Always run the inverter in a clean status.

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

NOTE

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

4.1.6 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		87600 hours	Replace (as required)
Main circuit smoothing capacitor	FR-A840-03250(110K) to 04810(185K)	87600 hours	Replace (as required)
	FR-A840-05470(220K) to 06830(280K)	20000 hours	Replace (as required)
On-board smoothing capacitor		87600 hours	Replace the board (as required)
Main circuit fuse		87600 hours	Replace (as required)
Water-cooled heatsink		21900 hours*2	Replace

*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 Consider the usage condition of the coolant and others for replacement.

NOTE

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

◆Displaying the life of the inverter parts

The inverter diagnoses the main circuit capacitor, control circuit capacitor, cooling fan, and inrush current limit circuit by itself and estimates their lives.
The self-diagnostic warning is output when the life span of each part is near its end. It gives an indication of replacement time.

Guideline for life judgment by the life warning output

Parts	Judgment level
Main circuit capacitor	85% of the initial capacity
Control circuit capacitor	Estimated remaining life 10%
Inrush current limit circuit	Estimated remaining life 10% (Power ON: 100,000 times left)
Cooling fan	Specified speed

NOTE

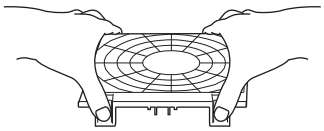
- Refer to the Instruction Manual (Detailed) to perform the life check of the inverter parts.

◆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.

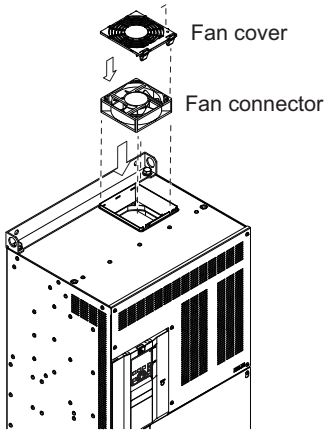
◆Removal (FR-A840-03250(110K) or FR-A840-03610(132K))

1) Push the hooks from above and remove the fan cover.



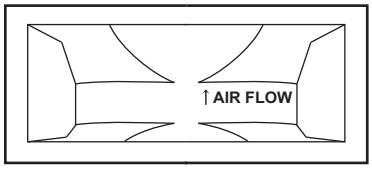
2) Disconnect the fan connector.

3) Pull out the fan.



◆Reinstallation (FR-A840-03250(110K) or FR-A840-03610(132K))

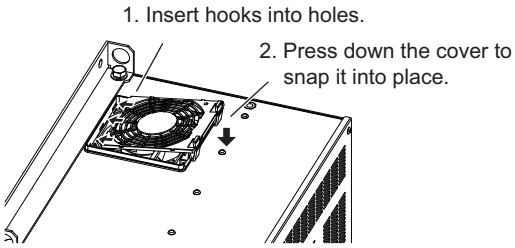
1) Before installing the new fan, check the orientation of the fan to be sure that the "AIR FLOW" arrow printed on the side of the fan points upward.



[Fan side view]

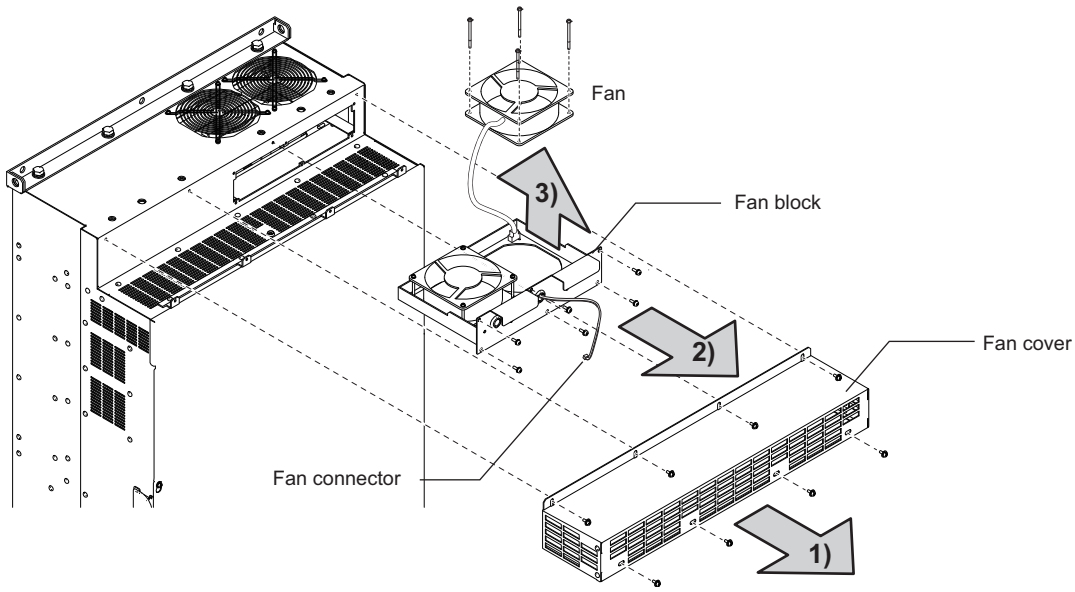
2) Reconnect the fan connector.

3) Fit the fan cover.



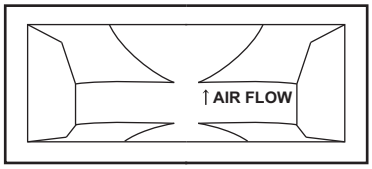
◆Removal (FR-A840-04320(160K) to FR-A840-06830(280K))

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.



◆ Reinstallation (FR-A840-04320(160K) to FR-A840-06830(280K))

1) Before installing the new fan, check the orientation of the fan to be sure that the "AIR FLOW" arrow printed on the side of the fan points upward.



[Fan side view]

2) Install fans referring to the above figure.

NOTE

- Installing the fan in the opposite air flow direction 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. To prevent an electric shock accident, power off the inverter and wait for at least 10 minutes as the inverter circuits are charged with voltage even after power OFF. Check that the charge lamp is OFF before starting the replacement.

◆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 87600 hours.

End of life appearance criteria are as follows:

- Case: Check the side and bottom faces for expansion.
- Sealing plate: Check for remarkable warp and extreme crack.
- Others: Check for external crack, discoloration, liquid leakage, etc.

End of life performance criterion is the measured capacitance of the capacitor reduced below 80% of the rating.

NOTE

- The inverter diagnoses the main circuit capacitor and control circuit capacitor by itself and can judge their lives. (Refer to the 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 between the relay output terminals C1 and B1 or A1, or terminals C2 and B2 or A2.

◆Main circuit fuse inside the inverter

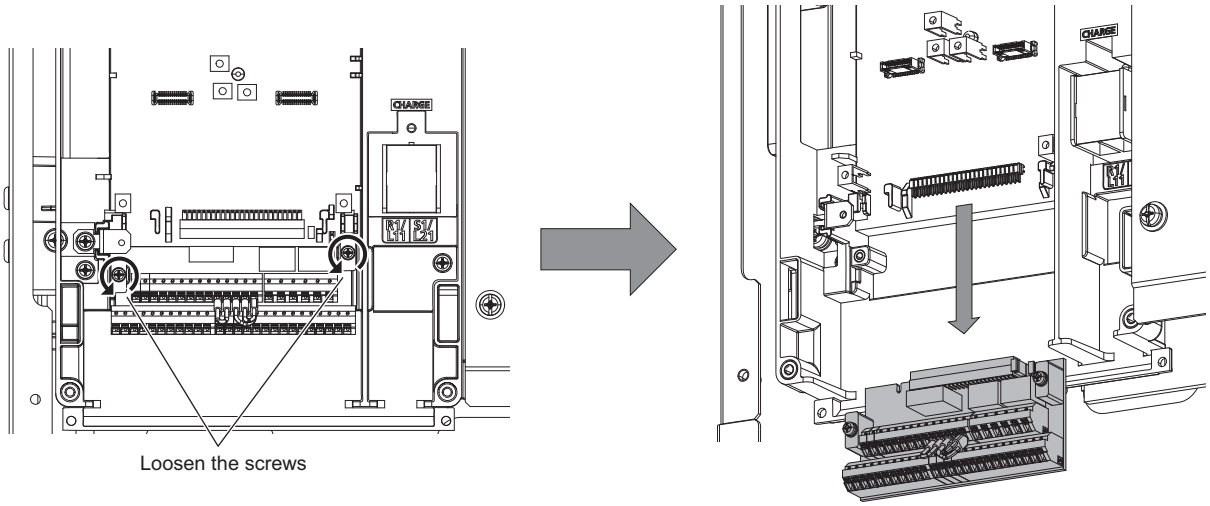
A fuse is used inside the inverter. Surrounding air temperature and operating condition affect the life of fuses. When the inverter is used in a normal air-conditioned environment, replace its fuse after about 87600 hours.

4.1.7 Removal and reinstallation of the control circuit terminal block

The FR-A800 series inverter has a removable control circuit terminal block, which can be replaced with a new one or a control terminal option.

◆Removal and reinstallation

1) Loosen the two 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.

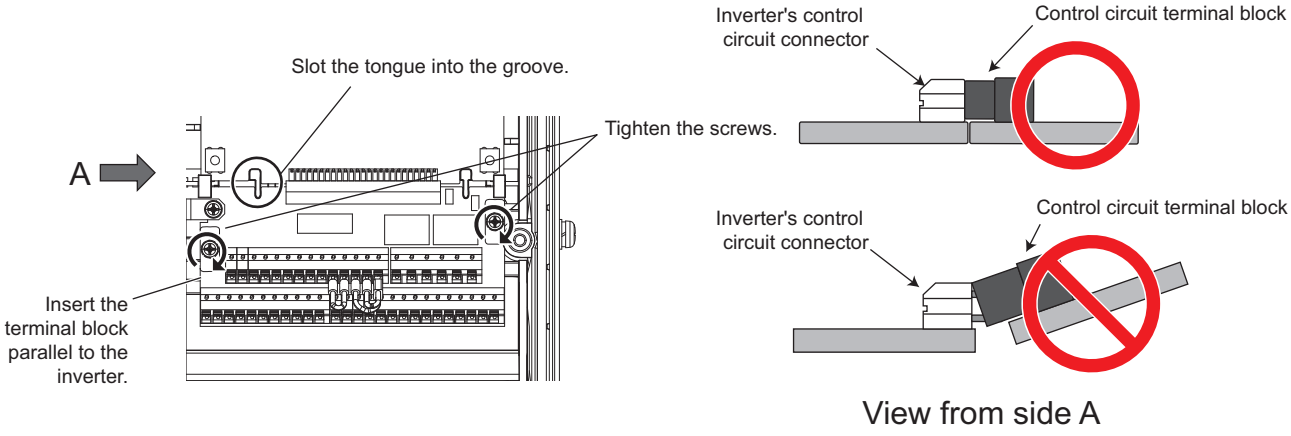
NOTE

- 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.

◆Removal and reinstallation precautions

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

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



NOTE

- Do not tilt the terminal block while tightening the screws or removing it from the inverter. (Otherwise, stress applied to the control circuit terminal block or the control circuit connector may damage the pins.)
- After replacing the control terminal block, connect the jumper connector to the correct position in accordance with the control logic of input signals. (Refer to **page 50**.)

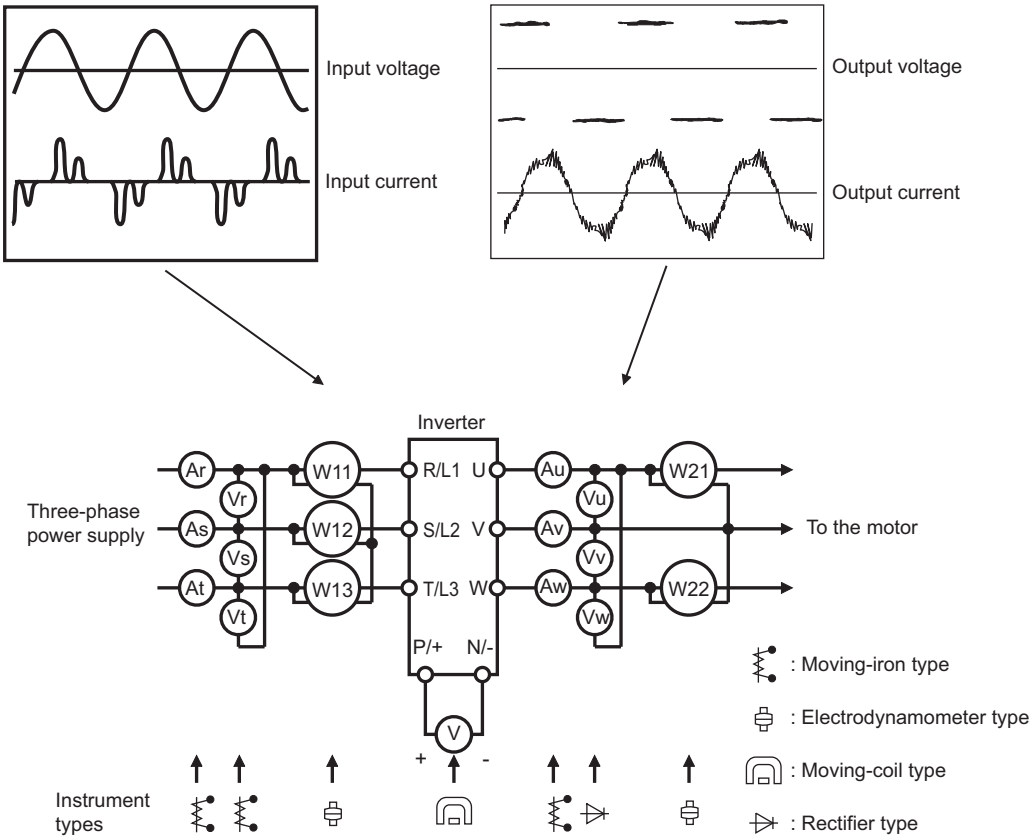
4.2 Measurement of main circuit voltages, currents, and powers

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

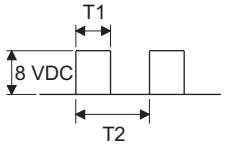
NOTE

- When installing meters etc. on the inverter output side:
  When the inverter-to-motor wiring length is long, the meters and CT meters 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)	
Input voltage V1	Across terminals R/L1 and S/L2, S/L2 and T/L3, and T/L3 and R/L1	Moving-iron AC voltmeter*4	Commercial power supply Within permissible AC voltage fluctuation (Refer to page 106.)	
Input current I1	Line current at terminals R/L1, S/L2, and T/L3	Moving-iron AC ammeter*4		
Input power P1	At terminals R/L1, S/L2, and T/L3 and across terminals R/L1 and S/L2, S/L2 and T/L3, and T/L3 and R/L1	Digital power meter (for inverter) or electrodynamic single-phase wattmeter	P1 = W11 + W12 + W13 (3-wattmeter method)	
Input power factor Pf1	Calculate after measuring input voltage, input current, and input power. $Pf_1 = \frac{P_1}{\sqrt{3}V_1 \times I_1} \times 100\,\%$			
Output voltage V2	Across U and V, V and W, and W and U	Rectifier AC voltage meter*1*4 (moving-iron voltmeter not available)	Difference between the phases must be within 1% of the maximum output voltage.	
Output current I2	Line current at terminals U, V and W	Moving-iron AC ammeter*2*4	Each current must be equal to or lower than the inverter rated current. Difference between the phases must be within 10%.	
Output power P2	At terminals U, V, and W and across terminals U and V, and V and W	Digital power meter (for inverter) or electrodynamic single-phase wattmeter	P2 = W21 + W22 2-wattmeter method (or 3-wattmeter method)	
Output power factor Pf2	Calculate in similar manner to input power factor. $Pf_2 = \frac{P_2}{\sqrt{3}V_2 \times I_2} \times 100\,\%$			
Converter output	Across terminals P/+ and N/-	Moving-coil type instrument (such as tester)	A measured value can be monitored on the PU. Reference value: 1.35 × V1	
Frequency setting signal	Across terminals 2, 4(+) and 5	Moving-coil type instrument (tester and such may be used with internal resistance 50 kΩ or more)	0 to 10 VDC, 4 to 20 mA	Terminal 5 is common
	Across terminals 1(+) and 5		0 to ±5 VDC and 0 to ±10 VDC	
Frequency setting power supply	Across terminals 10(+) and 5		5.2 VDC	
	Across terminals 10E(+) and 5		10 VDC	
Frequency meter signal	Across terminals AM(+) and 5		Approximately 10 VDC at maximum frequency (without frequency meter)	
	Across terminals CA(+) and 5		Approximately 20 mADC at maximum frequency	
	Across terminals FM(+) and SD		Approximately 5 VDC at maximum frequency (without frequency meter)  Pulse width T1: Adjust with **C0 (Pr.900)**. Pulse cycle T2: Set with **Pr.55**. (frequency monitor only)	Terminal SD is common
Start signal Select signal Reset signal Output stop signal	Across terminals STF, STR, RH, RM, RL, JOG, RT, AU, STP (STOP), CS, RES, MRS(+) and SD (for sink logic)		Voltage when terminal is open: 20 to 30VDC Voltage when signal is ON: 1 V or less	

Item	Measuring point	Measuring instrument	Remarks (reference measured value)		
Fault signal	Across terminals A1 and C1 Across terminals B1 and C1	Moving-coil type instrument (such as tester)	Continuity test result*3		
				[Normal]	[Fault]
			Across terminals A1 and C1	Discontinuity	Continuity
			Across terminals B1 and C1	Continuity	Discontinuity

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

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

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

*4 A digital power meter (designed for inverter) can also be used to measure.

4.2.1 Measurement of powers

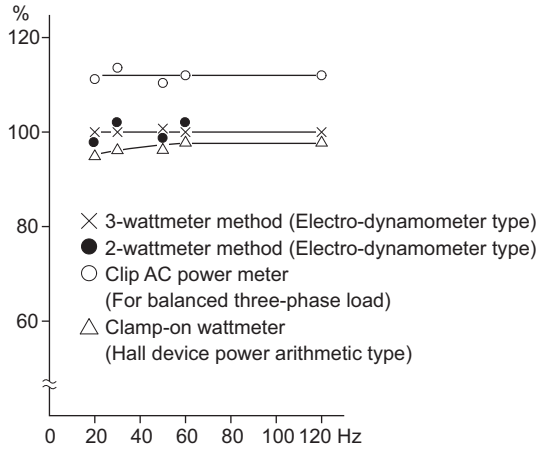
Use digital power meters (for inverter) for the both of inverter input and output side. Alternatively, measure using electrodynamic type single-phase wattmeters for the both of inverter input and output side in two-wattmeter or three-wattmeter method. As the current is liable to be imbalanced especially 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]

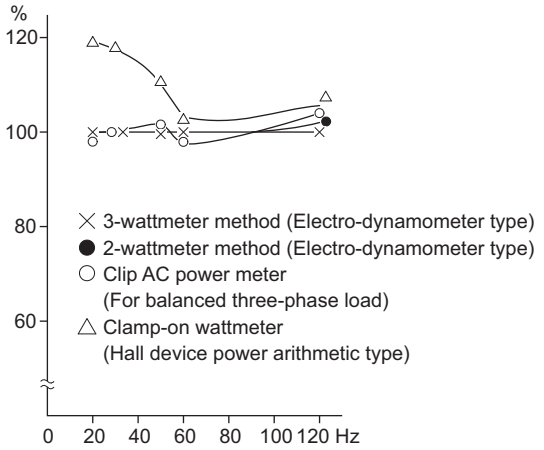
Constant output of 60 Hz or more frequency with a constant-torque (100%). The value obtained by the 3-wattmeter method with a 4-pole 3.7 kW induction motor is assumed to be 100%.



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

4.2.2 Measurement of voltages and use of PT

◆Inverter 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.

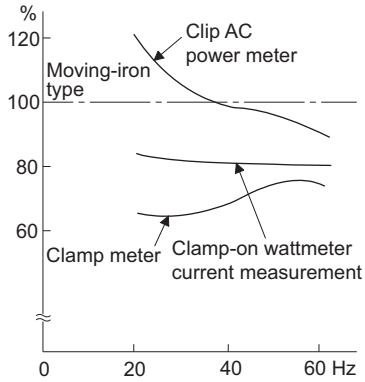
◆PT

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 inverter.)

4.2.3 Measurement of currents

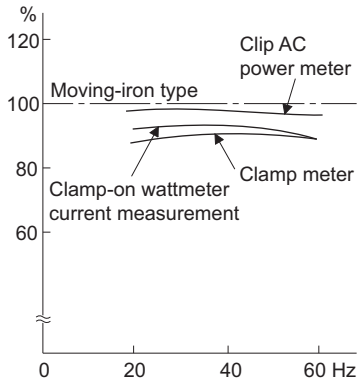
Use moving-iron type meters on both the input and output sides of the inverter. However, if the carrier frequency exceeds 5 kHz, do not use that meter since an overcurrent losses produced in the internal metal parts of the meter will increase and the meter may burn out. In this case, use an approximate-effective value type.
Since current on the inverter 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 inverter input current

[Measurement conditions]
Indicated value of the moving-iron type ammeter is 100%.



Example of measuring inverter output current

4.2.4 Use of CT and transducer

A CT may be used in both the input and output sides 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.

4.2.5 Measurement of inverter input power factor

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

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

4.2.6 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.

4.2.7 Measurement of inverter output frequency

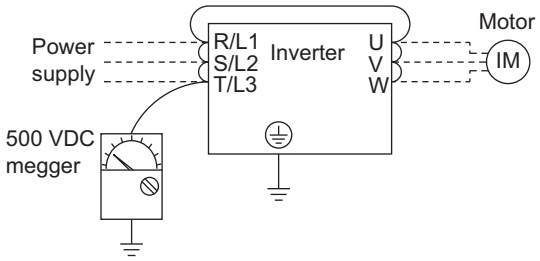
In the initial setting of the FM-type inverter, a pulse train proportional to the output frequency is output across the pulse train output terminals FM and SD of the inverter. This pulse train output can be counted by a frequency counter, or a meter (moving-coil type voltmeter) can be used to read the 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 Instruction Manual (Function).
In the initial setting of the CA-type inverter, a pulse train proportional to the output frequency is output across the analog current output terminals CA and 5 of the inverter. Measure the current using an ammeter or tester.
For detailed specifications of the analog current output terminal CA, refer to the Instruction Manual (Function).

4.2.8 Insulation resistance test using megger

- For the inverter, 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 so that the test voltage is not applied to the inverter.
- For the continuity test of the control circuit, use a tester (high resistance range) and do not use the megger or buzzer.



4.2.9 Withstand voltage test

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

5 SPECIFICATIONS

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

5.1 Inverter rating 106
5.2 Common specifications 107
5.3 Inverter outline dimensions 109

5.1 Inverter rating

Model FR-A840-[ ]-LC			03250	03610	04320	04810	05470	06100	06830
			110K	132K	160K	185K	220K	250K	280K
Applicable motor capacity (kW)*1		LD	132	160	185	220	250	280	315
		ND (initial setting)	110	132	160	185	220	250	280
Output	Rated capacity (kVA)*2	LD	198	248	275	329	367	417	465
		ND (initial setting)	165	198	248	275	329	367	417
	Rated current (A)	LD	260	325	361	432	481	547	610
		ND (initial setting)	216	260	325	361	432	481	547
	Overload current rating*3	LD	120% 60 s, 150% 3 s (inverse-time characteristics) at surrounding air temperature 50°C						
		ND (initial setting)	150% 60 s, 200% 3 s (inverse-time characteristics) at surrounding air temperature 50°C						
	Rated voltage*4		Three-phase 380 to 500 V						
	Regenerative braking	Brake transistor	FR-BU2 (Option)						
		Maximum brake torque*5	10% torque/continuous						
Power supply	Rated input AC voltage/frequency		Three-phase 380 to 500 V 50/60Hz*6						
	Permissible AC voltage fluctuation		323 to 550V 50/60Hz						
	Permissible frequency fluctuation		±5%						
	Rated input current (A)*7	LD	260	325	361	432	481	547	610
		ND (initial setting)	216	260	325	361	432	481	547
	Power supply capacity (kVA)*8	LD	198	248	275	329	367	417	465
		ND (initial setting)	165	198	248	275	329	367	417
Protective structure (IEC 60529)*9			Open type (IP00)						
Cooling system			Liquid cooling + forced air cooling						
Approx. mass (kg)			83	83	124	124	172	172	172

*1 The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi Electric 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 Value for the ND rating

*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 The rated input current indicates a value at a rated output voltage. The impedance at the power supply side (including those of the input reactor and cables) affects the rated input current.

*8 The power supply capacity is the value when at the rated output current. It varies by the impedance at the power supply side (including those of the input reactor and cables).

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

5.2 Common specifications

Control specifications	Control method		Soft-PWM control, high carrier frequency PWM control (selectable among V/F control, Advanced magnetic flux vector control, Real sensorless vector control), vector control*1, and PM sensorless vector control.
	Output frequency range		0.2 to 590 Hz (The upper-limit frequency is 400 Hz under Advanced magnetic flux vector control, Real sensorless vector control, vector control*1, and PM sensorless vector control.)
	Frequency setting resolution	Analog input	0.015 Hz/60 Hz (0 to 10 V/12 bits for terminals 2 and 4) 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 590 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, PM sensorless vector control)
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	100k pulses/s
	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, retry function, carrier frequency selection, fast-response current limit, forward/reverse rotation prevention, operation mode selection, slip compensation, droop control, load torque high-speed frequency control, speed smoothing control, traverse, auto tuning, applied motor selection, gain tuning, RS-485 communication, Ethernet communication, PID control, PID pre-charge function, easy dancer control, cooling fan operation selection, stop selection (deceleration stop/coasting), power-failure deceleration stop function*3, stop-on-contact control, PLC function, life diagnosis, maintenance timer, current average monitor, multiple rating, orientation control*1, speed control, torque control, position control, pre-excitation, torque limit, test run, 24 V power supply input for control circuit, safety stop function, anti-sway control, emergency drive
	Output signal	Open collector output (five terminals) Relay output (two terminals)	Inverter running, Up to frequency, Instantaneous power failure/undervoltage, Overload warning, Output frequency detection, Fault The output signal can be changed using **Pr.190 to Pr.196 (Output terminal function selection)**. Fault codes of the inverter can be output (4 bits) from the open collector.
		Pulse train output (FM type)	50k pulses/s
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 function		**Fault**	Overcurrent trip during acceleration, Overcurrent trip during constant speed, Overcurrent trip during deceleration or stop, Regenerative overvoltage trip during acceleration, Regenerative overvoltage trip during constant speed, Regenerative overvoltage trip during deceleration or stop, Inverter overload trip, Motor overload trip, Heatsink overheat, Instantaneous power failure, Undervoltage, Input phase loss*3, Stall prevention stop, Loss of synchronism detection*3, Upper limit fault detection*3, Lower limit fault detection*3, Output side earth (ground) fault overcurrent, Output short circuit, Output phase loss, External thermal relay operation*3, PTC thermistor operation*3, Option fault, Communication option fault, Parameter storage device fault, PU disconnection, Retry count excess*3, 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*3, Inrush current limit circuit fault, Communication fault (inverter), Analog input fault, USB communication fault, Safety circuit fault,Overspeed occurrence*3, Speed deviation excess detection*1*3, Signal loss detection*1*3, Excessive position fault*1*3, Encoder signal loss for orientation*1*3, Brake sequence fault*3, Encoder phase fault*1*3, 4 mA input fault*3, Pre-charge fault*3, PID signal fault*3, Opposite rotation deceleration fault*3, Internal circuit fault, Abnormal internal temperature, Magnetic pole position unknown*1, External fault during output operation*3, Ethernet communication fault*8, Internal storage device fault
		Alarm, Warning, Error message	Fan alarm, Stall prevention (overcurrent), Stall prevention (overvoltage), Electronic thermal relay function pre-alarm, PU stop, Speed limit indication*3, Parameter copy, Maintenance signal output*3, USB host error, Home position return setting error*3, Home position return uncompleted*3, Home position return parameter setting error*3, Operation panel lock*3, Password locked*3, Parameter write error, Copy operation error, 24 V external power supply operation, Low flow rate input warning, Continuous operation during communication fault, Load fault warning, Ethernet communication fault*8, Emergency drive in operation
Environment	**Surrounding air temperature**		-10°C to +50°C (non-freezing)*6
	Surrounding air humidity		95% RH or less (non-condensing) (With circuit board coating (conforming to IEC60721-3-3:1994 3C2/3S2)) 90% RH or less (non-condensing) (Without circuit board coating)
	Coolant	**Coolant temperature**	1 to 40°C (non-freezing)
		Coolant flow rate*7	3.0 to 3.7 L/min (FR-A840-03250(110K) and FR-A840-03610(132K)) 6.0 to 7.5 L/min (FR-A840-04320(160K) to FR-A840-06830(280K))
		Maximum permissible pressure	300 kPa
	Storage temperature*4		-20°C to +65°C
	Atmosphere		Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt, etc.)
	Altitude/vibration		2000 m or less *5 2.9 m/s^2 or less 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, the starting torque is limited to 150% by the torque limit level.

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

*4 Temperature applicable for a short time, e.g. in transit.
To store the inverter after the coolant has passed through the pipes, fill the pipes with coolant sufficiently enough that it contains antifreezing agent to prevent corrosion. Or fill the pipes with nitrogen gas after the inside of the pipes is fully dried. If any moisture remains inside the pipes, it may react with oxygen in the air to form corrosion.

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

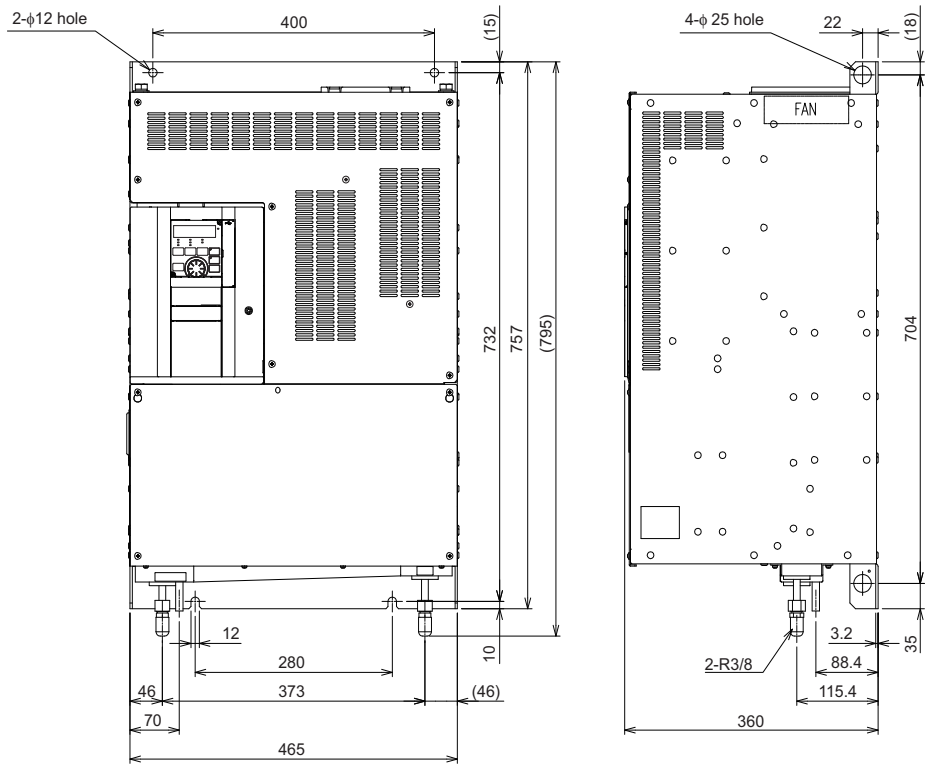
*6 Condensation may occur depending on the humidity and the coolant temperature. Adjust the humidity and the coolant temperature to prevent condensation.

*7 Under normal condition, keep the flow rate between 3.2 and 3.5 L/min for the FR-A840-03610(132K) or lower and between 6.5 and 7.0 L/min for the FR-A840-04320(160K) or higher.

*8 Available for the FR-A800-E only

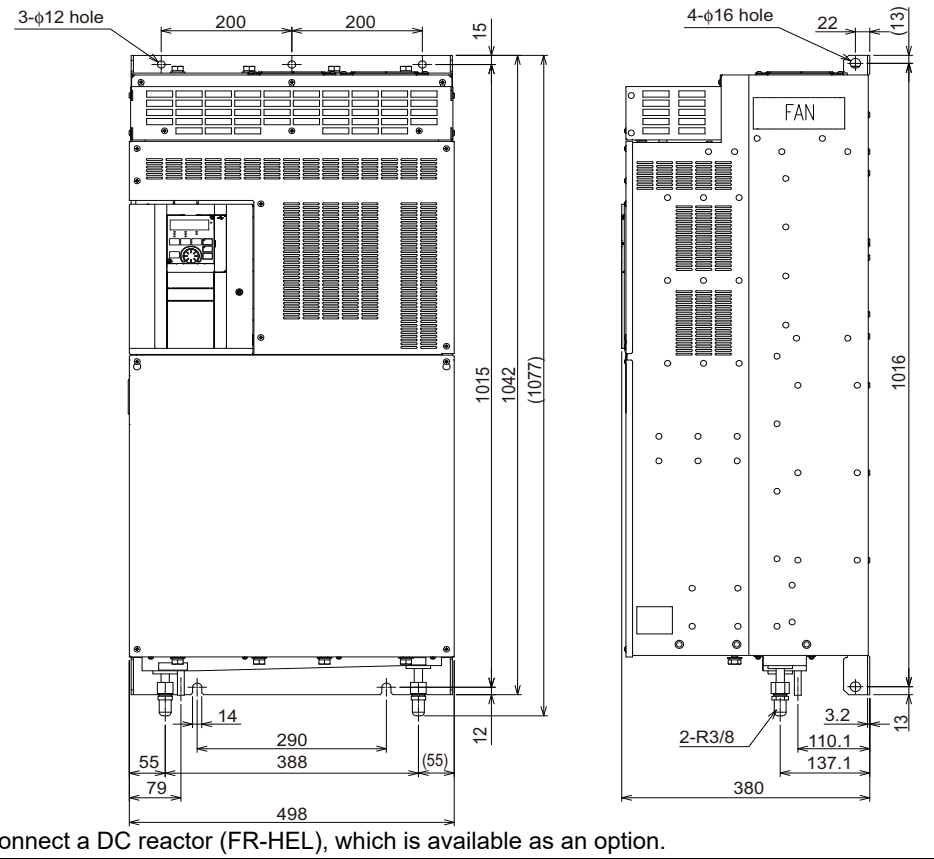
5.3 Inverter outline dimensions

FR-A840-03250(110K), FR-A840-03610(132K)-LC



Always connect a DC reactor (FR-HEL), which is available as an option. (Unit: mm)

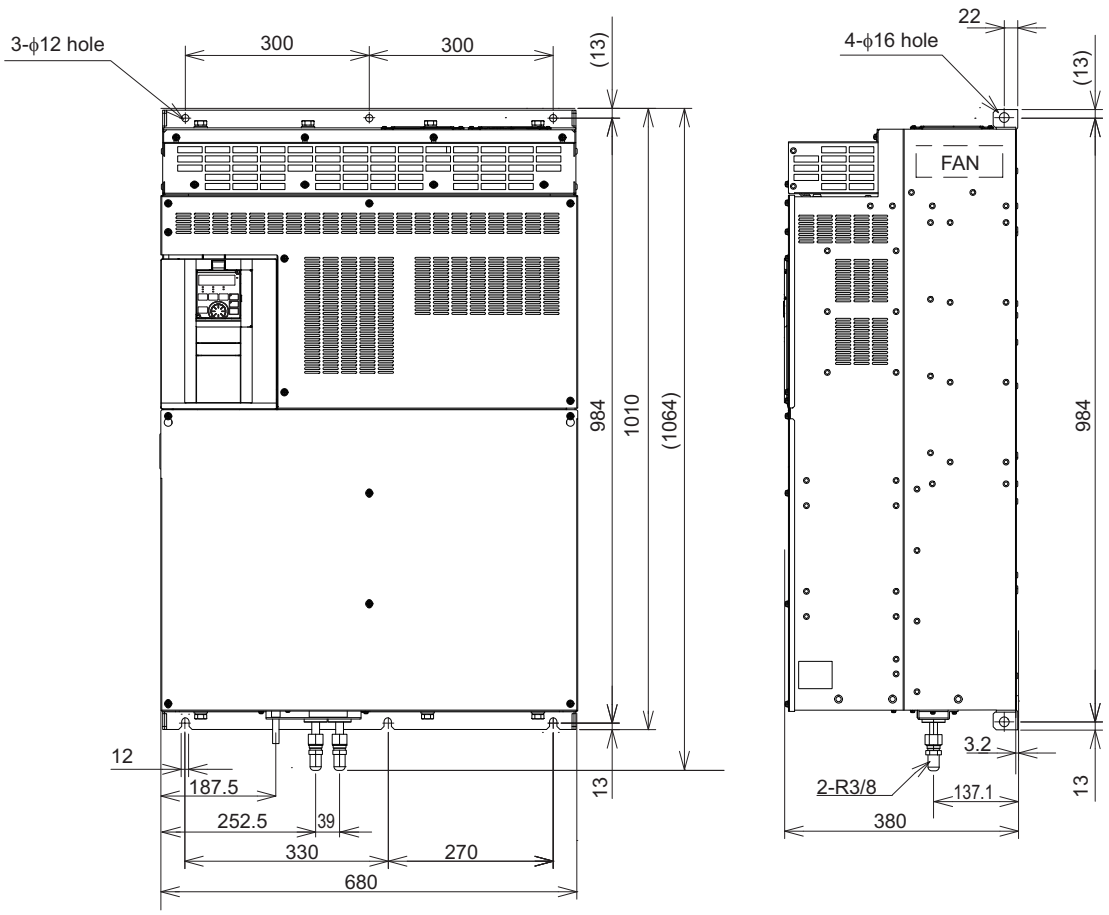
FR-A840-04320(160K), FR-A840-04810(185K)-LC



Always connect a DC reactor (FR-HEL), which is available as an option. (Unit: mm)

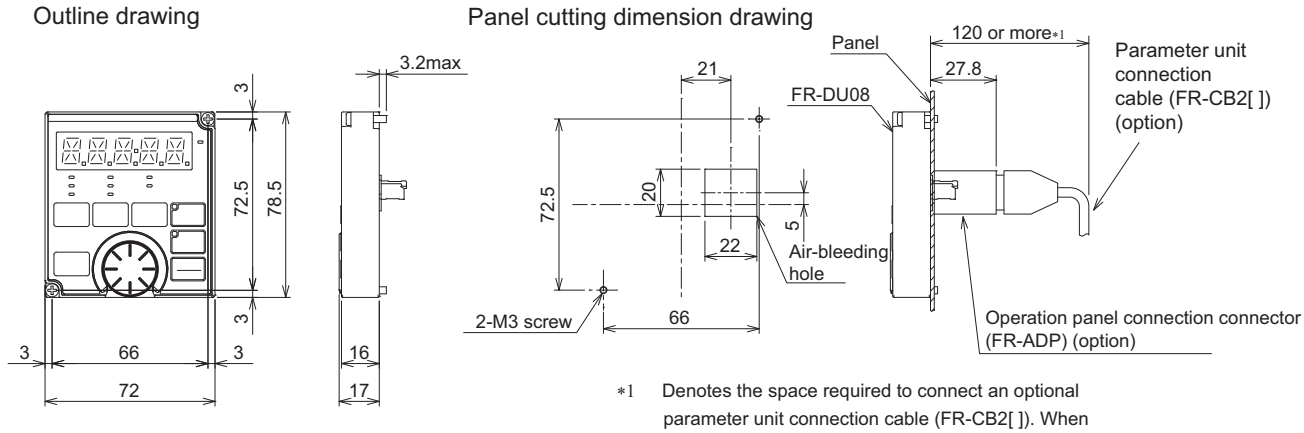
Inverter outline dimensions

FR-A840-05470(220K), FR-A840-06100(250K), FR-A840-06830(280K)-LC



Always connect a DC reactor (FR-HEL), which is available as an option. (Unit: mm)

Operation panel (FR-DU08)



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

(Unit: mm)

APPENDIX

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

Appendix 1 Instructions for compliance with the EU Directives.....112
Appendix 2 Instructions for UL and cUL.....115
Appendix 3 Instructions for EAC 117
Appendix 4 Restricted Use of Hazardous Substances in Electronic and Electrical Products.....118
Appendix 5 Referenced Standard (Requirement of Chinese standardized law).....118
Appendix 6 Compliance with the UK certification scheme.....119
Appendix 7 Compliance with the EU ErP Directive (Ecodesign Directive) 119

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.
  Name: Mitsubishi Electric Europe B.V.
  Address: Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

◆EMC Directive

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

- EMC Directive: 2014/30/EU
- Standard(s): EN61800-3 Second environment / PDS Category "C3"
- This inverter is not intended to be used on a low-voltage public network which supplies domestic premises. When using the inverter in a residential area, take appropriate measures and ensure the conformity of the inverter used in the residential area.
- Radio frequency interference is expected if used on such a network.
- The installer shall provide a guide for installation and use, including recommended mitigation devices.

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

◆Note

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

- This inverter is equipped with an EMC filter with a class C3. Enable the EMC filter. (For details, refer to **page 79**.)
- Connect the inverter to an earthed power supply.
- Install a motor and a control cable written in the EMC Installation Guidelines (BCN-A21041-204) and Technical News (MF-S-136) according to the instruction.
- To ensure sufficient function of the built-in EMC filter, motor cable lengths should not be exceeded more than 20 m.
- Confirm that the inverter conforms 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 and affix the CE marking on the inverters.

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

◆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 securely.
- Wire the earth terminal independently. (Do not connect two or more cables to one terminal.)
- Use the cable sizes indicated on **page 37** under the following conditions.
  - Surrounding air temperature: 40°C maximum

  If conditions are different from above, select appropriate wire according to EN60204-1 or IEC60364-5-52.
- Use a tinned (plating should not include zinc) crimp 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 37**.
- Use the molded case circuit breaker and magnetic contactor which conform to the EN or IEC Standard.
- This product can cause a d.c. current in the protective earthing conductor. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product.
- 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) 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 IP 2X 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, use cables of the type and size set forth in EN60204-1 or IEC60364-5-52.
- The operating capacity of the relay outputs (terminal symbols A1, B1, C1, A2, B2 and C2) should be 30 VDC, 0.3 A. (Relay output has basic isolation from the inverter internal circuit.)
- Control circuit terminals indicated on **page 27** are safely isolated from the main circuit.
- Environment (For the detail, refer to **page 19**.)

	During operation	In storage	During transportation
Surrounding air temperature	LD, ND (initial setting): -10 to +50°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	2000 m *1	1000 m	10000 m

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

◆Wiring protection

Class T, Class J, Class CC, or Class L fuse must be provided.
(Use a product which conforms to the EN or IEC Standard.)

FR-A840-[]-LC	03250 (110K)	03610 (132K)	04320 (160K)	04810 (185K)	05470 (220K)	06100 (250K)	06830 (280K)
Rated fuse voltage(V)	500 V or more						
Fuse allowable rating (A)	400	500	600	700	800	900	1000

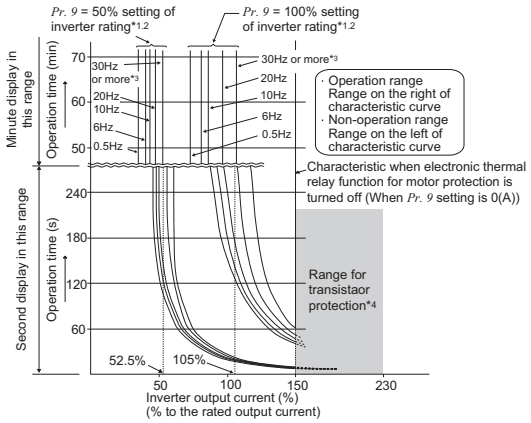
◆Short circuit ratings

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 of the motor, stops the operation of the inverter's output transistor, and stops the output. (The operation characteristic is shown on the left.)

- When using the Mitsubishi Electric constant-torque motor

(1) Set one of "1, 13 to 16, 50, 53, 54" in **Pr.71**. (This provides a 100% continuous 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 inverter rated current. It is not the percentage to the rated motor current.
∗3 When you set the electronic thermal relay function dedicated to the Mitsubishi Electric 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 multiple motors are driven with a single inverter or when a multi-pole motor or a special motor is driven, install an external thermal relay (OCR) between the inverter and motors. Note that the current indicated on the motor rating plate is affected by the line-to-line leakage current (details in the 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 this case, use an external thermal relay.
- A special motor cannot be protected by the electronic thermal relay function. Use an external thermal relay.
- Set **Pr.9** = "0" for vector-control-dedicated motors (SF-V5RU) because they are equipped with thermal protectors.
- Motor over temperature sensing is not provided by the drive.
- Electronic thermal memory retention function is not provided by the drive.

◆EU RoHS Directive

We declare that our inverters are compliant to the EU RoHS Directive (2011/65/EU) and affix the CE marking on the inverters.

Appendix 2 Instructions for UL and cUL

(Standard to comply with: UL 508C, CSA C22.2 No.274-13)

◆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 below types of inverters have been approved as products for use in enclosure and approval tests were conducted under the following conditions.

Design the enclosure so that the surrounding air temperature, humidity and ambience of the inverter will satisfy the specifications. (Refer to page 19.)

◆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-A840-[]-LC	03250 (110K)	03610 (132K)	04320 (160K)	04810 (185K)	05470 (220K)	06100 (250K)	06830 (280K)
Rated fuse voltage(V)	500 V or more						
Fuse allowable rating (A)	400	500	600	700	800	900	1000

◆Wiring to the power supply and the motor

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

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

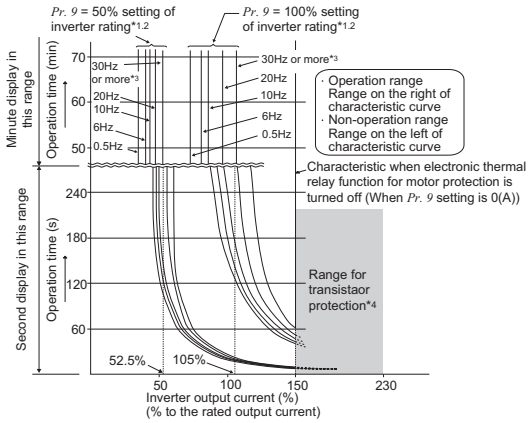
◆Short circuit ratings

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, stops the operation of the inverter's output transistor, and stops the output. (The operation characteristic is shown on the left.)

- When using the Mitsubishi Electric constant-torque motor

(1) Set one of "1, 13 to 16, 50, 53, 54" in **Pr.71**. (This provides a 100% continuous 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 inverter rated current. It is not the percentage to the rated motor current.
∗3 When you set the electronic thermal relay function dedicated to the Mitsubishi Electric 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 multiple motors are driven with a single inverter or when a multi-pole motor or a special motor is driven, install an external thermal relay (OCR) between the inverter and motors. Note that the current indicated on the motor rating plate is affected by the line-to-line leakage current (details in the 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 this case, use an external thermal relay.
- A special motor cannot be protected by the electronic thermal relay function. Use an external thermal relay.
- Set **Pr.9** = "0" for vector-control-dedicated motors (SF-V5RU) because they are equipped with thermal protectors.
- Motor over temperature sensing is not provided by the drive.

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 Turkey A.S. Head Office
  Address: Serifali Mahallesi Kale Sokak. No:41 34775 Umraniye, Istanbul, Turkey
  Phone: +90-216-969-25-00
  Fax: +90-216-661-44-47

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。

Appendix 5 Referenced Standard (Requirement of Chinese standardized law)

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

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

Appendix 6 Compliance with the UK certification scheme

We declare that this product conforms with the related technical requirements under UK legislation, and affix the UKCA (UK Conformity Assessed) marking on the product.
Approval conditions are the same as those for the EU Directives. (Refer to page 112.)

UKCA marking:
The UKCA marking is used for products sold in the markets of Great Britain (England, Wales, and Scotland) from January 1, 2021 after the departure of the UK from the EU on January 31, 2020.

Appendix 7 Compliance with the EU ErP Directive (Ecodesign Directive)

Based on the EU ErP Directive (Ecodesign Directive), the power loss data of the inverters are shown in the following table.
The regulation covers 3-phase variable speed drives from 0.12 kW ≤ Pn ≤ 1 000 kW.

• LD rated

Model name	Rated Apparent power (kVA)	Stand by loss (W)	load point 1 (90;100) (%)	load point 2 (50;100) (%)	load point 3 (0;100) (%)	load point 4 (90;50) (%)	load point 5 (50;50) (%)	load point 6 (0;50) (%)	load point 7 (50;25) (%)	load point 8 (0;25) (%)	IE class
FR-A840-03250(110K)(-**)-LC	198	99.1	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-03610(132K)(-**)-LC	248	99.1	1.5	1.5	1.5	0.8	0.8	0.8	0.5	0.5	IE2
FR-A840-04320(160K)(-**)-LC	275	139.8	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-04810(185K)(-**)-LC	329	139.8	1.5	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-05470(220K)(-**)-LC	367	169.4	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-06100(250K)(-**)-LC	417	169.4	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-06830(280K)(-**)-LC	465	169.4	1.5	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2

Note: ** indicates alpha numeric combination which means an inverter type such as 1 and 2.

• ND rated

Model name	Rated Apparent power (kVA)	Stand by loss (W)	load point 1 (90;100) (%)	load point 2 (50;100) (%)	load point 3 (0;100) (%)	load point 4 (90;50) (%)	load point 5 (50;50) (%)	load point 6 (0;50) (%)	load point 7 (50;25) (%)	load point 8 (0;25) (%)	IE class
FR-A840-03250(110K)(-**)-LC	165	99.1	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-03610(132K)(-**)-LC	198	99.1	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-04320(160K)(-**)-LC	248	139.8	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-04810(185K)(-**)-LC	275	139.8	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-05470(220K)(-**)-LC	329	169.4	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-06100(250K)(-**)-LC	367	169.4	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2
FR-A840-06830(280K)(-**)-LC	417	169.4	1.4	1.4	1.4	0.7	0.7	0.7	0.5	0.5	IE2

Note: ** indicates alpha numeric combination which means an inverter type such as 1 and 2.

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 caused by using the emergency drive function
- a failure generated by an unforeseeable cause with a scientific technology that was not available at the time of the shipment of the Product from our company
- any other failures which we are not responsible for or which you acknowledge we are not responsible for

2. Term of warranty after the stop of production

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

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

3. Service in overseas

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

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

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

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

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

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

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

5. Change of Product specifications

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

6. Application and use of the Product

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

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

MEMO

REVISIONS

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

Revision Date	*Manual number	Revision
Jul. 2017	IB(NA)-0600683ENG-A	First edition
Aug. 2018	IB(NA)-0600683ENG-B	Added • Operation panel (FR-DU08) • Safety stop function • Ethernet communication • Referenced Standard (Requirement of Chinese standardized law)
Oct. 2024	IB(NA)-0600683ENG-C	Added • Emergency drive in operation (ED) • Compliance with the UK certification scheme • Compliance with the EU ErP Directive (Ecodesign Directive) Edited • Instructions for compliance with the EU Directives • Instructions for EAC • Referenced Standard (Requirement of Chinese standardized law) • Deletion of "enclosed CD-ROM"

MITSUBISHI ELECTRIC CORPORATION
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