# CHAPTER 6

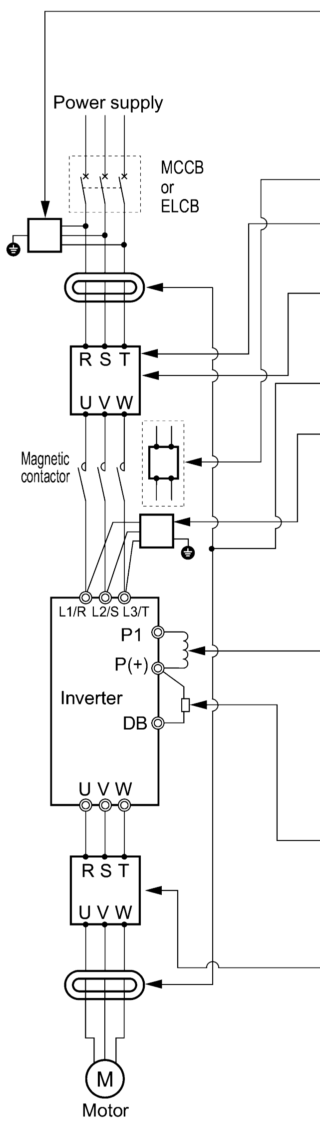
# SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-Mini's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Contents

# 6.1 Configuring the FRENIC-Mini

This section lists the names and features of peripheral equipment and options for the FRENIC-Mini series of inverters and includes a configuration example for reference. Refer to Figure 6.1 for a quick overview of available options.



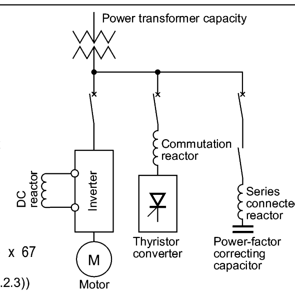

| Name | Function |
|---|---|
| **Surge absorber** | Suppresses surges or noise invading from an external source, preventing malfunction from magnetic contactors, control relays and timers, etc. |
| **Arrester** | Suppresses induced lightning surges from power source, thus protecting all equipment connected to the power source. |
| **Surge killer** | Absorbs surges or noise invading from an external source, preventing malfunction of electronic equipment used in the switchboard. |
| **Frequency setting device** | Frequency setting potentiometer (mounted externally) |
| **Frequency meter** | Displays the frequency in accordance with signals output from the inverter. |
| **Option for single-phase 100V input** | This is used in cases where a single-phase 100V power supply is used to feed a three-phase 200V inverter. (It can be applied to the inverter of 0.75kW or less.) |
| **EMC compliance filter** | This is a dedicated filter which complies with the European EMC (Emission) Directive. |
| **AC REACTOR (ACR)** | Used for power factor improvement and power supply coordination. However, it is recommended that a DC REACTOR with a higher efficiency and which is more compact and lightweight be used. Use a DC REACTOR (DCR) as a countermeasure for harmonics. If it is necessary to supply a stabilized power supply, such as a DC bus system and running from that (PN connection operation), please use such a reactor. |
| **Ferrite ring reactor for reducing radio noise** | Reduces radio frequency noise. If the wiring between motor and inverter is shorter than 20m, use the ferrite ring reactor in the power supply side. If longer than 20m, use it in the output side. |
| **Filter capacitor for reducing radio interference** | Reduces noise.<br>For frequencies in the AM radio frequency band of 1MHz or less, a noise reduction effect can be obtained. Absolutely never connect this device to the inverter's output side. |
| **DC REACTOR (DCR)** | [Use the DCR to normalize the power supply in the following cases.]<br>1. The power transformer capacity is 500kVA or over and exceeds the inverter rated capacity by 10 times.<br>2. The inverter and a thyristor converter are connected with the same transformer.<br>*Check if the thyristor converter uses a commutation reactor. If not, AC reactor must be connected to the power supply side.<br>3. Overvoltage trip occurs due to open/close of the phase-advancing capacitor for the power supply lines.<br>4. The voltage unbalance exceeds 2%.<br>$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67$<br>(IEC 61800-3 (5.2.3))<br><br><br>[For improving input power-factor, reducing harmonics]<br>• Used to reduce input harmonic current (correcting power-factor) |
| **Braking resistor** | Used to increase the braking capability when the motor needs to start and stop frequently or when the moment of inertia is large. |
| **Output circuit filter** | This filter is connected to the output circuit of inverters, and has the following functions:<br>1. Suppressing fluctuation of motor terminal voltage<br>Protects the motor insulation from being damaged by surge voltage.<br>2. Suppressing leakage current from output side wiring<br>Reduces the leakage current caused when several motors are operated in parallel or connected with long wiring.<br>3. Suppressing radiation noise or inductive noise from output side wiring<br>Effective noise suppression device for long wiring applications such as plant<br>* There are two kinds of filters for 400V series. Choose a desired one according to the purpose of use. |
| **RS485 communications card** | This makes communication to a PLC or personal computer system easy. |
| **Remote operation extension cable** | Used to connect the RS485 communications card with the remote keypad, USB-RS485 converter, etc. |
| **Remote keypad** | Used when performing inverter remote operations with the remote keypad. |
| **Copy adaptor** | Allows copying data to multiple inverters with easy connection to the inverter body. |
| **Connector adaptor** | Used for the connector replacement of the copy adaptor. |
| **Inverter support loader software** | Inverter support loader software, Windows based, that makes setting of function codes easy. |
| **USB-RS485 converter** | Used to connect the RS485 communications card with a USB port of your personal computer.<br>Manufacturer: System Sacom Sales Corp. Phone: +81-3-5623-5933 Web site: http://www.sacom.co.jp |
| **NEMA1 kit** | NEMA1 kit protects the inverter body with the structure that conforms to the NEMA1 standard (approved as UL TYPE1). |
| **Attachments** | Permit change of protective structure, replacement of Fuji's previous inverter model and installation on the DIN rails, etc. |

Figure 6.1 Quick Overview of Options

## 6.2 Selecting Wires and Crimp Terminals

This section contains information needed to select wires for connecting the inverter to commercial power lines, motor or any of the optional/peripheral equipment. The level of electric noise issued from the inverter or received by the inverter from external sources may vary depending upon wiring and routing. To solve such noise-related problems, refer to Appendix A "Advantageous Use of Inverters (Notes on electrical noise)."

Select wires that satisfy the following requirements:

- Sufficient capacity to flow the rated average current (allowable current capacity).
- Protective device coordination with an overcurrent circuit breaker such as an MCCB in the overcurrent zone for overcurrent protection.
- Voltage loss due to the wire length is within the allowable range.
- Suitable for the type and size of terminals of the optional equipment to be used.

Recommended wires are listed below. Use these wires unless otherwise specified.

■ 600V class of vinyl-insulated wires (IV wires)

Use this class of wire for the power circuits. This class of wire is hard to twist, so using it for the control signal circuits is not recommended. Maximum ambient temperature for this wire is 60°C.

■ 600V heat-resistant PVC insulated wires or 600V polyethylene insulated wires (HIV wires)

As wires in this class are smaller in diameter and more flexible than IV wires and can be used at a higher ambient temperature (75°C), they can be used for both of the main power and control signal circuits. To use this class of wire for the control circuits, you need to correctly twist the wires and keep the wiring length for equipment being connected as short as possible.

■ 600V cross-linked polyethylene-insulated wires (FSLC wires)

Use this class of wire mainly for power and grounding circuits. These wires are smaller in diameter and more flexible than those of the IV and HIV classes of wires, meaning that these wires can be used to save on space and increase operation efficiency of your power system, even in high temperature environments. The maximum allowable ambient temperature for this class of wires is 90°C. The (Boardlex) wire range available from Furukawa Electric Co., Ltd. satisfies these requirements.

■ Shielded-Twisted cables for internal wiring of electronic/electric equipment

Use this category of cables for the control circuits of the inverter so as to prevent the signal lines from being affected by noise from external sources, including the power input/output lines of the inverter themselves. Even if the signal lines are inside the power control cabinet, always use this category of cables when the length of wiring is longer than normal. Cables satisfying these requirements are the Furukawa's BEAMEX S shielded cables of the XEBV and XEWV ranges.

Currents Flowing across the Inverter Terminals

Table 6.1 summarizes average (effective) electric currents flowing across the terminals of each inverter model for ease of reference when selecting peripheral equipment, options and electric wires for each inverter--including supplied power voltage and applicable motor rating.

Table 6.1 Currents Flowing through Inverter

| Power supply voltage | Applicable motor rating (kW) | 200 V/400 V (380 V), 50 Hz | | | | 220 V (200 V)/440 V (380 V), 60 Hz | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Input RMS current (A) DC reactor (DCR) | | DC link bus current (A) | Braking resistor circuit current (A) | Input RMS current (A) DC reactor (DCR) | | DC link bus current (A) | Braking resistor circuit current (A) |
| | | w/ DCR | w/o DCR | | | w/ DCR | w/o DCR | | |
| Three-phase 200 V | 0.1 | 0.57 | 1.1 | 0.70 | - | 0.51 (0.55) | 1.1 (1.1) | 0.62 (0.67) | - |
| | 0.2 | 0.93 | 1.7 | 1.1 | - | 0.85 (0.92) | 1.7 (1.8) | 1.0 (1.1) | - |
| | 0.4 | 1.6 | 3.0 | 2.0 | 1.2 | 1.5 (1.6) | 3.0 (3.0) | 1.8 (2.0) | 1.2 |
| | 0.75 | 3.0 | 5.1 | 3.7 | 1.6 | 2.8 (3.0) | 5.0 (5.3) | 3.4 (3.7) | 1.6 |
| | 1.5 | 5.7 | 9.4 | 7.0 | 3.6 | 5.2 (5.6) | 9.0 (9.5) | 6.3 (6.9) | 3.6 |
| | 2.2 | 8.3 | 13.0 | 10.2 | 3.5 | 7.6 (8.3) | 12.3 (13.2) | 9.3 (10.1) | 3.5 |
| | 3.7, 4.0 | 14.0 | 22.2 | 17.2 | 4.1 | 12.7 (13.9) | 20.6 (22.2) | 15.6 (17.0) | 4.1 |
| Three-phase 400 V | 0.4 | 0.81 (0.85) | 1.6 (1.7) | 0.99 (1.0) | 0.8 | 0.74 (0.85) | 1.7 (1.7) | 0.91 (1.0) | 0.8 |
| | 0.75 | 1.5 (1.6) | 2.9 (3.0) | 1.8 (1.9) | 1.1 | 1.4 (1.6) | 3.0 (3.0) | 1.7 (2.0) | 1.1 |
| | 1.5 | 2.9 (3.0) | 5.7 (5.7) | 3.5 (3.6) | 1.8 | 2.6 (3.0) | 5.1 (5.9) | 3.2 (3.6) | 1.8 |
| | 2.2 | 4.2 (4.4) | 7.9 (7.9) | 5.1 (5.3) | 1.8 | 3.8 (4.3) | 7.1 (8.2) | 4.6 (5.3) | 1.8 |
| | 3.7, 4.0 | 7.0 (7.3) | 12.5 (13.0) | 8.6 (9.0) | 2.1 | 6.4 (7.3) | 11.1 (12.9) | 7.8 (8.9) | 2.1 |
| Single-phase 200 V | 0.1 | 1.1 | 1.8 | 1.1 | - | 1.0 (1.1) | 1.8 (1.8) | 1.0 (1.1) | - |
| | 0.2 | 2.0 | 3.2 | 2.0 | - | 1.8 (1.9) | 3.1 (3.2) | 1.8 (1.9) | - |
| | 0.4 | 3.5 | 5.2 | 3.5 | 0.82 | 3.1 (3.4) | 5.0 (5.4) | 3.1 (3.4) | 0.82 |
| | 0.75 | 6.4 | 9.5 | 6.4 | 1.4 | 5.8 (6.3) | 9.1 (9.7) | 5.8 (6.3) | 1.4 |
| | 1.5 | 11.7 | 16.0 | 11.7 | 1.4 | 10.5 (11.3) | 15.5 (16.4) | 10.5 (11.3) | 1.4 |
| | 2.2 | 17.5 | 24.2 | 17.5 | 1.7 | 15.8 (17.0) | 23.4 (24.8) | 15.8 (17.0) | 1.7 |

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  Power source capacity: 500 kVA; power source internal impedance: 5%
- The current listed in the above table will vary in inverse proportion to the power supply voltage, such as 230 VAC and 380 VAC.
- The braking current is always constant, independent of braking resistor specifications, including built-in, standard and 10%ED models.

## 6.2.1 Recommended wires

Tables 6.2 and 6.3 list the recommended wires according to the internal temperature of your power control cabinet.

■ If the internal temperature of your power control cabinet is 50°C or below

Table 6.2 Wire Size (for main circuit power input and inverter output)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | Recommended wire size (mm$^2$) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main circuit power input [L1/R , L2/S , L3/T] or [L1/L, L2/N] | | | | | | | | Inverter output [U , V , W] | | | |
| | | | w/ DC reactor (DCR) | | | | w/o DC reactor (DCR) | | | | | | | |
| | | | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Current |
| | | | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | (A) |
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.57 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.1 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.8 |
| | 0.2 | FRN0.2C1■-2□ | | | | 0.93 | | | | 1.8 | | | | 1.5 |
| | 0.4 | FRN0.4C1■-2□ | | | | 1.6 | | | | 3.1 | | | | 3.0 |
| | 0.75 | FRN0.75C1■-2□ | | | | 3.0 | | | | 5.3 | | | | 5.5 |
| | 1.5 | FRN1.5C1■-2□ | | | | 5.7 | | | | 9.5 | | | | 8.0 |
| | 2.2 | FRN2.2C1■-2□ | | | | 8.3 | | | | 13.2 | | | | 11 |
| | 3.7, 4.0 | FRN3.7C1■-2□ | | | | 14.0 | 5.5 | | | 22.2 | 3.5 (4.0) | | | 17 |
| Three-phase 400 V | 0.4 | FRN0.4C1■-4□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.85 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.7 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.5 |
| | 0.75 | FRN0.75C1■-4□ | | | | 1.6 | | | | 3.1 | | | | 2.5 |
| | 1.5 | FRN1.5C1■-4□ | | | | 3.0 | | | | 5.9 | | | | 3.7 |
| | 2.2 | FRN2.2C1■-4□ | | | | 4.4 | | | | 8.2 | | | | 5.5 |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | | | | 7.3 | | | | 13.0 | | | | 9 |
| Single-phase 200 V | 0.1 | FRN0.1C1■-7□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.1 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.8 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.8 |
| | 0.2 | FRN0.2C1■-7□ | | | | 2.0 | | | | 3.3 | | | | 1.5 |
| | 0.4 | FRN0.4C1■-7□ | | | | 3.5 | | | | 5.4 | | | | 3.0 |
| | 0.75 | FRN0.75C1■-7□ | | | | 6.4 | | | | 9.7 | | | | 5.0 |
| | 1.5 | FRN1.5C1■-7□ | | | | 11.7 | 3.5 (4.0) | | | 16.4 | | | | 8.0 |
| | 2.2 | FRN2.2C1■-7□ | 3.5 (4.0) | | | 17.5 | 5.5 (6.0) | 3.5 (4.0) | | 24.8 | | | | 11 |

Table 6.2 Cont. (for DC reactor, braking resistor, control circuits, and inverter grounding)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | Recommended wire size (mm$^2$) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DC reactor [P1, P(+)] | | | | Braking resistor [P(+), DB] | | | | Control circuit | | | Inverter grounding ⏚[G] | | |
| | | | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Allowable temp.*1 | | |
| | | | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | 60°C | 75°C | 90°C |
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.70 | - | - | - | - | 0.5 | 0.5 | 0.5 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) |
| | 0.2 | FRN0.2C1■-2□ | | | | 1.1 | | | | | | | | | | |
| | 0.4 | FRN0.4C1■-2□ | | | | 2.0 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.2 | | | | | | |
| | 0.75 | FRN0.75C1■-2□ | | | | 3.7 | | | | 1.6 | | | | | | |
| | 1.5 | FRN1.5C1■-2□ | | | | 7.0 | | | | 3.6 | | | | | | |
| | 2.2 | FRN2.2C1■-2□ | | | | 10.2 | | | | 3.5 | | | | | | |
| | 3.7, 4.0 | FRN3.7C1■-2□ | 3.5 (4.0) | | | 17.2 | | | | 4.1 | | | | | | |
| Three-phase 400 V | 0.4 | FRN0.4C1■-4□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.0 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.8 | 0.5 | 0.5 | 0.5 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) |
| | 0.75 | FRN0.75C1■-4□ | | | | 1.9 | | | | 1.1 | | | | | | |
| | 1.5 | FRN1.5C1■-4□ | | | | 3.6 | | | | 1.8 | | | | | | |
| | 2.2 | FRN2.2C1■-4□ | | | | 5.3 | | | | 1.8 | | | | | | |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | | | | 9.0 | | | | 2.1 | | | | | | |
| Single-phase 200 V | 0.1 | FRN0.1C1■-7□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.1 | - | - | - | - | 0.5 | 0.5 | 0.5 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) |
| | 0.2 | FRN0.2C1■-7□ | | | | 2.0 | | | | | | | | | | |
| | 0.4 | FRN0.4C1■-7□ | | | | 3.5 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 0.82 | | | | | | |
| | 0.75 | FRN0.75C1■-7□ | | | | 6.4 | | | | 1.4 | | | | | | |
| | 1.5 | FRN1.5C1■-7□ | | | | 11.7 | | | | 1.4 | | | | | | |
| | 2.2 | FRN2.2C1■-7□ | 3.5 (4.0) | | | 17.5 | | | | 1.7 | | | | 3.5 (4.0) | | |

*1 Assuming the use of bare wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V class of polyethylene-insulated cross-link wires for 90°C.

Notes: 1) A box (■) in the above tables replaces S or E depending on enclosure.
2) A box (□) in the above tables replaces A, C, E, or J depending on shipping destination.
3) Values in parentheses ( ) in the above tables denote wire sizes for the European version.

If environmental requirements such as power supply voltage and ambient temperature differ from those listed above, select wires suitable for your system by referring to Table 6.1 and Appendices, App. F "Allowable Current of Insulated Wires."

## ■ If the internal temperature of your power control cabinet is 40°C or below

Table 6.3 Wire Size (for main circuit power input and inverter output)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | Recommended wire size (mm²) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Main circuit power input [L1/R , L2/S , L3/T] or [L1/L, L2/N] | | | | | | | | Inverter output [U , V , W] | | | |
| | | | w/ DC reactor (DCR) | | | | w/o DC reactor (DCR) | | | | | | | |
| | | | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Current |
| | | | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | (A) |
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | | | | 0.57 | | | | 1.1 | | | | 0.8 |
| | 0.2 | FRN0.2C1■-2□ | | | | 0.93 | | | | 1.8 | | | | 1.5 |
| | 0.4 | FRN0.4C1■-2□ | | | | 1.6 | 2.0 (2.5) | | | 3.1 | | | | 3.0 |
| | 0.75 | FRN0.75C1■-2□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 3.0 | | 2.0 (2.5) | 2.0 (2.5) | 5.3 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 5.5 |
| | 1.5 | FRN1.5C1■-2□ | | | | 5.7 | | | | 9.5 | | | | 8.0 |
| | 2.2 | FRN2.2C1■-2□ | | | | 8.3 | | | | 13.2 | | | | 11 |
| | 3.7, 4.0 | FRN3.7C1■-2□ | | | | 14.0 | 3.5 (4.0) | | | 22.2 | | | | 17 |
| Three -phase 400 V | 0.4 | FRN0.4C1■-4□ | | | | 0.85 | | | | 1.7 | | | | 1.5 |
| | 0.75 | FRN0.75C1■-4□ | | | | 1.6 | | | | 3.1 | | | | 2.5 |
| | 1.5 | FRN1.5C1■-4□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 3.0 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 5.9 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 3.7 |
| | 2.2 | FRN2.2C1■-4□ | | | | 4.4 | | | | 8.2 | | | | 5.5 |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | | | | 7.3 | | | | 13.0 | | | | 9 |
| Single-phase 200 V | 0.1 | FRN0.1C1■-7□ | | | | 1.1 | | | | 1.8 | | | | 0.8 |
| | 0.2 | FRN0.2C1■-7□ | | | | 2.0 | | | | 3.3 | | | | 1.5 |
| | 0.4 | FRN0.4C1■-7□ | | | | 3.5 | 2.0 (2.5) | | | 5.4 | | | | 3.0 |
| | 0.75 | FRN0.75C1■-7□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 6.4 | | 2.0 (2.5) | 2.0 (2.5) | 9.7 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 5.0 |
| | 1.5 | FRN1.5C1■-7□ | | | | 11.6 | | | | 16.4 | | | | 8.0 |
| | 2.2 | FRN2.2C1■-7□ | | | | 17.5 | 3.5 (4.0) | | | 24.8 | | | | 11 |

Table 6.3 Cont. (for DC reactor, braking resistor, control circuit, and inverter grounding)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | Recommended wire size (mm²) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | DC reactor [P1, P(+)] | | | | Braking resistor [P(+), DB] | | | | Control circuit | | | Inverter grounding ⏚ [G] | | |
| | | | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Current | Allowable temp.*1 | | | Allowable temp.*1 | | |
| | | | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | (A) | 60°C | 75°C | 90°C | 60°C | 75°C | 90°C |
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | | | | 0.7 | - | - | - | - | | | | | | |
| | 0.2 | FRN0.2C1■-2□ | | | | 1.1 | | | | | | | | | | |
| | 0.4 | FRN0.4C1■-2□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 2.0 | | | | 1.2 | | | | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) |
| | 0.75 | FRN0.75C1■-2□ | | | | 3.7 | | | | 1.6 | 0.5 | 0.5 | 0.5 | | | |
| | 1.5 | FRN1.5C1■-2□ | | | | 7.0 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 3.6 | | | | | | |
| | 2.2 | FRN2.2C1■-2□ | | | | 10.2 | | | | 3.5 | | | | | | |
| | 3.7, 4.0 | FRN3.7C1■-2□ | | | | 17.2 | | | | 4.1 | | | | | | |
| Three -phase 400 V | 0.4 | FRN0.4C1■-4□ | | | | 1.0 | | | | 0.8 | | | | | | |
| | 0.75 | FRN0.75C1■-4□ | | | | 1.9 | | | | 1.1 | | | | | | |
| | 1.5 | FRN1.5C1■-4□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 3.6 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.8 | 0.5 | 0.5 | 0.5 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) |
| | 2.2 | FRN2.2C1■-4□ | | | | 5.3 | | | | 1.8 | | | | | | |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | | | | 9.0 | | | | 2.1 | | | | | | |
| Single-phase 200 V | 0.1 | FRN0.1C1■-7□ | | | | 1.1 | - | - | - | - | | | | | | |
| | 0.2 | FRN0.2C1■-7□ | | | | 2.0 | | | | | | | | | | |
| | 0.4 | FRN0.4C1■-7□ | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 3.5 | | | | 0.82 | 0.5 | 0.5 | 0.5 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) |
| | 0.75 | FRN0.75C1■-7□ | | | | 6.4 | 2.0 (2.5) | 2.0 (2.5) | 2.0 (2.5) | 1.4 | | | | | | |
| | 1.5 | FRN1.5C1■-7□ | | | | 11.7 | | | | 1.4 | | | | | | |
| | 2.2 | FRN2.2C1■-7□ | | | | 17.5 | | | | 1.7 | | | | | | |

*1 Assuming the use of bare wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V class of polyethylene-insulated cross-link wires for 90°C.

Notes:
1) A box (■) in the above tables replaces S or E depending on enclosure.
2) A box (□) in the above tables replaces A, C, E, or J depending on shipping destination.
3) Values in parentheses ( ) in the above tables denote wire sizes for the European version.

📖 If environmental requirements such as power supply voltage and ambient temperature differ from those listed above, select wires suitable for your system by referring to Table 6.1 and Appendices, App. F "Allowable Current of Insulated Wires."

## 6.2.2 Crimp terminals

Table 6.4 lists the recommended ring tongue crimp terminals that can be specified by the wires and screws to be used for your inverter model.

Table 6.4 Crimp Terminal Size

| Wire size ($mm^2$) | Terminal screw size | Ring tongue crimp terminal |
|---|---|---|
| 0.5 | M3.5 | 1.25 - 3.5 |
| | M4 | 1.25 - 4 |
| 0.75 | M3.5 | 1.25 - 3.5 |
| | M4 | 1.25 - 4 |
| 1.25 | M3.5 | 1.25 - 3.5 |
| | M4 | 1.25 - 4 |
| 2.0 | M3.5 | 2 - 3.5 |
| | M4 | 2 - 4 |
| 3.5/5.5 | M4 | 4 - 5.5 |

Refer to Chapter 8, Section 8.4.3 "Terminal arrangement diagram and screw specifications" to select the correct terminal screw size.

# 6.3 Peripheral Equipment

## [ 1 ] Molded case circuit breaker (MCCB), earth leakage circuit breaker (ELCB) and magnetic contactor (MC)

### [ 1.1 ] Functional overview

■ MCCBs and ELCBs*

*With overcurrent protection

Molded Case Circuit Breakers (MCCBs) are designed to protect the power circuits between the power supply and inverter's main circuit terminals (L1/R, L2/S and L3/T for three phase, or L1/L and L2/N for single-phase power source) from overload or short-circuit, which in turn prevents secondary accidents caused by the inverter malfunctioning.

Earth Leakage Circuit Breakers (ELCBs) function in the same way as MCCBs.

Built-in overcurrent/overload protective functions protect the inverter itself from failures related to its input/output lines.

■ MCs

An MC can be used at both the power input and output sides of the inverter. At each side, the MC works as described below. When inserted in the output circuit of the inverter, the MC can also switch the motor drive power source between the inverter output and commercial power lines.

<u>At the power source side</u>

Insert an MC in the power source side of the inverter in order to:

(1) Forcibly cut off the inverter from the power source (generally, commercial/factory power lines) with the protective function built into the inverter, or with the external signal input.

(2) Stop the inverter operation in an emergency when the inverter cannot interpret the stop command due to internal/external circuit failures.

(3) Cut off the inverter from the power source when the MCCB inserted in the power source side cannot cut it off for maintenance or inspection purpose. For the purpose only, it is recommended that you use an MC capable of turning the MC ON/OFF manually.

Note: When your system requires starting/stopping the motor(s) driven by the inverter with the MC, the frequency of the starting/stopping operation should be once or less per hour. The more frequent the operation, the shorter operation life of the MC and capacitor/s used in the DC link bus due to thermal fatigue caused by the frequent charging of the current flow. It is recommended that terminal commands (FWD), (REV) and (HLD) for 3-wire operation or the keypad be used for starting/stopping the motor.

<u>At the output side</u>

Insert an MC in the power output side of the inverter in order to:

(1) Prevent externally turned-around current from being applied to the inverter power output terminals (U, V, and W) unexpectedly. An MC should be used, for example, if a circuit that switches the motor driving power source between the inverter output and commercial power lines is connected to the inverter.

Tip: As application of the external current to the inverter's secondary (output) circuits may break the Insulated Gate Bipolar Transistors (IGBTs), MCs should be used in the power control system circuits to switch the motor drive power source to the commercial power lines after the motor has come to a complete stop. Also ensure that voltage is never mistakenly applied to the inverter output terminals due to unexpected timer operation, or similar.

(2) Drive more than one motor selectively by a single inverter.

(3) Selectively cut off the motor whose thermal overload relay or equivalent devices have been activated.

Driving the motor using commercial power lines

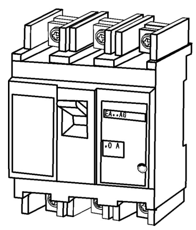
MCs can also be used to switch the power source of the motor driven by the inverter to a commercial power source.

Select the MC so as to satisfy the rated currents listed in Table 6.1, which are the most critical RMS currents for using the inverter. For switching the motor drive source between the inverter output and commercial power lines, use the MC of class AC3 specified by JIS C8325 in the commercial line side.

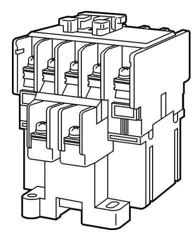
## [ 1.2 ] Connection example and criteria for selection of circuit breakers

Figure 6.2 shows a connection example for MCCB or ELCB (with overcurrent protection) in the inverter input circuit. Table 6.5 lists the rated current for the MCCB and corresponding inverter models. Table 6.6 lists the applicable grades of ELCB sensitivity.

| ⚠WARNING |
|---|
| Insert an MCCB or ELCB (with overcurrent protection) recommended for each inverter for its input circuits. Do not use an MCCB or ELCB of a higher rating than that recommended.<br>**Doing so could result in a fire.** |



Molded case circuit breaker/
earth leakage circuit breaker



Magnetic contactor

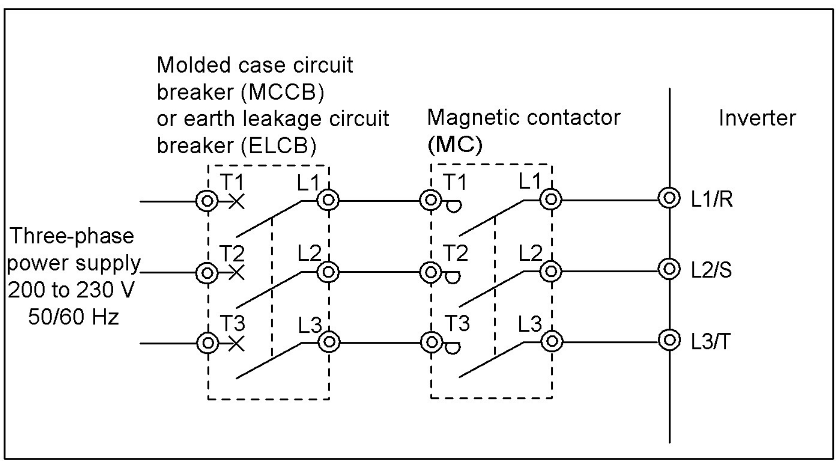



Figure 6.2 External Views of Molded Case Circuit Breaker/Earth Leakage Circuit Breaker, Magnetic Contactor and Connection Example

Table 6.5 Rated Current of Molded Case Circuit Breaker/Earth Leakage Circuit Breaker and Magnetic Contactor

<table>
<tr><th rowspan="3">Power supply voltage</th><th rowspan="3">Applicable motor rating (kW)</th><th rowspan="3">Inverter type</th><th colspan="2">MCCB, ELCB Rated current (A)<br>DC reactor (DCR)</th><th colspan="2">Magnetic contactor type MC1 (for input circuit)<br>DC reactor (DCR)</th><th rowspan="3">Magnetic contactor type MC2 (for output circuit)</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr></tr>
<tr><td rowspan="7">Three-phase 200 V</td><td>0.1</td><td>FRN0.1C1■-2□</td><td rowspan="4">5 (6)</td><td rowspan="3">5 (6)</td><td rowspan="7">SC-05</td><td rowspan="6">SC-05</td><td rowspan="7">SC-05</td></tr>
<tr><td>0.2</td><td>FRN0.2C1■-2□</td></tr>
<tr><td>0.4</td><td>FRN0.4C1■-2□</td></tr>
<tr><td>0.75</td><td>FRN0.75C1■-2□</td><td>10</td></tr>
<tr><td>1.5</td><td>FRN1.5C1■-2□</td><td rowspan="2">10</td><td>15 (16)</td></tr>
<tr><td>2.2</td><td>FRN2.2C1■-2□</td><td>20 (25)</td></tr>
<tr><td>3.7, 4.0</td><td>FRN3.7C1■-2□</td><td>20 (25)</td><td>30 (35)</td><td>SC-5-1</td></tr>
<tr><td rowspan="5">Three-phase 400 V</td><td>0.4</td><td>FRN0.4C1■-4□</td><td rowspan="4">5 (6)</td><td rowspan="2">5 (6)</td><td rowspan="5">SC-05</td><td rowspan="5">SC-05</td><td rowspan="5">SC-05</td></tr>
<tr><td>0.75</td><td>FRN0.75C1■-4□</td></tr>
<tr><td>1.5</td><td>FRN1.5C1■-4□</td><td>10</td></tr>
<tr><td>2.2</td><td>FRN2.2C1■-4□</td><td>15 (16)</td></tr>
<tr><td>3.7<br>4.0</td><td>FRN3.7C1■-4□<br>FRN4.0C1■-4□</td><td>10</td><td>20 (25)</td></tr>
<tr><td rowspan="6">Single-phase 200 V</td><td>0.1</td><td>FRN0.1C1■-7□</td><td rowspan="3">5 (6)</td><td rowspan="2">5 (6)</td><td rowspan="6">SC-05</td><td rowspan="5">SC-05</td><td rowspan="6">SC-05</td></tr>
<tr><td>0.2</td><td>FRN0.2C1■-7□</td></tr>
<tr><td>0.4</td><td>FRN0.4C1■-7□</td><td>10</td></tr>
<tr><td>0.75</td><td>FRN0.75C1■-7□</td><td>10</td><td>15 (16)</td></tr>
<tr><td>1.5</td><td>FRN1.5C1■-7□</td><td>15 (16)</td><td>20 (25)</td></tr>
<tr><td>2.2</td><td>FRN2.2C1■-7□</td><td>20 (25)</td><td>30 (35)</td><td>SC-5-1</td></tr>
</table>

- The above table lists the rated current of MCCBs and ELCBs to be used in the power control cabinet with an internal temperature of lower than 50°C. The rated current is factored by a correction coefficient of 0.85 as the MCCBs' and ELCBs' original rated current is specified when using them in an ambient temperature of 40°C or lower. Select an MCCB and/or ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the **600V HIV (allowable ambient temperature: 75°C)** wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or ELCB with the rated current listed in the above table. Do not use an MCCB or ELCB with a rating higher than that listed.

Notes: 1) A box (■) in the above table replace S or E depending on enclosure.
2) A box (□) in the above table replaces A, C, E, or J depending on shipping destination.
3) Values in parentheses ( ) in the above table denote rated currents for the European version.

Table 6.6 lists the relationship between the rated leakage current sensitivity of ELCBs (with overcurrent protection) and wiring length of the inverter output circuits. Note that the sensitivity levels listed in the table are estimated values based on the results obtained by the test setup in the Fuji laboratory where each inverter drives a single motor.

Table 6.6 Rated Current Sensitivity of Earth Leakage Circuit Breakers (ELCBs)

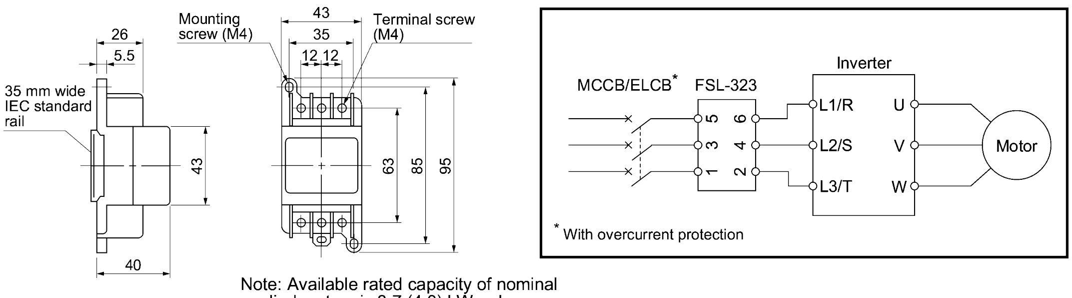
| Power supply voltage | Applicable motor rating (kW) | Rated current of applicable motor (A) | Wiring length and current sensitivity | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 10m | 30m | 50m | 100m | 200m | 300m |
| Three-phase 200 V | 0.1 | 0.68 | | | | | | |
| | 0.2 | 1.4 | | | | | | |
| | 0.4 | 2.3 | | | | | | |
| | 0.75 | 3.6 | | | | | | |
| | 1.5 | 6.5 | | 30mA | | 100mA | | 200mA |
| | 2.2 | 9.2 | | | | | | |
| | 3.7, 4.0 | 15 | | | | | | |
| | 5.5 | 22 | | | | | | |
| | 7.5 | 29 | | | | | | |
| Three-phase 400 V | 0.4 | 1.2 | | | | | | |
| | 0.75 | 1.8 | | | | | | |
| | 1.5 | 3.3 | | | | | | |
| | 2.2 | 4.6 | 30mA | | 100mA | | 200mA | 500mA |
| | 3.7, 4.0 | 7.5 | | | | | | |
| | 5.5 | 11 | | | | | | |
| | 7.5 | 14.5 | | | | | | |
| Single-phase 200 V | 0.1 | 0.68 | | | | | | |
| | 0.2 | 1.4 | | | | | | |
| | 0.4 | 2.3 | | | | | | |
| | 0.75 | 3.6 | | 30mA | | 100mA | | 200mA |
| | 1.5 | 6.5 | | | | | | |
| | 2.2 | 9.2 | | | | | | |

- Values listed above were obtained using Fuji ELCB EG or SG series applied to the test setup.
- The rated current of applicable motor rating indicates values for Fuji standard motor (4 poles, 50 Hz and 200 V 3-phase).
- The leakage current is calculated based on grounding of the single wire for 200V Δ type and the neutral wire for 400V Y type power lines.
- Values listed above are calculated based on the static capacitance to the earth when the 600V class of vinyl-insulated IV wires are used in a metal conduit laid directly on the earth.
- Wiring length is the total length of wiring between the inverter and motor. If more than one motor is to be connected to a single inverter, the wiring length should be the total length of wiring between the inverter and motors.

## [ 2 ] Surge killers

A surge killer eliminates surge currents induced by lightning and noise from the power supply lines. Use of a surge killer is effective in preventing the electronic equipment, including inverters, from damage or malfunctioning caused by such surges and/or noise.

The applicable model of surge killer is the FSL-323. Figure 6.3 shows its external dimensions and a connection example. Refer to the catalog "Fuji Noise Suppressors (SH310: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.




Note: Available rated capacity of nominal applied motors is 3.7 (4.0) kW or less.

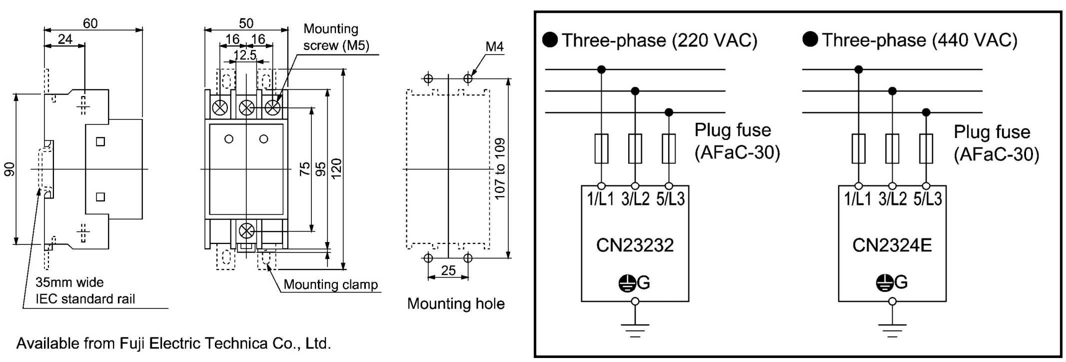
Available from Fuji Electric Technica Co., Ltd.

Figure 6.3 Dimensions of Surge Killer and Connection Example

## [ 3 ] Arresters

An arrester suppresses surge currents and noise invaded from the power supply lines. Use of an arrester is effective in preventing electronic equipment, including inverters, from damage or malfunctioning caused by such surges and/or noise.

Applicable arrester models are the CN23232 and CN2324E. Figure 6.4 shows their external dimensions and connection examples. Refer to the catalog "Fuji Noise Suppressors (SH310: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.




Available from Fuji Electric Technica Co., Ltd.

Figure 6.4 Arrester Dimensions and Connection Examples

## [ 4 ]  Surge absorbers

A surge absorber suppresses surge currents and noise from the power lines to ensure effective protection of your power system from the malfunctioning of the magnetic contactors, mini-control relays and timers.

Applicable surge absorber models are the S2-A-O and S1-B-O. Figure 6.5 shows their external dimensions. Refer to the catalog "Fuji Noise Suppressors (SH310: Japanese edition only)" for details. The surge absorbers are available from Fuji Electric Technica Co., Ltd.

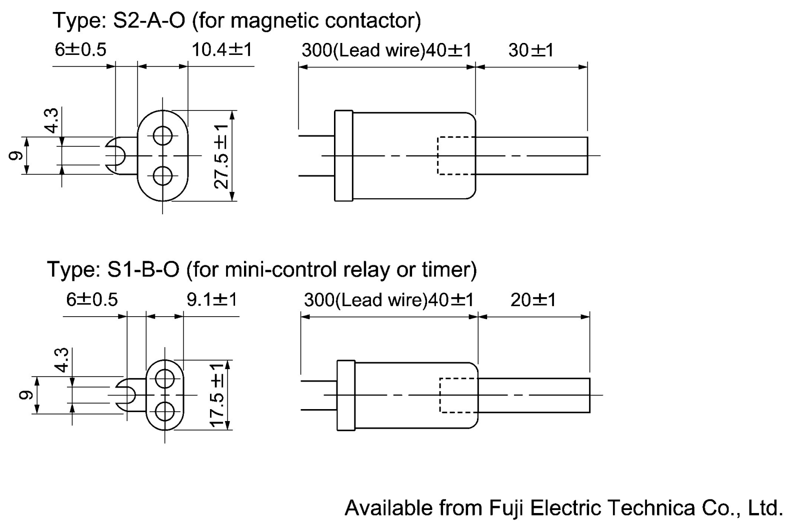



Figure 6.5  Surge Absorber Dimensions

# 6.4 Selecting Options

## 6.4.1 Peripheral equipment options

### [ 1 ] Braking resistors

A braking resistor converts regenerative energy generated from deceleration of the motor and converts it to heat for consumption. Use of a braking resistor results in improved deceleration performance of the inverter.

Refer to Chapter 7, Section 7.2 "Selecting a Braking Resistor."

#### [ 1.1 ] Standard model

The standard model of a braking resistor integrates a facility that detects the temperature on the heat sink of the resistor and outputs a digital ON/OFF signal if the temperature exceeds the specified level (as an overheating warning signal). To ensure that the signal is recognized at one of the digital input terminals of the FRENIC-Mini, assign the external alarm (THR) to any of terminals [X1] to [X3], [FWD] and [REV]. Connect the assigned terminal to terminal [1] of the braking resistor. Upon detection of the warning signal (preset detection level: 150°C), the inverter simultaneously transfers to Alarm mode, displays alarm *0H2* on the LED monitor and shuts down its power output.

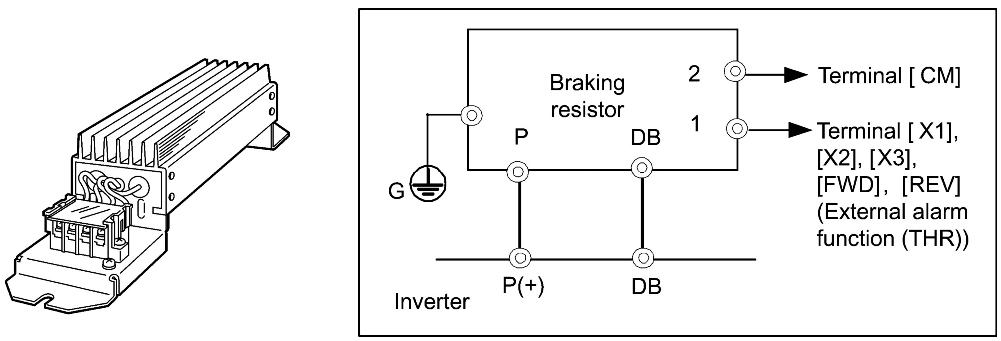



Figure 6.6 Braking Resistor (Standard Model) and Connection Example

Table 6.7 Braking Resistor (Standard Model)

| Power supply voltage | Inverter type | Option: Braking resistor: Type | Q'ty | Resistance (Ω) | Max. braking torque (%) | 50 Hz (N·m) | 60 Hz (N·m) | Continuous braking (100% torque conversion value): Discharging capability (kWs) | Braking time (s) | Repetitive braking (100 sec or less cycle): Average loss (kW) | Duty cycle (%ED) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Three-phase 200 V | FRN0.4C1■-2□ | DB0.75-2 | 1 | 100 | 150 | 4.02 | 3.32 | 9 | 45 | 0.044 | 22 |
| | FRN0.75C1■-2□ | | | | | 7.57 | 6.25 | 17 | | 0.068 | 18 |
| | FRN1.5C1■-2□ | DB2.2-2 | 1 | 40 | | 15.0 | 12.4 | 34 | | 0.075 | 10 |
| | FRN2.2C1■-2□ | | | | | 22.0 | 18.2 | 33 | 30 | 0.077 | 7 |
| | FRN3.7C1■-2□ | DB3.7-2 | 1 | 33 | | 37.1 | 30.5 | 37 | 20 | 0.093 | 5 |
| Three-phase 400 V | FRN0.4C1■-4□ | DB0.75-4 | 1 | 200 | 150 | 4.02 | 3.32 | 9 | 45 | 0.044 | 22 |
| | FRN0.75C1■-4□ | | | | | 7.57 | 6.25 | 17 | | 0.068 | 18 |
| | FRN1.5C1■-4□ | DB2.2-4 | 1 | 160 | | 15.0 | 12.4 | 34 | | 0.075 | 10 |
| | FRN2.2C1■-4□ | | | | | 22.0 | 18.2 | 33 | 30 | 0.077 | 7 |
| | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | DB3.7-4 | 1 | 130 | | 37.1 | 30.5 | 37 | 20 | 0.093 | 5 |
| Single-phase 200 V | FRN0.4C1■-7□ | DB0.75-2 | 1 | 100 | 150 | 4.02 | 3.32 | 9 | 45 | 0.044 | 22 |
| | FRN0.75C1■-7□ | | | | | 7.57 | 6.25 | 17 | | 0.068 | 18 |
| | FRN1.5C1■-7□ | DB2.2-2 | 1 | 40 | | 15.0 | 12.4 | 34 | | 0.075 | 10 |
| | FRN2.2C1■-7□ | | | | | 22.0 | 18.2 | 33 | 30 | 0.077 | 7 |

Notes: 1) A box (■) in the above table replaces S or E depending on enclosure.

2) A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

## [ 1.2 ] 10%ED model

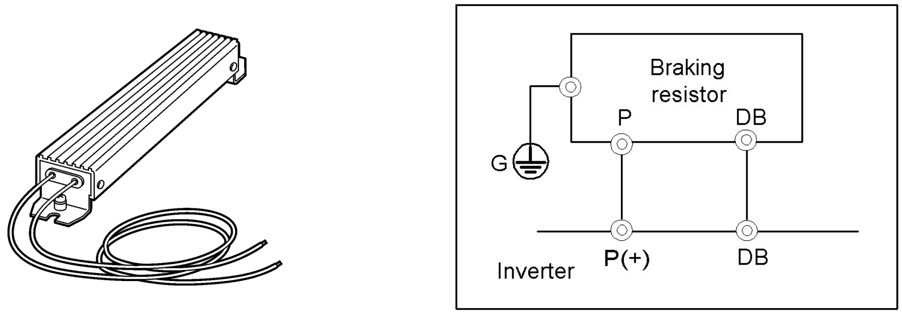



Figure 6.7 Braking Resistor (10 %ED Model) and Connection Example

Table 6.8 Braking Resistor (10 %ED Model)

| Power supply voltage | Inverter type | Option: Braking resistor Type | Q'ty | Resistance (Ω) | Max. braking torque (%) | 50 Hz (N·m) | 60 Hz (N·m) | Continuous braking (100% torque conversion value): Discharging capability (kWs) | Braking time (s) | Repetitive braking (100 sec or less cycle): Average loss (kW) | Duty cycle (%ED) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Three-phase 200 V | FRN0.4C1■-2□ | DB0.75-2C | 1 | 100 | 150 | 4.02 | 3.32 | 9 | 45 | 0.02 | 10 |
| | FRN0.75C1■-2□ | | | | | 7.57 | 6.25 | 17 | | 0.0375 | |
| | FRN1.5C1■-2□ | DB2.2-2C | 1 | 40 | | 15.0 | 12.4 | 34 | | 0.075 | |
| | FRN2.2C1■-2□ | | | | | 22.0 | 18.2 | 33 | 30 | 0.11 | |
| | FRN3.7C1■-2□ | DB3.7-2C | 1 | 33 | | 37.1 | 30.5 | 37 | 20 | 0.185 | |
| Three-phase 400 V | FRN0.4C1■-4□ | DB0.75-4C | 1 | 200 | 150 | 4.02 | 3.32 | 9 | 45 | 0.02 | 10 |
| | FRN0.75C1■-4□ | | | | | 7.57 | 6.25 | 17 | | 0.0375 | |
| | FRN1.5C1■-4□ | DB2.2-4C | 1 | 160 | | 15.0 | 12.4 | 34 | | 0.075 | |
| | FRN2.2C1■-4□ | | | | | 22.0 | 18.2 | 33 | 30 | 0.11 | |
| | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | DB3.7-4C | 1 | 130 | | 37.1 | 30.5 | 37 | 20 | 0.185 | |
| Single-phase 200 V | FRN0.4C1■-7□ | DB0.75-2C | 1 | 100 | 150 | 4.02 | 3.32 | 9 | 45 | 0.02 | 10 |
| | FRN0.75C1■-7□ | | | | | 7.57 | 6.25 | 17 | | 0.0375 | |
| | FRN1.5C1■-7□ | DB2.2-2C | 1 | 40 | | 15.0 | 12.4 | 34 | | 0.075 | |
| | FRN2.2C1■-7□ | | | | | 22.0 | 18.2 | 33 | 30 | 0.11 | |

Notes: 1) A box (■) in the above table replaces S or E depending on enclosure.
2) A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

The 10 %ED braking resistor does not support overheating detection or warning output, so an electronic thermal overload relay needs to be set up using function codes F50 and F51 to protect the braking resistor from overheating.

## [ 1.3 ] Compact model

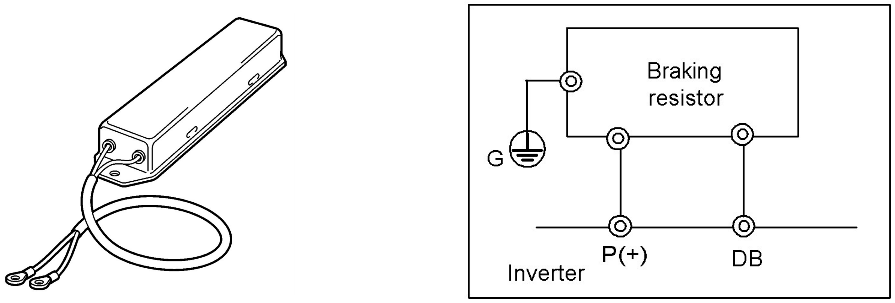



Figure 6.8 Braking Resistor (Compact Model) and Connection Example

Table 6.9 Braking Resistor (Compact Model)

| Power supply voltage | Item | | Model: TK80W120Ω | | | | |
|---|---|---|---|---|---|---|---|
| 200 V class | Resistor | Capacity (kW) | 0.08 | | | | |
| | | Resistance (Ω) | 120 | | | | |
| | Applicable inverter model | | FRN0.4 C1■-2□ | FRN0.75 C1■-2□ | FRN1.5 C1■-2□ | FRN2.2 C1■-2□ | FRN3.7 C1■-2□ |
| | Applicable motor output (kW) | | 0.4 | 0.75 | 1.5 | 2.2 | 3.7, 4.0 |
| | Average braking torque (%) | | 150 | 150 | 150 | 100 | 100 |
| | Allowable braking properties | Allowable duty cycle (%) | 15 | 5 | 5 | 5 | 5 |
| | | Allowable continuous braking time | 15 sec | 15 sec | 10 sec | 10 sec | 10 sec |
| | Braking unit | | Not required | | | | |

Notes: 1) A box (■) in the above table replaces S or E depending on enclosure.
2) A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

Note: This braking resistor is not suitable for use with the 400V class of inverters.

## [ 2 ] DC reactors (DCRs)

A DCR is mainly used for power supply normalization and for supplied power factor improvement (for reducing harmonic components).

### ■ For power supply normalization

- Use a DCR when the capacity of a power supply transformer exceeds 500 kVA and is 10 times or more the rated inverter capacity. In this case, the percentage-reactance of the power source decreases, and harmonic components and their peak levels increase. These factors may break rectifiers or capacitors in the converter section of inverter, or decrease the capacitance of the capacitor (which can shorten the inverter's service life).
- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.
- Use a DCR when the interphase voltage unbalance ratio of the inverter power source exceeds 2%.

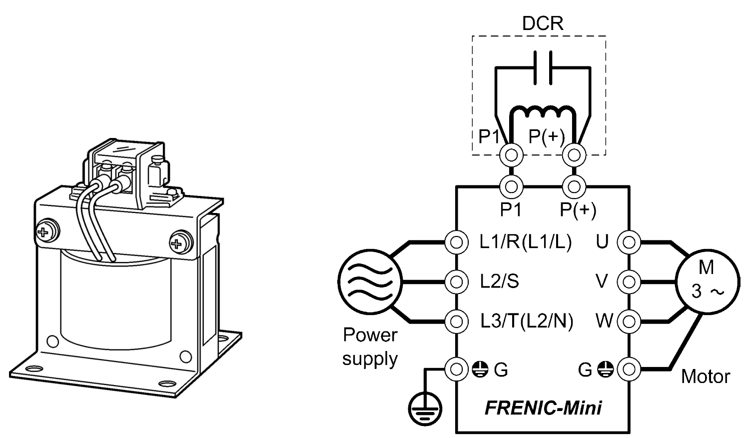
$$\text{Interphase voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{3 - phase average voltage (V)}} \times 67$$

### ■ For supplied power factor improvement (for suppressing harmonics)

Generally a capacitor is used to improve the power factor of the load, however, it cannot be used in a system that includes an inverter. Using a DCR increases the reactance of inverter's power source so as to decrease harmonic components on the power source lines and improve the power factor of inverter. Using a DCR improves the input power factor to approximately 95%.

Note

- At the time of shipping, a short bar is connected across terminals P1 and P (+) on the terminal block. Remove the jumper bar when connecting a DCR.
- If a DCR is not going to be used, do not remove the jumper bar.




For three-phase 200 V/400 V or single-phase 200 V

Figure 6.9 External View of a DC Reactor (DCR) and Connection Example

Table 6.10 DC Reactors (DCRs)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | DC reactor (DCR) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Type | Rated current (A) | Inductance (mH) | Coil resistance (mΩ) | Generated loss (W) |
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | DCR2-0.2 | 1.5 | 20 | 660 | 0.8 |
| | 0.2 | FRN0.2C1■-2□ | | | | | 1.6 |
| | 0.4 | FRN0.4C1■-2□ | DCR2-0.4 | 3.0 | 12 | 280 | 1.9 |
| | 0.75 | FRN0.75C1■-2□ | DCR2-0.75 | 5.0 | 7.0 | 123 | 2.8 |
| | 1.5 | FRN1.5C1■-2□ | DCR2-1.5 | 8.0 | 4.0 | 57.5 | 4.6 |
| | 2.2 | FRN2.2C1■-2□ | DCR2-2.2 | 11 | 3.0 | 43 | 6.7 |
| | 3.7, 4.0 | FRN3.7C1■-2□ | DCR2-3.7 | 18 | 1.7 | 21 | 8.8 |
| Three-phase 400 V | 0.4 | FRN0.4C1■-4□ | DCR4-0.4 | 1.5 | 50 | 970 | 2.0 |
| | 0.75 | FRN0.75C1■-4□ | DCR4-0.75 | 2.5 | 30 | 440 | 2.5 |
| | 1.5 | FRN1.5C1■-4□ | DCR4-1.5 | 4.0 | 16 | 235 | 4.8 |
| | 2.2 | FRN2.2C1■-4□ | DCR4-2.2 | 5.5 | 12 | 172 | 6.8 |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | DCR4-3.7 | 9.0 | 7.0 | 74.5 | 8.1 |
| Single-phase 200 V | 0.1 | FRN0.1C1■-7□ | DCR2-0.2 | 1.5 | 20 | 660 | 1.6 |
| | 0.2 | FRN0.2C1■-7□ | DCR2-0.4 | 3.0 | 12 | 280 | 1.9 |
| | 0.4 | FRN0.4C1■-7□ | DCR2-0.75 | 5.0 | 7.0 | 123 | 2.8 |
| | 0.75 | FRN0.75C1■-7□ | DCR2-1.5 | 8.0 | 4.0 | 57.5 | 4.6 |
| | 1.5 | FRN1.5C1■-7□ | DCR2-3.7 | 18 | 1.7 | 21 | 8.8 |
| | 2.2 | FRN2.2C1■-7□ | | | | | |

Note 1: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power source is 3-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power source capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Note 2: A box (■) in the above table replaces S or E depending on enclosure.

Note 3: A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

## [ 3 ] AC reactors (ACRs)

Use an ACR when the converter part of the inverter should supply very stable DC power, for example, in DC link bus operation (shared PN operation). Generally, ACRs are used for correction of voltage waveform and power factor or for power supply normalization, but not for suppressing harmonic components in the power lines. For suppressing harmonic components, use a DCR.

An ACR should be also used when the power source is extremely unstable; for example, when the power source involves an extremely large interphase voltage unbalance.

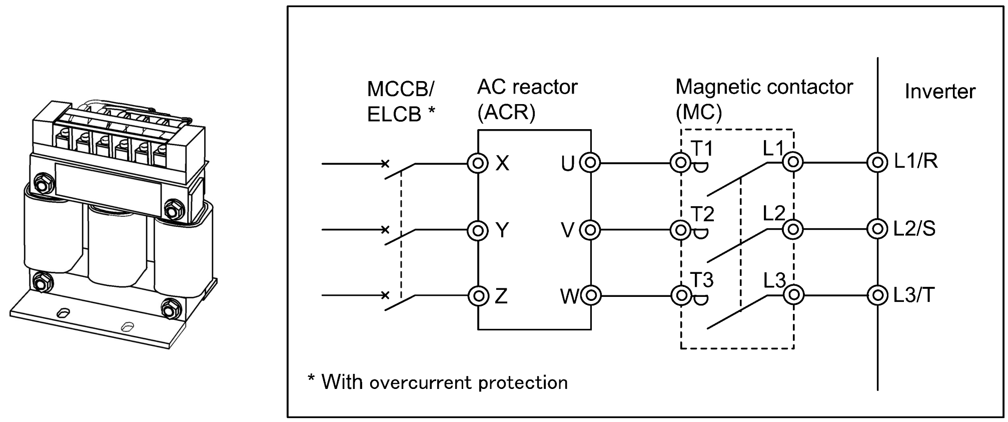



Figure 6.10 External View of AC Reactor (ACR) and Connection Example

Table 6.11 AC Reactor (ACR)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | AC reactor (ACR) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Type | Rated current (A) | Reactance (mΩ/phase) 50 Hz | Reactance (mΩ/phase) 60 Hz | Generated loss (W) |
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | ACR2-0.4A | 3 | 917 | 1100 | 2.5 |
| | 0.2 | FRN0.2C1■-2□ | | | | | 5 |
| | 0.4 | FRN0.4C1■-2□ | | | | | 10 |
| | 0.75 | FRN0.75C1■-2□ | ACR2-0.75A | 5 | 493 | 592 | 12 |
| | 1.5 | FRN1.5C1■-2□ | ACR2-1.5A | 8 | 295 | 354 | 14 |
| | 2.2 | FRN2.2C1■-2□ | ACR2-2.2A | 11 | 213 | 256 | 16 |
| | 3.7, 4.0 | FRN3.7C1■-2□ | ACR2-3.7A | 17 | 218 | 153 | 23 |
| Three-phase 400 V | 0.4 | FRN0.4C1■-4□ | ACR4-0.75A | 2.5 | 1920 | 2300 | 5 |
| | 0.75 | FRN0.75C1■-4□ | | | | | 10 |
| | 1.5 | FRN1.5C1■-4□ | ACR4-1.5A | 3.7 | 1160 | 1390 | 11 |
| | 2.2 | FRN2.2C1■-4□ | ACR4-2.2A | 5.5 | 851 | 1020 | 14 |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | ACR4-3.7A | 9 | 512 | 615 | 17 |
| Single-phase 200 V | 0.1 | FRN0.1C1■-7□ | ACR2-0.4A | 3 | 917 | 1100 | 5 |
| | 0.2 | FRN0.2C1■-7□ | | | | | 10 |
| | 0.4 | FRN0.4C1■-7□ | ACR2-0.75A | 5 | 493 | 592 | 12 |
| | 0.75 | FRN0.75C1■-7□ | ACR2-1.5A | 8 | 295 | 354 | 14 |
| | 1.5 | FRN1.5C1■-7□ | ACR2-2.2A | 11 | 213 | 256 | 16 |
| | 2.2 | FRN2.2C1■-7□ | ACR2-3.7A | 17 | 218 | 262 | 23 |

Note 1: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:
- The power source is 3-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power source capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

Note 2: A box (■) in the above table replaces S or E depending on enclosure.

Note 3: A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

## [ 4 ] Output circuit filters (OFLs)

Insert an OFL in the inverter power output circuit to:

- Suppress the voltage fluctuation at the motor power terminals
  This protects the motor from insulation damage caused by the application of high voltage surge currents from the 400 V class of inverters.
- Suppress leakage current (due to higher harmonic components) from the inverter output lines
  This reduces the leakage current when the motor is connected by long power feed lines. Keep the length of the power feed line less than 400 m.
- Minimize radiation and/or induction noise issued from the inverter output lines
  OFLs are effective noise suppression device for long wiring applications such as that used at plants.

Note: Use an ACR within the allowable carrier frequency range specified by function code F26. Otherwise, the filter will overheat.

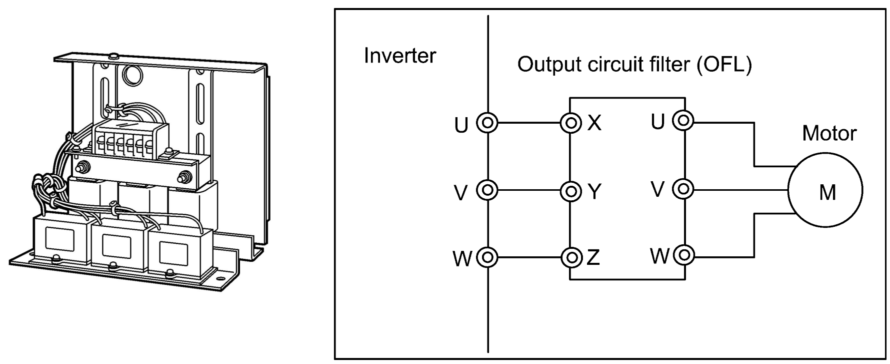



Figure 6.11 External View of Output Circuit Filter (OFL) and Connection Example

Table 6.12 Output Circuit Filter (OFL)

| Power supply voltage | Applicable motor rating (kW) | Inverter type | Filter type | Rated current (A) | Overload capability | Inverter power input voltage | Carrier frequency - allowable range (kHz) | Maximum frequency (Hz) |
|---|---|---|---|---|---|---|---|---|
| Three-phase 200 V | 0.1 | FRN0.1C1■-2□ | OFL-0.4-2 | 3 | 150 % for 1 min. 200 % for 0.5 sec | Three-phase 200 to 240 V 50/60 Hz | 8 to 15 | 400 |
| | 0.2 | FRN0.2C1■-2□ | | | | | | |
| | 0.4 | FRN0.4C1■-2□ | | | | | | |
| | 0.75 | FRN0.75C1■-2□ | OFL-1.5-2 | 8 | | | | |
| | 1.5 | FRN1.5C1■-2□ | | | | | | |
| | 2.2 | FRN2.2C1■-2□ | OFL-3.7-2 | 17 | | | | |
| | 3.7, 4.0 | FRN3.7C1■-2□ | | | | | | |
| Three-phase 400 V | 0.4 | FRN0.4C1■-4□ | OFL-0.4-4A | 1.5 | 150% for 1min. 200 % for 0.5 sec | Three-phase 380 to 480 V 50/60 Hz | 0.75 to 15 | 400 |
| | 0.75 | FRN0.75C1■-4□ | OFL-1.5-4A | 3.7 | | | | |
| | 1.5 | FRN1.5C1■-4□ | | | | | | |
| | 2.2 | FRN2.2C1■-4□ | OFL-3.7-4A | 9 | | | | |
| | 3.7<br>4.0 | FRN3.7C1■-4□<br>FRN4.0C1■-4□ | | | | | | |

Note 1: The OFL-***-4A models have no restrictions on carrier frequency.

Note 2: A box (■) in the above table replaces S or E depending on enclosure.

Note 3: A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

## [ 5 ] Ferrite ring reactors for reducing radio noise (ACL)

An ACL is used to reduce radio frequency noise emitted by the inverter.

An ACL suppresses the outflow of high frequency harmonics caused by switching operation for the power supply lines inside the inverter. Pass the power supply lines together through the ACL.

If wiring length between the inverter and motor is less than 20 m, insert an ACL to the power supply lines; if it is more than 20 m, insert it to the power output lines of the inverter.

Wire size is determined depending upon the ACL size (I.D.) and installation requirements.

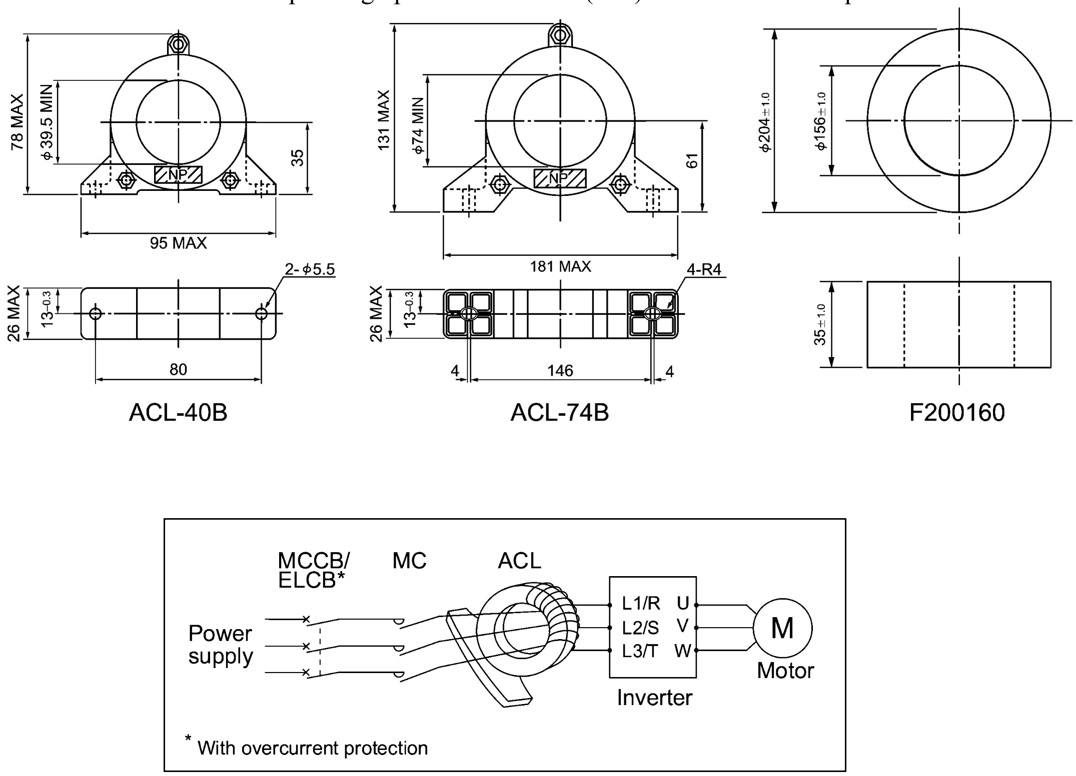



Figure 6.12 Dimensions of Ferrite Ring for Reducing Radio Noise (ACL) and Connection Example

Table 6.13 Ferrite Ring for Reducing Radio Noise (ACL)

| Ferrite ring type | Installation requirements | | Wire size ($mm^2$) |
|---|---|---|---|
| | Q'ty | Number of turns | |
| ACL-40B | 1 | 4 | 2.0 |
| | | | 3.5 |
| | | | 5.5 |
| | 2 | 2 | 8 |
| | | | 14 |
| ACL-74B | 1 | 4 | 8 |
| | | | 14 |
| | 2 | 2 | 22 |
| | | | 38 |
| | | | 60 |
| | 4 | 1 | 100 |
| | | | 150 |
| | | | 200 |
| | | | 250 |
| | | | 325 |

The selected wires are for use with 3-phase input/output lines (3 wires).

## [ 6 ] Options for 100 V single-phase power supply

An optional 100 V single-phase power supply may be used to operate an inverter designed for a 200 V 3-phase power supply with 100 V single-phase power. Select an option with correct capacity according to the specifications listed in Table 6.14.

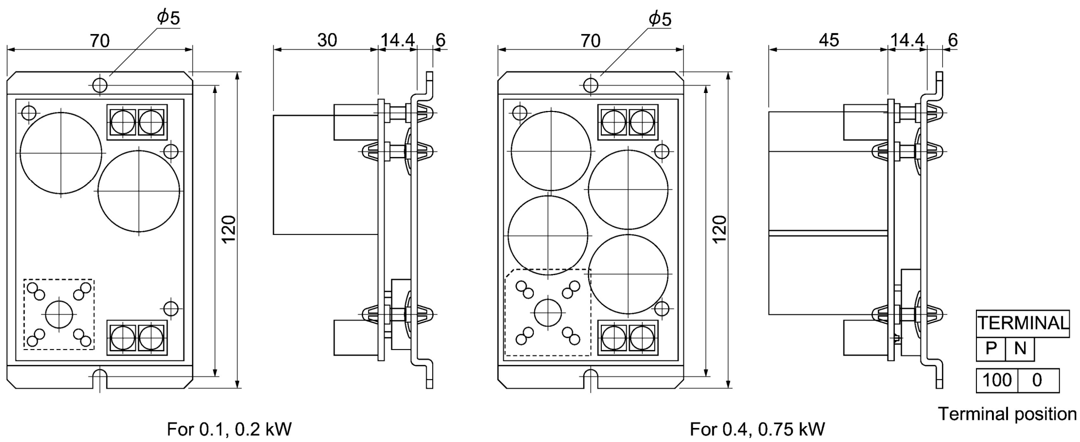



Figure 6.13 Optional Single-Phase 100 V Input Dimensions

Table 6.14 Optional Single-Phase 100 V Input

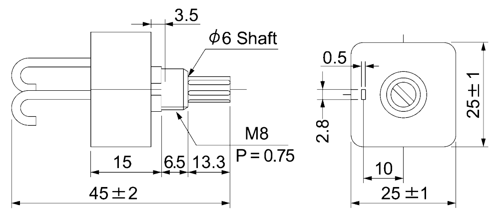
| Type | CAPA6-0.2 | CAPA6-0.4 | CAPA6-0.75 |
|---|---|---|---|
| Applicable inverter capacity (kW) | 0.1, and 0.2 | 0.4 | 0.75 |
| Rated capacity (kVA) | 0.5 | 1.1 | 1.8 |

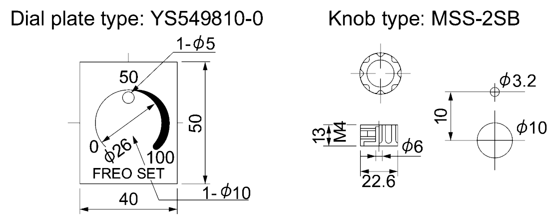
## 6.4.2 Options for operation and communications

### [ 1 ] External potentiometer for frequency setting

An external potentiometer may be used to set the drive frequency. Connect the potentiometer to control signal terminals [11] to [13] of the inverter as shown in Figure 6.14.

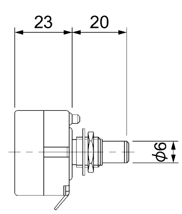
**Model: RJ-13 (BA-2 B-characteristics, 1 kΩ)**

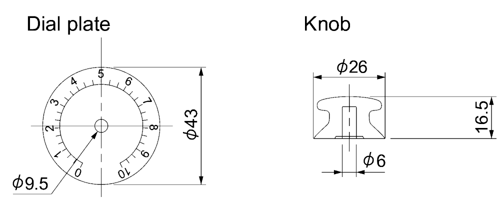



Note: The dial plate and knob must be ordered as separated items.
Available from Fuji Electric Technica Co., Ltd.

**Model: WAR3W (3W B-characteristics, 1 kΩ)**




Note: The dial plate and knob are supplied together with the external potentiometer WAR3W.
Available from Fuji Electric Technica Co., Ltd.

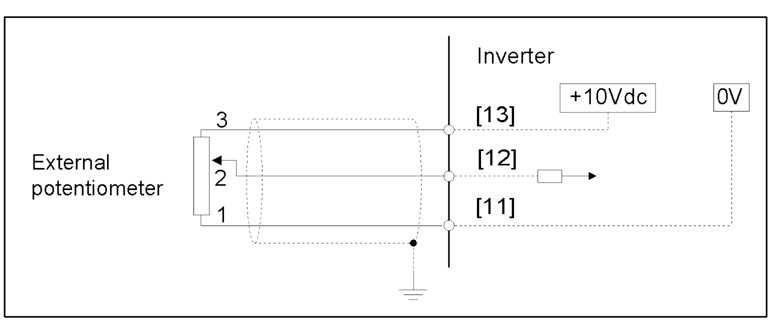



Figure 6.14 External Potentiometer Dimensions and Connection Example

## [ 2 ] RS485 communications card "OPC-C1-RS"

The RS485 communications card is designed exclusively for use with the FRENIC-Mini series of inverter and enables data to be sent to or received from other equipment.

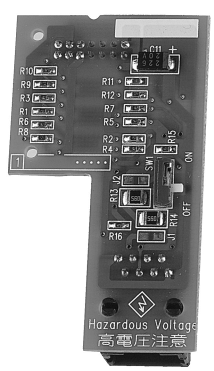
The RS485 communications facility also enables remote operation of the inverters using the remote keypad and host controllers such as Windows-based personal computers and PLCs (Programmable Logic Controllers), as follows:

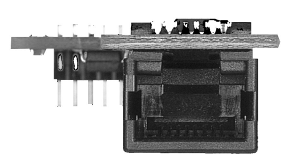
- Operating the inverters: setting the frequency, forward/reverse running, stopping, coast-to-stop and resetting, etc.
- Monitoring the operation status of the inverter: output frequency, output current and alarm information, etc.
- Setting function code data.

Table 6.15 Transmission Specifications

| Item | Specifications | | |
|---|---|---|---|
| Communication protocol | SX protocol (for exclusive use with the support loader software) | Modbus RTU (Conforming to Modicon's Modbus RTU) | Fuji general-purpose inverter protocol |
| Electrical specifications | EIA RS-485 | | |
| Number of units connected | Host: 1 unit, Inverter: 31 units | | |
| Transmission speed | 19200, 9600, 4800 and 2400 bps | | |
| Synchronization system | Synchronous start-stop | | |
| Transmission method | Half-duplex | | |





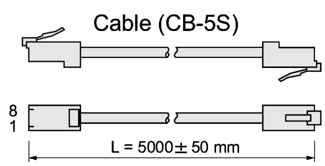
## [ 3 ] Remote keypad "TP-E1"

The keypad permits remote control of FRENIC-Mini, and function setting and display (with copy function).

## [ 4 ] Extension cable for remote operation

The extension cable connects the inverter with the remote keypad to enable remote operation of the inverter. The cable is a straight-wired type with RJ-45 jacks and its length is selectable from 5, 3, and 1 m.

| Type | Length (m) |
|---|---|
| CB-5S | 5 |
| CB-3S | 3 |
| CB-1S | 1 |




## [ 5 ] Copy adapter "CPAD-C1A"

The copy adapter can be easily connected to an inverter, and is used to copy data to multiple inverters.

## [ 6 ] Inverter support loader software

FRENIC Loader is support software which enables the inverter to be operated via the RS485 communications facility. The main functions include the following:

- Easy editing of function code data
- Monitoring the operation statuses of the inverter such as I/O monitor and multi-monitor
- Operation of inverters on a PC screen (Windows-based only)

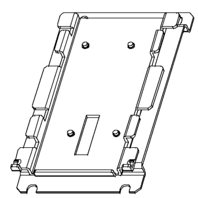
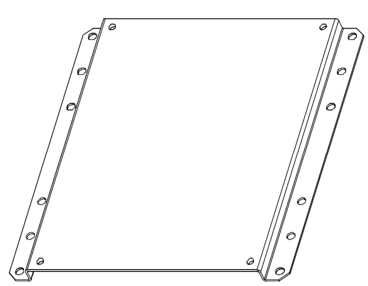
📖 Refer to Chapter 5 "RUNNING THOUGH RS485 COMMUNICATION (OPTION)" for details.

## 6.4.3 Extended installation kit options

### [ 1 ] Mounting adapters

FRENIC-Mini series of inverters can be installed in the control board of your system using mounting adapters which utilize the mounting holes used for conventional inverters (FVR-E11S series of 0.75 kW or below or 3.7 (4.0) kW). The FVR-E11S-2/4 (1.5 kW/2.2 kW) and FVR-E11S-7 (0.75 kW/1.5 kW) models may be replaced with the FRENIC-Mini series inverters without the use of adapters.

Table 6.16 Mounting Adapters

| Option model | Applicable inverter model | |
|---|---|---|
| | FRENIC-Mini | FVR-E11S |
| MA-C1-0.75  | FRN0.1C1S-2☐** | FVR0.1E11S-2☐ |
| | FRN0.2C1S-2☐** | FVR0.2E11S-2☐ |
| | FRN0.4C1S-2☐** | FVR0.4E11S-2☐ |
| | FRN0.75C1S-2☐** | FVR0.75E11S-2☐ |
| | FRN0.1C1S-7☐ | FVR0.1E11S-7☐ |
| | FRN0.2C1S-7☐ | FVR0.2E11S-7☐ |
| | FRN0.4C1S-7☐ | FVR0.4E11S-7☐ |
| | FRN0.75C1S-7☐ | |
| | FRN0.1C1E-2☐ | FVR0.1E11S-2☐ |
| | FRN0.2C1E-2☐ | FVR0.2E11S-2☐ |
| | FRN0.4C1E-2☐ | FVR0.4E11S-2☐ |
| | FRN0.75C1E-2☐ | FVR0.75E11S-2☐ |
| | FRN0.1C1E-7☐ | FVR0.1E11S-7☐ |
| | FRN0.2C1E-7☐ | FVR0.2E11S-7☐ |
| | FRN0.4C1E-7☐ | FVR0.4E11S-7☐ |
| MA-C1-3.7  | FRN3.7C1S-2☐** | FVR3.7E11S-2☐ |
| | FRN3.7C1S-4☐** | FVR3.7E11S-4☐ |
| | FRN4.0C1S-4☐** | FVR4.0E11S-4☐ |
| | FRN2.2C1S-7☐ | FVR2.2E11S-7☐ |

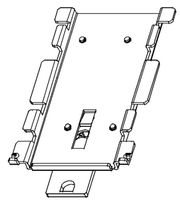
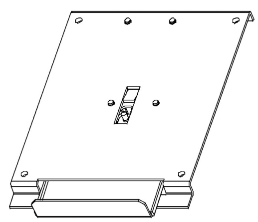
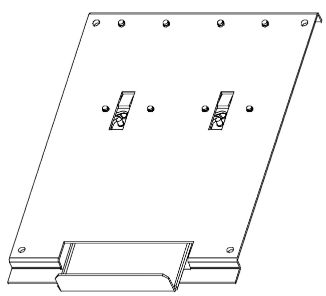
Note 1: Asterisks (**) in the model names replace numbers which denote the following:
21: braking resistor built-in type; No number: standard type
The built-in braking resistor models are available for inverters of 1.5 kW or higher.

Note 2: A box (☐) in the above table replaces A, C, E, or J depending on shipping destination.

## [ 2 ]  Rail mounting bases

A rail mounting base allows any of the FRENIC-Mini series of inverter to be mounted on a DIN rail (35 mm wide).

Table 6.17  Rail Mounting Base

| Option model | Applicable inverter type |
|---|---|
| RMA-C1-0.75<br> | FRN0.1C1S-2□**<br>FRN0.2C1S-2□**<br>FRN0.4C1S-2□**<br>FRN0.75C1S-2□** |
| | FRN0.1C1S-7□<br>FRN0.2C1S-7□<br>FRN0.4C1S-7□<br>FRN0.75C1S-7□ |
| | FRN0.1C1E-2□<br>FRN0.2C1E-2□<br>FRN0.4C1E-2□<br>FRN0.75C1E-2□ |
| | FRN0.1C1E-7□<br>FRN0.2C1E-7□<br>FRN0.4C1E-7□ |
| RMA-C1-2.2<br> | FRN1.5C1S-2□**<br>FRN2.2C1S-2□** |
| | FRN0.4C1S-4□**<br>FRN0.75C1S-4□**<br>FRN1.5C1S-4□**<br>FRN2.2C1S-4□** |
| | FRN1.5C1S-7□ |
| | FRN0.4C1E-4□<br>FRN0.75C1E-4□ |
| | FRN0.75C1E-7□ |
| RMA-C1-3.7<br> | FRN3.7C1S-2□** |
| | FRN3.7C1S-4□**<br>FRN4.0C1S-4□** |
| | FRN2.2C1S-7□ |
| | FRN1.5C1E-2□<br>FRN2.2C1E-2□<br>FRN3.7C1E-2□ |
| | FRN1.5C1E-4□<br>FRN2.2C1E-4□<br>FRN3.7C1E-4□<br>FRN4.0C1E-4□ |
| | FRN1.5C1E-7□<br>FRN2.2C1E-7□ |

Note 1: Asterisks (**) in the model names replace numbers which denote the following:
21: braking resistor built-in type; No number: standard type
The built-in braking resistor models are available for inverters of 1.5 kW or higher.

Note 2: A box (□) in the above table replaces A, C, E, or J depending on shipping destination.

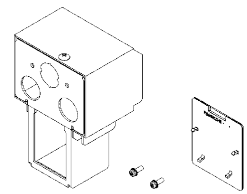
## [ 3 ] NEMA1 kit

NEMA1 kit, when fitted to the FRENIC-Mini series, protects the inverter body with the structure that conforms to the NEMA1 standard (approved as UL TYPE1).

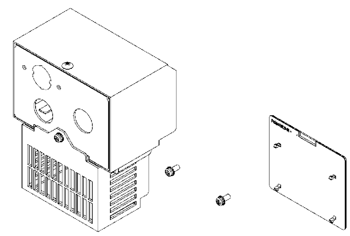
Table 6.18 NEMA1 Kit

| Power supply voltage | Applicable Inverter type | Option type | MODEL |
|---|---|---|---|
| Three-phase 200 V | FRN0.1C1S-2A** | NEMA1-0.2C1-2 | A |
| | FRN0.2C1S-2A** | | |
| | FRN0.4C1S-2A** | NEMA1-0.4C1-2 | |
| | FRN0.75C1S-2A** | NEMA1-0.75C1-2 | |
| | FRN1.5C1S-2A** | NEMA1-2.2C1-2 | B |
| | FRN2.2C1S-2A** | | |
| | FRN3.7C1S-2A** | NEMA1-3.7C1-2 | C |
| Three-phase 400 V | FRN0.4C1S-4A** | NEMA1-0.4C1-4 | A |
| | FRN0.75C1S-4A** | NEMA1-0.75C1-4 | |
| | FRN1.5C1S-4A** | NEMA1-2.2C1-2 | B |
| | FRN2.2C1S-4A** | | |
| | FRN3.7C1S-4A** | NEMA1-3.7C1-2 | C |
| Single-phase 200 V | FRN0.1C1S-7A | NEMA1-0.2C1-2 | A |
| | FRN0.2C1S-7A | | |
| | FRN0.4C1S-7A | NEMA1-0.4C1-2 | |
| | FRN0.75C1S-7A | NEMA1-0.75C1-7 | |
| | FRN1.5C1S-7A | NEMA1-1.5C1-7 | B |
| | FRN2.2C1S-7A | NEMA1-3.7C1-2 | C |

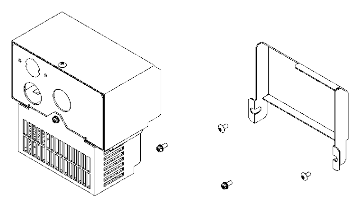
Note: For the inverter type FRN_ _ _C1S-_A**, the symbols ** are replaced with any of the following numeral codes:
21 (Braking resistor built-in type), None (Standard type)
The braking resistor built-in type is limited to the inverters for 1.5 kW or larger.



MODEL A



MODEL B



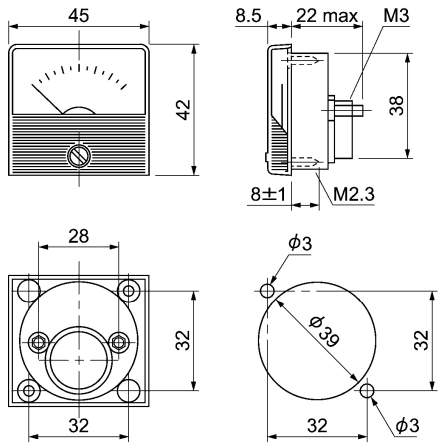
MODEL C

## 6.4.4 Meter options

### [ 1 ] Frequency meters

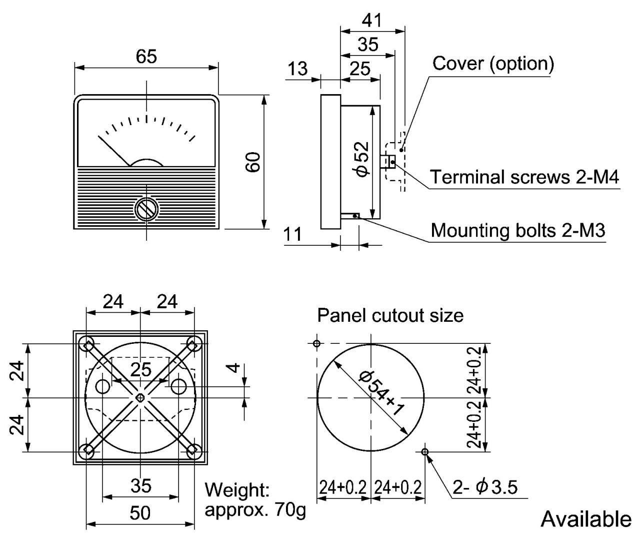
Connect a frequency meter to analog signal output terminals [FMA] (+) and [11] (-) of the inverter to measure the frequency component selected by function code F31. Figure 6.15 shows the dimensions of the frequency meter and a connection example.

**Model: TRM-45 (10 VDC, 1 mA)**




Available from Fuji Electric Technica Co., Ltd.

**Model: FM-60 (10 VDC, 1 mA)**




Available from Fuji Electric Technica Co., Ltd.

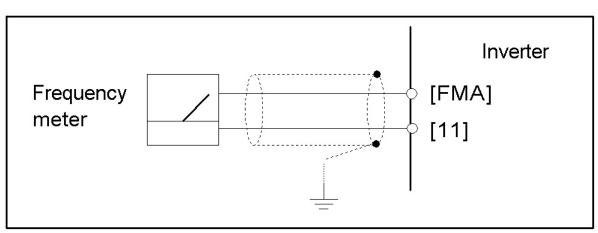



Figure 6.15 Frequency Meter Dimensions and Connection Example