YASKAWA

YASKAWA AC Drive CR700

For Cranes

Quick Start Guide

Type: CIPR-CR70Cxxxxxxxx
Models: 200 V Class, Three-Phase Input: 0.4 to 110 kW
400 V Class, Three-Phase Input: 0.4 to 315 kW

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Table of Contents

1 General Information

Do not use this manual as an alternative to the Technical Manual.

The products and specifications given in this manual and the manual contents can change without notice to make the product and manual better.

Be sure to always use the latest version of this manual. Use this manual to correctly install, wire, set, and operate this product.

Users can download the Technical Manual from the Yaskawa documentation website printed on the back cover.

2 Safety

Read all safety precautions before you install, wire, or operate the drive.

◆ Explanation of Signal Words

⚠ DANGER *This signal word identifies a hazard that will cause serious injury or death if you do not prevent it.*

⚠ WARNING *This signal word identifies a hazard that can cause death or serious injuries if you do not prevent it.*

⚠ CAUTION *This signal word identifies a hazardous situation, which, if not avoided, can cause minor or moderate injury.*

NOTICE *This signal word identifies a property damage message that is not related to personal injury.*

◆ General Safety Instructions

Yaskawa Electric manufactures and supplies electronic components for a variety of industrial applications. The selection and application of Yaskawa products is the responsibility of the designer of the equipment or the customer who assembles the final product. Yaskawa is not responsible for how our products are incorporated into the final system design. In all cases, Yaskawa products should not be incorporated into a product or design as the exclusive or sole safety control function. All control functions are designed to dynamically detect failures and operate safely without exception. All products that are designed to incorporate parts manufactured by Yaskawa must be provided to the end user and include proper warnings and instructions regarding their safe use and operation. All warnings from Yaskawa must be promptly issued to the end user. Yaskawa offers warranties only for the quality of our products, in compliance with standards and specifications that are described in the manual. Yaskawa does not offer other warranties, either explicit or implied. Injuries, property damage, and lost business opportunities caused by improper storage or handling and negligence oversight on the part of your company or your customers will void Yaskawa's warranty for the product.

Note:

Failure to obey the safety messages in the manual can cause serious injury or death. Yaskawa is not responsible for injuries or damage to equipment caused by ignoring the safety messages.

- Read this manual carefully when mounting, operating, and repairing AC drives.
- Obey all warnings, cautions, and notices.
- Approved personnel must perform all work.
- Install the drive according to this manual and local codes.

⚠ DANGER *Electrical Shock Hazard. Do not examine, connect, or disconnect wiring on an energized drive. Before servicing, disconnect all power to the equipment and wait for the time specified on the warning label at a minimum. The internal capacitor stays charged after the drive is de-energized. The charge indicator LED extinguishes when the DC bus voltage decreases below 50 Vdc. When all indicators are OFF, remove the covers before measuring for dangerous voltages to make sure that the drive is safe. If you do work on the drive when it is energized, it will cause serious injury or death from electrical shock.*

⚠ WARNING *Fire Hazard. Do not connect main power supply wiring to drive motor terminals U/T1, V/T2, and W/T3. Connect main power supply wiring to main circuit input terminals R/L1, S/L2, and T/L3. Incorrect wiring can cause serious injury or death from fire.*

⚠ WARNING *Crush Hazard. Only approved personnel can operate a crane or hoist to move the drive. If unapproved personnel operate a crane or hoist, it can cause serious injury or death from falling equipment.*

⚠ WARNING *Electrical Shock Hazard. Do not modify the drive body or drive circuitry. Modifications to drive body and circuitry can cause serious injury or death, will cause damage to the drive, and will void the warranty. Yaskawa is not responsible for modifications of the product made by the user.*

⚠ WARNING *Electrical Shock Hazard. Only let approved personnel install, wire, maintain, examine, replace parts, and repair the drive. If personnel are not approved, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Always ground the motor-side grounding terminal. If you do not ground the equipment correctly, it can cause serious injury or death if you touch the motor case.*

⚠ WARNING *Electrical Shock Hazard. Do not wear loose clothing or jewelry when you do work on the drive. Tighten loose clothing and remove all metal objects, for example watches or rings. Loose clothing can catch on the drive and jewelry can conduct electricity and cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Make sure that the protective ground wire complies with technical standards and local safety regulations. The IEC/EN 61800-5-1:2007 standard specifies that you must wire the power supply to automatically de-energize when the protective ground wire disconnects. You can also connect a protective ground wire that has a minimum cross-sectional area of 10 mm^2 (copper wire) or 16 mm^2 (aluminum wire). If you do not obey the standards and regulations, it can cause serious injury or death. The leakage current of the drive will be more than 3.5 mA in drive models 2xxxB, 4xxxB, and 4317A to 4605A.*

⚠ WARNING *Sudden Movement Hazard. Before you do Auto-Tuning, remove all personnel and objects from the area around the drive, motor, and load. The drive and motor can start suddenly during Auto-Tuning and cause serious injury or death.*

⚠ WARNING *Sudden Movement Hazard. Remove all personnel and objects from the area around the drive, motor, and machine and attach covers, couplings, shaft keys, and machine loads before you energize the drive. If personnel are too close or if there are missing parts, it can cause serious injury or death.*

⚠ WARNING *Damage to Equipment. Do not apply incorrect voltage to the main circuit of the drive. Operate the drive in the specified range of the input voltage on the drive nameplate. Voltages that are higher than the permitted nameplate tolerance can cause damage to the drive.*

⚠ WARNING *Fire Hazard. Do not put flammable or combustible materials on top of the drive and do not install the drive near flammable or combustible materials. Attach the drive to metal or other noncombustible material. Flammable and combustible materials can start a fire and cause serious injury or death.*

⚠ WARNING *Fire Hazard. Tighten all terminal screws to the correct tightening torque. Connections that are too loose or too tight can cause incorrect operation and damage to the drive. Incorrect connections can also cause death or serious injury from fire.*

⚠ WARNING *Fire Hazard. Tighten screws at an angle in the specified range shown in this manual. If you tighten the screws at an angle not in the specified range, you can have loose connections that can cause damage to the terminal block or start a fire and cause serious injury or death.*

⚠ WARNING *Crush Hazard. Use a crane or hoist to move large drives when necessary. If you try to move a large drive without a crane or hoist, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Do not cause a short circuit on the drive output circuit. A short circuit on the output can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. When there is a DC component in the protective earthing conductor, the drive can cause a residual current. When a residual current operated protective or monitoring device prevents direct or indirect contact, always use a type B Residual Current Monitor/Residual Current Device (RCM/RCD) as specified by IEC/EN 60755. If you do not use the correct RCM/RCD, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Ground the neutral point on the power supply of drive models 2xxxB/C and 4xxxB/C to comply with the EMC Directive before you turn on the EMC filter. If you turn ON the EMC filter, but you do not ground the neutral point, it can cause serious injury or death.*

⚠ WARNING *Crush Hazard. Test the system to make sure that the drive operates safely after you wire the drive and set parameters. If you do not test the system, it can cause damage to equipment or serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. After the drive blows a fuse or trips an RCM/RCD, do not immediately energize the drive or operate peripheral devices. Wait for the time specified on the warning label at a minimum and make sure that all indicators are OFF. Then check the wiring and peripheral device ratings to find the cause of the problem. If you do not know the cause of the problem, contact Yaskawa before you energize the drive or peripheral devices. If you do not fix the problem before you operate the drive or peripheral devices, it can cause serious injury or death.*

⚠ WARNING *Fire Hazard. Install sufficient branch circuit short circuit protection as specified by applicable codes and this manual. The drive is suitable for circuits that supply not more than 100,000 RMS symmetrical amperes, 240 Vac maximum (200 V Class), 480 Vac maximum (400 V Class). Incorrect branch circuit short circuit protection can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Do not modify the drive body or drive circuitry. Modifications to drive body and circuitry can cause serious injury or death, will cause damage to the drive, and will void the warranty. Yaskawa is not responsible for modifications of the product made by the user.*

⚠ CAUTION *Crush Hazard. Tighten terminal cover screws and hold the case safely when you move the drive. If the drive or covers fall, it can cause moderate injury.*

⚠ CAUTION *Burn Hazard. Do not touch a hot drive heatsink. De-energize the drive, wait for a minimum of 15 minutes, then make sure that the heatsink is cool before you replace the cooling fans. If you touch a hot drive heatsink, it can burn you.*

NOTICE *Damage to Equipment. When you touch the drive and circuit boards, make sure that you observe correct electrostatic discharge (ESD) procedures. If you do not follow procedures, it can cause ESD damage to the drive circuitry.*

NOTICE *Do not break the electrical connection between the drive and the motor when the drive is outputting voltage. Incorrect equipment sequencing can cause damage to the drive.*

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NOTICE *Damage to Equipment. Do not do a withstand voltage test or use a megohmmeter or megger insulation tester on the drive. These tests can cause damage to the drive.*

NOTICE *Do not operate a drive or connected equipment that has damaged or missing parts. You can cause damage to the drive and connected equipment.*

NOTICE *Fire Hazard. Install a fuse and equipment for residual current monitoring/detection (RCM/RCD). If you do not install these components, it can cause damage to the drive and connected equipment.*

NOTICE *Do not use unshielded wire for control wiring. Use shielded, twisted-pair wires and ground the shield to the ground terminal of the drive. Unshielded wire can cause electrical interference and unsatisfactory system performance.*

NOTICE *Damage to Equipment. Before you connect a dynamic braking option to the drive, make sure that qualified personnel read and obey the Braking Unit and Braking Resistor Unit Installation Manual (TOBPC72060001). If you do not read and obey the manual or if personnel are not qualified, it can cause damage to the drive and braking circuit.*

NOTICE *Make sure that all connections are correct after you install the drive and connect peripheral devices. Incorrect connections can cause damage to the drive.*

NOTICE *Use the drive ground wire to ground the drive only. Do not try to use the drive ground wire for other devices, for example welding machines or large-current electrical equipment.*

NOTICE *Use an inverter-duty motor or vector-duty motor with reinforced insulation and windings applicable for use with an AC drive. If the motor does not have the correct insulation, it can cause a short circuit or ground fault from insulation deterioration.*

◆ Intended Use

The drive is a commercial-use electrical device that controls the speed and rotation direction of a motor. Do not use the drive for any other purpose.

1. Carefully read the technical manual.
2. Read all safety precautions before you install, wire, or operate the drive.
3. When you install the drive, wire and ground it according to all applicable standards and safety precautions.
4. Make sure that you correctly install all components and protection covers.
5. Be sure to use the drive in the specified environmental conditions.

⚠ WARNING *Electrical Shock Hazard. Do not modify the drive body or drive circuitry. Modifications to drive body and circuitry can cause serious injury or death, will cause damage to the drive, and will void the warranty. Yaskawa is not responsible for modifications of the product made by the user.*

◆ Warranty Information

■ Exclusion of Liability

- This product is not designed and manufactured for use in life-support machines or systems.
- Contact a Yaskawa representative or your Yaskawa sales representative if you are considering the application of this product for special purposes, such as machines or systems used for passenger cars, medicine, airplanes and aerospace, nuclear power, electric power, or undersea relaying.

⚠ WARNING *Injury to Personnel. When you use this product in applications where its failure could cause the loss of human life, a serious accident, or physical injury, you must install applicable safety devices. If you do not correctly install safety devices, it can cause serious injury or death.*

3 Moving the Drive

Obey local laws and regulations when moving and installing this product.

⚠ CAUTION *Crush Hazard. Tighten terminal cover screws and hold the case safely when you move the drive. If the drive or covers fall, it can cause moderate injury.*

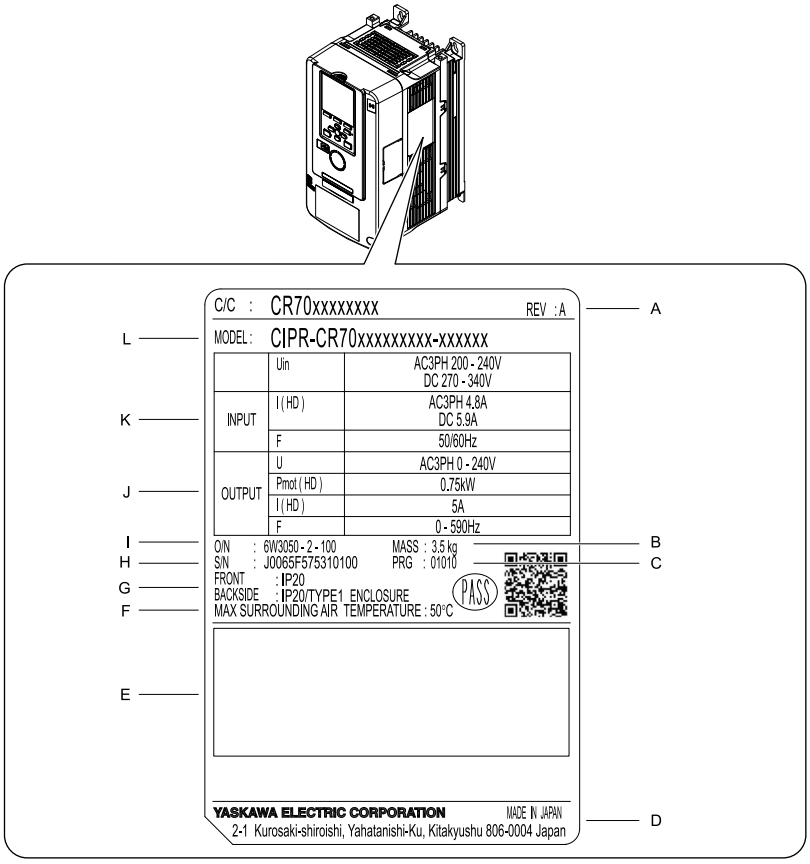
Drive Weight	Persons Necessary to Move the Drive
< 15 kg (33 lbs.)	1
≥ 15 kg (33 lbs.)	2 + using appropriate lifting equipment

Refer to the Technical Manual for information about how to use suspension systems, wires, or hanging metal brackets to move the drive.

4 Receiving

The product packaging contains the product and instruction manual.

1. Examine the drive for damage or missing parts. Immediately contact your nearest sales representative if there is damage to the drive.
2. Examine the drive model number to make sure that you received the correct model. Examine the model number in the "MODEL" section of the drive nameplate to make sure that you received the correct model.
3. Make sure that the product and motor combinations are correct. Contact your supplier or Yaskawa sales office if you received an incorrect drive model or if the drive does not operate correctly.
4. When you operate more than one drive, check all drives and motors separately.
5. Do not use damaged parts to connect the product and the motor.



A - Hardware revision
B - Weight
C - Drive software version
D - The address of the head office of Yaskawa Electric Corporation
E - Accreditation standards
F - Ambient Temperature Setting
G - Protection design
H - Serial number
I - Lot number
J - Output specifications
K - Input specifications
L - Drive Model

Figure 4.1 Nameplate Information Example

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◆ How to Read the Model Number

Use the information in the figure and the table to understand the drive model number.

CIPR-	CR70	C	2	003	B	B	A	A	-	G	A	A	A	A	A
1	2	3	4	5	6	7	8	9		10	11	12	13	14	15

Figure 4.2 Drive Model

Table 4.1 Model Number Details

No.	Description
1	Drive
2	Product series
3	Region code • C: Europe • A: Japan • T: Asia (Singapore)
4	Input power supply voltage • 2: Three-Phase AC 200 V Class • 4: Three-Phase AC 400 V Class
5	The rated output current **Note:** Refer to the tables for the rated output current by model.
6	EMC noise filter • A: No internal EMC filter • B: Internal category C3 EMC filter
7	Protection design • B: IP20/UL Open Type
8	Environmental specification • A: Standard • K: Gas-resistant • M: Humidity-resistant and dust-resistant • N: Oil-resistant • P: Humidity-resistant, dust-resistant, and vibration-resistant • R: Gas-resistant and vibration-resistant • S: Vibration-resistant • T: Oil-resistant and vibration-resistant **Note:** Drives with these specifications do not guarantee complete protection for the environmental conditions shown.
9	Design revision order
10	Control circuit terminal board G: 10 digital input/screw clamp terminal board type
11	Option (connector CN5-A) • A: No option • D: AI-A3 (Analog Input) • E: DI-A3 (Digital Input) • F: SI-C3 (CC-Link) • G: SI-ET3 (MECHATROLINK-III) • H: SI-N3 (DeviceNet) • J: SI-P3 (PROFIBUS-DP) • K: SI-T3 (MECHATROLINK-II) • M: SI-S3 (CANopen) • S: SI-EP3 (PROFINET Communications) • P: SI-EM3 (ModbusTCP/IP) • R: SI-EN3 (EtherNet/IP)
12	Option (connector CN5-B) • A: No option • B: AO-A3 (Analog Monitor) • C: DO-A3 (Digital Output) • U: PG-B3 (Complementary Type PG) • V: PG-X3 (Motor PG Feedback Line Driver Interface)
13	Option (connector CN5-C) • A: No option • U: PG-B3 (Complementary Type PG) • V: PG-X3 (Motor PG Feedback Line Driver Interface) • Z: PG-RT3 (Motor Feedback Resolver TS2640N321E64 Interface)
14	Keypad • A: LCD keypad (standard) • B: LCD keypad (humidity-resistant and dust-resistant) • D: Bluetooth LCD keypad *1 • E: Bluetooth LCD keypad (humidity-resistant and dust-resistant) *1 • F: LED keypad • G: LED keypad (humidity-resistant and dust-resistant)
15	Special applications A: Standard

*1 This certification is not available in all regions where you will use the device. Contact Yaskawa or your nearest sales representative for more information.

■ Rated Output Current

These tables give the rated output current values.

Note:
- These output current values are applicable for drives that operate at the default settings.
- Derate the output current in applications that:
  – Increase the carrier frequency
  – Have high ambient temperature
  – Install drives side-by-side.

Table 4.2 Rated Output Current (Three-Phase AC 200 V)

Symbol	Maximum Applicable Motor Output kW	Rated Output Current A
003	0.55	3.2
005	0.75	5
008	1.5	8
011	2.2	11
014	3.0	14
018	4.0	17.5
025	5.5	25
033	7.5	33
047	11	47
060	15	60
075	18.5	75
088	22	88
115	30	115
145	37	145
180	45	180
215	55	215
283	75	283
346	90	346
415	110	415

Table 4.3 Rated Output Current (Three-Phase AC 400 V)

Symbol	Maximum Applicable Motor Output kW	Rated Output Current A
002	0.55	1.8
003	1.1	3.4
005	1.5	4.8
006	2.2	5.5
007	3.0	7.2
009	4.0	9.2
015	5.5	14.8
018	7.5	18
024	11	24
031	15	31
039	18.5	39
045	22	45
060	30	60
075	37	75

Symbol	Maximum Applicable Motor Output kW	Rated Output Current A
091	45	91
112	55	112
150	75	150
180	90	180
216	110	216
260	132	260
304	160	304
371	200	371
414	220	414
453	250	453
605	315	605

5 Component Names and Functions

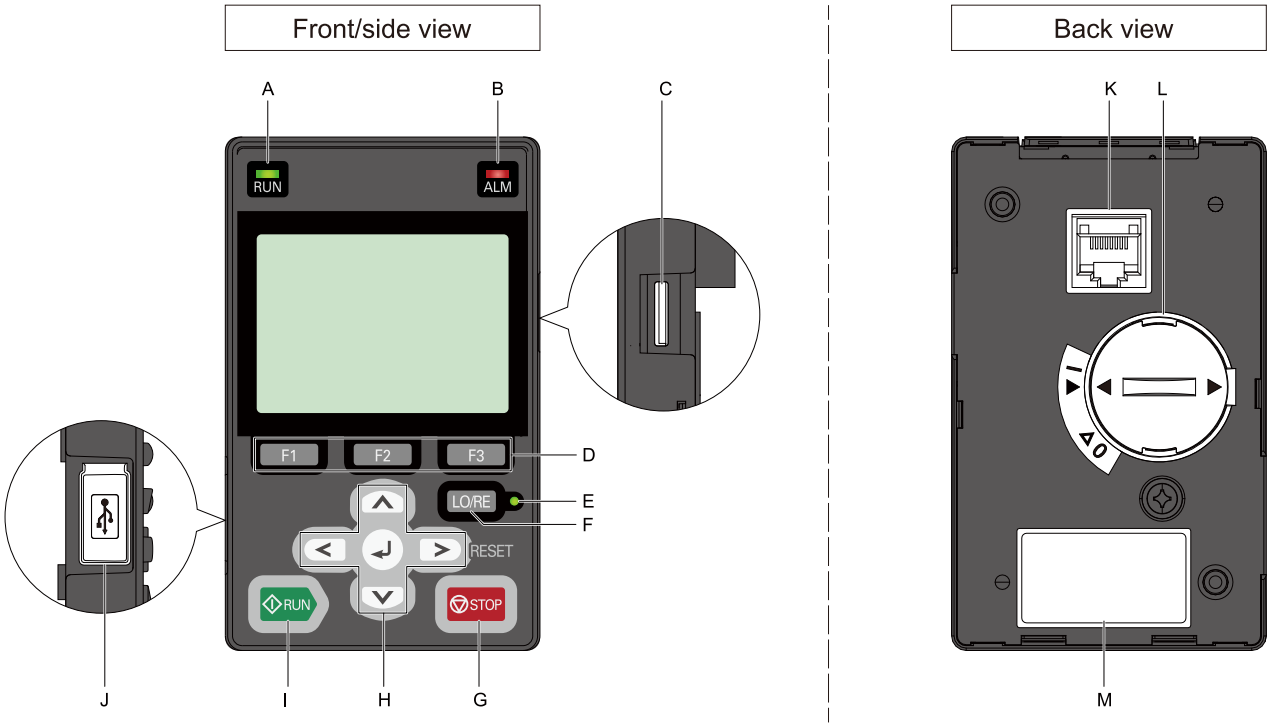

Figure 5.1 Keypad

Table 5.1 Component Names and Functions

No.	Name	Function
A	RUN LED 	Illuminates to show that the drive is operating the motor. The LED turns OFF when the drive stops. Flashes to show that: • The drive is decelerating to stop. • The drive received a Run command but the frequency reference is 0 Hz. Flashes quickly to show that: • The drive received a Run command from the MFDI terminals when the drive is not in Drive Mode. • The drive received a Fast Stop command. • The safety function shuts off the drive output. • The user pushed  on the keypad while the drive is operating in REMOTE Mode. • The drive is energized with an active Run command and *b1-17 = 0 [Run Command at Power Up = Disregard Existing RUN Command]*.
B	ALM LED 	Illuminates when the drive detects a fault. Flashes when the drive detects: • Alarm • An oPE parameter setting error • A fault or alarm during Auto-Tuning The light switches off when the drive is in normal operation. There is no fault or alarm.
C	microSD Card Insertion Slot	The insertion point for a microSD card.
D	Function Keys (F1, F2, F3) 	The menu shown on the keypad sets the functions for function keys. The name of each function is in the lower half of the display window.
E	LO/RE LED 	Illuminated: The keypad controls the Run command (LOCAL Mode). OFF: The control circuit terminal or serial transmission device controls the Run command (REMOTE Mode). **Note:** • LOCAL: Operated using the keypad. Use the keypad to enter Run/Stop commands and the frequency reference command. • REMOTE: Operated from the control circuit terminal or serial transmission. Use the frequency reference source entered in *b1-01* and the Run command source selected in *b1-02*.
F	LO/RE Selection Key 	This key is not used. **Note:** Cannot switch from Local Mode to Remote Mode.
G	STOP Key 	Stops drive operation. **Note:** The STOP key has highest priority Push  to stop the motor even when a Run command (REMOTE Mode) is active at MFDI terminals. Set *o2-02 = 0 [STOP Key Function Selection = Disabled]* to disable the priority in  .
H	Left Arrow Key 	Moves the cursor to the left.
	Up Arrow Key/Down Arrow Key 	• Scrolls up or down to display the next item or the previous item. • Selects parameter numbers, and increments or decrements setting values.
	Right Arrow Key (RESET) 	• Moves the cursor to the right. • Continues to the next screen. • Clears drive faults.
	ENTER Key 	• Enters parameter values and settings. • Selects menu items to move the user between keypad displays. • Selects each mode, parameter, and set value.
I	RUN Key 	Starts the drive in LOCAL mode. Starts the motor tuning procedure in Auto-Tuning Mode.
J	USB Terminal	Uses a USB cable (USB standard 2.0, type A - mini-B) to connect the keypad to a PC.
K	RJ-45 Connector	Connects to the drive using an RJ-45 8-pin straight through UTP CAT5e extension cable or keypad connector.
L	Clock Battery Cover	Remove it when installing/replacing the clock battery. **Note:** • Refer to “Replace the Keypad’s Battery” for details on the type of battery required and the installation procedure. • The clock battery is not supplied as accessories.
M	Nameplate	Displays keypad model, lot number, and FLASH number. **Note:** Keypads with FLASH number of 1002 or later can be used. Keypads with FLASH number of 1001 or earlier may not display messages properly.

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◆ Keypad Mode and Menu Displays

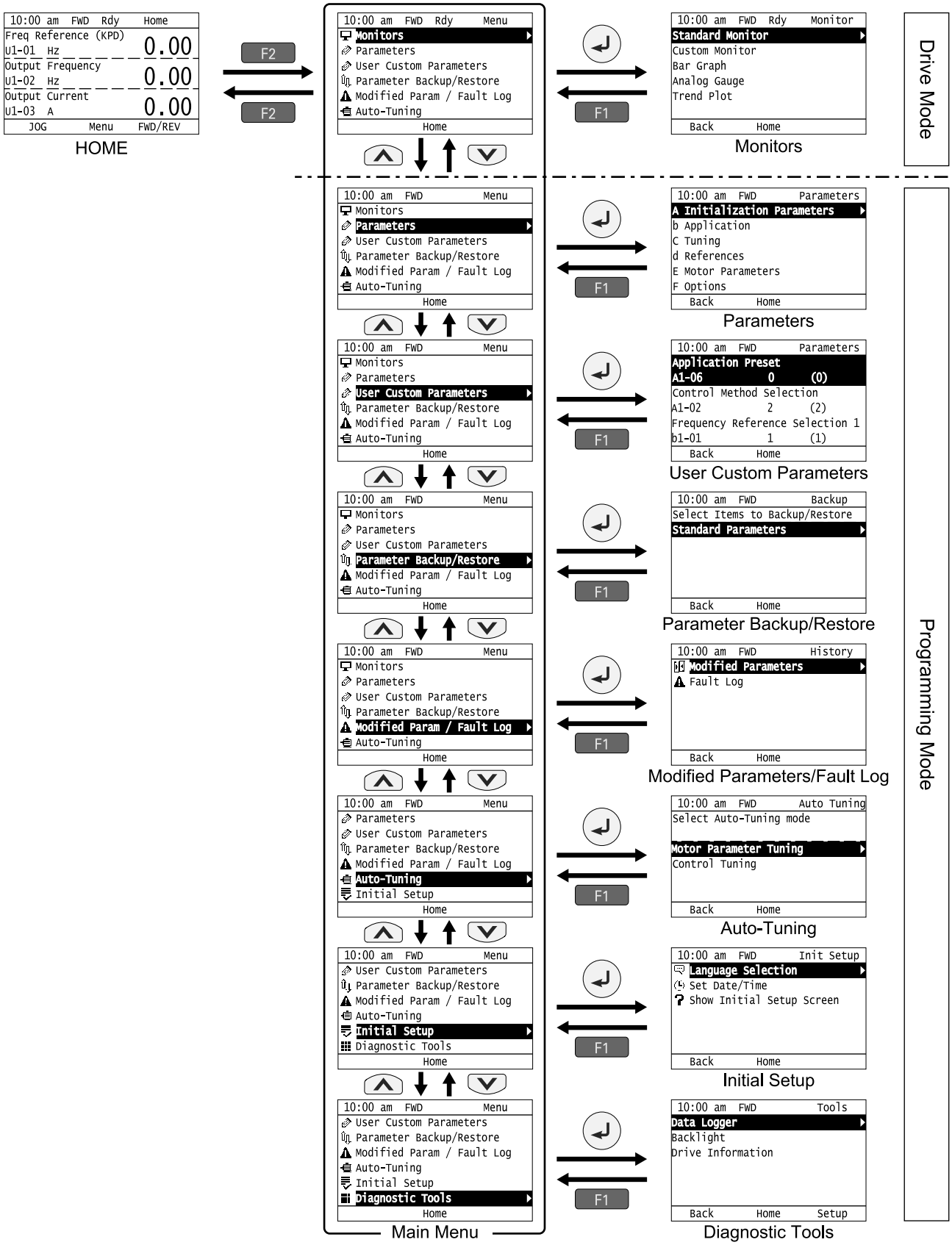


Figure 5.2 Keypad Functions and Display Levels

Note:

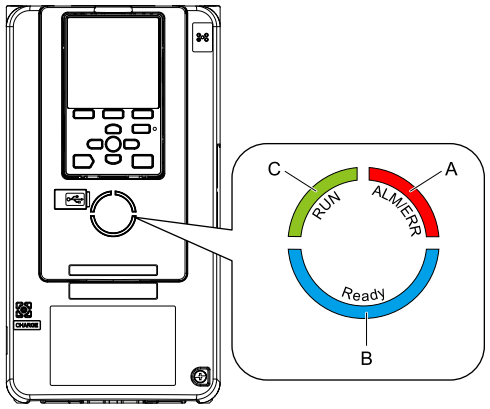
- Energize the drive with factory defaults to show the Initial Setup screen. Push F2 (Home) to show the HOME screen.
  –Select [No] from the [Show Initial Setup Screen] setting to not display the Initial Setup screen.
- Push < from the Home screen to show drive monitors.
- Push ↵ to set *d1-01 [Reference 1]* when the Home screen shows *U1-01 [Frequency Reference]* in LOCAL Mode.
- The keypad will show [Rdy] when the drive is in Drive Mode. The drive is prepared to accept a Run command.

Table 5.2 Drive Mode Screens and Functions

Mode	Keypad Screen	Function
Drive Mode	Monitors	Sets monitor items to display.
Programming Mode	Parameters	Changes parameter settings.
	User Custom Parameters	Shows the User Parameters.
	Parameter Backup/Restore	Saves parameters to the keypad as backup.
	Modified Parameters/Fault Log	Shows modified parameters and fault history.
	Auto-Tuning	Auto-Tunes the drive.
	Initial Setup Screen	Changes initial settings.
	Diagnostic Tools	Sets data logs and backlight.

6 LED Status Ring

The LED Status Ring on the drive cover shows the drive operating status.



A - ALM/ERR **C - RUN**
B - Ready

LED		Status	Description
A	ALM/ERR	Illuminated	The drive detects a fault.
		Flashing *1	The drive detects: • Alarm • An oPE parameter setting error • A fault or error during Auto-Tuning. **Note:** The LED will illuminate to identify a fault if the drive detects a fault and an alarm at the same time.
		OFF	No fault or alarm occurs on the drive.
B	Ready	Illuminated	The drive is operating or is prepared for operation.
		Flashing *1	The drive is in *STo [Safe Torque OFF]* Mode.
		Flashing Quickly *1	The voltage of the main circuit power supply dropped, and only the external 24 V power supply provides the power to the drive.
		OFF	• The drive detects a fault. • There is no fault and the drive received a Run command, but the drive cannot operate (such as when in Programming Mode, or when RUN is flashing).

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LED		Status	Description
C	RUN	Illuminated	The drive is in regular operation.
		Flashing *1	• The drive is decelerating to stop. • The drive received a Run command but the frequency reference is 0 Hz. • The drive received a DC Injection Braking command.
		Flashing Quickly *1	• The drive received a Run command from the MFDI terminals and is switching to REMOTE Mode while the drive is in LOCAL Mode. • The drive received a Run command from the MFDI terminals when the drive is not in Drive Mode. • The drive received a Fast Stop command. • The safety function shuts off the drive output. • The user pushed STOP on the keypad while the drive is operating in REMOTE Mode. • The drive is energized with an active Run command and *b1-17 = 0 [Run Command at Power Up = Disregard Existing RUN Command]*. • The drive is set to coast-to-stop with timer (*b1-03 = 3 [Stopping Method Selection = Coast to Stop with Timer]*), and the Run command is disabled then enabled during the Run wait time.
		OFF	The motor is stopped.

*1 Refer to Figure 6.1 for the difference between flashing and flashing quickly.

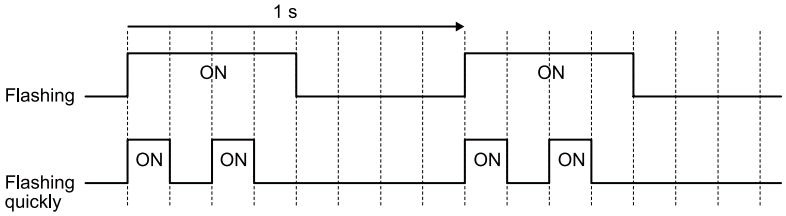


Figure 6.1 LED Flashing Statuses

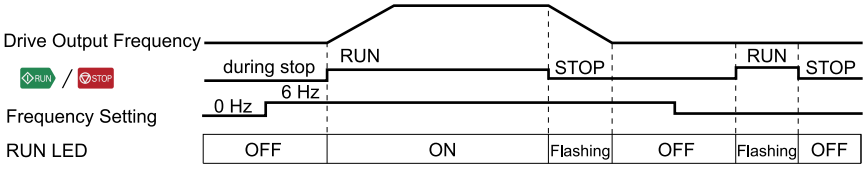


Figure 6.2 Relation between RUN LED and Drive Operation

7 Start-Up Procedure

1. Install and wire the drive.
2. Energize the drive.
3. Use *A1-06 [Application Preset]* to initialize the drive for a special application if necessary.
4. Use *A1-02 [Control Method Selection]* to do Auto-Tuning if necessary.
5. Run the motor without a load.
6. Make sure that the drive is operating correctly and make sure that the host controller is sending commands to the drive.
7. Connect the load.
8. Run the motor.
9. Make sure that the drive is operating correctly.
10. Set application parameters.
11. Check final operation and make sure that parameter settings are correct.

The drive is prepared to run the operation.

8 Mechanical Installation

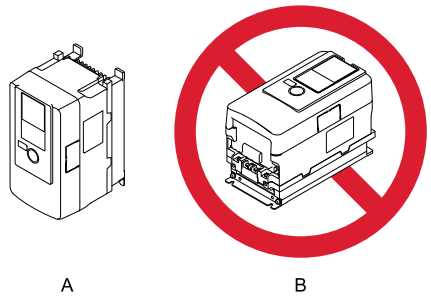
This section gives information about the standard environment for correct installation.

◆ Installation Orientation and Spacing

Install the drive vertically for sufficient cooling airflow.

Note:

Contact Yaskawa or your nearest sales representative for details about the drive models that can be installed on its side and their operating conditions.



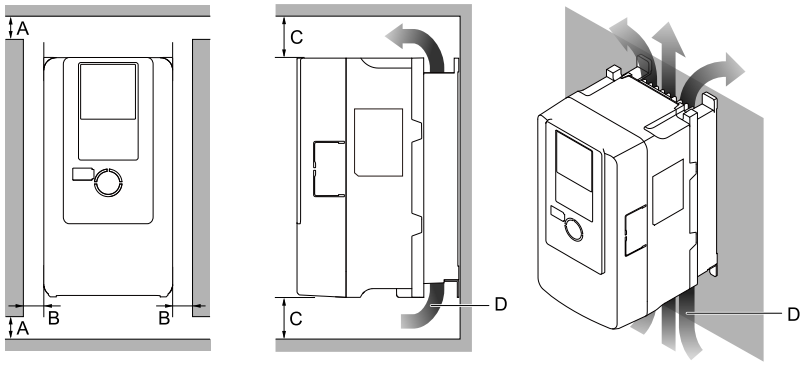
A - Upright installation

B - Horizontal installation

Figure 8.1 Installation Orientation

■ Single Unit Installation

Install the drive with the clearances specified in Figure 8.2 to guarantee sufficient space for wiring and airflow.



A - At least 50 mm (2 in.)

B - At least 30 mm (1.2 in.) on both sides

C - At least 120 mm (4.7 in.) above and below

D - Airflow direction

Figure 8.2 Drive Installation Space (Single Unit)

■ Mounting Multiple Drives Side-by-Side

Drive models 2003xB to 2075xB and 4002xB to 4039xB can take advantage of side-by-side installation.

When installing other drive models, ensure that enough space for single unit installation is placed around each drive.

When performing side-by-side installation of drives, ensure that enough space is provided for the installation of the drives with the clearances specified in Figure 8.3. Set *L8-35 [Installation Method Selection]* to *1 [Side-by-Side Mounting]*.

Derate the output current to match the ambient temperature.

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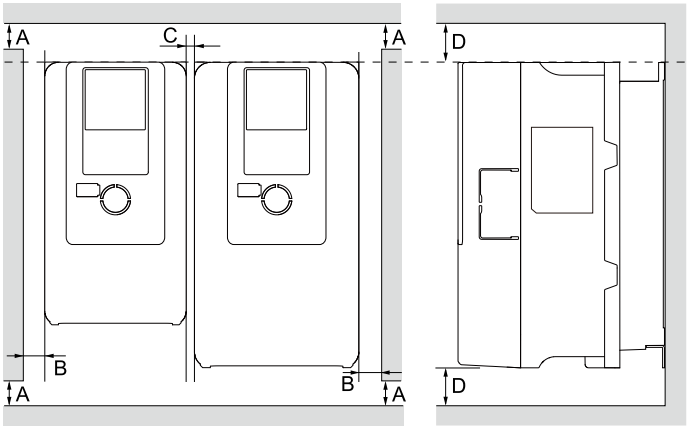


A - At least 50 mm (2 in.)
B - At least 30 mm (1.2 in.) on both sides
C - At least 2 mm (0.08 in.) between each drive
D - At least 120 mm (4.7 in.) above and below

Figure 8.3 Drive Installation Space (Side-by-Side Mounting)

Note:
- If the dimensions of the drives differ when using a side-by-side installation, then line up the tops of all the drives. This makes it easier to replace the cooling fan later.
- If mounting an enclosed wall-mounted type (UL Type 1) drive using a side-by-side installation, completely remove the top protective cover for the drive. Refer to "Attach the Top Protective Cover" to remove the top protective cover.

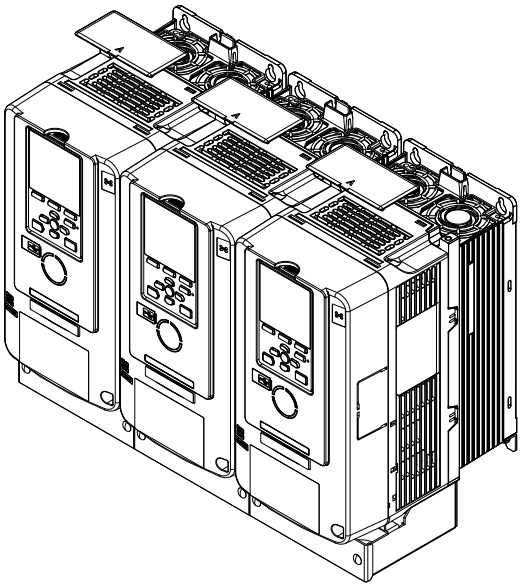


Figure 8.4 Enclosed Wall-Mounted Type (UL Type 1) Side-by-Side Mounting

◆ Using the Hanging Brackets to Move the Drive

Use the hanging brackets attached to the drive to temporarily lift the drive when you install the drive to a control panel or wall or when you replace the drive. Do not let the drive stay vertically or horizontally suspended or move the drive over a long distance while it is suspended.

Before you install the drive, make sure that you read these precautions:

⚠ WARNING *Crush Hazard. Before you hang the drive vertically, use screws to correctly attach the drive front cover and other drive components. If you do not secure the front cover, it can fall and cause minor injury.*

⚠ WARNING *Crush Hazard. When you use a crane or hoist to lift the drive during installation or removal, prevent more than 1.96 m/s^2 (0.2 G) vibration or impact. Too much vibration or impact can cause serious injury or death from falling equipment.*

⚠ WARNING *Crush Hazard. When you lift the drive during installation or removal, do not try to turn the drive over and do not ignore the hanging drive. If you move a hanging drive too much or if you ignore it, the drive can fall and cause serious injury or death.*

⚠ WARNING *Crush Hazard. When you install the drive, do not hold the front cover. Install the drive with holding the heatsink. If you hold the front cover, the cover will come off and the drive will fall, then it can cause injury.*

◆ Removing/Reattaching Covers

This section gives information about how to remove and reattach the front cover and terminal cover for wiring and inspection.

Different drive models have different procedures to remove and reattach the covers. Refer to Table 8.1 for details.

Table 8.1 Procedures to Remove Covers by Drive Model

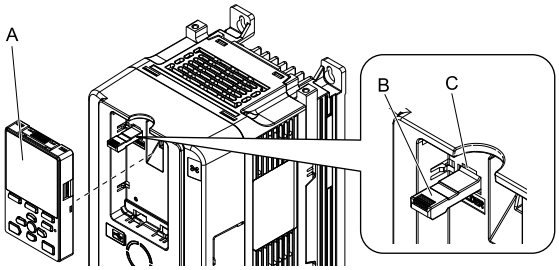
Model	Procedure
2003 - 2180 4002 - 4150	Procedure A
2215 - 2415 4180 - 4605	Procedure B

■ Removing/Reattaching the Cover Using Procedure A

⚠ DANGER *Electrical Shock Hazard. Do not examine, connect, or disconnect wiring on an energized drive. Before servicing, disconnect all power to the equipment and wait for the time specified on the warning label at a minimum. The internal capacitor stays charged after the drive is de-energized. The charge indicator LED extinguishes when the DC bus voltage decreases below 50 Vdc. When all indicators are OFF, remove the covers before measuring for dangerous voltages to make sure that the drive is safe. If you do work on the drive when it is energized, it will cause serious injury or death from electrical shock.*

Remove the Front Cover

1. Remove the keypad and the keypad connector, then insert the end of the keypad connector that has the tab into the keypad connector holder on the front cover.



A - Keypad
B - Keypad connector
C - Holder

Figure 8.5 Remove the Keypad and Keypad Connector

2. Loosen the front cover screws.

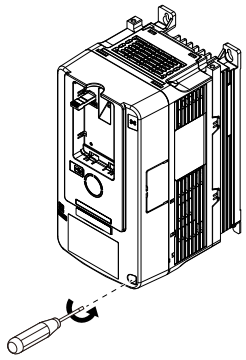


Figure 8.6 Loosen the Front Cover Screws

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3. Push on the tab in the side of the front cover then pull the front cover forward to remove it from the drive.

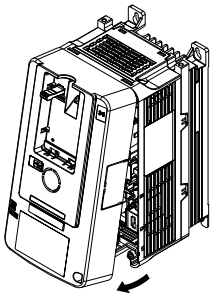


Figure 8.7 Remove the Front Cover

Install the Front Cover

1. Wire the drive and other peripheral devices.
2. Reverse the steps to reattach the cover.

Note:
- Wire the grounding terminals first, main circuit terminals next, and control circuit terminals last.
- Make sure that you do not pinch wires or signal lines between the front cover and the drive before you reattach the cover.
- Tighten the screws to a tightening torque of 0.98 N·m to 1.33 N·m (8.67 lbf·in to 11.77 lbf·in).

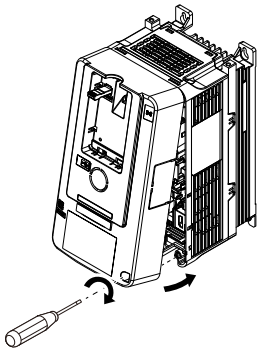


Figure 8.8 Install the Front Cover

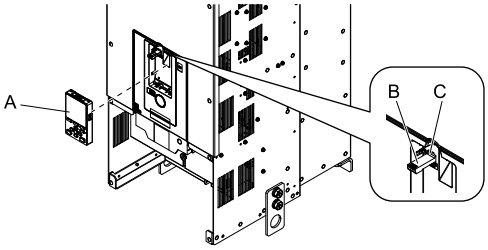
3. Reattach the keypad to the original position.

■ Removing/Reattaching the Cover Using Procedure B

⚠ DANGER *Electrical Shock Hazard. Do not examine, connect, or disconnect wiring on an energized drive. Before servicing, disconnect all power to the equipment and wait for the time specified on the warning label at a minimum. The internal capacitor stays charged after the drive is de-energized. The charge indicator LED extinguishes when the DC bus voltage decreases below 50 Vdc. When all indicators are OFF, remove the covers before measuring for dangerous voltages to make sure that the drive is safe. If you do work on the drive when it is energized, it will cause serious injury or death from electrical shock.*

Remove the Front Cover

1. Remove the terminal cover, keypad, and keypad connector, then insert the end of the keypad connector that has the tab into the keypad connector holder on the front cover.



A - Keypad
B - Keypad connector
C - Connector holder

Figure 8.9 Remove the Terminal Cover, Keypad, and Keypad Connector

2. Loosen the front cover screws.

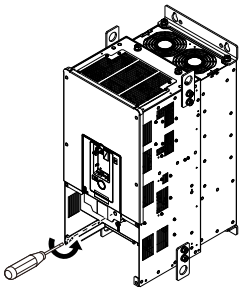
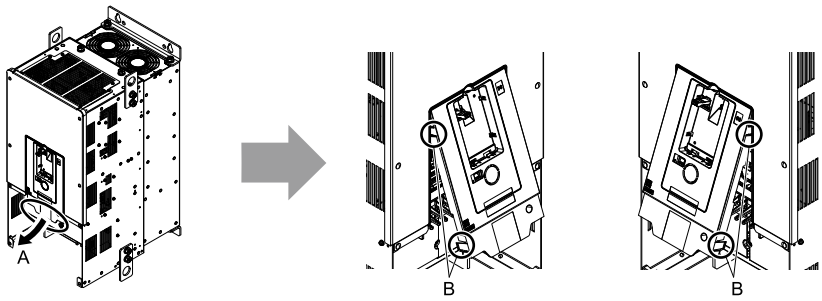


Figure 8.10 Loosen the Front Cover Screws

3. Push on the four tabs found on each side of the front cover, then pull the front cover forward to remove it from the drive.



A - Pull forward to remove the front cover.

B - Unhook the tabs found on the sides of the front cover.

Figure 8.11 Pull Forward to Remove the Front Cover

4. Remove the front cover from the drive.

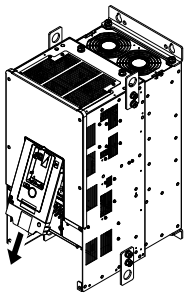


Figure 8.12 Remove the Front Cover

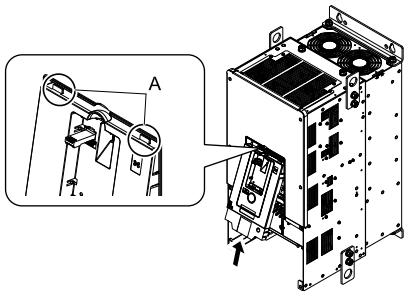
Reattach the Front Cover

Wire the drive and other peripheral devices then reattach the front cover.

Note:

Wire the grounding terminals first, main circuit terminals next, and control circuit terminals last.

1. Move the front cover to connect the hooks at the top of the front cover to the drive.



A - Hooks

Figure 8.13 Reattach the Front Cover

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2. Move the front cover until it clicks into position while pushing on the hooks on the left and right sides of the front cover.

Note:
Make sure that you do not pinch wires or signal lines between the front cover and the drive before you reattach the cover.

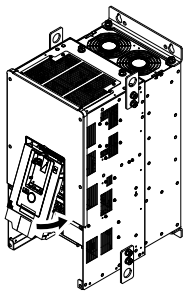

Figure 8.14 Reattach the Front Cover

3. Reattach the keypad to the original position.

Remove the Terminal Cover

1. Loosen the screws on the terminal cover, then pull down on the cover.

⚠ CAUTION *Crush Hazard. Loosen the cover screws. Do not fully remove them. If you fully remove the cover screws, the terminal cover can fall and cause moderate injury.*

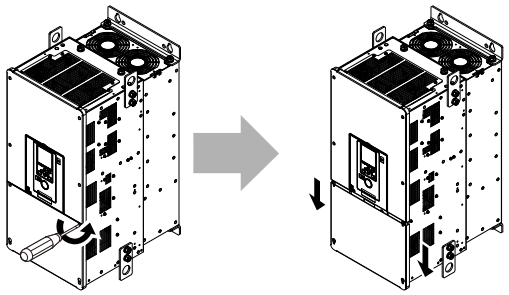

Figure 8.15 Loosen the Terminal Cover Mounting Screws

2. Pull the terminal cover away from the drive.

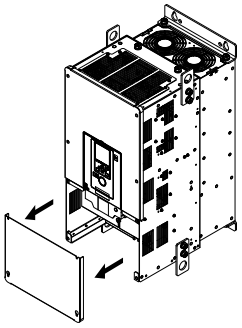

Figure 8.16 Remove the Terminal Cover

Reattach the Terminal Cover

Wire the drive and other peripheral devices then reattach the terminal cover.

Note:
- Wire the grounding terminals first, main circuit terminals next, and control circuit terminals last.
- Make sure that you do not pinch wires or signal lines between the wiring cover and the drive before you reattach the cover.
- Tighten the screws to a tightening torque of 0.98 N·m to 1.33 N·m (8.67 lbf·in to 11.77 lbf·in).

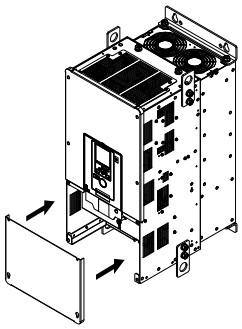

Figure 8.17 Reattach the Terminal Cover

9 Electrical Installation

DANGER *Electrical Shock Hazard. Do not examine, connect, or disconnect wiring on an energized drive. Before servicing, disconnect all power to the equipment and wait for the time specified on the warning label at a minimum. The internal capacitor stays charged after the drive is de-energized. The charge indicator LED extinguishes when the DC bus voltage decreases below 50 Vdc. When all indicators are OFF, remove the covers before measuring for dangerous voltages to make sure that the drive is safe. If you do work on the drive when it is energized, it will cause serious injury or death from electrical shock.*

WARNING *Electrical Shock Hazard. De-energize the drive and wait 5 minutes minimum until the Charge LED turns off. Remove the front cover and terminal cover to do work on wiring, circuit boards, and other parts. Use terminals for their correct function only. Incorrect wiring, incorrect ground connections, and incorrect repair of protective covers can cause death or serious injury.*

WARNING *Electrical Shock Hazard. Correctly ground the drive before you turn on the EMC filter switch. If you touch electrical equipment that is not grounded, it can cause serious injury or death.*

WARNING *Electrical Shock Hazard. Use the terminals for the drive only for their intended purpose. Refer to the technical manual for more information about the I/O terminals. Wiring and grounding incorrectly or modifying the cover may damage the equipment or cause injury.*

◆ Standard Connection Diagram

Wire the drive as specified by Figure 9.1.

WARNING *Sudden Movement Hazard. Check the I/O signals and the external sequences for the drive before you set the Application Preset function. When you set the Application Preset function (A1-06 ≠ 0), it changes the I/O terminal functions for the drive and it can cause equipment to operate unusually. This can cause serious injury or death.*

WARNING *Fire Hazard. Install sufficient branch circuit short circuit protection as specified by applicable codes and this manual. The drive is suitable for circuits that supply not more than 100,000 RMS symmetrical amperes, 240 Vac maximum (200 V Class), 480 Vac maximum (400 V Class). Incorrect branch circuit short circuit protection can cause serious injury or death.*

NOTICE *When the input voltage is 440 V or higher or the wiring distance is longer than 100 m (328 ft), make sure that the motor insulation voltage is sufficient or use an inverter-duty motor or vector-duty motor with reinforced insulation. Motor winding and insulation failure can occur.*

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Note:

Do not connect the AC control circuit ground to the drive enclosure. Incorrect ground wiring can cause the control circuit to operate incorrectly.

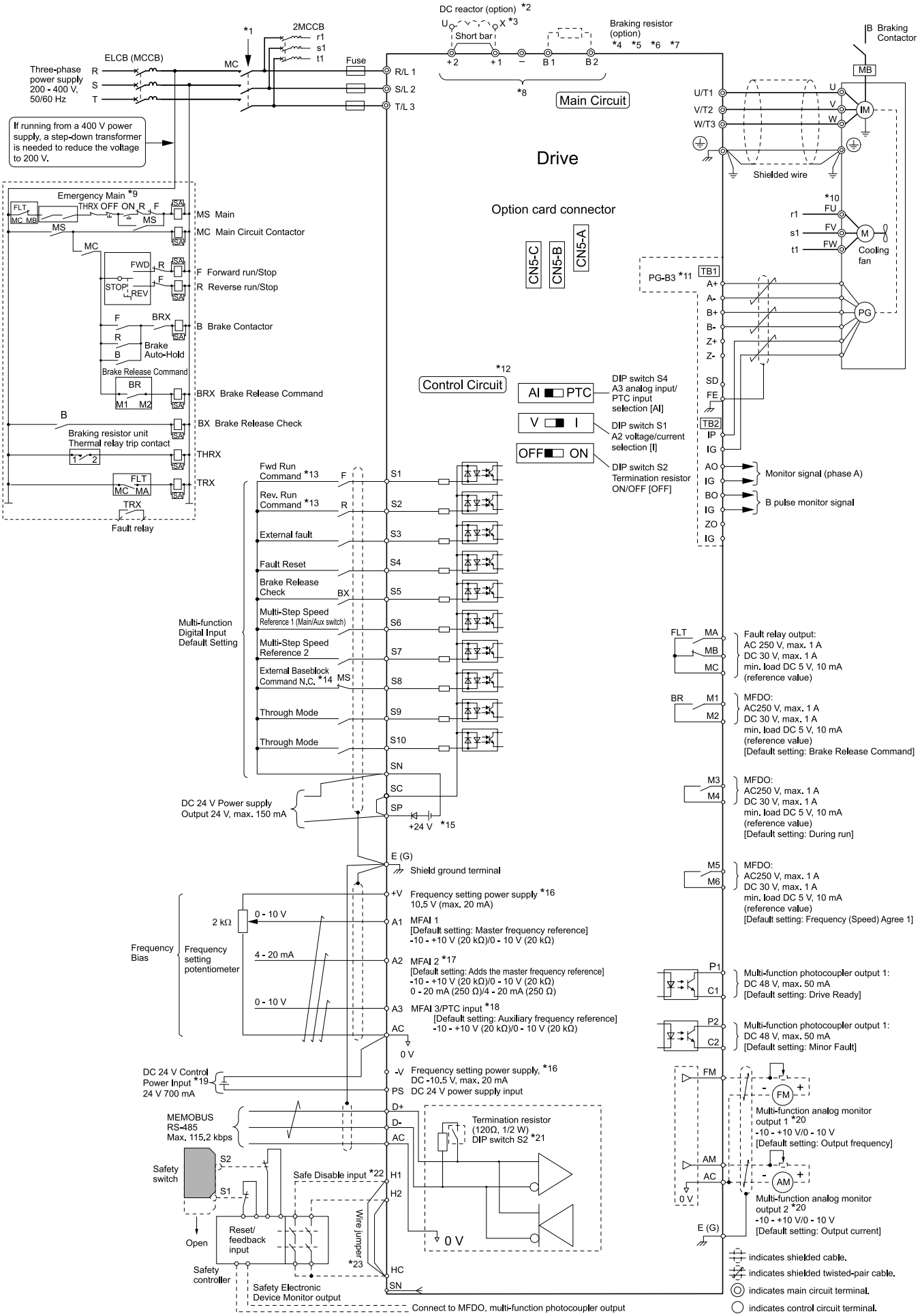


Figure 9.1 Standard Drive Connection Diagram

*1 Set the wiring sequence to de-energize the drive with the fault relay output.
*2 When you install a DC reactor, you must remove the jumper between terminals +1 and +2.
*3 Models 2088 to 2415 and 4045 to 4605 have a DC reactor.
*4 When you use a regenerative converter, regenerative unit, or braking unit, set *L8-55 = 0 [Internal DB TransistorProtection = Disable]*. the drive will detect *rF [Braking Resistor Fault]*.
*5 When you use a regenerative converter, regenerative unit, braking unit, braking resistor, or braking resistor unit, set *L3-04 = 0 [Stall Prevention during Decel = Disabled]*. If *L3-04 ≠ 0*, the drive could possibly not stop in the specified deceleration time.
*6 When you use an ERF-type braking resistor, set *L8-01 = 1 [3% ERF DB Resistor Protection = Enabled]* and set a wiring sequence to de-energize the drive with the fault relay output.
*7 When you connect a braking unit (CDBR series) or a braking resistor unit (LKEB series) to drive models 2088, 2115, and 4091, make sure that you use wires that are in the range of the applicable gauges for the drive. A junction terminal is necessary to connect wires that are less than the applicable gauge to the drive. Contact Yaskawa or your nearest sales representative for more information about selection and installation of the junction terminal.
*8 Connect peripheral options to terminals -, +1, +2, B1, and B2.

NOTICE *When you use the drive with a non-grounding, high-resistance grounding, or asymmetric-grounding network, put the EMC Filter screw or screws in the OFF position to disable the built-in EMC filter. Failure to obey the instructions can damage the drive.*

*9 Set a wiring sequence to de-energize the drive with the fault relay output.
*10 Cooling fan wiring is not necessary for self-cooling motors.
*11 Encoder circuit wiring (wiring to PG-B3 option) is not necessary for applications that do not use motor speed feedback.
*12 Connect a 24 V power supply to terminals PS-AC to operate the control circuit while the main circuit power supply is OFF.
*13 Set up the wiring to rotate the motor forward (FWD) it hoists a load, and reverse (REV) when it lowers a load in all control methods.
*14 When the external baseblock command is ON, the drive releases the baseblock.
*15 To set the MFDI power supply (Sinking/Sourcing Mode or internal/external power supply), install or remove a jumper between terminals SC-SP or SC-SN depending on the application.

NOTICE *Damage to Equipment. Do not close the circuit between terminals SP-SN. If you close the circuits between terminals SC-SP and terminals SC-SN at the same time, it will cause damage to the drive.*

- Sinking Mode, Internal power supply: Install the jumper to close the circuit between terminals SC-SP. Do not close the circuit between terminals SC-SN. If you connect the wires to the incorrect terminals, it will cause damage to the drive.
- Sourcing Mode, Internal power supply: Install the jumper to close the circuit between terminals SC-SN. Do not close the circuit between terminals SC-SP. If you connect the wires to the incorrect terminals, it will cause damage to the drive.
- External power supply: Remove the jumper from the MFDI terminals. It is not necessary to close the circuit between terminals SC-SP and terminals SC-SN.

*16 The maximum output current capacity for terminals + V and -V on the control circuit is 20 mA.

NOTICE *Do not install a jumper between terminals +V, -V, and AC. A closed circuit between these terminals will cause damage to the drive.*

*17 DIP switch S1 sets terminal A2 for voltage or current input. The default setting for S1 is current input (“I” side).
*18 DIP switch S4 sets terminal A3 for analog or PTC input.
*19 Connect the positive lead from an external 24 Vdc power supply to terminal PS and the negative lead to terminal AC.

NOTICE *Connect terminals PS and AC correctly for the 24 V power supply. If you connect the wires to the incorrect terminals, it will cause damage to the drive.*

*20 Use multi-function analog monitor outputs with analog frequency meters, ammeters, voltmeters, and wattmeters. Do not use monitor outputs with feedback-type signal devices.
*21 Set DIP switch S2 to the ON position to enable the termination resistor in the last drive when you use MEMOBUS/Modbus communications.
*22 To use the internal power supply with the Safe Disable input, use sourcing mode.
*23 Disconnect the wire jumpers between H1 and HC and H2 and HC to use the Safe Disable input.

EN

◆ Main Circuit Terminal Block Wiring Procedure

⚠ DANGER *Electrical Shock Hazard. Do not examine, connect, or disconnect wiring on an energized drive. Before servicing, disconnect all power to the equipment and wait for the time specified on the warning label at a minimum. The internal capacitor stays charged after the drive is de-energized. The charge indicator LED extinguishes when the DC bus voltage decreases below 50 Vdc. When all indicators are OFF, remove the covers before measuring for dangerous voltages to make sure that the drive is safe. If you do work on the drive when it is energized, it will cause serious injury or death from electrical shock.*

The procedures to wire the main circuit terminal block are different for different drive models. Refer to Table 9.1 for more information.

Table 9.1 Types of Wiring Procedure for the Main Circuit Terminal Block

Model	Procedure
2003 - 2180 4002 - 4150	Procedure A
2215 - 2415 4180 - 4605	Procedure B

■ Wire the Main Circuit Terminal Block with Procedure A

Notes on Wiring the Main Circuit Terminal Block

- Use copper wire. Do not use alumnium or other non-copper wire.
- Remove all unwanted objects that are near the terminal block connections.
- Remove the insulation from the connection wires to the wire stripping lengths shown in the manual.
- Do not use bent or crushed wires. Remove the damaged end of the wire before you use it.
- Do not solder stranded wire.
- If you use stranded wire, make sure that all of the wire strands are in the connection. Also, do not twist the stranded wire too much.
- Put the wire all the way into the terminal block. Remove the insulation from the wire to the recommended wire stripping length to fit the wire with insulation in the plastic housing.
- The tightening torque is different for different terminals. Tighten the screws to the specified tightening torque.
- Use a torque driver, torque ratchet, or torque wrench for the screws. A slotted driver or a hex tool will be necessary to wire the screw clamp terminal. Use applicable tools as specified by the recommended conditions in the product manual.
- If you use power tools to tighten the terminal screws, use a low speed setting (300 to 400 r/min).
- Users can purchase wiring tools from Yaskawa. Contact Yaskawa or your nearest sales representative for more information.
- Wire gauges on existing drive models to be replaced may not match wire gauge ranges on new drives. Contact Yaskawa or your nearest sales representative for wire gauges that you can and cannot use.
- Do not tighten the terminal screws at an angle of 5 degrees or more.

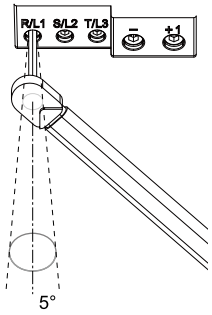


Figure 9.2 Permitted Angle

- Put the bit all the way into the hex socket to tighten the hex socket cap screw.
- When tightening straight-edge screws, hold the tip of the screwdriver in the center of the screw head. Do not let the tip of the screwdriver slip out from the groove of the screw.

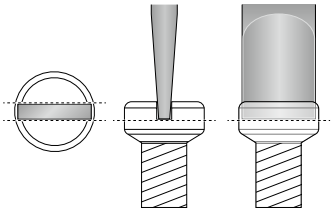
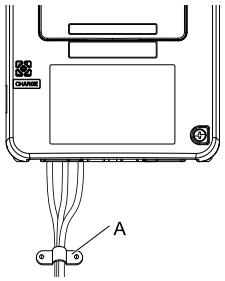


Figure 9.3 Tightening Slotted Screws

- After you connect the wires to the terminal block, lightly pull on the wires to make sure that they do not come out of the terminals.
- Remove the correct section of the wiring cover to make wiring easier.
- Regularly tighten loose terminal block screws to their specified tightening torques.
- Do not let strain on the wiring cause damage. Use a strain relief near the wiring to release the tension. Refer to Figure 9.4 for an example.



A - Strain relief

Figure 9.4 Strain Relief Example

Table 9.2 Recommended Wiring Tools

Screw Size	Screw Shape	Adapter	Bit		Torque Driver Model (Tightening Torque)	Torque Wrench
			Model	Manufacturer		
M4	Slotted (-)	Bit	SF-BIT-SL 1,0X4,0-70	PHOENIX CONTACT	TSD-M 3NM (1.2 - 3 N·m (10.6 - 26.6 lbf·in))	-
M5 *1	Slotted (-)	Bit	SF-BIT-SL 1,2X6,5-70	PHOENIX CONTACT	Wire Gauge ≤ 25 mm² (AWG 10): TSD-M 3NM (1.2 - 3 N·m (10.6 - 26.6 lbf·in))	Wire Gauge ≤ 25 mm² (AWG 10): -
					Wire Gauge ≥ 30 mm² (AWG 8): -	Wire Gauge ≥ 30 mm² (AWG 8): 4.1 - 4.5 N·m (36.3 - 39.8 lbf·in) *2 *3
M6	Hex socket cap (WAF: 5 mm)	Bit	SF-BIT-HEX 5-50	PHOENIX CONTACT	-	5 - 9 N·m (44.3 - 79.9 lbf·in) *2 *3
	Minus (-)	Bit	SF-BIT-SL 1,2X6,5-70	PHOENIX CONTACT	-	3 - 3.5 N·m (26.6 - 31.0 lbf·in) *2 *3
M8	Hex socket cap (WAF: 6 mm)	Bit	SF-BIT-HEX 6-50	PHOENIX CONTACT	-	8 - 12 N·m (70.8 - 106.2 lbf·in) *2 *3
M10	Hex socket cap (WAF: 8 mm)	Bit	SF-BIT-HEX 8-50	PHOENIX CONTACT	-	12 - 14 N·m (106.2 - 123.9 lbf·in) *2 *3

*1 When wiring drive models 2047, 4075, and smaller, select the correct tools for the wire gauge.
*2 Use 6.35 mm (0.25 in) bit socket holder.
*3 Use a torque wrench that can apply this torque measurement range.

Main Circuit Terminal Block Wiring Procedure

Remove the keypad and front cover before wiring the main circuit terminal block.

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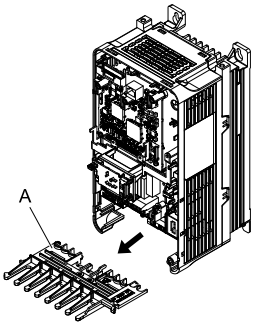
1. Pull the wiring cover away from the drive to remove it.



A - Wiring cover

Figure 9.5 Remove the Wiring Cover

2. Put the end of a prepared wire into the terminal block.

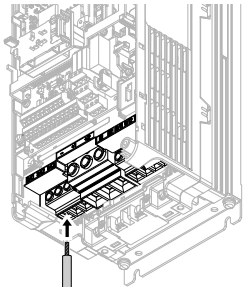


Figure 9.6 Install the Electrical Wire

Note:
If there is a jumper between terminals +1 and +2, loosen the terminal block screws and remove the jumper before wiring the terminals.

3. Tighten the screws to the specified torque.

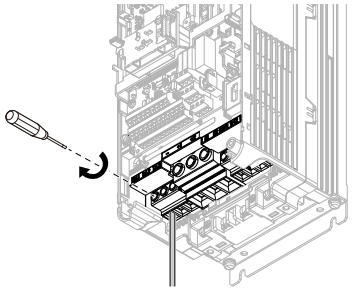
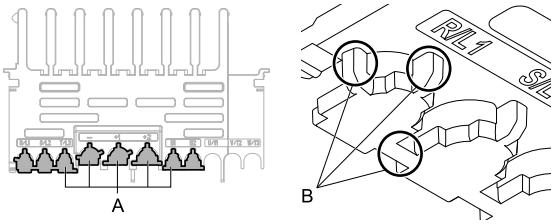


Figure 9.7 Tighten Terminal Block Screws

4. Examine the signal from the wired terminal and use a diagonal-cutting pliers to remove areas of the wiring cover cutaway section.
   To remove the wiring cover, cut off the portion shown in Figure 9.8.



A - Cutaway sections **B - Cut this portion with a diagonal-cutting pliers**

Figure 9.8 Clip the Cutaway Section of the Wiring Cover

Note:
- Different drive models have different wiring cover shapes.
- Only clip the section of the wiring cover that applies to the wired terminal. If you clip areas that do not apply to wired terminals, the protective enclosure will not keep its IP20 protective level.
- Tightly hold the cutaway section when removing pieces of the cutaway section. Pieces of the cutaway section can fly out and cause injury.
- Make sure that the clipped section does not cause damage to the wires.
- If you use wires that are not specified by Yaskawa, the protective enclosure could lose its IP20 protective level, although the wiring cover is correct. Contact Yaskawa or your nearest sales representative for more information.

5. Put the wiring cover in its initial position. Put the cables through the holes cut from the wiring cover.

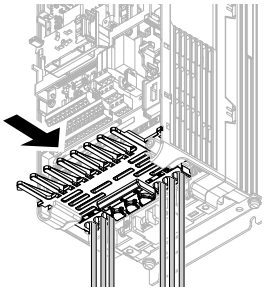


Figure 9.9 Reattach the Wiring Cover

6. Install the front cover and the keypad to their initial positions.

■ Wire the Main Circuit Terminal Block with Procedure B

Notes on Wiring the Main Circuit Terminal Block

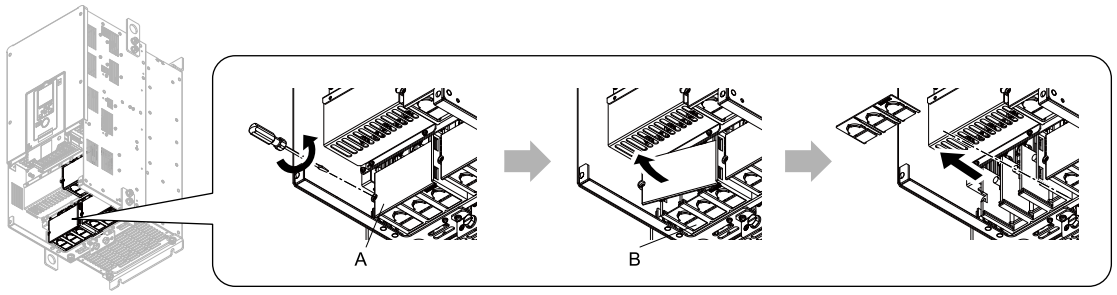
Note:

- After the wiring, do not twist or shake the electrical wires too much.
- Be sure to use only wires with the correct size, stripped wire length, and tightening torque as specified by Yaskawa.
- Use tools that fit the shape of the screw head to tighten and loosen the terminal block screws.
- Make sure that there are no loose stranded wires or frayed wires after wiring is complete.

Main Circuit Terminal Block Wiring Procedure

Remove the terminal cover before wiring the main circuit terminal block.

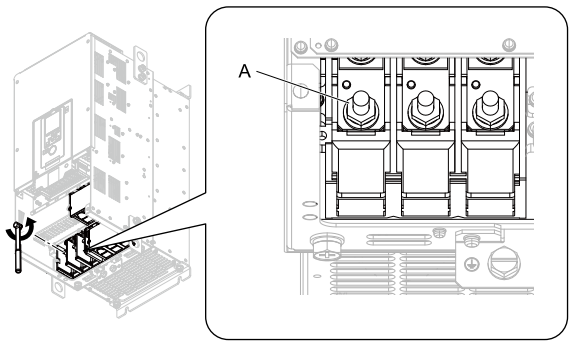
1. Remove the screws on the terminal block cover and pull the terminal block cover away from the drive. Pull the wiring cover away from the drive to remove the wiring cover after removing the terminal block cover.



A - Terminal block cover **B - Wiring cover**

Figure 9.10 Remove the Wiring Cover

2. Remove the terminal block nut.



A - Nut

Figure 9.11 Remove the Terminal Block Nut

3. Wire the closed-loop crimp terminal to the main circuit terminal block.

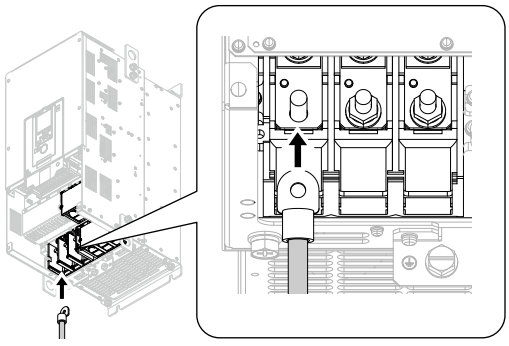


Figure 9.12 Install the Electrical Wire

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4. Tighten the nut to the specified torque.

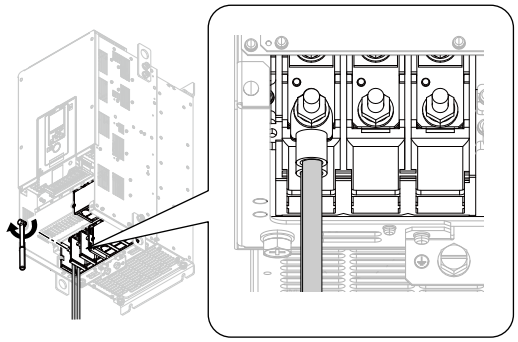
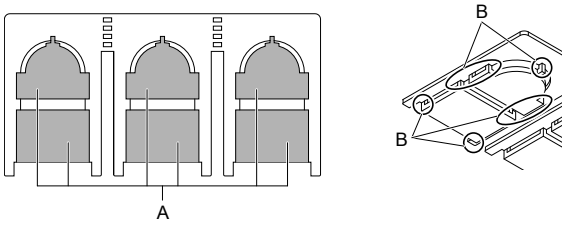


Figure 9.13 Tighten the Terminal Block Nut

5. Examine the signal from the wired terminal and use a diagonal-cutting pliers to remove areas of the wiring cover cutaway section.
   Cut the areas shown in Figure 9.14.



A - Cutaway sections **B - Use a diagonal-cutting pliers to clip this area.**

Figure 9.14 Clip the Cutaway Section of the Wiring Cover

Note:
- Different drive models have different wiring cover shapes.
- Clip only the areas from the wiring cover that apply to the wired terminal. If you clip areas that do not apply to wired terminals, the drive will not keep its IP20 protective level.
- When you clip pieces of the cutaway section, tightly hold the cutaway section. Pieces of the cutaway section can fly out and cause injury.
- Make sure that the clipped section does not cause damage to the wires.
- Although the wiring cover is correct, if you use wires that are not specified by Yaskawa, the drive will not keep its IP20 protective level.
- When you use the recommended gauge for the electrical wires, it is not necessary to attach the wiring cover of the main circuit power input terminal and the drive output terminal. When you use the applicable gauge for the electrical wires, attach the wiring cover.

6. Attach the wiring cover and terminal block cover to their initial positions and tighten the screws on the terminal block cover.

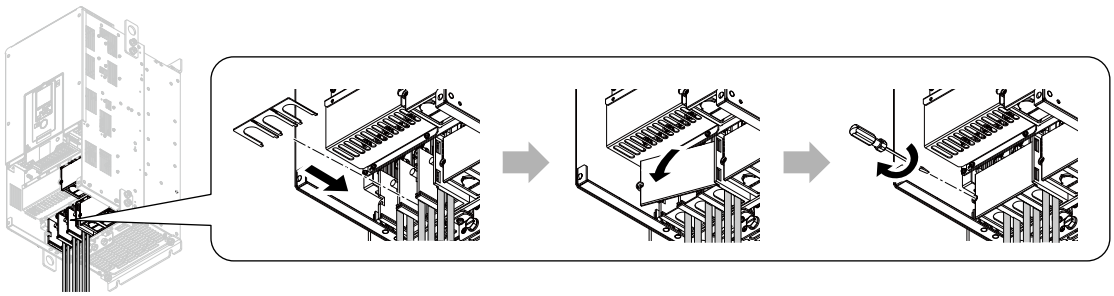


Figure 9.15 Reattach the Wiring Cover

7. Put the terminal cover back in its initial position.

◆ Main Circuit Terminal Functions

Refer to the following table for drive main circuit terminals and functions.

Table 9.3 Main Circuit Terminal Functions

<table>
<tr><th>Terminals</th><th colspan="3">Name</th><th rowspan="2">Function</th></tr>
<tr><th rowspan="2">Model</th><th>2003 - 2075</th><th>2088 - 2115</th><th>2145 - 2415</th></tr>
<tr><th>4002 - 4039</th><th>4045 - 4150</th><th>4180 - 4605</th></tr>
<tr><td>R/L1
S/L2
T/L3</td><td colspan="3">Main circuit power supply input</td><td>Connecting a commercial power supply.</td></tr>
<tr><td>U/T1
V/T2
W/T3</td><td colspan="3">Drive output</td><td>Connecting a motor.</td></tr>
<tr><td>B1
B2</td><td colspan="2">Braking resistor connection</td><td>-</td><td>Connecting a braking resistor or braking resistor unit.</td></tr>
<tr><td>+2</td><td rowspan="3">• DC power supply input (+1 and -)
• DC reactor connection (+1 and +2)</td><td colspan="2">-</td><td rowspan="4">Connecting peripheral devices such as:
• DC power input
• Braking unit
• DC Reactor
Note:
Remove the jumper between the terminals +1 and +2 when connecting a DC reactor.</td></tr>
<tr><td>+1</td><td rowspan="2">DC power supply input (+1 and -)</td><td rowspan="3">• DC power supply input (+1 and -)
• Braking unit connection (+3 and -)</td></tr>
<tr><td>-</td></tr>
<tr><td>+3</td><td colspan="2">-</td></tr>
<tr><td>⏚</td><td colspan="3">• 200 V: D class grounding (ground to 100 Ω or less)
• 400 V: C class grounding (ground to 10 Ω or less)</td><td>Grounding.</td></tr>
</table>

Note:
Use terminals B1 and - to connect a control unit (CDBR-type) to drive models 2003 to 2115 and 4002 to 4150 with built-in braking transistors.

◆ Main Circuit Wire Gauges and Tightening Torques

Select the correct wires for main circuit wiring.

Refer to *Wire Gauges and Tightening Torques on page 79* for wire gauges and tightening torques as specified by European standards.

Refer to *Wire Gauges and Tightening Torques on page 104* for wire gauges and tightening torques as specified by UL standards.

■ Wire Selection Precautions

⚠ WARNING *Electrical Shock Hazard. Make sure that the protective ground wire complies with technical standards and local safety regulations. The IEC/EN 61800-5-1:2007 standard specifies that you must wire the power supply to automatically de-energize when the protective ground wire disconnects. You can also connect a protective ground wire that has a minimum cross-sectional area of 10 mm² (copper wire) or 16 mm² (aluminum wire). If you do not obey the standards and regulations, it can cause serious injury or death. The leakage current of the drive will be more than 3.5 mA in drive models 2xxxB, 4xxxB, and 4317A to 4605A.*

Think about line voltage drop before selecting wire gauges. Select wire gauges that drop the voltage by 2% or less of the rated voltage. Increase the wire gauge and the cable length when the risk of voltage drops increases. Calculate line voltage drop with this formula:

Line voltage drop (V) = $\sqrt{3}$ × wire resistance (Ω/km) × wiring distance (m) × motor rated current (A) × 10^{-3}.

■ Precautions during Wiring

- Use terminals B1 and - to connect braking units to drives that have built-in braking transistors (models 2003 to 2115 and 4002 to 4150). Use terminals +3 and - to connect braking units to drives that do not have built-in braking transistors.
- Refer to “Yaskawa AC Drive Option Braking Unit, Braking Resistor Unit Instruction Manual (TOBPC72060001)” for information about wire gauges and tightening torques to connect braking resistor units or braking units.
- Use terminals +1 and - to connect a regenerative converter or regenerative unit.

⚠ WARNING *Fire Hazard. Do not connect a braking resistor to terminals +1 or -. Use terminals B1 and B2 for the braking resistor connections. If you connect a braking resistor to the incorrect terminals, it can cause damage to the drive and braking circuit and serious injury or death.*

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■ Main Circuit Wire Gauges and Tightening Torques

⚠ WARNING *Electrical Shock Hazard. Make sure that the protective ground wire complies with technical standards and local safety regulations. The IEC/EN 61800-5-1:2007 standard specifies that you must wire the power supply to automatically de-energize when the protective ground wire disconnects. You can also connect a protective ground wire that has a minimum cross-sectional area of 10 mm² (copper wire) or 16 mm² (aluminum wire). If you do not obey the standards and regulations, it can cause serious injury or death. The leakage current of the drive will be more than 3.5 mA in drive models 2xxxB, 4xxxB, and 4317A to 4605A.*

Note:

- The recommended wire gauges are based on drive continuous current ratings with 75 °C (167 °F) 600 V class 2 heat-resistant indoor PVC wire. Assume these conditions:
  - –Ambient temperature: 40 °C (104 °F) maximum
  - –Wiring distance: 100 m (3281 ft) maximum
  - –Rated current value
- Use terminals +1, +2, +3, -, B1, and B2 to connect a peripheral option such as a DC reactor or a braking resistor. Do not connect other items to these terminals.
- Refer to the instruction manual for each device for recommended wire gauges to connect peripheral devices or options to terminals +1, +2, +3, -, B1, and B2. Contact Yaskawa or your nearest sales representative if the recommended wire gauges for the peripheral devices or options are out of the range of the applicable gauges for the drive.

Three-Phase 200 V Class

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2003	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2005	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2008	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2011	R/L1, S/L2, T/L3	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	3.5	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2014	R/L1, S/L2, T/L3	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	5.5	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2018	R/L1, S/L2, T/L3	8	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	3.5 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2025	R/L1, S/L2, T/L3	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	8	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	3.5	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	5.5	5.5 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)
2033	R/L1, S/L2, T/L3	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	22	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	5.5	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	5.5	5.5 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2047	R/L1, S/L2, T/L3	22	2 - 22 (8 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	14	2 - 14 (5.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	38	2 - 38 (8 - 38)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	8 - 14 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2060	R/L1, S/L2, T/L3	38	2 - 38 (22 - 38)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	22	2 - 22 (14 - 22)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	50	2 - 50 (22 - 50)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	8 - 22 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2075	R/L1, S/L2, T/L3	50	2 - 50 (22 - 50)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	30	2 - 30 (14 - 30)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	60	2 - 60 (22 - 60)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	14	14 - 22 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2088	R/L1, S/L2, T/L3	38	22 - 38 (22 - 38)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	38	22 - 38 (22 - 38)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	60	30 - 60 (30 - 60)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	22	8 - 22 (8 - 22)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	14	14 - 38 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
2115	R/L1, S/L2, T/L3	60	22 - 60 (38 - 60)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	60	22 - 60 (38 - 60)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	80	30 - 80 (50 - 80)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	30	8 - 30 (8 - 30)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	22	22 - 38 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2145	R/L1, S/L2, T/L3	80	50 - 100 (80 - 100)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	80	50 - 125 (80 - 125)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4 *5	38	22 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3 *5	60	30 - 80 (50 - 80)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	22	22 - 60 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2180	R/L1, S/L2, T/L3	100	50 - 100 (80 - 100)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	125	50 - 125 (80 - 125)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4 *5	50	22 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3 *5	80	30 - 80 (50 - 80)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	22	22 - 60 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2215	R/L1, S/L2, T/L3	60 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	80 × 2P	30 - 125 × 2P (100 - 125 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	50 × 2P	22 - 60 × 2P (50 - 60 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	22	22 - 200 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2283	R/L1, S/L2, T/L3	80 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	80 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	100 × 2P	30 - 125 × 2P (100 - 125 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	60 × 2P	22 - 60 × 2P (50 - 60 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	38	38 - 200 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2346	R/L1, S/L2, T/L3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	150 × 2P	100 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	80 × 2P	38 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	⏚	38	38 - 200 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2415	R/L1, S/L2, T/L3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	150 × 2P	100 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	80 × 2P	38 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	⏚	60	60 - 200 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

*1 For IP20 protection, use wires that are in the range of applicable gauges.
*2 Remove insulation from the ends of wires to expose the length of wire shown.
*3 For wire gauges more than 30 mm², tighten to a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf·in to 40 lbf·in).
*4 Terminals - and +1 have two screws. The Recommended Gauge is the wire gauge for one terminal.
*5 A junction terminal is necessary to connect a braking unit (CDBR-series) to terminals - and +3.

Three-Phase 400 V Class

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4002	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4003	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4005	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4006	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4007	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4009	R/L1, S/L2, T/L3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	3.5	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4015	R/L1, S/L2, T/L3	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	5.5	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	2 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)
4018	R/L1, S/L2, T/L3	8	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	5.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	2 - 22 (2 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2	2 - 5.5 (2 - 5.5)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	3.5	3.5 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4024	R/L1, S/L2, T/L3	14	2 - 22 (8 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	8	2 - 14 (5.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	14	2 - 38 (8 - 38)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	3.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	5.5	5.5 - 14 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4031	R/L1, S/L2, T/L3	14	2 - 22 (8 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	14	2 - 14 (5.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	22	2 - 38 (8 - 38)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	5.5	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	5.5 - 14 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4039	R/L1, S/L2, T/L3	14	2 - 14 (3.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	14	2 - 14 (5.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	22	2 - 22 (3.5 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	8	2 - 8 (2 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	8 - 22 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4045	R/L1, S/L2, T/L3	14	2 - 14 (3.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	14	2 - 14 (5.5 - 14)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	22	2 - 22 (3.5 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	8 - 22 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4060	R/L1, S/L2, T/L3	22	2 - 22 (3.5 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	22	2 - 22 (3.5 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	30	2 - 30 (3.5 - 30)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	2 - 14 (2 - 14)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	14	14 - 38 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4075	R/L1, S/L2, T/L3	30	2 - 30 (5.5 - 30)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	30	2 - 30 (5.5 - 30)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	38	2 - 38 (22 - 38)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	22	2 - 22 (3.5 - 22)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	⏚	22	14 - 38 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4091	R/L1, S/L2, T/L3	38	22 - 60 (38 - 60)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	38	22 - 60 (38 - 60)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	50	30 - 80 (50 - 80)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	30	8 - 30 (8 - 30)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	22	14 - 38 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4112	R/L1, S/L2, T/L3	60	50 - 100 (80 - 100)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	60	50 - 125 (80 - 125)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4	30	22 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2 *5	50	30 - 80 (50 - 80)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	22	22 - 60 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4150	R/L1, S/L2, T/L3	80	50 - 100 (80 - 100)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	80	50 - 125 (80 - 125)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4	38	22 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2 *5	60	30 - 80 (50 - 80)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	22	22 - 60 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4180	R/L1, S/L2, T/L3	50 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	80 × 2P	30 - 125 × 2P (100 - 125 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	38 × 2P	22 - 60 × 2P (50 - 60 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	22	22 - 200 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4216	R/L1, S/L2, T/L3	50 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	80 × 2P	30 - 125 × 2P (100 - 125 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	50 × 2P	22 - 60 × 2P (50 - 60 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	30	22 - 200 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4260	R/L1, S/L2, T/L3	80 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	80 × 2P	22 - 100 × 2P (80 - 100 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	100 × 2P	30 - 125 × 2P (100 - 125 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	60 × 2P	22 - 60 × 2P (50 - 60 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	30	30 - 200 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4304	R/L1, S/L2, T/L3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	125 × 2P	100 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	100 × 2P	38 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	⏚	38	30 - 200 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4371	R/L1, S/L2, T/L3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	125 × 2P	60 - 125 × 2P (125 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	150 × 2P	100 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	125 × 2P	38 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	⏚	60	38 - 200 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4414	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	125 × 4P	60 - 125 × 4P (125 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	100 × 4P	60 - 150 × 4P (125 - 150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	100 × 4P	80 - 150 × 4P (150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	80 × 4P	30 - 125 × 4P (100 - 125 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	60	50 - 150 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4453	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	125 × 4P	60 - 125 × 4P (125 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	100 × 4P	60 - 150 × 4P (125 - 150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	100 × 4P	80 - 150 × 4P (150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	80 × 4P	30 - 125 × 4P (100 - 125 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	60	60 - 150 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4605	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	125 × 4P	60 - 125 × 4P (125 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	100 × 4P	60 - 150 × 4P (125 - 150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	125 × 4P	80 - 150 × 4P (150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	100 × 4P	30 - 125 × 4P (100 - 125 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	60	60 - 150 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

*1 For IP20 protection, use wires that are in the range of applicable gauges.
*2 Remove insulation from the ends of wires to expose the length of wire shown.
*3 For wire gauges more than 30 mm², tighten to a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf·in to 40 lbf·in).
*4 Terminals - and +1 have two screws. The Recommended Gauge is the wire gauge for one terminal.
*5 A junction terminal is necessary to connect a braking resistor unit (LKEB-series) to terminals B1 and B2.

◆ Motor and Main Circuit Connections

⚠ WARNING *Electrical Shock Hazard. Do not connect terminals R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, -, +1, +2, +3, B1, or B2 to the ground terminal. If you connect these terminals to earth ground, it can cause damage to the drive or serious injury or death.*

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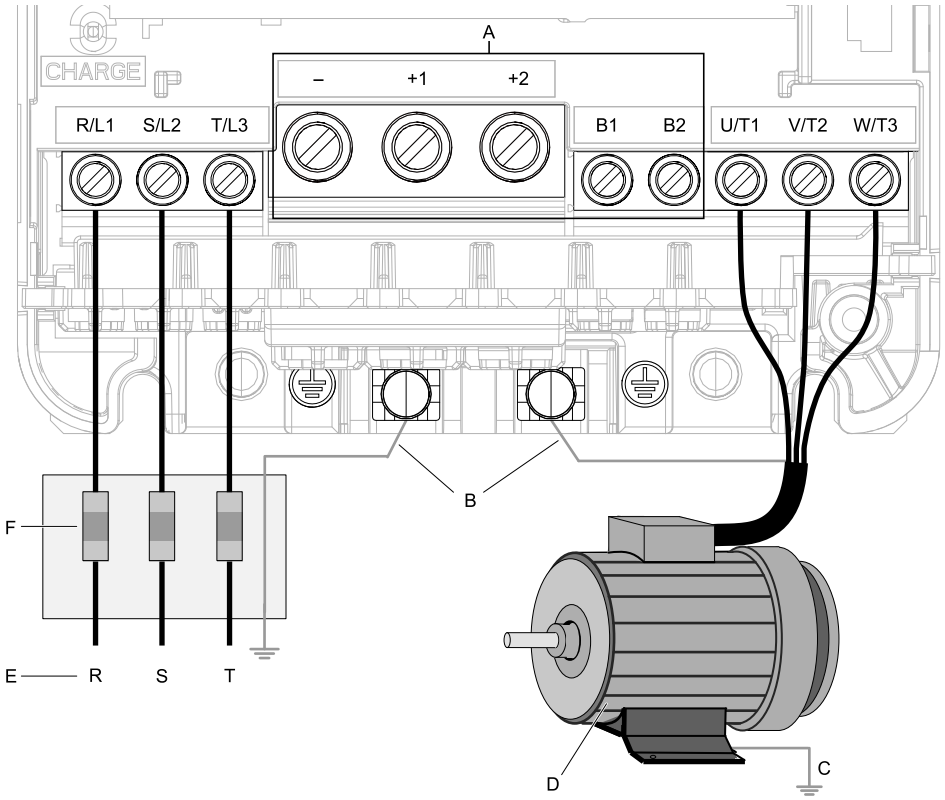


Note:
The location of terminals are different for different drive models.

A - DC bus terminal
B - Connect to the drive ground terminal.
C - Ground the motor case.
D - Three-Phase Motor
E - Use R, S, T for input power supply.
F - Input Protection (Fuses or Circuit Breakers)

Figure 9.16 Wiring the Main Circuit and Motor

◆ Control Circuit Terminal Block Functions

Hx-xx parameters set functions for the multi-function input and output terminals.

⚠ WARNING *Sudden Movement Hazard. Correctly wire and test all control circuits to make sure that the control circuits operate correctly. If you use a drive that has incorrect control circuit wiring or operation, it can cause death or serious injury.*

⚠ WARNING *Sudden Movement Hazard. Check the I/O signals and the external sequences for the drive before you set the Application Preset function. When you set the Application Preset function (A1-06 ≠ 0), it changes the I/O terminal functions for the drive and it can cause equipment to operate unusually. This can cause serious injury or death.*

NOTICE *Damage to Equipment. Do not energize and de-energize the drive more frequently than one time each 30 minutes. If you frequently energize and de-energize the drive, it can cause drive failure.*

■ Input Terminals

Refer to Table 9.4 for a list of input terminals and functions.
Text in parenthesis indicates the default setting for each multi-function output.

Table 9.4 Multi-function Digital Input Terminals

Mode	Terminals	Name (Default)	Function (Signal Level)
Digital Inputs	S1	Multi-function input selection 1 (ON: Forward run OFF: Stop)	• Photocoupler • 24 V, 6 mA **Note:** Install the wire jumpers between terminals SC-SP and SC-SN to set the MFDI power supply. • SINK Mode: Install a jumper between terminals SC and SP. Do not short circuit terminals SC and SN. Failure to obey will cause damage to the drive. • SOURCE Mode: Install a jumper between terminals SC and SN. Do not short circuit terminals SC and SP. Failure to obey will cause damage to the drive. • External power supply: No jumper necessary between terminals SC-SN and terminals SC-SP.
	S2	Multi-function input selection 2 (ON: Reverse run OFF: Stop)	
	S3	Multi-function input selection 3 (External fault (N.O.))	
	S4	Multi-function input selection 4 (Fault reset)	
	S5	Multi-function input selection 5 Brake Release Check	
	S6	Multi-function input selection 6 (Multi-step speed reference 1)	
	S7	Multi-function input selection 7 (Multi-step speed reference 2)	
	S8	Multi-function input selection 8 Baseblock Command (N.C.)	
	S9	Multi-function input selection 9 (Through Mode)	
	S10	Multi-function input selection 10 (Through Mode)	
	SN	Multi-function input power supply 0 V	MFDI power supply and sensor power supply, 24 Vdc (max. 150 mA) **Note:** Do not short circuit terminals SP and SN. Failure to obey will cause damage to the drive.
	SC	Multi-function input selection common	
	SP	Multi-function input power supply +24 Vdc	
Safe Disable Input	H1	Safe Disable input 1	Remove the jumper between terminals H1-HC and H2-HC when using the Safe Disable input. • 24 V, 6 mA • ON: Normal operation • OFF: Coasting motor • Internal impedance 4.7 kΩ • OFF time of at least 2 ms
	H2	Safe Disable input 2	
	HC	Safe Disable function common	
Master Frequency Reference	+V	Power supply for frequency setting	10.5 Vdc (allowable current 20 mA max.)
	-V	Power supply for frequency setting	-10.5 Vdc (allowable current 20 mA max.)
	A1	Multi-function analog input 1 (Master frequency reference)	Voltage input Select the signal level with *H3-01 [Terminal A1 Signal Level Select]*. • -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ) • 0 V to 10 V/100% (input impedance: 20 kΩ)
	A2	Multi-function analog input 2 (Combined to terminal A1)	Voltage input or current input Select the signal level with DIP switch S1 and *H3-09 [Terminal A2 Signal Level Select]*. • -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ) • 0 V to 10 V/100% (input impedance: 20 kΩ) • 4 mA to 20 mA/100%, 0 mA to 20 mA/100% (input impedance: 250 Ω)
	A3	Multi-function analog input 3/PTC input (Auxiliary frequency reference)	Voltage input Select the signal level with *H3-05 [Terminal A3 Signal Level Select]*. • -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ) • 0 V to 10 V/100% (input impedance: 20 kΩ) PTC input (Motor Overheat Protection) Set DIP switch S4 to “PTC” to set terminal A3 for PTC input.
	AC	Frequency reference common	0 V
	E (G)	Shielded cable	-

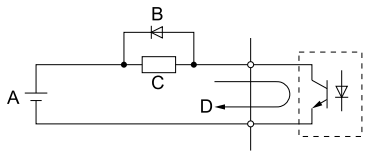
■ Output Terminals

Refer to Table 9.5 and Table 9.6 for a list of output terminals and functions.
Text in parenthesis indicates the default setting for each multi-function output.

EN

Table 9.5 Control Circuit Output Terminals

Mode	Terminals	Name (Default)	Function (Signal Level)
Fault relay output	MA	N.O. output (Fault)	• Relay output • DC30 V, 10 mA to 1 A • AC250 V, 10 mA to 1 A • Minimum load: 5 V, 10 mA (Reference value)
	MB	N.C. output (Fault)	
	MC	Digital output common	
Digital Outputs	M1	Digital Outputs (Brake Release Command)	• Relay output • DC30 V, 10 mA to 1 A • AC250 V, 10 mA to 1 A • Minimum load: 5 V, 10 mA (Reference value) **Note:** Switching life is estimated at 8,000,000 times (assumes 30 mA, inductive load) or 200,000 times (assumes 1 A, resistive load). When switching inductive load such as relay coils, connect surge absorbing element in parallel against the load for effective protection of relay contact.
	M2		
	M3	Digital Outputs (During run)	
	M4		
	M5	Digital Outputs (Speed agree 1)	
	M6		
Multi-function photocoupler output	P1	Multi-function photocoupler output (Drive operation ready (READY))	• Photocoupler output • 48 V, 2 mA to 50 mA **Note:** Connect a flywheel diode as shown in Figure 9.17 when driving a reactive load such as a relay coil. Ensure the diode rating is greater than the circuit voltage.
	C1		
	P2	Multi-function photocoupler output (Minor Fault)	
	C2		



A - External power, 48 V max.
B - Flywheel diode
C - Coil
D - 50 mA or less

Figure 9.17 Connecting a Flywheel Diode

Table 9.6 Control Circuit Monitor Output Terminals

Mode	Terminals	Name (Default)	Function (Signal Level)
Monitor output	FM	Analog monitor output 1 (Output frequency)	Voltage output • 0 V to +10 V/0% to 100% • -10 V to +10 V/-100% to +100% **Note:** Select with *H4-07 [MFAO Term FM Signal Level Select]* or *H4-08 [MFAO Term AM Signal Level Select]*.
	AM	Analog monitor output 2 (Output current)	
	AC	Monitor common	0 V

■ External Power Supply Input Terminals

Refer to Table 9.7 for a list of the functions of the external power supply input terminals.

Table 9.7 External Power Supply Input Terminals

Type	Terminal	Name (Default)	Function
External Power Supply Input Terminals	PS	External 24 V power supply input	Supplies backup power to the drive control circuit, keypad, and option board. 21.6 VDC to 26.4 VDC, 700 mA
	AC	External 24 V power supply ground	0 V

■ Serial Communication Terminals

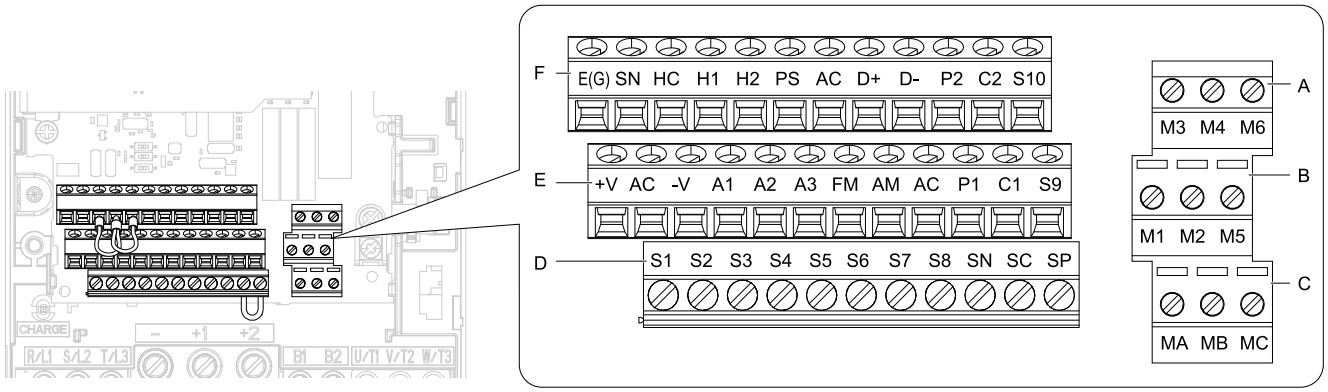
Refer to Table 9.8 for a list of serial communication terminals and functions.

Table 9.8 Serial Communication Terminals

Type	Terminal	Terminal Name	Function (Signal Level)	
Modbus Communication	D+	Communication input/output (+)	MEMOBUS/Modbus communications Use an RS-485 cable to connect the drive. **Note:** Set DIP switch S2 to ON to enable the termination resistor in the last drive in a MEMOBUS/Modbus network.	• RS-485 • MEMOBUS/Modbus communication protocol • Maximum 115.2 kbps
	D-	Communication output (-)		
	AC	Shield ground	0 V	

◆ Terminal Configuration

Control circuit terminals should are arranged as shown in the following figure.



A - Terminal block (TB2-3)
B - Terminal block (TB2-2)
C - Terminal block (TB2-1)
D - Terminal block (TB1)
E - Terminal block (TB3)
F - Terminal block (TB4)

Figure 9.18 Control Circuit Terminal Arrangement

The tightening torque for terminals is displayed on the reverse side of the front cover.

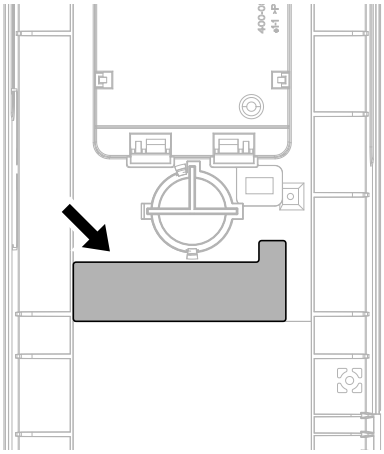


Figure 9.19 Tightening Torque Display (the Reverse Side of the Front Cover)

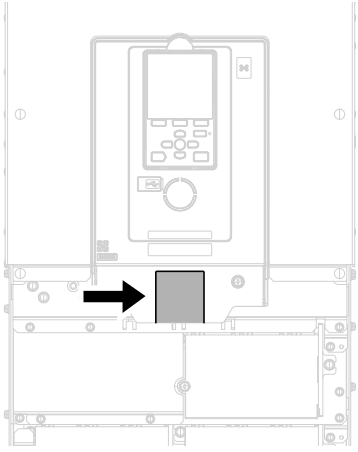


Figure 9.20 Tightening Torque Display (the below side of the front cover)

■ Control Circuit Wire Gauges and Tightening Torques

Use the tables in this section to select the correct wires. Use shielded wire to wire the control circuit terminal block. Use crimp ferrules on the wire ends to make the wiring procedure easier and more reliable.

EN

The tightening torque for the terminal screws is shown on the reverse side or the lower front side of the drive front cover.

Table 9.9 Main Circuit Wire Gauges and Tightening Torques

Terminal	Screw Size	Tightening Torque N·m (lbf·in)	Bare Wire		Crimp Ferrule	
			Recomm. Gauge mm² (AWG)	Applicable Gauge mm² (AWG)	Recomm. Gauge mm² (AWG)	Applicable Gauge mm² (AWG)
S1-S10, SC, SN, SP H1, H2, HC, SN +V, -V, A1, A2, A3, AC MA, MB, MC, M1 - M6 P1, C1, P2, C2 FM, AM, AC D+, D-, AC PS, E (G)	M3	0.5 - 0.6 (4.4 - 5.3)	0.75 (18)	• Stranded wire 0.2 - 1.0 (24 - 18) • Solid wire 0.2 - 1.5 (24 - 16)	0.5 (20)	0.25 - 0.5 (24 - 20)

Crimp Ferrules

Attach an insulated sleeve when you use crimp ferrules. Refer to the table for the recommended external dimensions and model numbers of the crimp ferrules.

Use the CRIMPFOX 6, a crimping tool made by PHOENIX CONTACT.

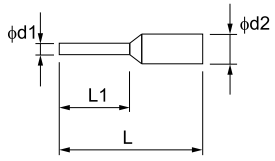


Figure 9.21 External Dimensions of Crimp Ferrules

Table 9.10 Crimp Ferrule Models and Sizes

Wire Gauge mm² (AWG)	Model	L (mm)	L1 (mm)	d1 (mm)	d2 (mm)
0.25 (24)	AI 0.25-8YE	12.5	8	0.8	2.0
0.34 (22)	AI 0.34-8TQ	12.5	8	0.8	2.0
0.5 (20)	AI 0.5-8WH, AI 0.5-8OG	14	8	1.1	2.5

◆ Wiring the Control Circuit Terminal

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch circuit boards while the drive is energized. If you touch the internal components of an energized drive, it can cause serious injury or death.*

NOTICE *Do not let wire shields touch other signal lines or equipment. Insulate the wire shields with electrical tape or shrink tubing. If you do not insulate the wire shields, it can cause a short circuit and damage the drive.*

Note:

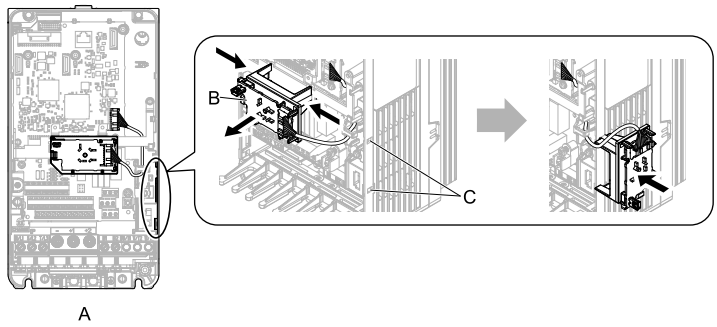
- Isolate control circuit wiring from main circuit wiring (terminals R/L1, S/L2, T/L3, B1, B2, U/T1, V/T2, W/T3, -, +1, +2) and other high-power wiring. If control circuit wiring is adjacent to main circuit wiring, it can cause incorrect operation of the drive and equipment from electrical interference.
- Isolate wiring for contact output terminals MA, MB, MC and M1-M6 from other control circuit wiring. If contact output terminal wiring is adjacent to other control circuit wiring, it can cause incorrect operation of the drive and equipment from electrical interference.
- Use a Class 2 power supply to connect external power to the control terminals. If the power supply for peripheral devices is incorrect, it can cause a decrease in drive performance.
- Connect the shield of shielded cable to the applicable ground terminal. Incorrect equipment grounding can cause drive or equipment malfunction from electrical interference.

Correctly ground the drive terminals and complete main circuit wiring before you wire the control circuit. Remove the keypad and front cover.

1. Push in on the tabs on the both sides of the LED status ring board to release the board from the bracket. Pull the board forward to remove it.

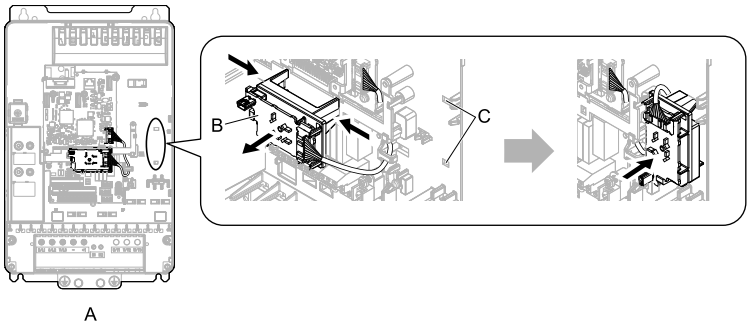
   NOTICE *When you remove the LED Status Board from the drive bracket, make sure that you temporarily install it in the holding position provided on the drive. If you cause damage to the LED status ring board, the LEDs will not function correctly.*

Note:
You can temporarily store the LED status ring board with the temporary placement holes on the drive. The location of the temporary placement holes is different on different drive models.



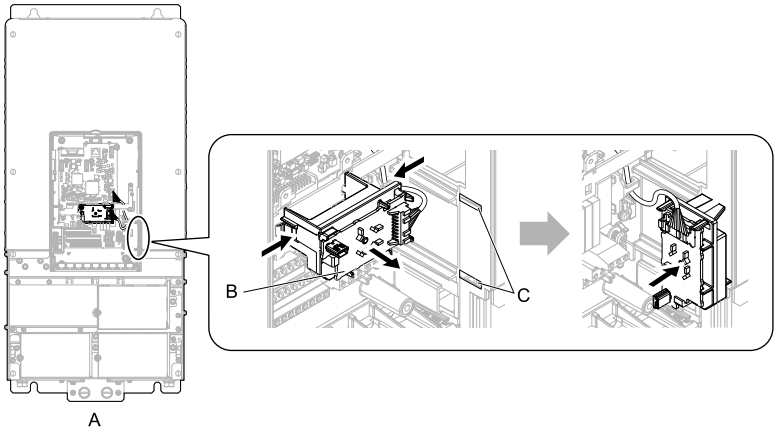
A - Drive front
B - LED status ring board
C - Temporary placement holes

Figure 9.22 Remove the LED Status Ring Board



A - Drive front
B - LED status ring board
C - Temporary placement holes

Figure 9.23 Remove the LED Status Ring Board



A - Drive front
B - LED status ring board
C - Temporary placement holes

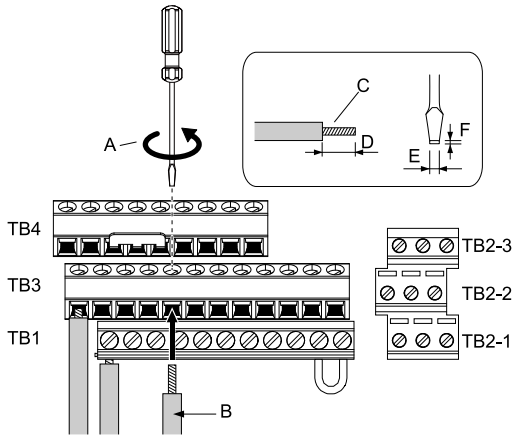
Figure 9.24 Remove the LED Status Ring Board

2. Refer to the figure and wire the control circuit.

⚠ WARNING *Fire Hazard. Tighten all terminal screws to the correct tightening torque. Connections that are too loose or too tight can cause incorrect operation and damage to the drive. Incorrect connections can also cause death or serious injury from fire.*

Note:
- Use shielded, twisted-pair wires and ground the shield to the ground terminal of the drive. Incorrect equipment grounding can cause drive or equipment malfunction from electrical interference.
- Do not use control circuit wiring that is longer than 50 m (164 ft) to supply the analog frequency reference from a remote source. If the control circuit wiring is too long, it can cause unsatisfactory system performance.

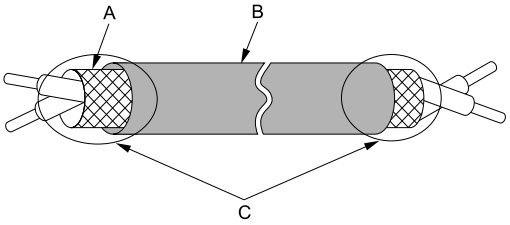
EN



A - Loosen the screws and put the wire into the opening on the terminal block.
B - Wire with a crimp ferrule attached, or unsoldered wire with the core wires lightly twisted
C - Pull back the shielding and lightly twist the end with your fingers to keep the ends from fraying.
D - When you do not use crimp ferrules, remove approximately 5.5 mm (0.21 in) of the covering at the end of the wire.
E - Blade width of 2.5 mm (0.1 in) or less
F - Blade thickness of 0.4 mm (0.01 in) or less

Figure 9.25 Wiring Procedure for the Control Circuit

Note:
- Do not solder the core wire. Soldered wiring connections can become loose and cause the drive to malfunction.
- Tighten all terminal screws to the correct tightening torque. Connections that are too loose or too tight can cause incorrect operation and damage to the drive. Incorrect connections can also cause death or serious injury from fire.
- Refer to Figure 9.26 for information to prepare terminal ends of the shielded wire.
- Prepare the wire ends of shielded twisted-pair wires as shown in Figure 9.26 to use an analog reference from an external frequency setting potentiometer to set the frequency. Connect the shield to terminal E (G) of the drive.



A - Connect the shield to terminal E (G) of the drive.
B - Sheath
C - Insulate with electrical tape or shrink tubing.

Figure 9.26 Prepare the Ends of Shielded Wire

3. Put the cable through the clearance in the wiring cover.

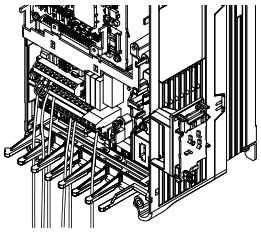


Figure 9.27 Control Circuit Wiring

4. Install the LED status ring board, front cover, and the keypad to their initial positions.

◆ Switches and Jumpers on the Terminal Board

The terminal board is equipped with several switches used to adapt the drive I/Os to the external control signals as shown in the Figure 9.28.

Set the switches to select the functions for the respective terminals.

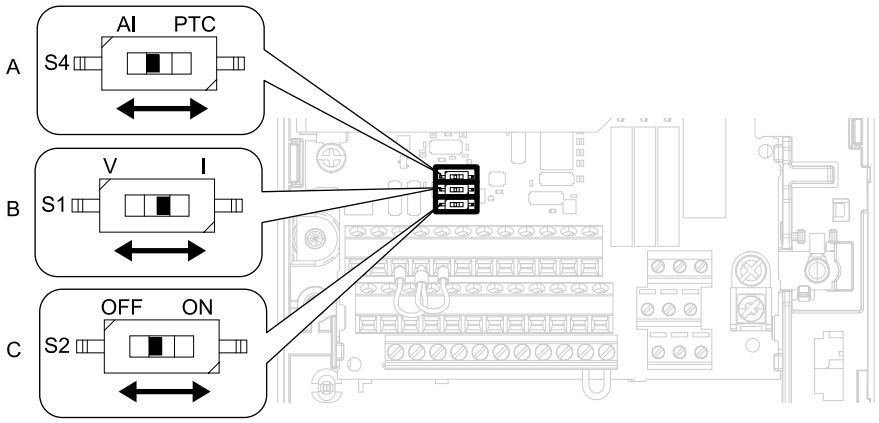


Figure 9.28 Locations of Switches

Table 9.11 I/O Terminals and Switches Functions

Position	Switch	Terminal	Function	Default
A	Dip switch S4	A3	Selects MFAI or PTC input.	AI (analog input)
B	DIP switch S1	A2	Selects the input signal type (voltage/current).	I (current input)
C	DIP switch S2	-	Enables or disables the MEMOBUS/Modbus communications termination resistor.	OFF

◆ Control I/O Connections

This section explains the settings for the listed I/O signals for the control circuit.

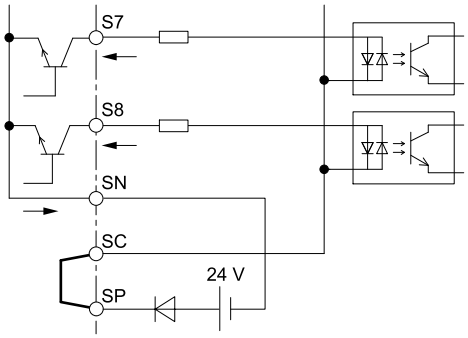
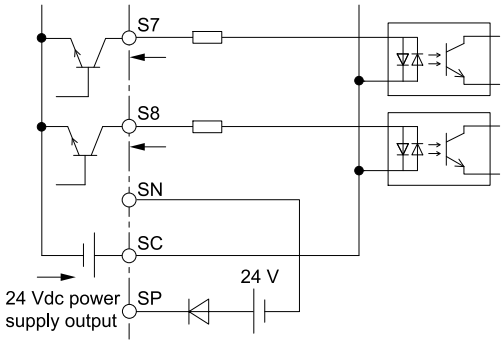
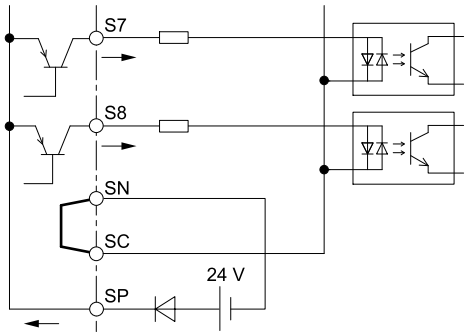
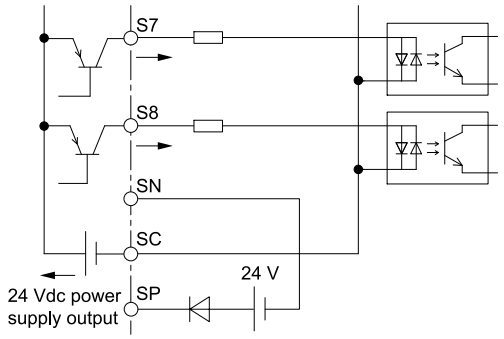
- Multi-function digital input (terminals S1 to S10)
- Multi-function digital output (terminals M1 to M6)
- Multi-function photocoupler output (terminals P1, C1, P2, C2)
- Multi-function analog input (terminals A1 to A3)
- PTC input (terminal A3)
- Multi-function analog monitor output (terminals FM, AM)
- MEMOBUS/Modbus communications (terminal D+, D-, AC)

■ Set Sinking Mode/Sourcing Mode

Close the circuit between terminals SC-SP and SC-SN to set the sinking mode/sourcing mode and the internal/external power supply for the MFDI terminals. The default setting for the drive is internal power supply sinking mode.

NOTICE *Damage to Equipment. Do not close the circuit between terminals SP-SN. If you close the circuits between terminals SC-SP and terminals SC-SN at the same time, it will cause damage to the drive.*

EN

Mode	Internal Power Supply (Terminal SN-SP)	External 24 V power supply
Sinking Mode (NPN)		
Sourcing Mode (PNP)		

■ Select Input Signals for Multi-Function Analog Input Terminals A1 to A3

Terminal A1 and A3 are set to voltage input. Terminal A2 can be used to input either a voltage or a current signal. Set the signal type as shown in the following table.

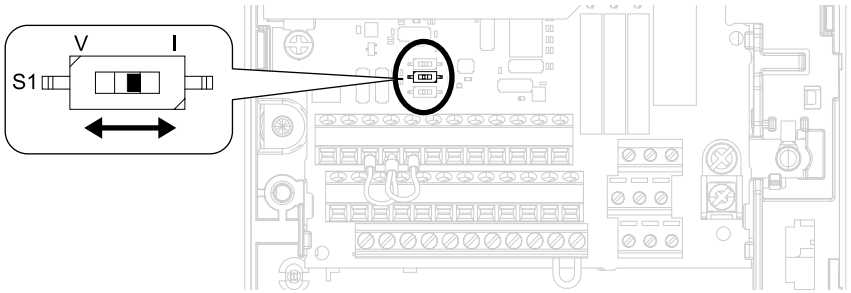


Figure 9.29 Location of DIP Switch S1

Terminal	Input Signal	DIP Switch Settings		Parameters	
		Switch	Setting	No.	Signal Level
A1	Voltage input	-	-	H3-01	0: 0 V to 10 V/100% (input impedance: 20 kΩ) 1: -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ)
A2	Voltage input	S1	V	H3-09	0: 0 V to 10 V/100% (input impedance: 20 kΩ) 1: -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ)
	Current input		I (Default)		2: 4 mA to 20 mA/100% (input impedance: 250 Ω) 3: 0 mA to 20 mA/100% (input impedance: 250 Ω)
A3	Voltage input	S4	AI (Default)	H3-05	0: 0 V to 10 V/100% (input impedance: 20 kΩ) 1: -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ)

Note:
- To set both A1 and A2 to frequency reference, set *H3-02, H3-10 = 0 [Terminal A1 Function Selection, Terminal A2 Function Selection = Frequency Bias]*. Both analog input values will be combined to create the frequency reference.
- To set DIP switches, use tweezers or a jig that has a tip of approximately 0.8 mm.
- To use terminal A3 as a voltage input terminal, set DIP switch S4 to "AI". The default setting of DIP switch S4 is "AI".

■ Set Multi-Function Analog Input Terminal A3 to PTC Input

Terminal A3 can be configured either as multi-function analog input, or as PTC input for motor overload protection.

Use DIP switch S4 to select the input function.

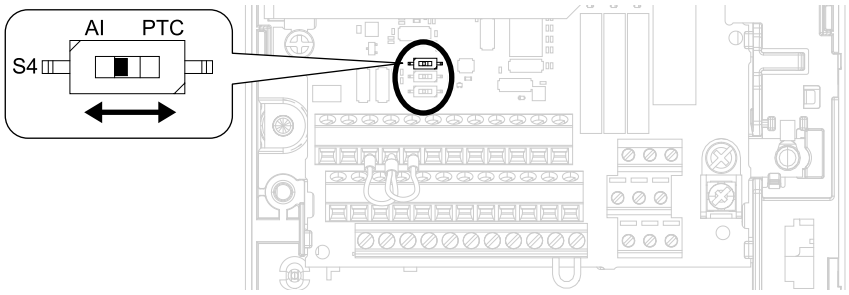


Figure 9.30 Location of DIP Switch S4

Terminal	Settings for DIP Switches	Description
A3	AI (Default)	Functions as multi-function analog input terminal. Select the function with *H3-06 [Terminal A3 Function Selection]*. Select the signal level with *H3-05 [Terminal A3 Signal Level Select]*. • 0: 0 V to 10 V/100% (input impedance: 20 kΩ) • 1: -10 V to +10 V/-100% to +100% (input impedance: 20 kΩ)
	PTC	Functions as PTC input terminal. Set *H3-06 = E [Motor Temperature (PTC input)]*. Set *H3-05 = 0 [0 to 10 V]*.

■ Switch ON Termination Resistor for MEMOBUS/Modbus Communications

Set DIP switch S2 to the ON position when the drive is the last slave in a MEMOBUS/Modbus communications. This drive is equipped with a built-in termination resistor for the RS-485 interface.

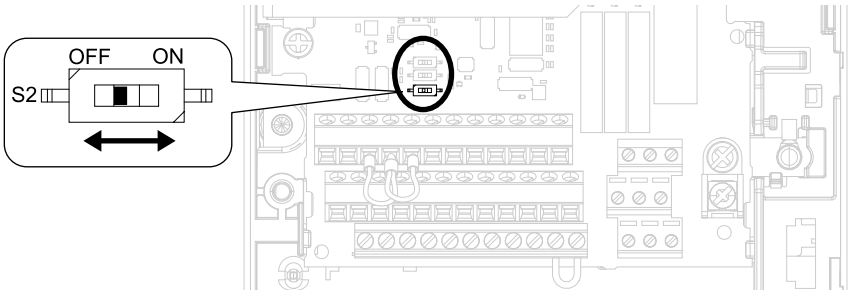


Figure 9.31 Location of DIP Switch S2

Table 9.12 MEMOBUS/Modbus Communications Termination Resistor Setting

DIP Switch S2	Description
ON	The built-in termination resistor is switched ON.
OFF (default)	The built-in termination resistor is switched OFF.

10 Drive Start-Up

EN

◆ Setup Wizard

The drive is prepared to run the operation. Use the motor data for Auto-Tuning and test runs.

1. Energize the drive to show the initial setup screen.

Note:

If the keypad does not show the Initial Setup screen, push F2 [Menu] to show the Menu screen then push F2 to select [Initial Setup].

2. Select [Set Date/Time] to set the date and time.

Note:

Open the clock battery cover to put in a battery to use the clock functions. Use a Hitachi Maxell “CR2016 Lithium Manganese Dioxide Lithium Battery” or an equivalent battery with these properties:
• Voltage: 3 V
• Operating temperature range: -20°C to +85°C (-4°F to +185°F)

3. Use *A1-06 [Application Preset]* and *A1-02 [Control Method Selection]* to do Auto-Tuning if necessary.

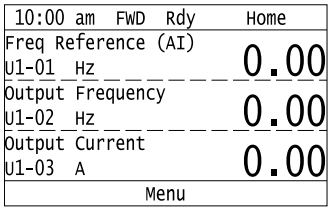
◆ Change Parameter Setting Values

This example shows how to change the setting value for *C1-01 [Acceleration Time 1]*. Do the steps in this procedure to set parameters for the application.

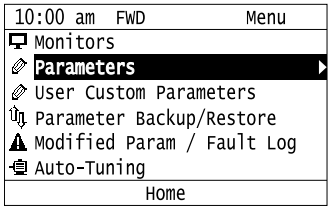
1. Push F2 (Home) to show the HOME screen.

Note:
- When the drive is in HOME Mode, the screen shows [Home] in the upper right-hand corner of the screen.
- If [Home] is not shown above the F2, push F1 (Back).

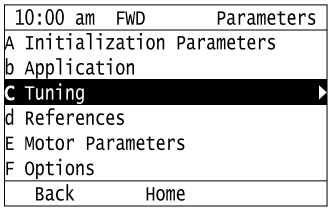
2. Push F2 (Menu).



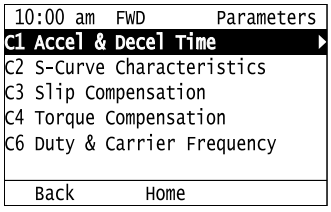
3. Push ▲ or ▼ to select [Parameters], then push ↵.



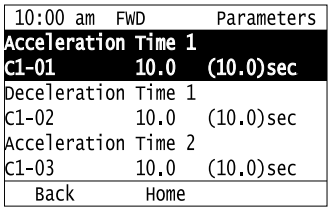
4. Push ▲ or ▲ to select [C Tuning], then push ↵.



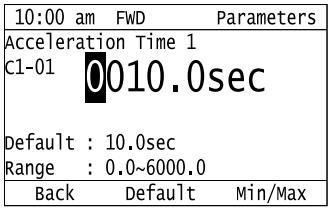
5. Push ▲ or ▼ to select [C1 Accel & Decel Time], then push ↵.



6. Push ▲ or ▼ to select *C1-01*, then push ↵.

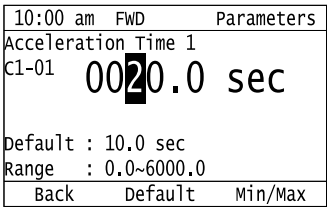


7. Push ◀ or ▶ to select the specified digit, then push ▲ or ▼ to select the correct number.



- Push F2 [Default] to set the parameter to factory default.
- Push F3 [Min/Max] to show the minimum value or the maximum value on the display.

8. Push ↵ to keep the changes.



9. Continue to change parameters, then push F1 [Back], F2 [Home] to go back to the home screen after you change all the applicable parameters.

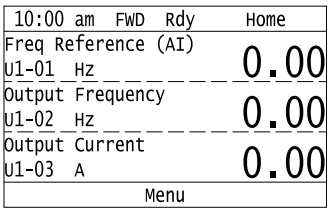
◆ Disable the Initial Setup Screen

Do the steps in this procedure to not show the initial start-up screen when the drive is energized.

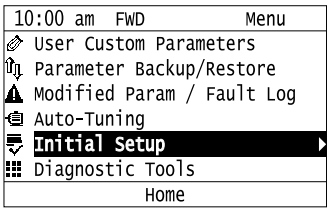
1. Push F2 (Home) to show the HOME screen.

Note:
- When the drive is in HOME Mode, the screen shows [Home] in the upper right-hand corner of the screen.
- If the screen does not show [Home] for F2, push F1 (Back), and then push F2 to show [Home].

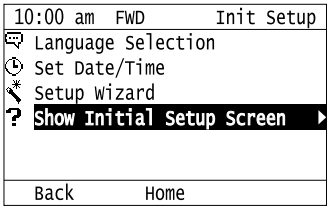
2. Push F2 (Menu).



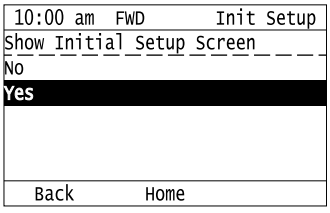
3. Push ∧ / ∨ to select [Initial Setup], then push ↵.



4. Push ∧ / ∨ to select [Show Initial Setup Screen], then push ↵.



5. Push ∧ / ∨ to select [No], then push ↵.



- [No]: The keypad will not show the Initial Setup Screen when the drive is energized.
- [Yes]: The keypad will show the Initial Setup Screen when the drive is energized.

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11 Maintenance

Only let authorized persons do maintenance, examine, or replace components on the drive.

Read this manual carefully and know all the precautions and safety information before installing, wiring, repairing, or examining the drive or replacing components.

Examine and maintain the drive and peripheral devices regularly to extend the life of the drive and decrease performance deterioration, decrease early wear, and decrease drive failures.

Regular examinations and maintenance will also decrease system downtime.

Refer to the Technical Manual for more information about maintenance and examinations.

Examine the drive one time each year at a minimum.

The operating conditions, environmental conditions, and use conditions will have an effect on the examination frequency for connected equipment.

Examine the drive more frequently if you use the drive in bad conditions or in these conditions:

- High ambient temperatures
- Frequent starting and stopping
- Changes in the AC power supply or load
- Too much vibration or shock loading
- Dust, metal dust, salt, sulfuric acid, or chlorine atmospheres
- Unsatisfactory storage conditions.

The drive has Maintenance Monitors that keep track of component wear and warn maintenance period when the estimated performance life is approaching. This Maintenance Monitor eliminates the need to shut down the entire system for unexpected problems.

Users can set alarm notifications to inform the maintenance periods for a specific drive component.

12 Drive Control, Duty Modes, and Programming

◆ Application Preset

⚠ WARNING *Sudden Movement Hazard. Check the I/O signals and the external sequences for the drive before you set the Application Preset function. When you set the Application Preset function (A1-06 ≠ 0), it changes the I/O terminal functions for the drive and it can cause equipment to operate unusually. This can cause serious injury or death.*

The drive software contains the application presets shown below. Set *A1-06 [Application Selection]* to align with the application to let the drive automatically set the best parameter settings for the selected application.

Set application preset as necessary. The device changes the related parameters based on *A1-06* as shown in Table 12.1.

Application	A1-06	Description
Crane (Hoist)	1	The drive automatically sets the parameters for a hoist application. **Note:** Make sure that you do Auto-Tuning after you set *A1-06* for a hoist application.
Crane (Traveling)	2	The drive automatically sets the parameters for a traveling application.
Closed Loop Crane (Hoist)	3	The drive automatically sets the parameters for a closed loop crane (hoist) application. **Note:** After you set *A1-06* for a closed loop crane (hoist) application, make sure that you do Auto-Tuning.

Note:

- Before you set *A1-06*, make sure that you set *A1-03 = 2220 [Initialize Parameters = 2-Wire Initialization]* to initialize parameters.
- It is not possible to change the *A1-06* value. To set an application preset, set *A1-03 = 2220* to initialize parameters, then set this parameter. If initializing all parameters will cause a problem, do not change the settings.

Table 12.1 A1-06 Setting Values and Best Parameter Settings

No.	Name	Application Preset (A1-06 Setting)		
		Crane (Hoist) (1)	Crane (Traveling) (2)	Closed Loop Crane (Hoist) (3)
A1-02	Control Method Selection	2: Open Loop Vector	0: V/f Control	3: Closed Loop Vector Control
b1-01	Frequency Reference Selection 1	0: Keypad	0: Keypad	0: Keypad
C1-01	Acceleration Time 1	3.0 s	3.0 s	3.0 s

No.	Name	Application Preset (A1-06 Setting)		
		Crane (Hoist) (1)	Crane (Traveling) (2)	Closed Loop Crane (Hoist) (3)
C1-02	Deceleration Time 1	3.0 s	3.0 s	3.0 s
C1-09	Fast Stop Time	2.0 s	2.0 s	2.0 s
d1-01	Reference 1	5.00 Hz	5.00 Hz	5.00 Hz
d1-02	Reference 2	25.00 Hz	25.00 Hz	25.00 Hz
d1-03	Reference 3	50.00 Hz	50.00 Hz	50.00 Hz
E1-03	V/f Pattern Selection	F: Custom	-	F: Custom
F1-05	Encoder 1 Rotation Selection	-	-	1: Pulse B leads in FWD Direction
H1-05	Terminal S5 Function Selection	-	3: Multi-Step Speed Reference 1	-
H1-06	Terminal S6 Function Selection	-	4: Multi-Step Speed Reference 2	-
H1-07	Terminal S7 Function Selection	-	6: Jog Reference Selection	-
H2-01	Term M1-M2 Function Selection	21: Brake Release Command	0: During Run	21: Brake Release Command
H2-02	Term M3-M4 Function Selection	1: Zero Speed	37: During Frequency Output	1: Zero Speed
H3-06	Terminal A3 Function Selection	F: Not Used	F: Not Used	F: Not Used
L2-03	Minimum Baseblock Time	0.1 s	-	0.1 s
L3-04	Stall Prevention during Decel	0: Disabled	0: Disabled	0: Disabled
L4-01	Speed Agree Detection Level	0.0 Hz	-	-
L4-02	Speed Agree Detection Width	0.0 Hz	-	-
L8-05	Input Phase Loss Protection Sel	1: Enabled	1: Enabled	1: Enabled
L8-07	Output Phase Loss Protection Sel	1: Enabled	1: Enabled	1: Enabled
L8-38	Carrier Frequency Reduction	1: Enabled below 6 Hz	1: Enabled below 6 Hz	1: Enabled below 6 Hz
L8-41	High Current Alarm Selection	1: Enabled	1: Enabled	1: Enabled
S1-01	Brake Release Frequency (FWD)	2.0 Hz	0.0 Hz	0.0 Hz
S1-02	Brake Release Frequency (REV)	2.0 Hz	0.0 Hz	0.0 Hz
S1-03	Brake Delay Frequency	3.0 Hz	0.0 Hz	0.0 Hz
S1-04	Brake Delay Time	0.30 s	0.00 s	0.00 s
S1-09	Torque Compensation (FWD)	50%	-	0%
S1-12	Brake Hold Frequency (FWD)	3.0 Hz	0.0 Hz	3.0 Hz
S1-13	Brake Hold Frequency (REV)	3.0 Hz	0.0 Hz	3.0 Hz
S1-14	Slip Prevention Frequency	3.0 Hz	0.0 Hz	0.0 Hz
S1-15	Slip Prevention Time	0.30 s	0.00 s	0.00 s
S1-16	Sequence Fault SE1 Detect Time	0.30 s	0.00 s	0.30 s
S1-17	Sequence Fault SE2 Detect Time	1.00 s	0.00 s	1.00 s
S1-18	Sequence Fault SE3 Detect Time	0.50 s	0.00 s	0.50 s
S1-19	Sequence Fault SE4 Detect Time	0.50 s	0.00 s	0.50 s
S1-54	Brake Sequence Selection	1: Enabled	0: Disabled	1: Enabled

Note:

When *A1-06 [Application Preset] ≠ 0*, the drive shows different parameters on the keypad for different application presets. Set *A1-13 [All Function Parameter Display] = 0* to show all available parameters.

◆ Control Method Selection

This section describes the following basic control methods:

- V/f Control
- Open Loop Vector Control

Refer to the Technical Manual for details on speed feedback motor control methods.

Select the most suitable control method for the application. The device performs control based on *A1-02 [Control Method Selection]*.

Control Method Selection	A1-02	Main Applications
V/f	0	• General-purpose variable speed control for multiple motors in particular (applications connecting multiple motors to a single drive) • When motor parameters are not available
Open Loop Vector Control	2 (Default)	• General-purpose variable speed control • Applications that require high-performance without machine encoders

◆ Auto-Tuning

⚠ WARNING *Injury to Personnel. Rotational Auto-Tuning rotates the motor at 50% or more of the motor rated frequency. Make sure that there are no issues related to safety in the area around the drive and motor. Increased motor frequency can cause serious injury or death.*

⚠ WARNING *Sudden Movement Hazard. Before you do Rotational Auto-Tuning, disconnect the load from the motor. The load can move suddenly and cause serious injury or death.*

Auto-Tuning automatically sets parameters on the drive connected to the motor. You must input some parameters individually during Auto-Tuning.

1. Select [Auto-Tuning] from the main menu to select the Auto-Tuning Mode.
2. Use the information in Table 12.2 to set *T1-01 [Auto-Tuning Mode Selection]*.
3. Push RUN to start Auto-Tuning.
   Refer to the Technical Manual for more information about Auto-Tuning.

Table 12.2 Auto-Tuning Mode Selection

Type	T1-01	Application Conditions and Benefits	A1-02 [Control Method Selection]	
			0 (V/f)	2 (OLV)
Rotational Auto-Tuning	0	• When you can decouple the motor and load and the motor can rotate freely while Auto-Tuning. • When operating motors that have fixed output characteristics. • When it is necessary to use motors that have high-precision control. Yaskawa recommends that you do Rotational Auto-Tuning to enable the most accurate motor control. • When you cannot decouple the motor and load, and the motor load is less than 30%.	-	Yes
Stationary Auto-Tuning 1	1	• When you cannot decouple the motor and load, but the motor load is more than 30%. • When the information from the motor test report or motor nameplate is not available. With Stationary Auto-Tuning, the energized drive stays stopped for approximately 1 minute. During this time, the drive automatically measures the necessary motor parameters. • When operating the motor with a light load after Auto-Tuning. The drive can automatically calculate the motor parameter settings necessary for torque control. Set *T1-12 = 1 [Test Mode Selection = Yes]* to do a test run after Auto-Tuning.	-	Yes
Line-to-Line Resistance	2	• After Auto-Tuning, the wiring distance between the drive and motor changed by 50 m or more. • When the wiring distance is 50 m or more in the V/f Control mode. • When the motor output and drive capacity are different.	Yes	Yes

Table 12.3 Input Data for Auto-Tuning

Item	Value
Motor Rated Power	kW
Motor Rated Voltage	V
Motor Rated Current (FLA)	A
Motor Base Frequency	Hz
Motor Maximum Frequency	Hz
Number of Poles	
Motor Base Speed	min^{-1}
Number of Motor Encoder Pulses *1	ppr
Motor No-Load Current *2	A
Motor Rated Slip Frequency *2	Hz

*1 Input this value when *A1-02 = 3 [Control Method Selection = Closed Loop Vector]*.
*2 Input this value when you do stationary Auto-Tuning. Prepare motor data from the motor test report. If the motor test report is not available, do not change this parameter.

◆ Drive Parameters

This section shows the most common parameters for applications. Refer to this table when you set parameters.

No. (Hex.)	Name	Description
A1-00 (0100) RUN	Language Selection	Sets the language for the LCD keypad. 0: English, 1: Japanese, 7: Chinese
A1-02 (0102)	Control Method Selection	Sets the control method for the drive application and the motor. 0: V/f Control, 1: V/f Control with Encoder, 2: Open Loop Vector, 3: Closed Loop Vector, 4: Advanced Open Loop Vector
A1-03 (0103)	Initialize Parameters	Sets parameters to default values. 0: No Initialization, 1110: User Initialization, 2220: 2-Wire Initialization
A1-06 (0127)	Application Preset	Sets the drive to operate in selected application conditions. 0: General-purpose, 1: Crane (Hoist), 2: Crane (Traveling), 3: Closed Loop Crane (Hoist)
b1-01 (0180)	Frequency Reference Selection 1	Sets the input method for the frequency reference. 0: Keypad, 1: Analog Input, 2: Memobus/Modbus Communications, 3: Option PCB
b1-02 (0181)	Run Command Selection 1	Sets the input method for the Run command. 0: Keypad, 1: Analog Input, 2: Memobus/Modbus Communications, 3: Option PCB
b1-03 (0182)	Stopping Method Selection	Sets the method to stop the motor after removing a Run command or entering a Stop command. 0: Ramp to Stop, 1: Coast to Stop, 2: DC Injection Braking to Stop, 3: Coast to Stop with Timer
b1-04 (0183)	Reverse Operation Selection	Sets the reverse operation function. 0: Reverse Enabled, 1: Reverse Disabled
C1-01 (0200) RUN	Acceleration Time 1	Sets the length of time to accelerate from zero to maximum output frequency.
C1-02 (0201) RUN	Deceleration Time 1	Sets the length of time to decelerate from maximum output frequency to zero.
C2-01 (020B)	S-Curve Time @ Start of Accel	Sets the S-curve acceleration time at start.
C2-02 (020C)	S-Curve Time @ End of Accel	Sets the S-curve acceleration time at completion.
C2-03 (020D)	S-Curve Time @ Start of Decel	Sets the S-curve deceleration time at start.
C2-04 (020E)	S-Curve Time @ End of Decel	Sets the S-curve deceleration time at completion.
C6-02 (0224)	Carrier Frequency Selection	Sets the switching frequency (carrier frequency) for the transistors in the drive. 1: 2.0 kHz, 2: 5.0 kHz, 3: 8.0 kHz, 4: 10.0 kHz, 5: 12.5 kHz, 6: 15.0 kHz, F: User Defined (C6-03 to C6-05)
d1-01 - d1-15 (0280 - 0290) RUN	Reference 1 to 15	Sets the frequency reference in the units from *o1-03 [Frequency Display Unit Selection*.
d1-17 (0292) RUN	Jog Reference	Sets the frequency reference in the units from *o1-03 [Frequency Display Unit Selection]*. Set *H1-xx = 6 [MFDI Function Select = Jog Reference Selection]* to use the Jog frequency reference.
d2-01 (0289)	Frequency Reference Upper Limit	Sets maximum limit for all frequency references. The maximum output frequency is 100%.
d2-02 (028A)	Frequency Reference Lower Limit	Sets minimum limit for all frequency references. The maximum output frequency is 100%.
E1-01 (0300)	Input AC Supply Voltage	Sets the drive input voltage.
E1-04 (0303)	Maximum Output Frequency	Sets the maximum output frequency for the V/f pattern.
E1-05 (0304)	Maximum Output Voltage	Sets the maximum output voltage for the V/f pattern.
E1-06 (0305)	Base Frequency	Sets the base frequency for the V/f pattern.
E1-09 (0308)	Minimum Output Frequency	Sets the minimum output frequency for the V/f pattern.

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No. (Hex.)	Name	Description
E2-01 (030E)	Motor Rated Current (FLA)	Sets the motor rated current in amps.
E2-11 (0318)	Motor Rated Power	Sets the motor rated power in 0.01 kW increments. (1 HP = 0.746 kW)
H1-01 - H1-10 (0438, 0439, 0400 - 0407)	Terminal Sx Function Select	Sets the functions for MFDI terminals S1 to S10.
H2-01 (040B)	Term M1-M2 Function Selection	Sets the function for MFDO terminal M1-M2.
H2-02 (040C)	Term M3-M4 Function Selection	Sets the function for MFDO terminal M3-M4.
H2-03 (040D)	Term M5-M6 Function Selection	Sets the function for MFDO terminal M5-M6.
H2-04 (040E)	Term P1-C1 Function Selection	Sets the function for MFDO terminal P1-C1.
H2-05 (040F)	Term P2-C2 Function Selection	Sets the function for MFDO terminal P2-C2.
H3-01 (0410)	Terminal A1 Signal Level Select	Sets the input signal level for MFAI terminal A1. 0: 0-10V (Lower Limit at 0), 1: -10 to +10V (Bipolar Reference)
H3-02 (0434)	Terminal A1 Function Selection	Sets the function for MFAI terminal A1.
H3-03 (0411) RUN	Terminal A1 Gain Setting	Sets the gain of the analog signal input to MFAI terminal A1.
H3-04 (0412) RUN	Terminal A1 Bias Setting	Sets the bias of the analog signal input to MFAI terminal A1.
H3-05 (0413)	Terminal A3 Signal Level Select	Sets the input signal level for MFAI terminal A3. 0: 0-10V (Lower Limit at 0), 1: -10 to +10V (Bipolar Reference)
H3-06 (0414)	Terminal A3 Function Selection	Sets the function for MFAI terminal A3.
H3-07 (0415) RUN	Terminal A3 Gain Setting	Sets the gain of the analog signal input to MFAI terminal A3.
H3-08 (0416) RUN	Terminal A3 Bias Setting	Sets the bias of the analog signal input to MFAI terminal A3.
H3-09 (0417)	Terminal A2 Signal Level Select	Sets the input signal level for MFAI terminal A2. 0: 0-10V (Lower Limit at 0), 1: -10 to +10V (Bipolar Reference), 2: 4 to 20 mA, 3: 0 to 20 mA
H3-10 (0418)	Terminal A2 Function Selection	Sets the function for MFAI terminal A2.
H3-11 (0419) RUN	Terminal A2 Gain Setting	Sets the gain of the analog signal input to MFAI terminal A2.
H3-12 (041A) RUN	Terminal A2 Bias Setting	Sets the bias of the analog signal input to MFAI terminal A2.
H3-13 (041B)	Analog Input FilterTime Constant	Sets the time constant for primary delay filters on MFAI terminals.
H3-14 (041C)	Analog Input Terminal Enable Sel	Sets the enabled terminal or terminals when *H1-xx = C [MFDI Function Select = Analog Terminal Enable Selection]* is ON. 1: Terminal A1 only, 2: Terminal A2 only, 3: Terminals A1 and A2, 4: Terminal A3 only, 5: Terminals A1 and A3, 6: Terminals A2 and A3, 7: Terminals A1, A2, and A3
H4-01 (041D)	Terminal FM Analog Output Select	Sets the monitor number to send from MFAO terminal FM.
H4-02 (041E) RUN	Terminal FM Analog Output Gain	Sets the gain of the *Ux-xx* monitor signal set in *H4-01 [terminals FM Monitor Selection]*.
H4-03 (041F) RUN	Terminal FM Analog Output Bias	Sets the bias of the *Ux-xx* monitor signal set in *H4-01 [Terminal FM Analog Output Select]*.

No. (Hex.)	Name	Description
H4-04 (0420)	Terminal AM Analog Output Select	Sets the monitoring number to be output from the MFAO terminal AM.
H4-05 (0421) RUN	Terminal AM Analog Output Gain	Sets the gain of the *Ux-xx* monitor signal set in *H4-04 [terminals AM Monitor Selection]*.
H4-06 (0422) RUN	Terminal AM Analog Output Bias	Sets the bias of the *Ux-xx* monitor signal set in *H4-04 [terminals AM Monitor Selection]*.
H4-07 (0423)	Terminal FM Signal Level Select	Sets the MFAO terminal FM output signal level. 0: 0-10V (Lower Limit at 0), 1: -10 to +10V (Bipolar Reference)
H4-08 (0424)	Terminal AM Signal Level Select	Sets the MFAO terminal AM output signal level. 0: 0-10V (Lower Limit at 0), 1: -10 to +10V (Bipolar Reference)
L1-01 (0480)	Motor Overload (oL1) Protection	Sets the motor overload protection with electronic thermal protectors. 0: Disable, 1: Variable Torque, 2: Constant Torque 10:1 Speed Range, 3: Constant Torque 100:1 SpeedRange, 6: Variable Torque (50Hz)
L1-02 (0481)	Motor Overload Protection Time	Sets the operation time for the electronic thermal protector of the drive to prevent damage to the motor. Usually it is not necessary to change this setting.
L3-04 (0492)	Stall Prevention during Decel	Sets the method that the drive will use to prevent overvoltage faults when it decelerates. 0: Disable, 1: General Purpose, 2: Intelligent (Ignore Accel Ramp), 3: General Purpose w/ DB resistor, 4: Overexcitation/High Flux 1, 5: Overexcitation/High Flux 2
S1-54 (06FD)	Brake Sequence Selection	Enables and disables operation toward a brake sequence. 0: Disable, 1: Enabled

13 Troubleshooting

If the drive or motor do not operate correctly, look at the drive keypad for fault and alarm information.

- For drive faults:
  - The keypad shows the fault code.
  - 

and ALM/ERR on the LED Status Ring illuminate continuously.
  - The drive shuts off output and the fault relay output activates. The motor coasts to stop.
- For drive alarms:
  - The keypad shows the alarm code.
  - 

and ALM/ERR on the LED Status Ring flash.
  - Usually, the drive will continue to operate the motor. Some alarms let you select a motor stopping method.

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◆ Fault Reset

1. Remove the cause of the fault or alarm.
2. While the keypad is showing the fault or alarm code, push F1 (RESET) or > on the keypad.

This table lists the most frequent faults and alarms with possible causes and solutions.
Refer to the Technical Manual for a full list of faults and alarms.

◆ Fault

This section gives information about some of the causes and possible solutions of faults. You must use the Fault Reset operation to remove the fault before you can operate the drive. Use the information in this table to remove the cause of the fault.

Code	Name	Causes	Possible Solutions
bAT	Keypad Battery Low Voltage	The keypad battery voltage is low.	Replace the keypad battery.
bCE	Bluetooth Communication Fault	The smartphone or tablet with DriveWizard Mobile installed is too far from the keypad.	Use the smartphone or tablet 10 m (32.8 ft) or nearer to the keypad. **Note:** *bCE* can occur when the smartphone or tablet is 10 m (32.8 ft) or nearer to the keypad depending on the specifications of the smartphone or tablet.
		Radio waves from a different device are causing interference with communications between the smartphone or tablet and keypad.	Make sure that no device around the keypad uses the same radio bandwidth (2400 MHz to 2480 MHz), and prevent radio interference.
boL	BrakingTransistor Overload Fault	The duty cycle of the braking transistor is high (the regeneration power or repetition frequency is high).	• Install a braking unit (CDBR-series). • Install a regenerative converter. • Increase the deceleration time.
bUS	Option Communication Error	The drive did not receive a signal from the controller.	Correct wiring errors.
CE	Modbus Communication Error	The communications cable wiring is incorrect.	Correct wiring errors.
		There is a short circuit in the communications cable or the communications cable is not connected.	• Repair short circuits and connect cables. • Replace the defective communications cable.
		Electrical interference caused a communication data error.	• Examine the control circuit lines, main circuit lines, and ground wiring, and decrease the effects of electrical interference. • Make sure that a magnetic contactor is not the source of the electrical interference, then use a Surge Protective Device if necessary. • Use only the recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Separate the communication wiring from drive power lines, and install a noise filter to the input side of the power supply for communication. • Decrease the effects of electrical interference from the controller.
CF	Control Fault	Motor parameters are set improperly.	Correctly set the motor parameters and do Auto-Tuning again.
CoF	Current Offset Fault	Drive starts operation while the induced voltage remains in the motor (during coasting to a stop or after rapid deceleration).	Specify a sequence in which operation is not restarted when induced voltage remains in the motor.
		A drive hardware problem occurred.	Replace the drive.
CP1	Comparator 1 Limit Fault	The monitor value set in *H2-20 [Comparator 1 Monitor Selection]* was within the range of *H2-21 [Comparator 1 Lower Limit]* and *H2-22 [Comparator 1 Upper Limit]*.	Examine the monitor value setting and remove the cause of the fault.
CP2	Comparator 2 Limit Fault	The monitor value set in *H2-26 [Comparator 2 Monitor Selection]* was outside the range of *H2-27 [Comparator 2 Lower Limit]* and *H2-28 [Comparator 2 Upper Limit]*.	Examine the monitor value setting and remove the cause of the fault.
CPF00 to CPF03, CPF07 to CPF08, CPF11 to CPF14, CPF16 to CPF24, and CPF26 to CPF39	Control Circuit Error	A drive hardware problem occurred.	• Re-energize the drive. • If the fault stays, replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
CPF06	EEPROM Memory Data Error	The drive power supply was switched off while the parameter Write command was entered from a communications option card.	Set *A1-03 = 2220 [Initialize Parameters = 2-Wire initialization]* and initialize the drive.
		An EEPROM peripheral circuit error occurred.	• Re-energize the drive and check if the fault still remains. • If the fault stays, replace the control board or the drive. For instructions on replacing the control board, contact Yaskawa or your nearest sales representative.
CPF25	Terminal Board not Connected	The terminal board is not correctly connected to the drive.	1. De-energize the drive. 2. Correctly connect the terminal board to the drive. 3. Re-energize the drive.
dEv	Speed Deviation	The load is too heavy.	Decrease the load.
E5	MECHATROLINK Watchdog Timer Err	The drive detected a watchdog circuit exception while it received data from the controller.	Examine the MECHATROLINK cable connection. If this error occurs frequently, examine the wiring and decrease the effects of electrical interference as specified by these manuals: • MECHATROLINK-II Installation Guide (MECHATROLINK Members Association, manual number MMATDEP011) • MECHATROLINK-III Installation Manual (MECHATROLINK Members Association, publication number MMATDEP018)

Code	Name	Causes	Possible Solutions
EF0	Option Card External Fault	The communication option received an external fault from the controller.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input from the controller.
EF1	External Fault (Terminal S1)	MFDI terminal S1 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF2	External Fault (Terminal S2)	MFDI terminal S2 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF3	External Fault (Terminal S3)	MFDI terminal S3 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF4	External Fault (Terminal S4)	MFDI terminal S4 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF5	External Fault (Terminal S5)	MFDI terminal S5 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF6	External Fault (Terminal S6)	MFDI terminal S6 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF7	External Fault (Terminal S7)	MFDI terminal S7 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF8	External Fault (Terminal S8)	MFDI terminal S8 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF9	External Fault (Terminal S9)	MFDI terminal S9 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
EF10	External Fault (Terminal S10)	MFDI terminal S10 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
Err	EEPROM Write Error	There was a problem with the EEPROM hardware.	• Re-energize the drive. • If the fault stays, replace the control board or the drive. Contact Yaskawa or your nearest sales representative to replace the board.
FAn	Internal Fan Fault	The circulation fan stopped operating correctly.	• Examine circulation fan operation. • Re-energize the drive. • Examine *U4-03 [Cooling Fan Ope Time]* and *U4-04 [Cool Fan Maintenance]*. If the performance life of the circulation fan is expired or if there is damage to the fan, replace the fan.
FAn1	Drive Cooling Fan Fault	The cooling fan stopped operating correctly.	• Examine cooling fan operation. • Re-energize the drive. • Examine *U4-03 [Cooling Fan Ope Time]* and *U4-04 [Cool Fan Maintenance]*. If the performance life of the cooling fan is expired or if there is damage to the fan, replace the fan.
		The circulation fan is damaged.	• Examine circulation fan operation. • Re-energize the drive. • Examine *U4-03 [Cooling Fan Ope Time]* and *U4-04 [Cool Fan Maintenance]*. If there is damage to the circulation fan or if the performance life of the fan is expired, replace the fan.
GF	Ground Fault	The motor is damaged from overheat or the motor insulation is deteriorated.	Measure the motor insulation resistance, and replace the motor if there is electrical conduction or unserviceable insulation.
		The motor main circuit cable is contacting ground to make a short circuit.	• Examine the motor main circuit cable for damage, and repair short circuits. • Measure the resistance between the motor main circuit cable and the ground terminal. If there is electrical conduction, replace the cable.
		An increase in the stray capacitance of the cable and the ground terminal caused an increase in the leakage current.	• If the wiring length of the cable is more than 100 m, decrease the carrier frequency. • Decrease the stray capacitance.
		There was a problem with the drive hardware.	Replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
LF	Output Phase Loss	The motor main circuit cable is disconnected.	Connect motor main circuit cable wiring. Correct wiring errors in the main circuit drive input power.
nSE	Node Setup Error	The *H1-xx = 47 [Node Setup (CANopen)]* terminal was activated during run.	Stop the drive when the Node Setup function is in use.

EN

Code	Name	Causes	Possible Solutions
oC	Overcurrent	The load is too heavy.	• Measure the current flowing into the motor. • Replace the drive with a larger capacity model if the current value exceeds the drive rated current. • Reduce the load or switch to a larger drive to avoid sudden changes in the current level.
		The motor is damaged from overheat or the motor insulation is deteriorated.	Measure the motor insulation resistance, and replace the motor if there is electrical conduction or unserviceable insulation.
		The motor main circuit cable is contacting ground to make a short circuit.	• Examine the motor main circuit cable for damage, and repair short circuits. • Measure the resistance between the motor main circuit cable and the ground terminal. If there is electrical conduction, replace the cable.
		The output transistor of the drive has been damaged due to a short circuit or ground fault on the drive output side.	• Make sure terminal B1 and terminals U/T1, V/T2, and W/T3 are not shorted. Also make sure terminal - and terminals U/T1, V/T2, and W/T3 are not shorted. • If a short circuit has occurred, contact Yaskawa or your nearest sales representative.
		The acceleration/deceleration time is too short.	• Calculate the torque necessary during acceleration related to the load inertia and the specified acceleration time. • Increase the value set in *C1-01, C1-03, C1-05, or C1-07 [Acceleration Time]* until the necessary torque is achieved. • Increase the value set in *C2-01 to C2-04 [S-Curve Characteristics]* until the necessary torque is achieved. • Replace the drive with a larger capacity model.
		The drive is trying to operate a specialized motor or a motor that is larger than the maximum applicable motor output of the drive.	• Examine the motor nameplate and reevaluate the motor and drive to make sure that the drive rated current is larger than the motor rated current. • Replace the drive with a larger capacity model.
		A magnetic contactor was switched at the output.	Set up the operation sequence so the magnetic contactor is not turned ON/OFF while the drive is outputting voltage.
		The V/f pattern settings are incorrect.	• Examine the ratios between the V/f pattern frequency and voltage. Decrease the voltage if it is too high compared to the frequency. • Adjust *E1-xx [V/f Pattern Parameters]* settings. For motor 2, adjust *E3-xx [V/f Pattern for Motor 2]* settings. For motor 3, adjust *E7-xx [V/f Pattern for Motor]* settings.
		Torque compensation gain is too large.	Decrease the value set in *C4-01 [Torque Compensation Gain]* so that the motor does not stall.
		A malfunction occurred due to noise.	Check the control circuit lines, main circuit lines, and ground wiring, and minimize the effects of electrical interference.
		The gain during overexcitation operation is set too large.	• Identify the timing under which the fault occurs. • If the fault occurs simultaneously with overexcitation operation, reduce the value set in *n3-13 [Overexcitation Deceleration Gain]*, considering the motor flux saturation.
		The drive received a Run command while the motor was coasting.	Reevaluate the sequence to ensure that the stop command is input after the motor has come to a complete stop.
		The control method is not set correctly for the motor being used.	Set *A1-02 [Control Method Selection]* correctly.
		The motor main circuit cable is too long.	Replace the drive with a larger capacity model.
oFA00	Option Not Compatible with Port	The option connected to connector CN5-A is not compatible.	Connect the option to the correct connector. **Note:** Encoder options are not compatible with connector CN5-A.
oFA01	Option Fault/Connection Error	The option card connected to connector CN5-A is not compatible.	1. De-energize the drive. 2. Refer to the option card manual and correctly connect the option card to the connector on the drive.
oFA02	Duplicate Options	The same option cards or the same type of option cards are connected to connectors CN5-A, B, and C.	Connect the option card to the correct connector. **Note:** Use connectors CN5-C and CN5-B to connect two encoder option cards.
oFA03 to oFA06	Option Card Error Occurred at Option Port CN5-A	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFA10, oFA11	Option Card Error Occurred at Option Port CN5-A	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFA12 to oFA17	Option Card Connection Error (CN5-A)	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.

Code	Name	Causes	Possible Solutions
oFA30 to oFA43	Communication Option Card Connection Error (CN5-A)	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFb00	Option Not Compatible with Port	The option connected to connector CN5-B is not compatible.	Connect the option to the correct connector. **Note:** DO-A3, AO-A3, PG-B3, and PG-X3 options can connect to connector CN5-B. To connect only one PG option card, use the CN5-C connector.
oFb01	Option Fault/Connection Error	The option card connected to connector CN5-B was changed during operation.	1. De-energize the drive. 2. Refer to the option card manual and correctly connect the option card to the connector on the drive.
oFb02	Duplicate Options	The same option cards or the same type of option cards are connected to connectors CN5-A, B, and C.	Connect the option card to the correct connector.
oFb03 to oFb11	Option Card Error Occurred at Option Port CN5-B	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFb12 to oFb17	Option Card Error Occurred at Option Port CN5-B	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFC00	Option Not Compatible with Port	The option connected to connector CN5-C is not compatible.	Connect the option to the correct connector. **Note:** AI-A3, DI-A3, and communication options cannot be connected to the CN5-C connector.
oFC01	Option Fault/Connection Error	The option card connected to connector CN5-C was changed during operation.	1. De-energize the drive. 2. Refer to the option card manual and correctly connect the option card to the connector on the drive.
oFC02	Duplicate Options	The same option cards or the same type of option cards are connected to connectors CN5-A, B, and C.	Connect the option card to the correct connector.
oFC03 to oFC11	Option Card Error Occurred at Option Port CN5-C	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFC12 to oFC17	Option Card Error Occurred at Option Port CN5-C	A fault occurred in the option card.	1. De-energize the drive. 2. Make sure that the option card is correctly connected to the connector. 3. If the problem continues, replace the option card.
oFC50 to oFC55	Option Card Error Occurred at Option Port CN5-C	A fault occurred in the option card.	Refer to the manual for the PG-RT3 option card.
oH	Heatsink Overheat	The ambient temperature is high and the heatsink temperature of the drive is more than the value set in *L8-02 [Overheat Alarm Level]*.	• Measure the ambient temperature. • Increase the airflow in the control panel. • Install a cooling device (cooling fan or air conditioner) to lower the ambient temperature. • Remove objects near the drive that are producing too much heat.
oH1	Heatsink Overheat	The ambient temperature is high and the heatsink temperature of the drive is more than the *oH1* detection level.	• Measure the ambient temperature. • Increase the airflow in the control panel. • Install a cooling device (cooling fan or air conditioner) to lower the ambient temperature. • Remove objects near the drive that are producing too much heat.
oH3	Motor Overheat (PTC Input)	The thermistor wiring that detects motor temperature is defective.	Correct wiring errors.
oH4	Motor Overheat Fault (PTC Input)	The motor has overheated.	• Examine the load level, acceleration/deceleration times, and motor start/stop frequency (cycle time). • Decrease the load. • Increase the values set in *C1-01 to C1-08 [Acceleration/ Deceleration Time]*. • Set *E2-01 [Motor Rated Current (FLA)]* correctly to the value specified by the motor nameplate. • Make sure that the motor cooling system is operating correctly, and repair or replace it if it is damaged. • Adjust *E1-04 to E1-10 [V/f Pattern Parameters]*. For motor 2, adjust *E3-xx [V/f Pattern for Motor 2]* settings. For motor 3, adjust *E7-xx [V/f Pattern for Motor 3]* settings. Decrease the values set in *Ex-08 [Mid Point A Voltage]* and *Ex-10 [Minimum Output Voltage]*. **Note:** If *Ex-08* and *Ex-10* are set too low, the overload tolerance will decrease at low speeds.

Code	Name	Causes	Possible Solutions
oL1	Motor Overload	The load is too heavy	Decrease the load. **Note:** The value set in *U4-16 [Motor Overload Estimate(oL1)]* must be less than 100 before *oL1* can be reset.
		The acceleration/deceleration time or cycle time is too short.	• Examine the acceleration/deceleration times and the motor start/stop frequency (cycle time). • Increase the values set in *C1-01 to C1-08 [Acceleration/ Deceleration Time]*.
		Overload occurred while running at low speed.	• Decrease the load when running at low speed. • Raise the motor speed. • If the motor is run frequently at low speeds, either replace it with one that is a size larger or use a drive dedicated motor. **Note:** If a general-purpose motor is used, overload may occur while running at low speed even when operating at below the rated current.
		L1-01 [Motor Overload Protection Select] is not set correctly.	Set *L1-01* in accordance with the motor characteristics if a drive dedicated motor is used.
		The V/f pattern does not fit the motor qualities.	• Examine the ratios between the V/f pattern frequency and voltage. Decrease the voltage if it is too high compared to the frequency. • Adjust *E1-04 to E1-10 [V/f Pattern Parameters]*. For motor 2, adjust *E3-04 to E3-10 [V/f Pattern for Motor 2]*. Decrease the values set in *E1-08 [Mid Point A Voltage]* and *E1-10 [Minimum Output Voltage]*. **Note:** If *E1-08* and *E1-10* are set too low, the overload tolerance will decrease at low speeds.
		Set *E1-06 [Base Frequency]* correctly.	Set *E1-06* correctly to the rated frequency that indicated on the motor nameplate.
		Multiple motors are running off the same drive.	Set *L1-01 = 0 [Motor Overload Protection Select = Disabled]*, and then configure a circuit to protect the motors by connecting a thermal overload relay to each motor.
		The characteristics of the electronic thermal protector and the characteristics of the motor overload do not match.	• Examine the motor characteristics and set *L1-01 [Motor Overload (oL1) Protection]* correctly. • Connect a thermal overload relay to the motor.
		The electronic thermal protector is operating at the wrong level.	Set *E2-01 [Motor Rated Current (FLA)]* correctly to the value specified by the motor nameplate.
		Motor loss due to overexcitation operation is increasing.	• Lower the value set in *n3-13 [Overexcitation Deceleration Gain]*. • Set *L3-04 ≠ 4 [Decel Stall Prevention Selection ≠ Overexcitation/High Flux]*. • Set *n3-23 = 0 [Overexcitation Operation Select = Enabled in both directions]*.
		The output current is fluctuating due to input power supply phase loss.	Make sure that there is no phase loss, and repair problems.
oL2	Drive Overload	The load is too heavy.	Decrease the load.
		The acceleration/deceleration time or cycle time is too short.	• Examine the acceleration/deceleration times and the motor start/stop frequency (cycle time). • Increase the values set in *C1-01 to C1-08 [Acceleration/ Deceleration Time]*.
		The V/f pattern does not fit the motor qualities.	• Examine the ratios between the V/f pattern frequency and voltage. Decrease the voltage if it is too high compared to the frequency. • Adjust *E1-xx [V/f Pattern Parameters]* settings. Decrease the values set in *E1-08 [Mid Point A Voltage]* and *E1-10 [Minimum Output Voltage]*. For motor 2, adjust *E3-xx [V/f Pattern for Motor 2]* settings. Decrease the values set in *E3-08 [Motor 2 Mid Point A Voltage]* and *E3-10 [Motor 2 Minimum Output Voltage]*. For motor 3, adjust *E7-xx [V/f Pattern for Motor 3]* settings. Decrease the values set in *E7-08 [Motor 3 Mid Point A Voltage]* and *E7-10 [Motor 3 Minimum Output Voltage]*. **Note:** If *Ex-08* and *Ex-10* are set too low, the overload tolerance will decrease at low speeds.
		The drive capacity is too small.	Replace the drive with a larger capacity model.
		Overload occurred while running at low speed.	• Decrease the load when running at low speed. • Replace the drive with a larger capacity model. • Decrease the value set in *C6-02 [Carrier Frequency Selection]*.
		Torque compensation gain is too large.	Decrease the value set in *C4-01 [Torque Compensation Gain]* so that the motor does not stall.

Code	Name	Causes	Possible Solutions
		The output current is fluctuating due to input power supply phase loss.	• Examine for wiring errors or disconnected wires in main circuit drive input power, and repair problems. • Make sure that there is no phase loss, and repair problems.
oL3	Overtorque Detection 1	A fault occurred on the machine. Example: The machine is locked.	Examine the machine and remove the cause of the fault.
oL4	Overtorque Detection 2	A fault occurred on the machine. Example: The machine is locked.	Examine the machine and remove the cause of the fault.
oL5	Overload Detection (oL5)	A fault occurred on the machine. Example: Overload occurred.	Examine the machine and remove the cause of the fault.
oL6	Light-load Accel 2 Fault (oL6)	The setting for hold level and fault detection level of Light-load 2 functions are not appropriate.	Adjust *S4-10 [L-L 2 Motoring Hold Level]*, *S4-12 [L-L 2 Regen Hold Level]*, and *S4-15 [L-L 2 Fault Detection Level]* settings.
oPr	Keypad Connection Fault	The keypad is not securely connected to the connector on the drive.	Examine the connection between the keypad and the drive.
oS	Overspeed	Overshoot is occurring.	Reduce *C5-01 [ASR Proportional Gain 1]* and increase *C5-02 [ASR Integral Time 1]*.
ov	Overvoltage	Deceleration time is too short and regenerative energy is flowing from the motor into the drive.	• Set *L3-04 = 1 [Stall Prevention during Decel = General Purpose]* to enable stall prevention. • Increase the value set in *C1-02, C1-04, C1-06, or C1-08 [Deceleration Time]*. • Connect a dynamic braking option to the drive. • Perform Deceleration Rate Auto-Tuning.
		The acceleration time is too short.	• Examine if sudden drive acceleration causes an overvoltage fault. • Increase the value set in *C1-01, C1-03, C1-05, or C1-07 [Acceleration Time]*. • Increase the value set in *C2-02 [S-Curve Time @ End of Accel]*.
		The braking load is too large.	Connect a dynamic braking option to the drive.
		Surge voltages are entered into input power supply.	Connect a DC reactor to the drive. **Note:** Within the same power supply system, turning phase advancing capacitors on and off, and operating thyristor converters may apply surge voltages and cause the input voltage to rise abnormally.
		The drive output cable or motor is shorted to ground (the current short to ground is charging the main circuit capacitor of the drive through the power supply).	1. Examine the motor main circuit cable, terminals, and motor terminal box, and then remove ground faults. 2. Re-energize the drive.
		The power supply voltage is too high.	Decrease the power supply voltage so that it matches the drive rated voltage.
		The braking resistor or braking resistor unit wiring is incorrect.	Correct wiring errors in the connection to the braking resistor or braking resistor unit.
		The encoder cable is incorrectly wired or disconnected.	Examine for wiring errors or disconnected wires in the encoder cable, and repair problems.
		Noise interference along the encoder cable.	Separate the encoder cable from the source of the noise such as the drive output line.
		A drive malfunction occurred due to electrical interference.	• Examine the control circuit lines, main circuit lines, and ground wiring, and decrease the effects of electrical interference. • Make sure that a magnetic contactor is not the source of the electrical interference, then use a Surge Protective Device if necessary.
		The load inertia is not set correctly.	• Examine the load inertia settings when using Stall Prevention during Deceleration function. • Adjust *L3-25 [Load Inertia Ratio]* settings in accordance with the machine.
		Motor hunting occurs.	• Adjust the parameters that control hunting. • Adjust *n1-02 [Hunting Prevention Gain Setting]* settings. • Adjust *n2-02 [Automatic Freq Regulator Time 1]* and *n2-03 [Automatic Freq Regulator Time 2]* settings.
PF	Input Phase Loss	There is a phase loss in the drive input power.	Correct errors with the wiring for main circuit drive input power.
		There is loose wiring in the drive input power terminals.	Tighten the terminal screws to the correct tightening torque.
		The drive input power voltage is changing too much.	• Examine the input power for problems. • Make the drive input power stable. • If the input power supply is good, examine the magnetic contactor on the main circuit side for problems.
		There is unsatisfactory balance between voltage phases.	• Examine the input power for problems. • Make the drive input power stable. • Set *L8-05 = 0 [Input Phase Loss Protection Sel = Disabled]*.

Code	Name	Causes	Possible Solutions
		The main circuit capacitors have become unserviceable.	• Examine the capacitor maintenance time in monitor *U4-05 [CapacitorMaintenance]*. If *U4-05* is more than 90%, replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative. • If drive input power is correct and the fault stays, replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
PGo	Encoder (PG) Feedback Loss	The encoder cable is disconnected or wired incorrectly.	Examine for wiring errors or disconnected wires in the encoder cable, and repair problems.
PGoH	Encoder (PG) Hardware Fault	The encoder cable is disconnected.	Connect any disconnected wires in the encoder cable.
rF	Braking Resistor Fault	The resistance of the dynamic braking option that is connected to the drive is too low.	Use a dynamic braking option that fits the model and duty rating of the drive.
rH	Braking Resistor Overheat	The deceleration time is too short and excessive regenerative energy is flowing back into the drive.	• Check the load level, deceleration time, and speed. • Decrease the load. • Increase the values set in *C1-02, C1-04, C1-06, or C1-08 [Deceleration Times]*. • Use a dynamic braking option that lets you use more power.
		The duty cycle is too high.	Examine the duty cycle. **Note:** When *L8-01 = 1 [3% ERF DB Resistor Protection = Enabled]*, the maximum braking duty cycle is 3%.
		The braking load is too heavy.	• Calculate the braking load and braking power again, and decrease the braking load. • Use a braking resistor that improves braking power.
		The braking resistor is not sufficient.	Use the braking resistor specifications to select a sufficient braking resistor.
rr	Dynamic Braking Transistor Fault	The drive control circuit is damaged.	• Re-energize the drive. • If the fault stays, replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
SC	Short Circuit/IGBT Failure	Overheating caused damage to the motor or the motor insulation is not satisfactory.	Measure the motor insulation resistance, and replace the motor if there is electrical conduction or unserviceable insulation.
SCF	Safety Circuit Fault	The safety circuit is broken.	Replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
SE1	Brake Sequence Fault 1 (SE1)	A forward and a reverse command were input simultaneously.	Examine the forward and reverse command sequence circuit.
SE2	Brake Sequence Fault 2 (SE2)	The motor is not connected and the current does not flow. The break release command (BR) does not turn ON.	Examine the motor circuit.
SE3	Brake Sequence Fault 3 (SE3)	Sequence Error of the Brake Circuit.	Examine the sequence circuit of brake release check signal (BX).
SE4	Brake Sequence Fault 4 (SE4)	The break release check (BX) turns ON when the break release command (BR) is OFF.	Examine the sequence circuit of brake release check signal (BX).
SvE	Zero Servo Fault	The value set in the torque limit is too small.	Adjust torque limit-related parameters *L7-01 to L7-04*.
TiM	Keypad Time Not Set	There is a battery in the keypad, but the date and time are not set.	Use the keypad to set the date and time.
Uv1	DC Bus Undervoltage	There is a phase loss in the drive input power.	Examine for wiring errors or disconnected wires in main circuit drive input power, and repair problems.
		There is loose wiring in the drive input power terminals.	Tighten the terminal screws to the correct tightening torque.
		The drive input power voltage is changing too much.	• Review the power supply voltage so that it matches the drive rated voltage. • Make the drive input power stable. • If the input power supply is good, examine the magnetic contactor on the main circuit side for problems.
		There was a loss of power.	Improve the power supply.
		The main circuit capacitors have become unserviceable.	Examine the capacitor maintenance time in monitor *U4-05 [CapacitorMaintenance]*. If *U4-05* is more than 90%, replace the control board or the drive. For more information about replacing the control board, contact Yaskawa or your nearest sales representative.
		The relay or contactor on the soft-charge bypass relay is damaged.	Examine the soft-charge bypass relay maintenance time in monitor *U4-06 [PreChargeRelayMainte]*. If *U4-06* is more than 90%, replace the control board or the drive. For more information about replacing the control board, contact Yaskawa or your nearest sales representative.

Code	Name	Causes	Possible Solutions
Uv2	Control Power Undervoltage	A drive hardware problem occurred.	• Re-energize the drive and check if the fault still remains. • Replace the control board or the entire drive if the fault continues. Contact Yaskawa or your nearest sales representative for instructions on replacing the control board.
Uv3	Soft Charge Answerback Fault	The relay or contactor on the soft-charge bypass relay is damaged.	• Re-energize the drive. • If the fault stays, replace the control board or the drive. • Check monitor *U4-06 [PreChargeRelayMainte]* shows the performance life of the soft-charge bypass relay. If *U4-06* is more than 90%, replace the board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.

◆ Minor Faults/Alarms

This section gives information about the causes and possible solutions when a minor fault or alarm occurs. Use the information in this table to remove the cause of the minor fault or alarm.

Code	Name	Causes	Possible Solutions
AEr	Station Address Setting Error (CC-Link, CANopen, MECHATROLINK)	Option card node address is outside of the acceptable setting range.	• For CC-Link communication, set *F6-10 [CC-Link Node Address]* correctly. • For MECHATROLINK communication, set *F6-20 [MECHATROLINK Station Address]* correctly. • For CANopen communication, set *F6-35 [CANopen Node ID Selection]* correctly.
bAT	Keypad Battery Low Voltage	The voltage of keypad battery is decreased.	Replace the keypad battery.
bb	Baseblock	An external baseblock command was entered through MFDI terminal S1 to S10, and the drive output stopped as shown by an external baseblock command.	Examine the external sequence and timing of the baseblock command input.
bCE	Bluetooth Communication Error	The smart device with DriveWizard Mobile installed is too far from the keypad.	Move the smart device to 10 m or nearer from the keypad. **Note:** *bCE* can occur when the smart device is 10 m or nearer to the keypad depending on the specifications of the smart device.
		Radio waves from a different device are causing interference with communications between the smart device and keypad.	Make sure that no device around the keypad uses the same radio bandwidth (2400 MHz to 2480 MHz), and prevent radio interference.
boL	Braking Transistor Overload	The duty cycle of the braking transistor is high (the regeneration power or repetition frequency is high).	• Install a braking unit (CDBR series). • Install a regenerative converter. • Increase the deceleration time.
		The braking transistor protective function is enabled when a regenerative converter is being used.	Set *L8-55 = 0 [InternalBrakingTransistorProtect = Disable]*.
		The built-in braking transistor is damaged.	Replace the drive.
bUS	Option Communication Error	The communications cable wiring is incorrect.	Correct wiring errors.
		There is a short circuit or disconnection in the communications cable.	• Repair disconnected cables and short circuits for proper wiring. • Replace a faulty communications cable with a normal one.
		Communication data error occurred due to noise.	• Examine the control circuit lines, main circuit lines, and ground wiring, and decrease the effects of electrical interference. • Make sure that a magnetic contactor is not the source of the electrical interference, then use a Surge Protective Device if necessary. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Separate all communication wiring from drive power lines, and install a noise filter to the input side of the power supply for communication. • Minimize the effects of controller noise.
		The option card is not correctly connected to the drive.	Mount the option card to the drive correctly.
		The option card is damaged.	if there are no problems with the wiring and the error continues to occur, replace the option card.
CALL	Serial Comm Transmission Error	The communications cable wiring is incorrect.	Correct wiring errors.
		There is a short circuit or disconnection in the communications cable.	• Repair disconnected cables and short circuits for proper wiring. • Replace a faulty communications cable with a normal one.
		Programming error occurred on the controller side.	Examine communications at start-up and correct programming errors.

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Code	Name	Causes	Possible Solutions
		Communications circuitry is damaged.	• Perform a self-diagnostics check. • If the problem continues, replace the control board or the entire drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
		Termination resistor setting for MEMOBUS/ Modbus communications is incorrect.	Enable the termination resistor in the last drive in a MEMOBUS/ Modbus network by setting DIP switch S2 to the ON position.
CE	Modbus Communication Error	The communications cable wiring is incorrect.	Correct wiring errors.
		There is a short circuit or disconnection in the communications cable.	• Repair disconnected cables and short circuits for proper wiring. • Replace a faulty communications cable with a normal one.
		Communication data error occurred due to noise.	• Examine the control circuit lines, main circuit lines, and ground wiring, and decrease the effects of electrical interference. • Make sure that a magnetic contactor is not the source of the electrical interference, then use a Surge Protective Device if necessary. • Use only recommended cables or other shielded line. Ground the shield on the controller side or the drive input power side. • Separate all communication wiring from drive power lines, and install a noise filter to the input side of the power supply for communication. • Minimize the effects of controller noise.
		Communication protocol is incompatible.	• Examine the values set in *H5-xx*. • Examine the settings on the controller side and correct the difference in communication conditions.
		The time set in *H5-09 [CE Detection Time]* is too short for the communications cycle.	• Change the controller software settings. • Increase the value set in *H5-09*.
		Something in the controller software or hardware is causing a communication problem.	Examine the controller and remove the cause of the error.
CP1	Comparator 1 Limit Fault	The monitor value set in *H2-20 [Comparator 1 Monitor Selection]* was within the range of *H2-21 [Comparator 1 Lower Limit]* and *H2-22 [Comparator 1 Upper Limit]*.	Examine the monitor value and remove the cause of the error.
CP2	Comparator 2 Limit Fault	The monitor value set in *H2-26 [Comparator 2 Monitor Selection]* was outside the range of *H2-27 [Comparator 2 Lower Limit]* and *H2-28 [Comparator 2 Upper Limit]*.	Examine the monitor value and remove the cause of the error.
CrST	Cannot Reset	The drive received a fault reset command when a Run command was active.	Turn off the Run command then de-energize and re-energize the drive.
CyC	MECHATROLINK CommCycleSettingErr	The communications cycle of the controller was set outside the allowable range of the MECHATROLINK interface option card.	Set the communications cycle of the controller so that it falls within the allowable range of the MECHATROLINK interface option card.
dEv	Speed Deviation	The load is too heavy	Decrease the load.
		The acceleration/deceleration time is too short.	Increase the values set in *C1-01 to C1-08 [Acceleration/ Deceleration Time]*.
		The *dEv* detection level settings are incorrect.	Adjust *F1-10 [Speed Deviation Detection Level]* and *F1-11 [Speed Deviation Detect DelayTime]*.
		The load is locked up.	Examine the machine.
		The holding brake is stopping the motor.	Release the holding brake.
E5	MECHATROLINK Watchdog Timer Err	A watchdog circuit exception was detected while receiving data from the controller.	Examine the MECHATROLINK cable connection. If this error occurs frequently, check the wiring and minimize the effects of noise in accordance with the following manuals: • MECHATROLINK-II Installation Guide (MECHATROLINK Members Association, manual number MMATDEP011) • MECHATROLINK-III Installation Manual (MECHATROLINK Members Association, publication number MMATDEP018)
EF	FWD/REV Run Command Input Error	A forward command and a reverse command were input simultaneously for longer than 0.5 s.	Examine the forward and reverse command sequence and correct the problem.
EF0	Option Card External Fault	The communication option card received an external fault from the controller.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input from the controller.
		Programming error occurred on the controller side.	Examine the operation of the controller program.
EF1	External Fault (Terminal S1)	MFDI terminal S1 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S1.
		External fault [H1-01 = 2C to 2F] is set to MFDI terminal S1, but the terminal is not in use.	Correctly set the MFDI.

Code	Name	Causes	Possible Solutions
EF2	External Fault (Terminal S2)	MFDI terminal S2 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S2.
		External fault [H1-02 = 2C to 2F] is set to MFDI terminal S2, but the terminal is not in use.	Correctly set the MFDI.
EF3	External Fault (Terminal S3)	MFDI terminal S3 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S3.
		External fault [H1-03 = 2C to 2F] is set to MFDI terminal S3, but the terminal is not in use.	Correctly set the MFDI.
EF4	External Fault (Terminal S4)	MFDI terminal S4 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S4.
		External fault [H1-04 = 2C to 2F] is set to MFDI terminal S4, but the terminal is not in use.	Correctly set the MFDI.
EF5	External Fault (terminal S5)	MFDI terminal S5 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S5.
		External fault [H1-05 = 2C to 2F] is assigned to MFDI terminal S5 that is not in use.	Correctly set the MFDI.
EF6	External Fault (terminal S6)	MFDI terminal S6 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S6.
		External fault [H1-06 = 2C to 2F] is assigned to MFDI terminal S6 that is not in use.	Correctly set the MFDI.
EF7	External Fault (terminal S7)	MFDI terminal S7 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S7.
		External fault [H1-07 = 2C to 2F] is assigned to MFDI terminal S7 that is not in use.	Correctly set the MFDI.
EF8	External Fault (terminal S8)	MFDI terminal S8 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S8.
		External fault [H1-08 = 2C to 2F] is assigned to MFDI terminal S8 that is not in use.	Correctly set the MFDI.
EF9	External Fault (Terminal S9)	MFDI terminal S9 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S9.
		*External fault [H1-09 = 2C to 2F]*is set to MFDI terminal S9, but the terminal is not in use.	Correctly set the MFDI.
EF10	External Fault (Terminal S10)	MFDI terminal S10 caused an external fault through an external device.	1. Find the device that caused the external fault and remove the cause. 2. Clear the external fault input in the MFDI.
		The wiring is incorrect.	Correctly connect the signal line to MFDI terminal S10.
		External fault [H1-10 = 2C to 2F] is set to MFDI terminal S10, but the terminal is not in use.	Correctly set the MFDI.
EP24v	External Power 24V Supply	The voltage of the main circuit power supply decreased, and the 24 V power supply is supplying power to the drive.	• Examine the main circuit power supply. • Turn ON the main circuit power supply to run the drive.
FAn	Internal Fan Fault	The circulation fan has malfunctioned.	• Examine circulation fan operation. • Re-energize the drive and check if the fault still remains. • Examine *U4-03 [Cooling Fan Ope Time]* and *U4-04 [Cool Fan Maintenance]*. If the performance life of the circulation fan is expired or if there is damage to the fan, replace the fan.

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Code	Name	Causes	Possible Solutions
FWdL	Fwd Limit (FWdL)	The terminal assigned to *H1-xx = 31, 32 [MFDI Function Select = Forward Travel Limit (N.O.), Forward Travel Limit (N.C.)]* is input, the Run command has been disabled.	Turn OFF the Travel Limit to input the Reverse run command.
HCA	High Current Alarm	The load is too heavy.	• Decrease the load for applications with repetitive starts and stops. • Replace the drive with a larger capacity model.
		The acceleration/deceleration time is too short.	• Calculate the torque necessary during acceleration related to the load inertia and the specified acceleration time. • Increase the values set in *C1-01 to C1-08 [Acceleration/ Deceleration Time]* until you get the necessary torque. • Replace the drive with a larger capacity model.
		The drive is trying to operate a specialized motor or a motor that is larger than the maximum applicable motor output of the drive.	• Examine the motor nameplate and reevaluate the motor and drive to make sure that the drive rated current is larger than the motor rated current. • Replace the drive with a larger capacity model.
L24v	Loss of External Power 24 Supply	The voltage of the backup 24 V power supply has decreased. The main circuit power supply is operating correctly.	• Examine the external 24 V power supply for disconnected wires and wiring errors and repair the problems. • Examine the external 24 V power supply for problems.
LoG	Log Com Error	There is not a micro SD in the keypad.	Put a micro SD card in the keypad.
		• USB connected • The number of log communication files is more than 1000. • The capacity of the micro SD card has been exceeded. • The line number data in a log communication file is incorrect. • A communication error between the keypad and drive occurred during a log communication.	Set *o5-01 = 0 [Log Start/Stop Selection = OFF]*.
LT-1	Cooling Fan Maintenance Time	The cooling fan is at 90% of its expected performance life.	1. Use the procedures in this manual to replace the cooling fan. 2. Set *o4-03 = 0 [Fan Operation Time Setting = 0 h]* to reset the cooling fan operation time.
LT-2	Capacitor Maintenance Time	The capacitors for the main circuit and control circuit are at 90% of expected performance life.	Replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
LT-3	SoftChargeBypassRelay MainteTime	The soft charge bypass relay is at 90% of its expected performance life.	Replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
LT-4	IGBT Maintenance Time (50%)	The IGBT is at 50% of its expected performance life.	Check the load, carrier frequency, and output frequency.
oH	Heatsink Overheat	The ambient temperature is high and the heatsink temperature is more than *L8-02 [Overheat Alarm Level]*.	• Measure the ambient temperature. • Increase the airflow in the control panel. • Install a cooling device (cooling fan or air conditioner) to lower the ambient temperature. • Remove objects near the drive that are producing too much heat.
		There is not sufficient airflow around the drive.	• Give the drive the correct installation space as shown in the manual. • Make sure that there is sufficient circulation around the control panel. • Examine the drive for dust or other unwanted materials that could clog the cooling fan. • Remove unwanted materials that prevent air circulation.
		The internal cooling fan or fans have stopped.	1. Use the procedures in this manual to replace the cooling fan. 2. Set *o4-03 = 0 [CoolingFan OperationTime Setting = 0 h]* to reset the cooling fan operation time.
oH2	External Overheat (H1-XX=B)	*oH2 [External Overheat (H1-XX=B)]* signal was input from an external device.	1. Identify the external device that output the overheat alarm and remove the cause of the problem. 2. Clear the *Overheat Alarm (oH2) [H1-xx = B]* that was set to MFDI terminals S1 to S10.
oH3	Motor Overheat (PTC Input)	The thermistor wiring that detects motor temperature is defective.	Correct wiring errors.
oL3	Overtorque 1	A fault occurred on the machine. Example: The machine is locked.	Examine the machine and remove the cause of the fault.
oL4	Overtorque 2	A fault occurred on the machine. Example: The machine is locked.	Examine the machine and remove the cause of the fault.
oL5	Overload Detection (oL5)	A fault occurred on the machine. Example: Overload occurred.	Examine the machine and remove the cause of the fault.
oL6	Light-load Accel 2 Fault (oL6)	The setting for hold level and fault detection level of Light-load 2 functions are not appropriate.	Adjust *S4-10 [L-L 2 Motoring Hold Level]*, *S4-12 [L-L 2 Regen Hold Level]*, and *S4-15 [L-L 2 Fault Detection Level]* settings.

Code	Name	Causes	Possible Solutions
oS	Overspeed	Overshoot is occurring.	Decrease *C5-01 [ASR Proportional Gain 1]* and increase *C5-02 [ASR Integral Time 1]*.
ov	DC Bus Overvoltage	There are surge voltages in the input power supply.	Connect a DC reactor to the drive. **Note:** If you turn the phase advancing capacitors ON and OFF and use thyristor converters in the same power supply system, there can be surge voltages that irregularly increase the input voltage.
		The drive output cable or motor is shorted to ground. (The current short to ground is charging the main circuit capacitor of the drive through the power supply.)	1. Examine the motor main circuit cable, terminals, and motor terminal box, and then remove ground faults. 2. Re-energize the drive.
		The power supply voltage is too high.	Decrease the power supply voltage so that it matches the drive rated voltage.
		A drive malfunction occurred due to electrical interference.	• Check the control circuit lines, main circuit lines, and ground wiring, and minimize the effects of electrical interference. • Check whether a magnetic contactor is the electrical interference source, and use Surge Protective Device if necessary.
PASS	Modbus Communication Test	The MEMOBUS/Modbus communications test is complete.	The *PASS* display will turn off after communications test mode is cleared.
PF	Input Phase Loss	There is a phase loss in the drive input power.	Examine for wiring errors or disconnected wires in main circuit drive input power, and repair problems.
PGo	Encoder (PG) Feedback Loss	The encoder cable is incorrectly wired or disconnected.	Examine for wiring errors or disconnected wires in the encoder cable, and repair problems.
PGoH	Encoder (PG) Hardware Fault	The encoder cable is disconnected.	Correct any disconnected wires in the encoder cable.
rEvL	Rev Limit (rEvL)	The terminal assigned to *H1-xx = 33, 34 [MFDI Function Select = Rev Limit (rEvL), Reverse Travel Limit (N.C.)]* is input, the Run command has been disabled.	Turn OFF the Travel Limit to input the Forward run command.
rUn	Motor Switch during Run	The drive received a *Motor 2/3 Selection [H1-xx = 16 or 39]* during run.	Review the sequence to ensure that Motor 2/3 Selection is input while the drive is stopped.
SE	Modbus Test Mode Error	MEMOBUS/Modbus communications self-diagnostics *[H1-xx = 67]* was done while the drive was running.	Stop the drive and do MEMOBUS/Modbus communications self-diagnostics.
STo	Safe Torque OFF	Safe Disable inputs H1-HC and H2-HC are open.	• Make sure that the Safe Disable signal is input from an external source to terminal H1-HC and H2-HC. • When the Safe Disable function is not in use, connect terminals H1-HC and H2-HC.
		There is internal damage to the two Safe Disable channels.	Replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
SToF	Safe Torque OFF Hardware	One of the two terminals H1-HC or H2-HC received the Safe Disable input signal.	• Make sure that the Safe Disable signal is input from an external source to terminal H1-HC or H2-HC. • When the Safe Disable function is not in use, connect terminals H1-HC and H2-HC.
		The Safe Disable input signal is wired incorrectly.	
		There is internal damage to one Safe Disable channel.	Replace the control board or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
TiM	Keypad Time Not Set	There is a battery in the LCD keypad, but the date and time are not set.	Set the date and time with the LCD keypad.
TrPC	IGBT Maintenance Time (90%)	The IGBT is at 90% of its expected performance life.	Replace the IGBT or the drive. For information about replacing the control board, contact Yaskawa or your nearest sales representative.
Uv	Undervoltage	The drive input power voltage is changing too much.	• Review the power supply voltage so that it matches the drive rated voltage. • Make the drive input power stable. • If the input power supply is good, examine the magnetic contactor on the main circuit side for problems.

◆ Parameter Setting Errors

Parameter setting errors occur when multiple parameter settings do not agree, or when parameter setting values are not correct. Refer to the table in this section, examine the parameter setting that caused the error, and remove the cause of the error. You must first correct the parameter setting errors before you can operate the drive. The drive will not send notification signals for the faults and alarms when these parameter setting errors occur.

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Code	Name	Causes	Possible Solutions
oPE01	Drive Capacity Setting Error	The value set in *o2-04 [Drive Model (KVA) Selection]* does not agree with the drive model.	Set *o2-04* to the correct value.
oPE02	Parameter Range Setting Error	Parameter settings are not in the applicable setting range.	1. Push ↵ to show *U1-18 [oPE Fault Parameter]*, and find parameters that are not in the applicable setting range. 2. Correct the parameter settings. **Note:** If more than one error occurs at the same time, other *oPExx* errors have priority over *oPE02*.
		Set *E2-01 ≤ E2-03 [Motor Rated Current (FLA) ≤ Motor No-Load Current]*.	Make sure that *E2-01 > E2-03*. **Note:** If it is necessary to set *E2-01 < E2-03*, first lower the value set in *E2-03*, and then set *E2-01*.
oPE03	Multi-Function Input Setting Err	A function assigned to these parameters conflicts. • *H1-01 to H1-10 [Terminal Sx Function Selection]* • *F3-10 to F3-25 [Terminal Dx Function Selection]* • *H7-01 to H7-04 [Virtual Multi-Function Input]*	Set the parameters correctly.
oPE05	Run Cmd/Freq Ref Source Sel Err	The setting to assign the Run command or frequency reference to an option card is incorrect.	Set the parameters correctly.
oPE06	Control Method Selection Error	*A1-02 = 1 or 3 [Control Method Selection = CL-V/f, CLV]* is set, but there is no encoder option connected to the drive.	• Connect an encoder option to the drive. • Set *A1-02* correctly.
oPE07	Analog Input Selection Error	The settings for *H3-02, H3-06, and H3-10 [MFAI Function Select]* and *H7-30 [Virtual Analog Input Selection]* overlap.	Change the settings to *H3-02, H3-06, H3-10, and H7-30* so that the functions assigned to them no longer overlap. **Note:** These functions can be set to multiple analog input terminals at the same time: • Setting value *0 [Frequency Reference]* • Setting values *F and 1F [Not Used]*
oPE08	Parameter Selection Error	A function was set that is not compatible with the control method selected in *A1-02 [Control Method Selection]*.	1. Push ↵ to show *U1-18 [oPE Fault Parameter]*, and find parameters that are not in the applicable setting range. 2. Set the parameters correctly. **Note:** If more than one error occurs at the same time, other *oPExx* errors have priority over *oPE02*.
oPE10	V/f Data Setting Error	The parameters that set the V/f pattern do not satisfy the following conditions: • For motor 1: *E1-09 ≤ E1-07 < E1-06 ≤ E1-11 ≤ E1-04 [Minimum Output Frequency ≤ Mid Point A Frequency < Base Frequency ≤ Mid Point B Frequency ≤ Maximum Output Frequency]* • For motor 2: *E3-09 ≤ E3-07 < E3-06 ≤ E3-11 ≤ E3-04 [Minimum Output Frequency ≤ Mid Point A Frequency < Base Frequency ≤ Mid Point B Frequency ≤ Maximum Output Frequency]* • For motor 3: *E7-09 ≤ E7-07 < E7-06 ≤ E7-11 ≤ E7-04 [Minimum Output Frequency ≤ Mid Point A Frequency < Base Frequency ≤ Mid Point B Frequency ≤ Maximum Output Frequency]*	Set the parameters correctly to satisfy the conditions.
oPE11	Carrier Frequency Setting Error	These parameters are set at the same time: • *C6-05 > 6 [Carrier Freq Proportional Gain > 6]* • *C6-04 > C6-03 [Carrier Frequency Lower Limit > Carrier Frequency Upper Limit]* **Note:** When *C6-05 < 7*, *C6-04* becomes disabled. The drive sets the carrier frequency to the value set to *C6-03*.	Set *C6-02 to C6-05* correctly.
oPE18	Online Tuning Param Setting Err	The parameters that control online tuning are set incorrectly. In OLV control, one of these parameters was set when *n6-01 = 2 [Online Tuning Selection = Voltage Correction Tuning]*: • *E2-02 [Motor Rated Slip]* is set to 30% of the default setting or lower. • *E2-06 [Motor Leakage Inductance]* is set to 50% of the default setting or lower. • *E2-03 = 0 [Motor No-Load Current = 0 A]* has been set.	Set *E2-02, E2-03, and E2-06* correctly.
oPE22	Parameter Setting Error	The crane sequence parameter (frequency) setting error for motor 1.	Set the parameters correctly.
oPE23	Parameter Setting Error	When Vector control, set *L7-01 and L7-02 < S1-07 and S1-08 [Torque Limit < Brake Release Torque]*.	Make sure that *L7-01 and L7-02 ≧ S1-07 and S1-08*.

Code	Name	Causes	Possible Solutions
oPE24	Light-load Accel 2 Fault (oL6)	The following commands are set in *H1-xx [MFDI Function Select]* simultaneously: • *Setting value 30 [Light-load Accel 1 Enabled]* and *setting value 36 [Light-load Accel 1 Enabled]*	Remove the function settings that are not in use.
oPE25	Parameter Setting Error	The crane sequence parameter (frequency) setting error for motor 2 and motor 3.	Set the parameters correctly.

◆ Auto-Tuning Errors

This table gives information about errors detected during Auto-Tuning. If the drive detects an Auto-Tuning error, the keypad will show the error and the motor will coast to stop. The drive will not send notification signals for faults and alarms when Auto-Tuning errors occur.

Two types of Auto-Tuning errors are: *Endx* and *Erx*. *Endx* identifies that Auto-Tuning has successfully completed with calculation errors. Find and repair the cause of the error and do Auto-Tuning again, or set the motor parameters manually. You can use the drive in the application if you cannot find the cause of the *Endx* error.

Erx identifies that Auto-Tuning was not successful. Find and repair the cause of the error and do Auto-Tuning again.

Code	Name	Causes	Possible Solutions
End1	Excessive Rated Voltage Setting	The torque reference was more than 20% during Auto-Tuning or the no-load current that was measured after Auto-Tuning is more than 80%.	• Make sure that the input motor nameplate data is correct. • Do Auto-Tuning again and correctly set the motor nameplate data. • If you can uncouple the motor and load, remove the motor from the machine and do Rotational Auto-Tuning again. • If you cannot uncouple the motor and load, use the results from Auto-Tuning.
End2	Iron Core Saturation Coefficient	The motor nameplate data entered during Auto-Tuning is incorrect.	• Make sure that the input motor nameplate data is correct. • Do Auto-Tuning again and correctly set the motor nameplate data.
End3	Rated Current Setting Alarm	The rated current value is incorrect.	Do Auto-Tuning again and set the correct rated current shown on the motor nameplate.
End4	Adjusted Slip Calculation Error	The Auto-Tuning results were not in the applicable parameter setting range.	• Make sure the input motor nameplate data is correct. • Do Rotational Auto-Tuning again and correctly set the motor nameplate data. • If you cannot uncouple the motor and load, do Stationary Auto-Tuning 2.
End5	Resistance Tuning Error	The Auto-Tuning results of the Line-to-Line Resistance were not in the applicable range.	• Make sure that the input motor nameplate data is correct. • Examine and repair damaged motor wiring.
End6	Leakage Inductance Alarm	The Auto-Tuning results were not in the applicable parameter setting range.	Make sure that the input motor nameplate data is correct, and do Auto-Tuning again.
End7	No-Load Current Alarm	The Auto-Tuning results of the motor no-load current value were not in the applicable range.	Examine and repair damaged motor wiring.
Er-01	Motor Data Error	The motor nameplate data entered during Auto-Tuning is incorrect.	• Make sure that the motor nameplate data is correct. • Do Auto-Tuning again and correctly set the motor nameplate data.
Er-02	Drive in an Alarm State	The motor nameplate data entered during Auto-Tuning is incorrect.	• Make sure that the motor nameplate data entered in Auto-Tuning is correct. • Do Auto-Tuning again and correctly set the motor nameplate data.
Er-03	STOP Button was Pressed	During Auto-Tuning, STOP was pushed.	Auto-Tuning did not complete correctly. Do Auto-Tuning again.
Er-04	Line-to-Line Resistance Error	The Auto-Tuning results were not in the applicable parameter setting range.	• Examine and repair motor wiring. • Disconnect the machine from the motor and do Rotational Auto-Tuning again.
Er-05	No-Load Current Error	The Auto-Tuning results were not in the applicable parameter setting range.	• Examine and repair motor wiring. • Disconnect the machine from the motor and do Rotational Auto-Tuning again.
Er-08	Rated Slip Error	The motor nameplate data entered during Auto-Tuning is incorrect.	• Make sure that the input motor nameplate data is correct. • Do Auto-Tuning again and correctly set the motor nameplate data.
Er-09	Acceleration Error	The motor did not accelerate for the specified acceleration time.	1. Increase the value set in *C1-01 [Acceleration Time 1]*. 2. Disconnect the machine from the motor and do Rotational Auto-Tuning again.
Er-10	Motor Direction Error	There is defective drive and motor wiring.	Examine and repair motor wiring.
Er-11	Motor Speed Error	The torque reference during acceleration is too high (100%).	• Increase the value set in *C1-01 [Acceleration Time 1]*. • Disconnect the machine from the motor and do Rotational Auto-Tuning again.

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Code	Name	Causes	Possible Solutions
Er-12	Current Detection Error	There is a phase loss in the drive input power. (U/T1, V/T2, W/T3)	Examine and repair motor wiring.
Er-13	Leakage Inductance Alarm	The motor rated current value is incorrect.	Correctly set the rated current indicated on the motor nameplate and perform Auto-Tuning again.
Er-14	Motor Speed Error 2	The motor speed was more than two times the amplitude of speed reference during Inertia Tuning.	Decrease the value set in *C5-01 [ASR Proportional Gain 1]*.
Er-15	Torque Saturation Error	During Inertia Tuning, the output torque was more than the value set in *L7-01 to L7-04 [Torque Limit]*.	• Increase the value set in *L7-01 to L7-04 [Torque Limit]* as much as possible. • Decrease the values set for the frequency and amplitude of the test signals used when doing inertia tuning. First, decrease the test signal amplitude, and then do Inertia Tuning. If the error continues, decrease the test signal frequency and do Inertia Tuning again.
Er-16	Inertia ID Error	The inertia found by the drive was too small or too large during Inertia Tuning (10% or less, or 50000% or more).	• Decrease the values set for the frequency and amplitude of the test signals used when doing inertia tuning. First, decrease the test signal amplitude, and then do Inertia Tuning. If the error continues, decrease the test signal frequency and do Inertia Tuning again • Correctly set the motor inertia as specified by the motor, and do Inertia Tuning again.
Er-17	Reverse Prohibited Error	*b1-04 = 1 [Reverse Operation Selection = Reverse Disabled]* **Note:** You cannot do Inertia Tuning if the drive cannot rotate the motor in reverse.	1. Enable reverse in the target machine. 2. Set *b1-04 = 0 [Reverse Enabled]*. 3. Do Inertia Tuning again.

◆ Backup Function Operating Mode Display and Errors

■ Operating Mode Display

When you use the LCD keypad to do the backup function, the keypad shows the running operation on the LCD display. These indicators do not show that an error has occurred.

Keypad Display	Name	Display	Status
Drive and Keypad mismatch. Should the parameters be restored?	Detection of inconsistency between the drive and keypad	Normally displayed	The drive detected the connection of a keypad from a different drive. Select [Yes] to copy parameters backed up in the keypad to the connected drive.
Restore Restore from keypad	Restoring parameters	Flashing	The parameters stored in the keypad have been restored to the drive.
End	Backup/restore/verify operation ended normally	Normally displayed	The parameter backup, restore, or verify operation ended normally.
Backup Backup from Drive	Backing up parameters	Flashing	The parameters stored in the drive are being backed up to the keypad.
Verify Keypad & Drive	Verifying parameters	Flashing	The parameter settings stored in the keypad and the parameter settings in the drive match or are being compared.

■ Backup Function Runtime Errors

When an error occurs, the keypad shows a code to identify the error.

The table in this section show the error codes. If there are errors, refer to these tables:

Note:

Push any key on the keypad to clear an error.

Code	Name	Causes	Possible Solutions
CPEr	Control Mode Mismatch	The keypad setting and drive setting for *A1-02 [Control Method Selection]* do not agree.	1. Set *A1-02* on the drive to the same value that is on the keypad. 2. Restore the parameters.
CPyE	Error Writing Data	Parameter restore did not end correctly.	Restore the parameters.
CSEr	Control Mode Mismatch	The keypad is broken.	Replace the keypad.
dFPS	Drive Model Mismatch	You tried to restore parameters to a different drive model than the one that you backed up.	1. Examine the drive model that you used to back up the parameters. 2. Restore the parameters.
iFEr	Keypad Communication Error	There was a communications error between the keypad and the drive.	Examine the connector or cable connection.
ndAT	Error Received Data	The parameter settings for model and specifications (power supply voltage and capacity) are different between the keypad and the drive.	1. Make sure that drive model and the value set in *o2-04 [Drive Model (KVA) Selection]* agree. 2. Restore the parameters.

Code	Name	Causes	Possible Solutions
rdEr	Error Reading Data	You tried to back up the data when *o3-02 = 0 [Copy Allowed Selection = Disabled]*.	Set *o3-02 = 1 [Enabled]* and back up again.
vAEr	Voltage Class, Capacity Mismatch	The power supply specifications or drive capacity parameter settings are different between the keypad and the drive.	1. Make sure that drive model and the value set in *o2-04 [Drive Model (KVA) Selection]* agree. 2. Restore the parameters.
vFyE	Parameters do not Match	The parameters that are backed up in the keypad and the parameters in the drive are not the same.	1. Restore or backup the parameter again. 2. Verify the parameters.

14 Drive Specifications

Note:
- Perform Rotational Auto-Tuning to achieve the specifications listed for OLV, CLV, and AOLV.
- Install the drive in an environment that meets the required specifications for optimum product life.

Table 14.1 Control Characteristics

Item	Specification
Control Method	• V/f Control • V/f Control w/ PG • Open Loop Vector Control • Closed Loop Vector • Advanced Open Loop Vector
Frequency Control Range	• Advanced Open Loop Vector Control (AOLV): 0.01Hz - 120 Hz • Closed Loop V/f Control(CL-V/f), Closed Loop Vector Control (CLV): 0.01Hz - 400 Hz • V/f Control (V/f), Open Loop Vector Control (OLV): 0.01 Hz - 590 Hz
Frequency Accuracy (Temperature Fluctuation)	Digital inputs: Within ±0.01% of the maximum output frequency (-10 °C to +40 °C (14 °F to 104 °F)) Analog inputs: Within ±0.1% of the maximum output frequency (25 °C ±10 °C (77 °F ±18 °F))
Frequency Setting Resolution	Digital inputs: 0.01 Hz Analog inputs: 1/2048 of the maximum output frequency (11-bit signed)
Output Frequency Resolution	0.001 Hz
Frequency Setting Signal	Main speed frequency reference: -10 Vdc to +10 Vdc (20 kΩ), 0 Vdc to 10 Vdc (20 kΩ), 4 mA to 20 mA (250 Ω), 0 mA to 20 mA (250 Ω)
Starting Torque	• V/f Control (V/f): 150%/3 Hz • Closed Loop V/f Control (CL-V/f): 150%/3 Hz • Open Loop Vector Control (OLV): 200%/0.3 Hz • Closed Loop Vector Control (CLV): 200%/0 min^{-1} • Advanced Open Loop Vector (AOLV): 200%/0.3 Hz **Note:** Drive capacity must selected appropriately to obtain this starting torque under Open Loop Vector Control (OLV), Closed Loop Vector Control (CLV), and Advanced Open Loop Vector Control (AOLV).
Speed Control Range	• V/f Control (V/f): 1:40 • Closed V/f Control (CL-V/f): 1:40 • Open Loop Vector Control (OLV): 1:200 • Closed Loop Vector Control (CLV): 1:1500 • Advanced Open Loop Vector Control (AOLV): 1:200
Zero Speed Control	Possible in Closed Loop Vector Control (CLV).
Torque Limits	Parameter settings allow separate limits in four quadrants in Open Loop Vector Control (OLV), Closed Loop Vector Control (CLV), and Advanced Open Loop Vector Control (AOLV).
Accel & Decel Time	0.0 s to 6000.0 s The drive allows four selectable combinations of independent acceleration and deceleration settings.
Braking Torque	Approx. 20% Approx. 125% with a dynamic braking option • Short-time average deceleration torque Motor output 0.4/0.75 kW: over 100% Motor output 1.5 kW: over 50% Motor output 2.2 kW and larger: over 20%, approximately 40% with overexcitation braking • Continuous regenerative torque: Approx. 20%. Dynamic braking option allows for approximately 125%, 10% ED, 10 s **Note:** • Models 2003 to 2115 and 4002 to 4150 have a braking transistor. • Set *L3-04 = 0 [Stall Prevention during Decel = Disabled]* when using a regenerative converter, regenerative unit, braking unit, braking resistor, or braking resistor unit. The drive may not stop within the designated deceleration time if *L3-04 = 0*. • Short-time average deceleration torque refers to the torque required to decelerate the motor (uncoupled from the load) from the rated speed to zero. Actual specifications may vary depending on motor characteristics. • Continuous regenerative torque and short-time average deceleration torque for motors 2.2 kW and larger vary depending on motor characteristics.

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Item	Specification
V/f Characteristics	Select from 15 predefined V/f patterns, or a user-set V/f pattern.
Main Control Functions	Droop Control, Feed Forward Control, Zero Servo Function, Torque Limit, 9 Step Speed (max.), Accel/Decel Switch, S-curve Accel/Decel, Auto-Tuning (Rotational and Stationary), Cooling Fan ON/OFF Switch, Slip Compensation, Torque Compensation, Frequency Jump, Upper/lower Limits for Frequency Reference, DC Injection Braking at Start and Stop, Overexcitation Braking, MEMOBUS/Modbus Communication (RS-485: max. 115.2 kbps), Removable Terminal Block with Parameter Backup Function, Online Tuning, Overexcitation Deceleration, Inertia (ASR) Tuning, Crane Sequence.

Table 14.2 Protection Function

Item	Specification
Motor Protection	Electronic thermal overload protection
Momentary Overcurrent Protection	Drive stops when the output current is more than 200% of the rated output current.
Overload Protection	Drive stops when the output current is more than 150% of the rated output current for 60 s. **Note:** The drive may trigger the overload protection function at 150% of the drive rated output in under 60 s if the output frequency is less than 6 Hz.
Overvoltage Protection	200 V class: Stops when the DC bus voltage is more than approximately 410 V 400 V class: Stops when the DC bus voltage is more than approximately 820 V
Undervoltage Protection	200 V class: Stops when the DC bus voltage decreases to less than approximately 190 V 400 V class: Stops when the DC bus voltage decreases to less than approximately 380 V
Heatsink Overheat Protection	Thermistor
Braking Resistor Overheat Protection	Overheat detection for braking resistor (optional ERF-type, 3% ED)
Stall Prevention	Stall prevention is available during acceleration, deceleration, and during run.
Ground Fault Protection	Electronic circuit protection **Note:** This protection detects any ground faults during run. The drive will not provide protection when: • There is a low-resistance ground fault for the motor cable or terminal block • Energizing the drive when there is a ground fault present.
DC Bus Charge LED	Charge LED illuminates when DC bus voltage is above 50 V.

Table 14.3 Environment

Environment	Conditions
Area of Use	Indoors • Noxious Fumes: IEC60721-3-3:3C2 • Dust: IEC60721-3-3:3S2
Power Supply	Overvoltage Category III
Ambient Temperature	Open chassis type (IP20): -10°C to +50 °C (14 °F to 122 °F) Enclosed wall-mounted type (UL Type 1): -10 °C to +40 °C (14 °F to 104 °F) • Do not use the drive in a location where the temperature changes suddenly to improve the drive reliability. • When installing the drive in an enclosure, use a cooling fan or air conditioner to keep the internal air temperature in the permitted range. • Do not let the drive freeze. • Derate the output current and output voltage to install the drive in areas with ambient temperatures ≤ 60 °C (140 °F).
Humidity	95% RH or less Do not let condensation form on the drive.
Storage Temperature	-20 °C to +70 °C (-4 °F to +158 °F) (short-term temperature during transportation)
Surrounding Area	Pollution degree 2 or less Install the drive in an area without: • Oil mist, corrosive or flammable gas, or dust • Metal powder, oil, water, or other unwanted materials • Radioactive materials or flammable materials, including wood • Harmful gas or fluids • Salt • Direct sunlight Keep wood or other flammable materials away from the drive.
Altitude	1000 m (3281 ft.) maximum **Note:** Derate the output current by 1% for each 100 m (328 ft.) to install the drive in altitudes between 1000 m to 4000 m (3281 ft. to 13123 ft.). It is not necessary to derate the rated voltage in these conditions: • Installing the drive at 2000 m (6562 ft.) or lower • Installing the drive between 2000 m to 4000 m (6562 ft. to 13123 ft.) and grounding the neutral point on the power supply. Contact Yaskawa or your nearest sales representative when not grounding the neutral point.

Environment	Conditions
Vibration	• 10 Hz to 20 Hz: 1 G (9.8 m/s^2, 32.15 ft/s^2) • 20 Hz to 55 Hz: 2003 to 2180, 4002 to 4150: 0.6 G (5.9 m/s^2, 19.36 ft/s^2) 2215 to 2415, 4180 to 4605: 0.2 G (2.0 m/s^2, 6.56 ft/s^2)
Installation Orientation	Install the drive vertically for sufficient cooling airflow.

Table 14.4 Standard

Item	Specification
Harmonized Standard	• UL61800-5-1 • EN61800-3 • IEC/EN61800-5-1 • Two Safe Disable inputs and one EDM output according to ISO/EN13849-1 Cat.III PLe, IEC/EN61508 SIL3
Protection Design	Open-chassis type (IP20) Enclosed wall-mounted type (UL Type 1) **Note:** Installing UL Type 1 kit on an open-chassis type (IP20) drive to convert the drive to a wall-mount enclosure (UL Type 1).

15 European Standards

Figure 15.1 CE Mark

The CE Mark indicates that the product meets environmental and safety standards in the European Union. Products manufactured, sold, or imported within the European Union are required to display the CE Mark.

European Union standards include standards for electrical appliances (Low Voltage Directive), standards for electrical noise (EMC Directive), and standards for machinery (Machinery Directive).

This product displays the CE Mark in accordance with the Low Voltage Directive, the EMC Directive, and the Machinery Directive.

Table 15.1 Harmonized Standard

European Directive	Harmonized Standard
CE Low Voltage Directive Compliance 2014/35/EU	IEC/EN 61800-5-1:2007
EMC Directive 2014/30/EU	EN 61800-3:2004/A1:2012
Machinery Directive 2006/42/EC	• ISO/EN ISO 13849-1:2015 (Cat.3, PL e) • IEC 62061/A2:2015 (SIL CL 3) • EN 62061/A2:2015 (SIL CL 3) • IEC/EN 61800-5-2:2007 (SIL3)

The customer is responsible for displaying the CE Mark on the final device containing this product. Customers must verify themselves that the final device is compliant with EU standards.

◆ CE Low Voltage Directive Compliance

It has been confirmed that this product complies with the CE Low Voltage Directive by conducting a test according to IEC/EN 61800-5-1:2007.

The following conditions must be satisfied for machines and devices incorporating this product to comply with the CE Low Voltage Directive.

■ Area of Use

Install this product in a location with Overvoltage Category III and pollution degree 2 or less as specified in IEC/CE 60664.

■ Guarding Against Debris

When you install IP20/UL Open type drives (models: 2xxxxB, 4xxxxB), use an enclosure panel that does not let unwanted material enter the drive from above or below.

■ Wiring Diagram

Refer to Figure 15.2 for an example of a drive that is wired for compliance with the CE Low Voltage Directive.

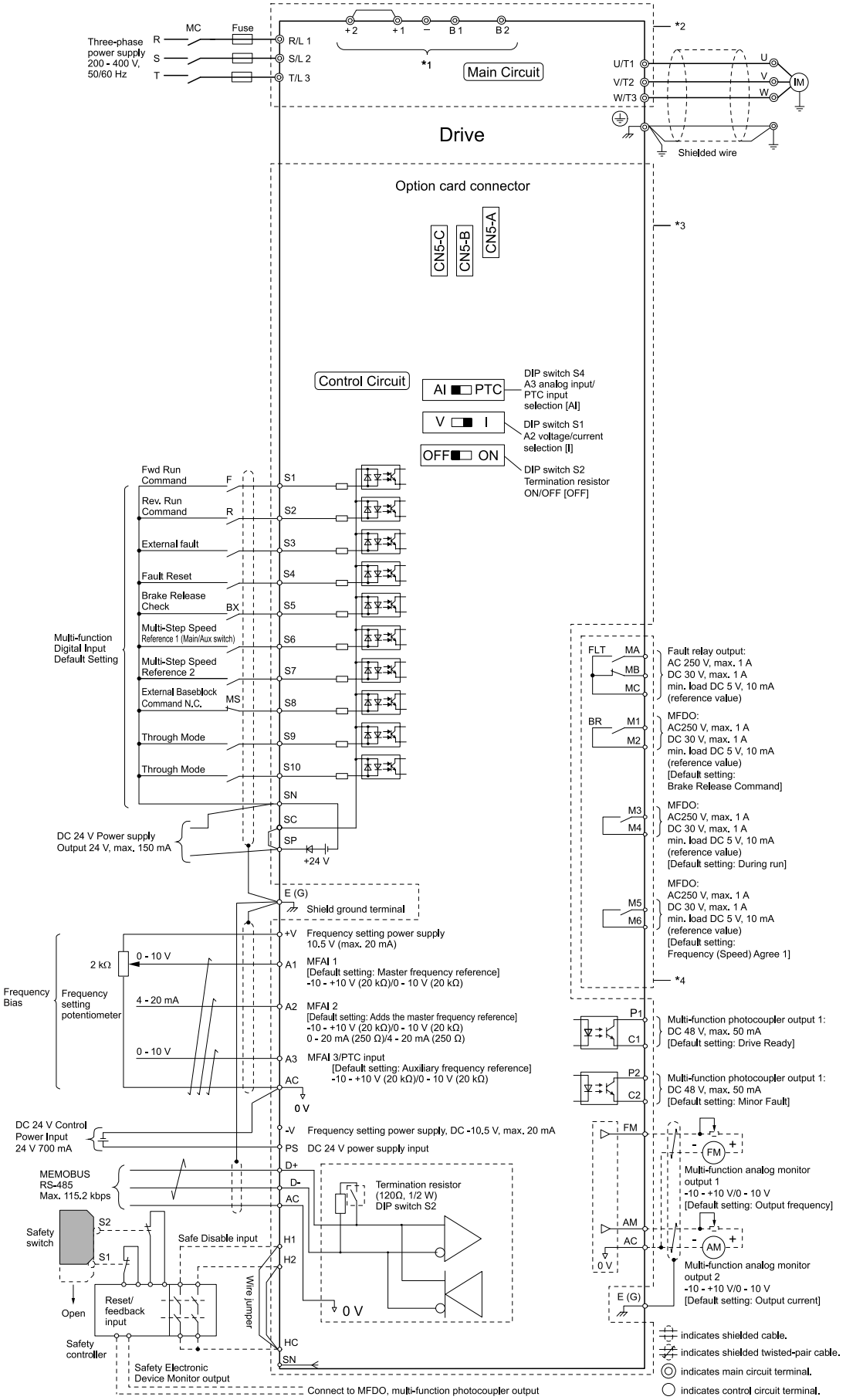

Figure 15.2 Wiring Diagram for CE Low Voltage Directive Compliance

*1 Connect peripheral options to terminals -, +1, +2, B1, and B2. Do not connect an AC power supply lines to these terminals.
*2 For circuit protection, the main circuit is separated from the surface case that would otherwise come into contact with the main circuit.
*3 The control circuit is a Safety Extra-Low Voltage circuit that must be separated from other circuits by reinforced insulation. Ensure that the Safety Extra-Low Voltage circuit is connected as required.
*4 Reinforced insulation separates the output terminals from other circuits. Users may also connect circuits that are not Safety Extra-Low Voltage circuits if the drive output is 250 Vac 1 A max. or 30 Vdc 1 A max.

■ Wire Gauges and Tightening Torques

Note:

- The recommended wire gauges based on drive continuous current ratings using 75 °C (167 °F) 600 V class 2 heat resistant indoor PVC wire. Assume the following usage conditions:
  – Ambient temperature: 40 °C (104 °F) or lower
  – Wiring distance: 100 m (3281 ft.) or shorter
  – Rated current value
- Use terminals +1, +2, +3, -, B1, and B2 to connect peripheral options such as a DC reactor or a braking resistor. Do not connect anything other than optional devices.
- Refer to the specific instruction manual of each device for wire gauges when connecting peripheral devices or options to terminals +1, +2, +3, -, B1, and B2. Contact Yaskawa or your nearest sales representative if the recommended wire gauges for the peripheral devices or options are out of the range of the applicable gauge for the drive.

Three-Phase 200 V Class

Table 15.2 Main Circuit Wire Gauges and Tightening Torques (200 V Class)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2003	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2005	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2008	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2011	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2014	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	4	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2018	R/L1, S/L2, T/L3	6	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	6	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6 *4	4 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2025	R/L1, S/L2, T/L3	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	6	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	10	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	6 - 10 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)
2033	R/L1, S/L2, T/L3	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	16	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	4	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	6 - 10 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2047	R/L1, S/L2, T/L3	25	2.5 - 25 (10 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	16	2.5 - 16 (6 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	35	2.5 - 35 (10 - 35)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	10 - 16 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2060	R/L1, S/L2, T/L3	35	2.5 - 35 (25 - 35)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	16	2.5 - 16 (16)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	50	2.5 - 50 (35 - 50)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	16 - 25 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2075	R/L1, S/L2, T/L3	35	2.5 - 35 (25 - 35)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	25	2.5 - 25 (16 - 25)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	50	2.5 - 50 (35 - 50)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	16	2.5 - 16 (2.5 - 16)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	16 - 25 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2088	R/L1, S/L2, T/L3	35	16 - 35 (25 - 35)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	35	16 - 35 (25 - 35)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	50	25 - 50 (25 - 50)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	25	6 - 25 (6 - 25)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	16	16 - 25 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
2115	R/L1, S/L2, T/L3	50	16 - 50 (50)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	50	16 - 50 (50)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	70	25 - 70 (50 - 70)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	35	6 - 35 (6 - 35)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	25	25 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2145	R/L1, S/L2, T/L3	70	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	70	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5 *6	35	16 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3 *6	50	25 - 70 (50 - 70)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	35	25 - 50 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2180	R/L1, S/L2, T/L3	95	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	95	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5 *6	50	16 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3 *6	70	25 - 70 (50 - 70)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	50	25 - 50 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2215	R/L1, S/L2, T/L3	50 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	70 × 2P	35 - 120 × 2P (120 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	35 × 2P	25 - 70 × 2P (70 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	95	95 - 240 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2283	R/L1, S/L2, T/L3	70 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	70 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	95 × 2P	35 - 120 × 2P (120 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	50 × 2P	25 - 70 × 2P (70 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	95	95 - 240 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2346	R/L1, S/L2, T/L3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	120 × 2P	95 - 185 × 2P (185 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	70 × 2P	50 - 95 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	120	120 - 240 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
2415	R/L1, S/L2, T/L3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	120 × 2P	95 - 185 × 2P (185 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	70 × 2P	50 - 95 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	120	120 - 240 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

*1 For IP20 protection, use wires that are in the range of applicable gauges.
*2 Remove insulation from the ends of wires to expose the length of wire shown.
*3 For wire gauges more than 30 mm², tighten to a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf·in to 40 lbf·in).
*4 Install an ELCB with this wire gauge to maintain compliance with IEC/EN 61800-5-1:2007.
*5 Terminals - and +1 have two screws. The Recommended Gauge is the wire gauge for one terminal.
*6 A junction terminal is necessary to connect a braking unit (CDBR-series) to terminals - and +3.

Three-Phase 400 V Class

Table 15.3 Main Circuit Wire Gauges and Tightening Torques (400 V Class)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4002	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4003	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4005	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4006	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4007	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4009	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4015	R/L1, S/L2, T/L3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	4	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *4	2.5 - 10 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)
4018	R/L1, S/L2, T/L3	6	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	4	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	6	2.5 - 16 (2.5 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	2.5	2.5 - 4 (2.5 - 4)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6 *4	4 - 10 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4024	R/L1, S/L2, T/L3	10	2.5 - 25 (10 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	6	2.5 - 16 (6 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	10	2.5 - 35 (10 - 35)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	2.5	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	6 - 16 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4031	R/L1, S/L2, T/L3	10	2.5 - 25 (10 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	6	2.5 - 16 (6 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	16	2.5 - 35 (10 - 35)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	4	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	6 - 16 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4039	R/L1, S/L2, T/L3	16	2.5 - 16 (4 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	10	2.5 - 10 (6 - 10)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	25	2.5 - 25 (6 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	6	2.5 - 6 (2.5 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	10 - 25 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4045	R/L1, S/L2, T/L3	16	2.5 - 16 (4 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	16	2.5 - 16 (6 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	25	2.5 - 25 (6 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	10 - 25 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4060	R/L1, S/L2, T/L3	25	2.5 - 25 (2.5 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	25	2.5 - 25 (2.5 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	25	2.5 - 25 (4 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	10	2.5 - 10 (2.5 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	16 - 25 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4075	R/L1, S/L2, T/L3	25	2.5 - 25 (10 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	25	2.5 - 25 (10 - 25)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	35	2.5 - 35 (16 - 35)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	16	2.5 - 16 (4 - 16)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	⏚	16	16 - 25 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4091	R/L1, S/L2, T/L3	35	16 - 50 (50)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	35	16 - 50 (50)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	50	25 - 70 (50 - 70)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	25	6 - 35 (6 - 35)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	16	16 - 25 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4112	R/L1, S/L2, T/L3	50	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	50	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5	25	16 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2 *6	50	25 - 70 (50 - 70)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	25	25 - 50 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4150	R/L1, S/L2, T/L3	70	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	70	50 - 95 (95)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5	35	16 - 50 (50)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2 *6	50	25 - 70 (50 - 70)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	35	25 - 50 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4180	R/L1, S/L2, T/L3	50 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	70 × 2P	35 - 120 × 2P (120 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	35 × 2P	25 - 70 × 2P (70 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	50	50 - 240 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)

Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4216	R/L1, S/L2, T/L3	50 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	70 × 2P	35 - 120 × 2P (120 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	50 × 2P	25 - 70 × 2P (70 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	70	70 - 240 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4260	R/L1, S/L2, T/L3	70 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	70 × 2P	25 - 95 × 2P (70 - 95 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	95 × 2P	35 - 120 × 2P (120 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	70 × 2P	25 - 70 × 2P (70 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	95	95 - 240 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4304	R/L1, S/L2, T/L3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	120 × 2P	95 - 185 × 2P (185 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	70 × 2P	50 - 95 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	120	120 - 240 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4371	R/L1, S/L2, T/L3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	120 × 2P	70 - 150 × 2P (150 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	120 × 2P	95 - 185 × 2P (185 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	95 × 2P	50 - 95 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	95	35 - 240 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4414	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	120 × 4P	70 - 150 × 4P (150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	95 × 4P	70 - 150 × 4P (120 - 150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	95 × 4P	95 - 185 × 4P (185 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	70 × 4P	35 - 95 × 4P (95 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	150	50 - 150 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

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Model	Terminal	Recomm. Gauge mm²	Applicable Gauge (IP20 Applicable Gauge *1) mm²	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4453	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	120 × 4P	70 - 150 × 4P (150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	95 × 4P	70 - 150 × 4P (120 - 150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	95 × 4P	95 - 185 × 4P (185 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	70 × 4P	35 - 95 × 4P (95 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	95 × 2P	60 - 150 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4605	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	120 × 4P	70 - 150 × 4P (150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	95 × 4P	70 - 150 × 4P (120 - 150 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	95 × 4P	95 - 185 × 4P (185 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	70 × 4P	35 - 95 × 4P (95 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	95 × 2P	60 - 150 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

*1 For IP20 protection, use wires that are in the range of applicable gauges.
*2 Remove insulation from the ends of wires to expose the length of wire shown.
*3 For wire gauges more than 30 mm², tighten to a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf·in to 40 lbf·in).
*4 Install an ELCB with this wire gauge to maintain compliance with IEC/EN 61800-5-1:2007.
*5 Terminals - and +1 have two screws. The Recommended Gauge is the wire gauge for one terminal.
*6 A junction terminal is necessary to connect a braking resistor unit (LKEB-series) to terminals B1 and B2.

■ Connect a Fuse to the Input Side (Primary Side)

The drive circuit protection must comply with IEC/EN 61800-5-1:2007 for protection against a short circuit in the internal circuitry. Connect semiconductor fuses on the input side for branch circuit protection.

⚠ WARNING *Electrical Shock Hazard. After the drive blows a fuse or trips an RCM/RCD, do not immediately energize the drive or operate peripheral devices. Wait for the time specified on the warning label at a minimum and make sure that all indicators are OFF. Then check the wiring and peripheral device ratings to find the cause of the problem. If you do not know the cause of the problem, contact Yaskawa before you energize the drive or peripheral devices. If you do not fix the problem before you operate the drive or peripheral devices, it can cause serious injury or death.*

Three-Phase 200 V Class

Table 15.4 Factory-Recommended Branch Circuit Protection (200 V Class)

Drive Model	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/Bussmann
2003	FWH-45B
2005	FWH-45B
2008	FWH-45B
2011	FWH-100B
2014	FWH-100B
2018	FWH-100B
2025	FWH-125B
2033	FWH-150B
2047	FWH-200B
2060	FWH-225A
2075	FWH-225A FWH-250A *1
2088	FWH-225A FWH-250A *1

Drive Model	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/Bussmann
2115	FWH-275A FWH-300A *1
2145	FWH-275A FWH-350A *1
2180	FWH-325A FWH-450A *1
2215	FWH-600A
2283	FWH-800A
2346	FWH-1000B
2415	FWH-1000B

*1 Yaskawa recommends a fuse with a large rated current for applications with repeated loads.

Three-Phase 400 V Class

Table 15.5 Factory-Recommended Branch Circuit Protection (400 V Class)

Drive Model	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/Bussmann
4002	FWH-50B
4003	FWH-50B
4005	FWH-50B
4006	FWH-60B
4007	FWH-60B
4009	FWH-60B
4015	FWH-80B
4018	FWH-90B
4024	FWH-150B
4031	FWH-200B
4039	FWH-200B
4045	FWH-225A
4060	FWH-250A
4075	FWH-275A
4091	FWH-275A
4112	FWH-300A
4150	FWH-325A FWH-400A *1
4180	FWH-500A
4216	FWH-600A
4260	FWH-700A
4304	FWH-800A
4371	FWH-1000B
4414	FWH-1200B
4453	FWH-1200B
4605	FWH-1400A FWH-1600A *1

*1 Yaskawa recommends a fuse with a large rated current for applications with repeated loads.

■ CE Standards Compliance for DC Power Supply Input

To comply with CE Standards, install a fuse for the DC power supply input.

Figure 15.3 shows a wiring example for a DC power supply with two drives connected in parallel.

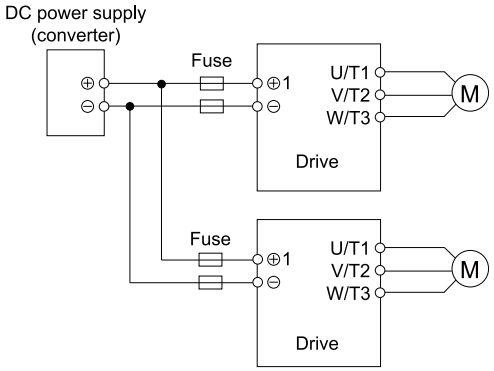


Figure 15.3 Wiring Example for DC Power Supply Input

Note:
- Install a fuse for each drive when operating more than one drive. If one fuse blows, replace all fuses.
- Install the external filter (system) to comply with the EMC Directive.
- Do not ground the main circuit bus.

Refer to Table 15.6 and Table 15.7 for the recommended fuses.

Three-Phase 200 V Class

Table 15.6 Recommended Fuse (Three-Phase 200 V Class)

Drive Model	Fuse Manufacturer: Bussmann	
	Model	Qty
2003	FWH-45B	2
2005	FWH-45B	2
2008	FWH-45B	2
2011	FWH-100B	2
2014	FWH-100B	2
2018	FWH-100B	2
2025	FWH-125B	2
2033	FWH-150B	2
2047	FWH-200B	2
2060	FWH-250A	2
2075	FWH-250A FWH-300A *1	2
2088	FWH-250A FWH-275A *1	2
2115	FWH-300A FWH-350A *1	2
2145	FWH-350A FWH-450A *1	2
2180	FWH-450A FWH-600A *1	2
2215	FWH-600A FWH-700A *1	2
2283	FWH-800A FWH-1000B *1	2
2346	FWH-1000B	2
2415	FWH-1000B	2

*1 Yaskawa recommends a fuse with a large rated current for applications with repeated loads.

Three-Phase 400 V Class

Table 15.7 Recommended Fuse (Three-Phase 400 V Class)

Drive Model	Fuse Manufacturer: Bussmann	
	Model	Qty
4002	FWH-50B	3
4003	FWH-50B	2
4005	FWH-50B	2
4006	FWH-60B	2
4007	FWH-60B	2
4009	FWH-60B	2
4015	FWH-80B	2
4018	FWH-90B	2
4024	FWH-150B	2
4031	FWH-200B	2
4039	FWH-200B	2
4045	FWH-225A	2
4060	FWH-250A	2
4075	FWH-275A	2
4091	FWH-275A	2
4112	FWH-300A FWH-325A *1	2
4150	FWH-400A FWH-450A *1	2
4180	FWH-500A FWH-600A *1	2
4216	FWH-600A FWH-700A *1	2
4260	FWH-700A FWH-800A *1	2
4304	FWH-800A FWH-1000B *1	2
4371	FWH-1000B FWH-1200B *1	2
4414	FWH-1200B FWH-1400A *1	2
4453	FWH-1200B FWH-1600A *1	2
4605	FWH-1600A	2

*1 Yaskawa recommends a fuse with a large rated current for applications with repeated loads.

◆ EMC Directive

Drives with built-in EMC filters (models 2xxxB, 4xxxB) were tested in accordance with European standard IEC/EN 61800-3:2004/A1:2012, and comply with the EMC Directive.

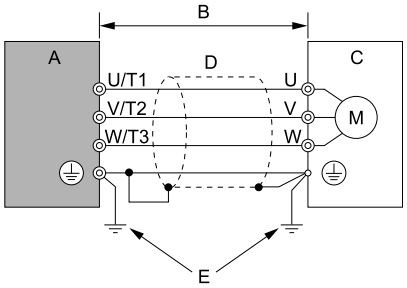
Use drives with built-in EMC filters or install external EMC filters to the drive input side to comply with the EMC Directive. Refer to *Installing the External EMC Noise Filter on page 98* for the installation of the EMC filter.

■ Install a Drive to Conform to the EMC Directive

Install drive models 2xxxB and 4xxxB with this procedure to comply with the EMC Directive when the drive is a single unit or installed in a larger device.

1. Install the drive on a grounded metal plate.

2. Wire the drive and motor.
3. Ground the wire shielding on the drive side and motor side.



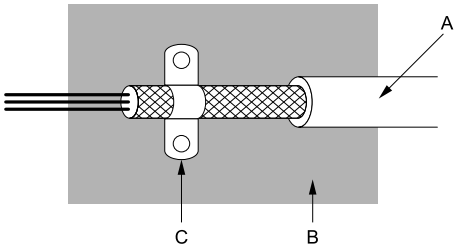
A - Drive
B - 10 m (32.8 ft) maximum
C - Motor
D - Metal conduit
E - Grounding wire

Figure 15.4 Wiring the Drive and Motor

Note:
- Use a braided shield cable for the drive and motor wiring or put the wires through a metal conduit.
- The maximum wiring length between the drive and motor is 10 m (32.8 ft). Keep the wire as short as possible.
- Keep the grounding wire as short as possible.

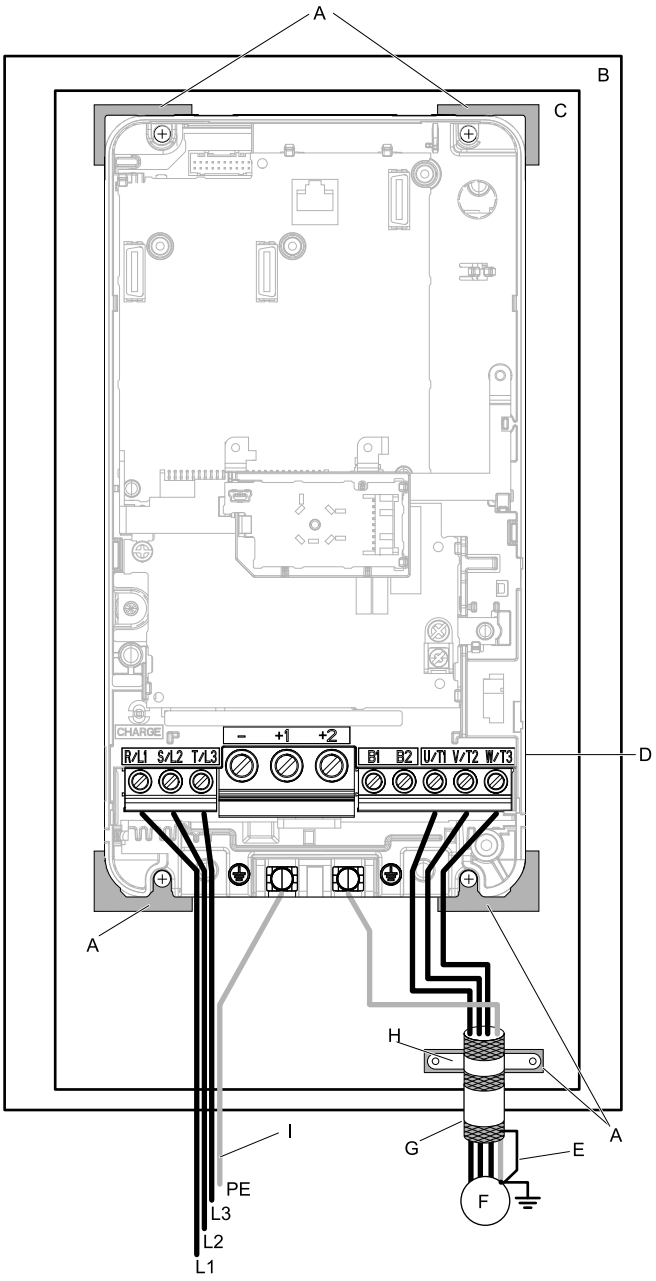
4. Use a cable clamp to ground the motor cable to the metal plate.

Note:
Make sure that the protective ground wire complies with technical specifications and local safety standards.



A - Braided shield cable
B - Metal plate
C - Cable clamp (conductive)

Figure 15.5 Ground the Shield



A - Grounding surface (Remove any paint or sealant.)
B - Enclosure panel
C - Metal plate
D - Drive
E - Shielded wire
F - Motor
G - Motor cable
H - Cable clamp
I - Grounding wire

Figure 15.6 Install a Drive with a Built-in EMC Filter

5. Connect the DC reactor to decrease harmonic distortion. Refer to *DC Reactor on page 101* to select a DC reactor.

Note:
- To maintain compliance with IEC/EN 61000-3-2 on drive models 2003, 2005, 4002, and 4003, install a DC reactor.
- The terminal block for the drive main circuit and the terminal block for the DC reactor have different shapes. The drive has a European-style terminal block, and the DC reactor has a round terminal block. Correctly prepare the ends of the wiring.

Ground Wiring

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch circuit boards while the drive is energized. If you touch the internal components of an energized drive, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Ground the neutral point on the power supply of drive models 2xxxB/C and 4xxxB/C to comply with the EMC Directive before you turn on the EMC filter. If you turn ON the EMC filter, but you do not ground the neutral point, it can cause serious injury or death.*

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Enable the Internal EMC Filter

On drive models 2xxxB and 4xxxB, move the screw or screws to turn ON and OFF (enable and disable) the EMC filter.

⚠ WARNING *Electrical Shock Hazard. Disconnect all power to the drive, wait for the time specified on the warning label, and check the drive for dangerous voltages before you remove covers or touch EMC filter screws. If you touch the screws when there are dangerous voltages, it will cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch circuit boards while the drive is energized. If you touch the internal components of an energized drive, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Ground the neutral point on the power supply of drive models 2xxxB/C and 4xxxB/C to comply with the EMC Directive before you turn on the EMC filter. If you turn ON the EMC filter, but you do not ground the neutral point, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Connect the ground cable correctly. If you touch electrical equipment that is not grounded, it can cause serious injury or death.*

NOTICE *To disable the internal EMC filter, move the screws from ON to OFF and then tighten to the specified torque. If you fully remove the screws or tighten the screws to an incorrect torque, it can cause drive failure.*

NOTICE *Move the EMC switch screw or screws to the OFF position for networks that are not symmetrically grounded. If the screws are not in the correct position, it can cause damage to the drive.*

Make sure that the symmetric grounding network is applied, and install the screw or screws in the ON position to enable the built-in EMC filter in compliance with the EMC Directive. The EMC filter switch screw or screws are installed in the OFF position by default.

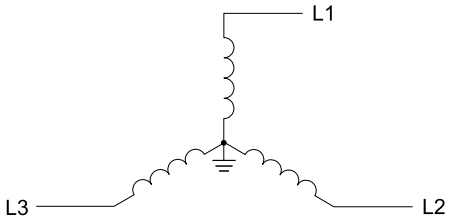
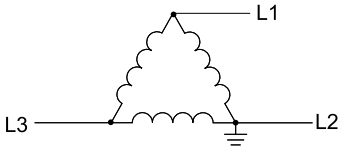
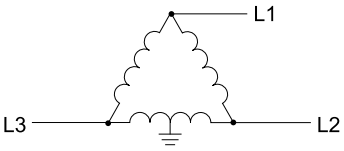


Figure 15.7 Symmetric Grounding

NOTICE *When you use the drive with a non-grounding, high-resistance grounding, or asymmetric-grounding network, put the EMC Filter screw or screws in the OFF position to disable the built-in EMC filter. Failure to obey the instructions can damage the drive.*

Table 15.8 shows asymmetric grounding networks.

Table 15.8 Asymmetric Grounding

Type of Grounding	Diagram
Grounded at the corner of the delta connection	
Grounded at the middle of the side	

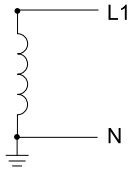
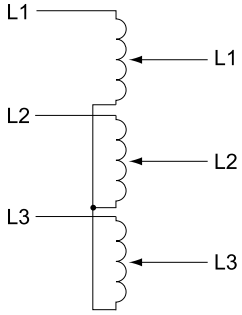
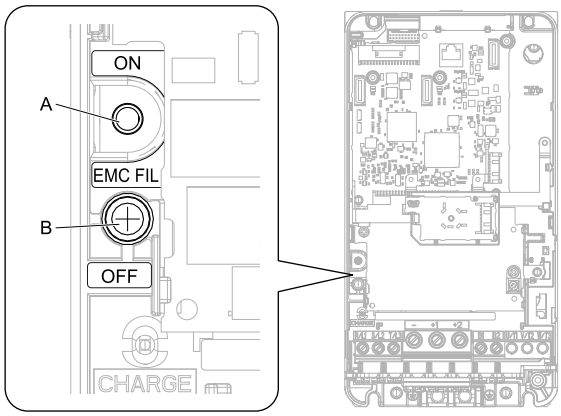
Type of Grounding	Diagram
Single-phase, grounded at the end point	
Three-phase variable transformer without solidly grounded neutral	

Table 15.9 EMC Filter Switch Location

Model	Switch Location Diagram
2003B - 2033B, 4002B - 4018B	Figure 15.8
2047B, 4024B, 4031B	Figure 15.9
2060B, 2075B, 4039B, 4045B	Figure 15.10
2088B, 2115B - 2180B, 4060B, 4075B - 4150B	Figure 15.11
2215B - 2283B, 4180B - 4260B	Figure 15.12
2346B, 2415B, 4304B, 4371B	Figure 15.13
4414B - 4605B	Figure 15.14



A - SW (ON) **B - Screw (OFF)**

Figure 15.8 EMC Filter Switch Location 1

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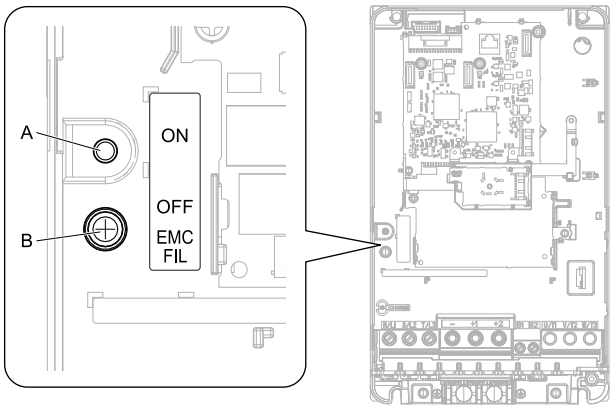
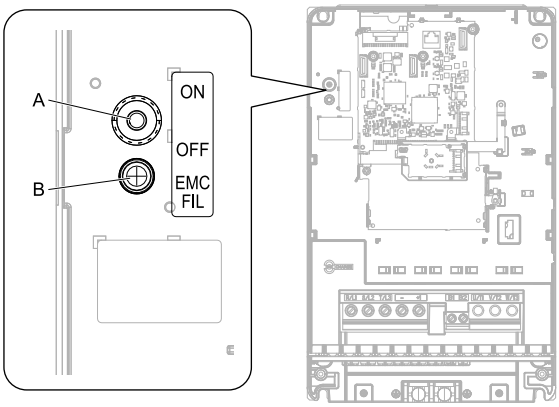


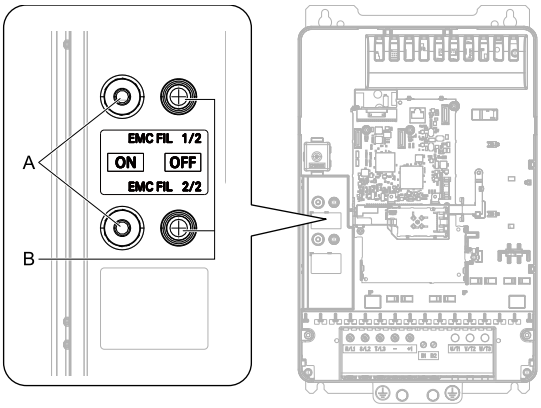
A - SW (ON) **B - Screw (OFF)**

Figure 15.9 EMC Filter Switch Location 2



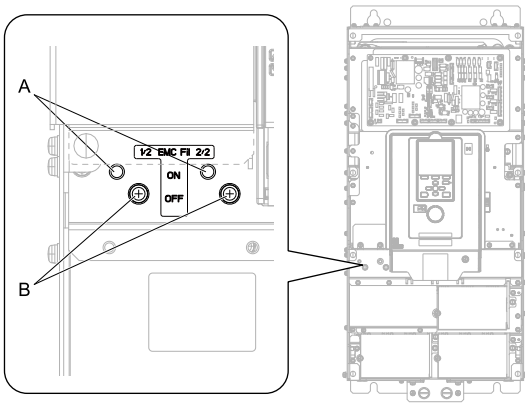
A - SW (ON) **B - Screw (OFF)**

Figure 15.10 EMC Filter Switch Location 3



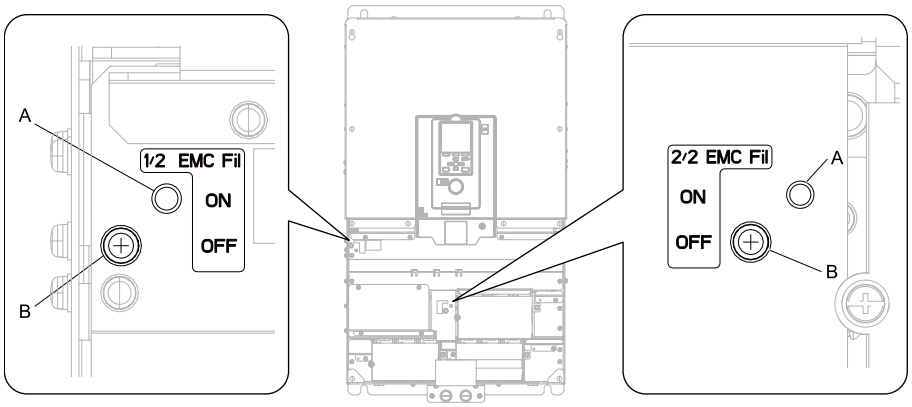
A - SW (ON) **B - Screw (OFF)**

Figure 15.11 EMC Filter Switch Location 4



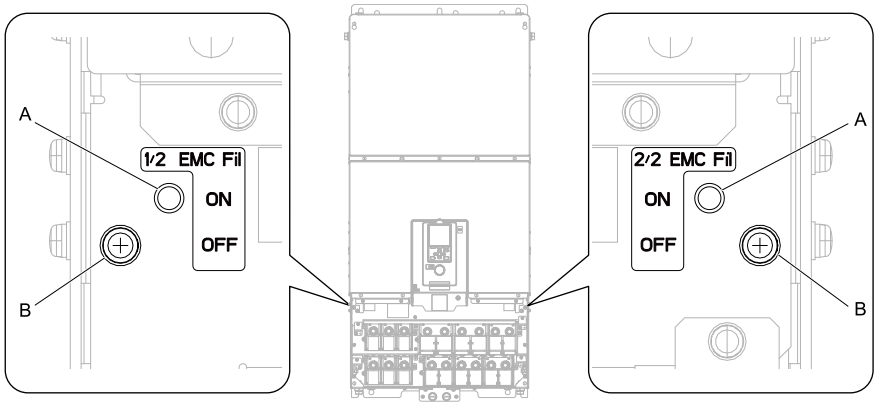
A - SW (ON) **B - Screw (OFF)**

Figure 15.12 EMC Filter Switch Location 5



A - SW (ON) **B - Screw (OFF)**

Figure 15.13 EMC Filter Switch Location 6



A - SW (ON) **B - Screw (OFF)**

Figure 15.14 EMC Filter Switch Location 7

If you lose an EMC filter switch screw, use the table to find the correct replacement screw and install the new screw with the correct tightening torque.

NOTICE *Only use the screws specified in this manual. If you use screws that are not approved, it can cause damage to the drive.*

EN

Table 15.10 Screw Sizes and Tightening Torques

Model	Screw Size	Tightening Torque N·m
2003 - 2075, 4002 - 4045	M4 × 20	1.0 - 1.3
2088 - 2180, 4060 - 4150	M4 × 25	1.0 - 1.3
2215 - 2415, 4180 - 4605	M5 × 25	2.0 - 2.5

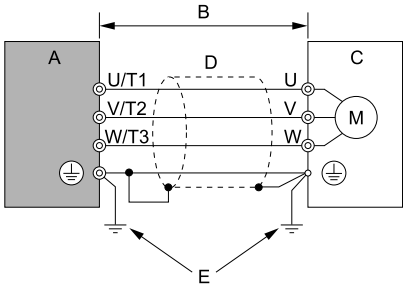
■ Installing the External EMC Noise Filter

This product (model: 2xxxA, 4xxxA) must meet conditions in this section to comply with EN 61800-3:2004 +A1:2012.

Connect an EMC noise filter to the input side (primary side) that complies with European standards as specified by Yaskawa. Refer to *External EMC Noise Filter Selection on page 100* to select the correct EMC noise filter.

Use this procedure to install an EMC noise filter to make machinery and devices added to the drive comply with the EMC Directive.

1. Install the drive and EMC noise filter on the same grounded metal plate.
2. Wire the drive and motor.
3. Ground the wire shielding in the drive side and motor side.



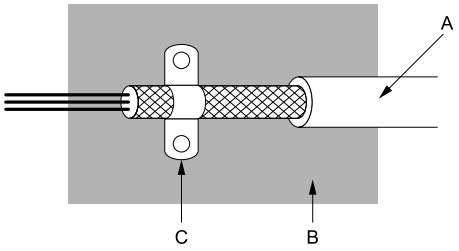
A - Drive Series
B - 10 m (32.8 ft.) maximum
C - Motor
D - Metal conduit
E - Grounding wire

Figure 15.15 Wiring the Drive and Motor

Note:
- Use a braided shield cable for the drive and motor wiring or put the wires through a metal conduit.
- The maximum wiring length between the drive and motor is 10 m (32.8 ft.). Keep the cable between the drive and motor as short as possible.
- Keep the grounding wire as short as possible.

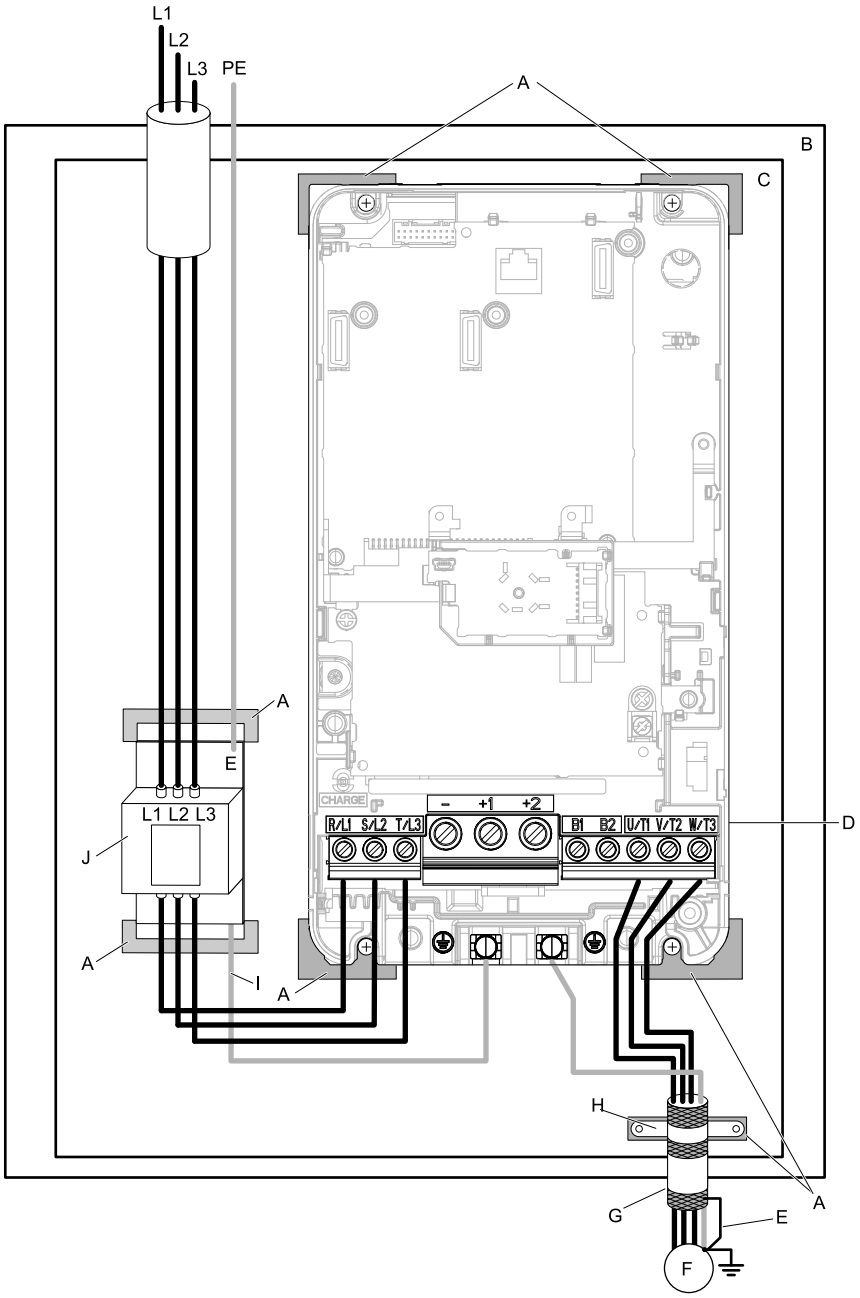
4. Use a cable clamp to ground the motor cable to the metal plate.

Note:
Make sure that the protective ground wire complies with technical specifications and local safety standards.



A - Braided shield cable
B - Metal plate
C - Cable clamp (conductive)

Figure 15.16 Ground the shield



A - Grounding surface (Remove any paint or sealant.)
B - Enclosure panel
C - Metal plate
D - Drive Series
E - Ground the shield.
F - Motor
G - Motor cable (Braided shield cable: max. 10 m (32.8 ft.))
H - Cable clamp
I - Grounding wire
J - EMC noise filter

Figure 15.17 EMC Noise Filter and Drive Installation Procedure

5. Connect the DC reactor to decrease harmonic distortion. Refer to *DC Reactor on page 101* to select a DC reactor.

Note:
- To maintain compliance with IEC/EN 61000-3-2 on drive models 2003, 2005, 4002, 4003, install a DC reactor.
- The main circuit terminal block for the drive, and the terminal blocks for the DC reactor come in different shapes. The drive has a European style terminal block, and the DC reactor has a round terminal block. Correctly prepare the ends of the wiring.

Ground Wiring

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch circuit boards while the drive is energized. If you touch the internal components of an energized drive, it can cause serious injury or death.*

⚠ WARNING *Electrical Shock Hazard. Ground the neutral point on the power supply of drive models 2xxxB/C and 4xxxB/C to comply with the EMC Directive before you turn on the EMC filter. If you turn ON the EMC filter, but you do not ground the neutral point, it can cause serious injury or death.*

External EMC Noise Filter Selection

Table 15.11 External EMC Noise Filter (2xxxA)

Model	EMC Noise Filter Model	Quantity	Manufacturer
2003A	RTEN-5006	1	TDK
2005A	RTEN-5010	1	TDK
2008A	RTEN-5020	1	TDK
2011A	RTEN-5020	1	TDK
2014A	RTEN-5030	1	TDK
2018A	RTEN-5030	1	TDK
2025A	RTEN-5060	1	TDK
2033A	RTEN-5060	1	TDK
2047A	RTEN-5080	1	TDK
2060A	FS5972-100-35	1	Schaffner
2075A	FS5972-100-35	1	Schaffner
2088A	FS5972-170-40	1	Schaffner
2115A	FS5972-170-40	1	Schaffner
2145A	FS5972-170-40	1	Schaffner
2180A	FS5972-250-37	1	Schaffner
2215A	FS5972-410-99	1	Schaffner
2283A	FS5972-410-99	1	Schaffner
2346A	FS5972-410-99	1	Schaffner
2415A	FS5972-600-99	1	Schaffner

Table 15.12 External EMC Noise Filter (4xxxA)

Model	EMC Noise Filter Model	Quantity	Manufacturer
4002A	B84143A0010R106	1	TDK
4003A	B84143A0010R106	1	TDK
4005A	B84143A0010R106	1	TDK
4006A	B84143A0010R106	1	TDK
4007A	B84143A0020R106	1	TDK
4009A	B84143A0020R106	1	TDK
4015A	B84143A0035R106	1	TDK
4018A	B84143A0035R106	1	TDK
4024A	B84143A0050R106	1	TDK
4031A	B84143A0065R106	1	TDK
4039A	B84143A0065R106	1	TDK
4045A	B84143A0065R106	1	TDK
4060A	B84143A0080R106	1	TDK
4075A	FS5972-100-35	1	Schaffner
4091A	FS5972-170-40	1	Schaffner
4112A	FS5972-170-40	1	Schaffner
4150A	FS5972-170-40	1	Schaffner
4180A	FS5972-250-37	1	Schaffner
4216A	FS5972-250-37	1	Schaffner
4260A	FS5972-410-99	1	Schaffner
4304A	FS5972-410-99	1	Schaffner

Model	EMC Noise Filter Model	Quantity	Manufacturer
4371A	FS5972-410-99	1	Schaffner
4414A	FS5972-600-99	1	Schaffner
4453A	FS5972-600-99	1	Schaffner
4605A	FS5972-410-99	2	Schaffner

■ DC Reactor

Install the DC reactor listed in Table 15.13 for drive models 2003, 2005, 4002, 4003 to comply with IEC/EN 61000-3-2.

Table 15.13 DC Reactors for Harmonic Suppression

Drive Model	DC Reactor Manufacturer: Yaskawa Electric Corporation	
	Model	Rating
2003	UZDA-B	5.4 A, 8 mH
2005	UZDA-B	5.4 A, 8 mH
4002	UZDA-B	3.2 A, 28 mH
4003	UZDA-B	3.2 A, 28 mH

EN

16 UL Standards

Figure 16.1 UL/cUL Mark

The UL/cUL Mark indicates that this product satisfies stringent safety standards. This mark appears on products in the United States and Canada. It shows UL approval, indicating that it has been determined that the product complies with safety standards after undergoing strict inspection and assessment.
You must use UL Listed or UL Recognized parts for all primary components that are built into electrical equipment that has UL approval.

This product has been tested in accordance with UL standard UL61800-5-1, and has been verified to be in compliance with UL standards.

Machines and devices integrated with this product must satisfy the following conditions for compliance with UL standards.

◆ Area of Use

Install this product in a location with Overvoltage Category III and pollution degree 2 or less as specified in UL61800-5-1.

■ Ambient Temperature Setting

Maintain the ambient temperature within the following ranges according to the enclosure type.

- IP20/UL Type 1: -10 °C to +40 °C (14 °F to 104 °F)
- IP20/UL Open Type: -10 °C to +50 °C (14 °F to 122 °F)

◆ Wiring to the Main Circuit Terminal

Wire the main circuit terminal block correctly in accordance with the instructions in the manual.

Be sure to use UL approved closed-loop crimp terminals for drive models 2346 to 2415 and 4304 to 4605 to maintain compliance with the UL standard. Use the tools recommend by the terminal manufacturer to crimp the closed-loop crimp terminal. Refer to *Closed-Loop Crimp Terminals on page 113* for details about closed-loop crimp terminal (UL compliant products).

Refer to *Three-Phase 200 V Class on page 104* and *Three-Phase 400 V Class on page 108* to select wire gauge.

Read the following instructions before wiring the terminal block.

■ Notes on Wiring the Main Circuit Terminal Block

- Use copper wire. Do not use alumnium or other non-copper wire.
- Remove all unwanted objects that are near the terminal block connections.
- Remove the insulation from the connection wires to the wire stripping lengths shown in the manual.
- Do not use bent or crushed wires. Remove the damaged end of the wire before you use it.
- Do not solder stranded wire.
- If you use stranded wire, make sure that all of the wire strands are in the connection. Also, do not twist the stranded wire too much.
- Put the wire all the way into the terminal block. Remove the insulation from the wire to the recommended wire stripping length to fit the wire with insulation in the plastic housing.
- The tightening torque is different for different terminals. Tighten the screws to the specified tightening torque.
- Use a torque driver, torque ratchet, or torque wrench for the screws. A slotted driver or a hex tool will be necessary to wire the screw clamp terminal. Use applicable tools as specified by the recommended conditions in the product manual.
- If you use power tools to tighten the terminal screws, use a low speed setting (300 to 400 r/min).
- Users can purchase wiring tools from Yaskawa. Contact Yaskawa or your nearest sales representative for more information.

- Wire gauges on existing drive models to be replaced may not match wire gauge ranges on new drives. Contact Yaskawa or your nearest sales representative for wire gauges that you can and cannot use.
- Do not tighten the terminal screws at an angle of 5 degrees or more.

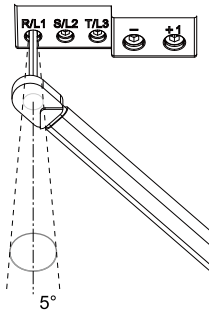


Figure 16.2 Permitted Angle

- Put the bit all the way into the hex socket to tighten the hex socket cap screw.
- When tightening straight-edge screws, hold the tip of the screwdriver in the center of the screw head. Do not let the tip of the screwdriver slip out from the groove of the screw.

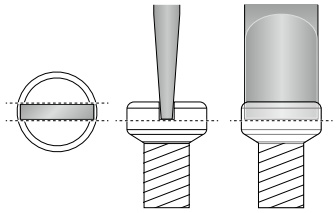
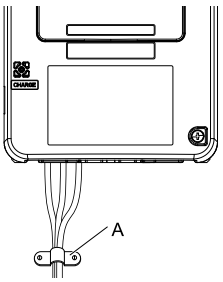


Figure 16.3 Tightening Slotted Screws

- After you connect the wires to the terminal block, lightly pull on the wires to make sure that they do not come out of the terminals.
- Remove the correct section of the wiring cover to make wiring easier.
- Regularly tighten loose terminal block screws to their specified tightening torques.
- Do not let strain on the wiring cause damage. Use a strain relief near the wiring to release the tension. Refer to Figure 16.4 for an example.



A - Strain relief

Figure 16.4 Strain Relief Example

Table 16.1 Recommended Wiring Tools

Screw Size	Screw Shape	Adapter	Bit		Torque Driver Model (Tightening Torque)	Torque Wrench
			Model	Manufacturer		
M4	Slotted (-)	Bit	SF-BIT-SL 1,0X4,0-70	PHOENIX CONTACT	TSD-M 3NM (1.2 - 3 N·m (10.6 - 26.6 lbf·in))	-
M5 *1	Slotted (-)	Bit	SF-BIT-SL 1,2X6,5-70	PHOENIX CONTACT	Wire Gauge ≤ 25 mm² (AWG 10): TSD-M 3NM (1.2 - 3 N·m (10.6 - 26.6 lbf·in))	Wire Gauge ≤ 25 mm² (AWG 10): -
					Wire Gauge ≥ 30 mm² (AWG 8): -	Wire Gauge ≥ 30 mm² (AWG 8): 4.1 - 4.5 N·m (36.3 - 39.8 lbf·in) *2 *3

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Screw Size	Screw Shape	Adapter	Bit		Torque Driver Model (Tightening Torque)	Torque Wrench
			Model	Manufacturer		
M6	Hex socket cap (WAF: 5 mm)	Bit	SF-BIT-HEX 5-50	PHOENIX CONTACT	-	5 - 9 N·m (44.3 - 79.9 lbf·in) *2 *3
	Minus (-)	Bit	SF-BIT-SL 1,2X6,5-70	PHOENIX CONTACT	-	3 - 3.5 N·m (26.6 - 31.0 lbf·in) *2 *3
M8	Hex socket cap (WAF: 6 mm)	Bit	SF-BIT-HEX 6-50	PHOENIX CONTACT	-	8 - 12 N·m (70.8 - 106.2 lbf·in) *2 *3
M10	Hex socket cap (WAF: 8 mm)	Bit	SF-BIT-HEX 8-50	PHOENIX CONTACT	-	12 - 14 N·m (106.2 - 123.9 lbf·in) *2 *3

*1 When wiring drive models 2047, 4075, and smaller, select the correct tools for the wire gauge.
*2 Use 6.35 mm (0.25 in) bit socket holder.
*3 Use a torque wrench that can apply this torque measurement range.

■ Wire Gauges and Tightening Torques

Refer to *Three-Phase 200 V Class on page 104* and *Three-Phase 400 V Class on page 108* for the recommended wire gauges and tightening torques of the main circuit terminals.

Comply with local standards concerning appropriate wire gauges in the region where the drive is used.

Note:

- The recommended wire gauges based on drive continuous current ratings using 75 °C (167 °F) 600 V class 2 heat resistant indoor PVC wire. Assume the following usage conditions:
  - Ambient temperature: 40 °C (104 °F) or lower
  - Wiring distance: 100 m (3281 ft.) or shorter
  - Rated current value
- Use terminals +1, +2, +3, -, B1, and B2 to connect peripheral options such as a DC reactor or a braking resistor. Do not connect anything other than optional devices.
- Refer to the specific instruction manual of each device for wire gauges when connecting peripheral devices or options to terminals +1, +2, +3, -, B1, and B2. Contact Yaskawa or your nearest sales representative if the recommended wire gauges for the peripheral devices or options are out of the range of the applicable gauge for the drive.
- Use UL approved closed-loop crimp terminals on the drive main circuit terminals in drive models 2215 to 2415 and 4180 to 4605. Use the tools recommend by the terminal manufacturer to ensure that the terminals are correctly fastened.

Three-Phase 200 V Class

Table 16.2 Main Circuit Wire Gauges and Tightening Torques (200 V Class)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Terminal Screw Size	Shape	
2003	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2005	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Terminal Screw Size	Shape	
2008	R/L1, S/L2, T/L3	12	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	12	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2011	R/L1, S/L2, T/L3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	12	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	10	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2014	R/L1, S/L2, T/L3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2018	R/L1, S/L2, T/L3	8	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	12 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
2025	R/L1, S/L2, T/L3	6	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	8	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	6	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	12	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	10 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)

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Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Terminal Screw Size	Shape	
2033	R/L1, S/L2, T/L3	6	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	6	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	3	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	10	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	10 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)
2047	R/L1, S/L2, T/L3	3	14 - 3 (8 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	4	14 - 4 (10 - 4)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	1	14 - 1 (8 - 1)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	8	14 - 8 (14 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	8 - 6 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2060	R/L1, S/L2, T/L3	1	14 - 1 (6 - 1)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	3	14 - 3 (6 - 3)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	1/0	14 - 1/0 (4 - 1/0)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	8	14 - 8 (14 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	6 - 4 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2075	R/L1, S/L2, T/L3	1/0	14 - 1/0 (6 - 1/0)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	2	14 - 2 (6 - 2)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	2/0	14 - 2/0 (4 - 2/0)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	6	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	6 - 4 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
2088	R/L1, S/L2, T/L3	1/0	6 - 1/0 (6 - 1/0)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	1/0	6 - 1/0 (6 - 1/0)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	2/0	2 - 2/0 (2 - 2/0)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	4	14 - 4 (10 - 4)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	6	6 - 4 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Terminal Screw Size	Shape	
2115	R/L1, S/L2, T/L3	2/0	6 - 2/0 (2 - 2/0)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	2/0	6 - 2/0 (2 - 2/0)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	4/0	2 - 4/0 (2 - 4/0)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	3	14 - 3 (10 - 3)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	4	4 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
2145	R/L1, S/L2, T/L3	4/0	2 - 250 (2/0 - 250)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	4/0	2 - 300 (3/0 - 300)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4 *5	1	6 - 2/0 (1/0 - 2/0)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3 *5	1/0	4 - 2/0 (1 - 2/0)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4 - 1/0 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2180	R/L1, S/L2, T/L3	250	2 - 250 (2/0 - 250)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	300	2 - 300 (3/0 - 300)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4 *5	2/0	6 - 2/0 (1/0 - 2/0)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3 *5	2/0	4 - 2/0 (1 - 2/0)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4 - 1/0 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2215	R/L1, S/L2, T/L3	2/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	2/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	4/0 × 2P	2 - 250 × 2P (4/0 - 250 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	4 - 1/0 × 2P (1/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	3	3 - 350 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2283	R/L1, S/L2, T/L3	4/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	3/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	250 × 2P	2 - 250 × 2P (4/0 - 250 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	4 - 1/0 × 2P (1/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	2	2 - 350 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)

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Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Terminal Screw Size	Shape	
2346	R/L1, S/L2, T/L3	250 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	250 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	350 × 2P	4/0 - 400 × 2P (300 - 400 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	3/0 × 2P	1/0 - 4/0 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	1	1 - 350 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
2415	R/L1, S/L2, T/L3	250 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	300 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	350 × 2P	4/0 - 400 × 2P (300 - 400 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	3/0 × 2P	1/0 - 4/0 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	1	1 - 350 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

*1 For IP20 protection, use wires that are in the range of applicable gauges.
*2 Remove insulation from the ends of wires to expose the length of wire shown.
*3 For wire gauges more than AWG 8, tighten to a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf·in to 40 lbf·in).
*4 Terminals - and +1 have two screws. The Recommended Gauge is the wire gauge for one terminal.
*5 A junction terminal is necessary to connect a braking unit (CDBR-series) to terminals - and +3.

Three-Phase 400 V Class

Table 16.3 Main Circuit Wire Gauges and Tightening Torques (400 V Class)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4002	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	12	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4003	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	12	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4005	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4006	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4007	R/L1, S/L2, T/L3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	12	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4009	R/L1, S/L2, T/L3	12	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	10	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M4	Phillips/slotted combo	1.2 - 1.5 (10.6 - 13.3)
4015	R/L1, S/L2, T/L3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	14	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)

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Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4018	R/L1, S/L2, T/L3	8	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3 (14 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	12	14 - 10 (14 - 10)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	12 - 8 (-)	-	M5	Phillips/slotted combo	2.0 - 2.5 (17.7 - 22.1)
4024	R/L1, S/L2, T/L3	6	14 - 3 (8 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	8	14 - 4 (10 - 4)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	6	14 - 1 (8 - 1)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	14 - 8 (14 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	10 - 6 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4031	R/L1, S/L2, T/L3	6	14 - 3 (8 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	8	14 - 4 (10 - 4)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	4	14 - 1 (8 - 1)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	14 - 8 (14 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	10 - 6 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4039	R/L1, S/L2, T/L3	4	14 - 4 (10 - 4)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	6	14 - 6 (10 - 6)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1, +2	3	14 - 3 (10 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	8	14 - 8 (14 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	8 - 4 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)
4045	R/L1, S/L2, T/L3	4	14 - 4 (10 - 4)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	4	14 - 4 (10 - 4)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	3	14 - 3 (10 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	8	14 - 8 (14 - 8)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	8 - 4 (-)	-	M6	Phillips/slotted combo	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4060	R/L1, S/L2, T/L3	3	14 - 3 (12 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	3	14 - 3 (12 - 3)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	2	14 - 2 (10 - 2)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	B1, B2	6	14 - 6 (14 - 6)	10	M4	Slotted (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	6 - 4 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4075	R/L1, S/L2, T/L3	2	14 - 2 (10 - 2)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	U/T1, V/T2, W/T3	2	14 - 2 (10 - 2)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	-, +1	1/0	14 - 1/0 (6 - 1/0)	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	6	14 - 6 (14 - 6)	18	M5	Slotted (-)	2.3 - 2.5 (19.8 - 22) *3
	⏚	4	6 - 4 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4091	R/L1, S/L2, T/L3	1/0	6 - 2/0 (2 - 2/0)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	1	6 - 2/0 (2 - 2/0)	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	2/0	2 - 4/0 (2 - 4/0)	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	3	14 - 3 (10 - 3)	21	M6	Slotted (-)	3 - 3.5 (27 - 31)
	⏚	4	6 - 4 (-)	-	M6	Hex bolt (+)	5.4 - 6.0 (47.8 - 53.1)
4112	R/L1, S/L2, T/L3	3/0	2 - 250 (2/0 - 250)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2/0	2 - 300 (3/0 - 300)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4	2	6 - 2/0 (1/0 - 2/0)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2 *5	1	4 - 2/0 (1 - 2/0)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4 - 1/0 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4150	R/L1, S/L2, T/L3	4/0	2 - 250 (2/0 - 250)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	4/0	2 - 300 (3/0 - 300)	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4	1/0	6 - 2/0 (1/0 - 2/0)	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2 *5	1/0	4 - 2/0 (1 - 2/0)	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4 - 1/0 (-)	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)

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Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4180	R/L1, S/L2, T/L3	1/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	1/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	3/0 × 2P	2 - 250 × 2P (4/0 - 250 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	4 - 1/0 × 2P (1/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	4	4 - 350 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4216	R/L1, S/L2, T/L3	2/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	2/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	3/0 × 2P	2 - 250 × 2P (4/0 - 250 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	4 - 1/0 × 2P (1/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	2	2 - 350 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4260	R/L1, S/L2, T/L3	3/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	3/0 × 2P	3 - 4/0 × 2P (2/0 - 4/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	-, +1	4/0 × 2P	2 - 250 × 2P (4/0 - 250 × 2P)	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	4 - 1/0 × 2P (1/0 × 2P)	-	M10	Hex self-locking nut	20 (177)
	⏚	2	2 - 350 (-)	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4304	R/L1, S/L2, T/L3	250 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	250 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	350 × 2P	4/0 - 400 × 2P (300 - 400 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	3/0 × 2P	1 - 4/0 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	1	1 - 350 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4371	R/L1, S/L2, T/L3	300 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	300 × 2P	2/0 - 300 × 2P (250 - 300 × 2P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	400 × 2P	4/0 - 400 × 2P (300 - 400 × 2P)	-	M12	Hex self-locking nut	35 (310)
	+3	4/0 × 2P	1 - 4/0 × 2P (-)	-	M12	Hex self-locking nut	35 (310)
	⏚	1	1 - 350 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

Model	Terminal	Recomm. Gauge AWG, kcmil	Applicable Gauge (IP20 Applicable Gauge *1) AWG, kcmil	Wire Stripping Length *2 mm	Terminal Screw		Tightening Torque N·m (lbf·in)
					Size	Shape	
4414	R/L1, S/L2, T/L3, R1/L11, S1/L21, T1/L31	250 × 4P	2/0 - 300 × 4P (250 - 300 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	4/0 × 4P	2/0 - 300 × 4P (250 - 300 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	4/0 × 4P	3/0 - 400 × 4P (300 - 400 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	3/0 × 4P	2 - 4/0 (4/0 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	1/0	1/0 - 300 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4453	R/L1, S/L2, T/L3, R1/L11, S1/L21, T1/L31	250 × 4P	2/0 - 300 × 4P (250 - 300 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	4/0 × 4P	2/0 - 300 × 4P (250 - 300 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	300 × 4P	3/0 - 400 × 4P (300 - 400 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	3/0 × 4P	2 - 4/0 × 4P (4/0 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	2/0	2/0 - 300 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)
4605	R/L1, S/L2, T/L3, R1/L11, S1/L21, T1/L31	300 × 4P	2/0 - 300 × 4P (250 - 300 × 4P)	-	M12	Hex self-locking nut	35 (310)
	U/T1, V/T2, W/T3	300 × 4P	2/0 - 300 × 4P (250 - 300 × 4P)	-	M12	Hex self-locking nut	35 (310)
	-, +1	400 × 4P	3/0 - 400 × 4P (300 - 400 × 4P)	-	M12	Hex self-locking nut	35 (310)
	+3	4/0 × 4P	2 - 4/0 × 4P (4/0 × 4P)	-	M12	Hex self-locking nut	35 (310)
	⏚	2/0	2/0 - 300 (-)	-	M12	Hex bolt (slotted)	32 - 40 (283 - 354)

*1 For IP20 protection, use wires that are in the range of applicable gauges.
*2 Remove insulation from the ends of wires to expose the length of wire shown.
*3 For wire gauges more than AWG 8, tighten to a tightening torque of 4.1 N·m to 4.5 N·m (36 lbf·in to 40 lbf·in).
*4 Terminals - and +1 have two screws. The Recommended Gauge is the wire gauge for one terminal.
*5 A junction terminal is necessary to connect a braking resistor unit (LKEB-series) to terminals B1 and B2.

■ Closed-Loop Crimp Terminals

To comply with UL standards on drive models 2215 to 2415 and 4180 to 4605, use UL-approved closed-loop crimp terminals. Use the tools recommend by the terminal manufacturer to crimp the closed-loop crimp terminal. Yaskawa recommends closed-loop crimp terminals from JST Mfg. Co., Ltd. and insulation caps from Tokyo DIP Co., Ltd. Contact Yaskawa or your nearest sales representative to make an order.

Refer to Table 16.4 to select crimp terminals as specified by drive model and wire gauge.

Note:

To comply with UL standards, use only insulated crimp terminals or crimp terminals with insulation tubing. Use UL-Listed, vinyl-coated insulated copper wires for operation with a continuous maximum permitted temperature of 75 °C at 600 V.

Table 16.4 Closed-Loop Crimp Terminals and Insulation Caps

Model	Recomm. Gauge (AWG, kcmil)					Terminal Screw Size	Crimp Terminal Model	Crimping Tool		Insulation Cap Model
	R/L1, S/L2, T/L3	U/T1, V/T2, W/T3	-, +1	+3	⏚			Tool Model	Die Jaw	
2003 - 2018	-	-	-	-	10	M4	R5.5-4	YA-4	AD-900	TP-005
2025, 2033	-	-	-	-	8	M5	R8-5	YA-4	AD-901	TP-008
2047	-	-	-	-	6	M6	R14-6	YA-4	AD-902	TP-014
2060 - 2088	-	-	-	-	6	M6	R14-6	YA-4	AD-902	TP-014
2115	-	-	-	-	4	M6	R22-6	YA-5	AD-953	TP-022

Model	Recomm. Gauge (AWG, kcmil)					Terminal Screw Size	Crimp Terminal Model	Crimping Tool		Insulation Cap Model
	R/L1, S/L2, T/L3	U/T1, V/T2, W/T3	-, +1	+3	⏚			Tool Model	Die Jaw	
2145, 2180	-	-	-	-	4	M8	R22-8	YA-5	AD-953	TP-022
2215	-	-	-	-	-	M10	R38-10	YF-1 YET-150-1	TD-224, TD-212	TP-038
	-	-	-	1/0 × 2P	-		R60-10		TD-225, TD-213	TP-060
	2/0 × 2P	2/0 × 2P	-	-	-		80-10		TD-227, TD-214	TP-080
	-	-	4/0 × 2P	-	-		R100-10		TD-228, TD-214	TP-100
2283	-	-	-	-	2	M10	R38-10	YF-1 YET-150-1	TD-224, TD-212	TP-038
	-	-	-	1/0 × 2P	-		R60-10		TD-225, TD-213	TP-060
	-	3/0 × 2P	-	-	-		80-10		TD-227, TD-214	TP-080
	4/0 × 2P	-	-	-	-		R100-10		TD-228, TD-214	TP-100
	-	-	250 × 2P	-	-		R150-10		TD-229, TD-215	TP-150
2346	-	-	-	-	1	M12	R60-12	YF-1 YET-300-1	TD-321, TD-311	TP-060
	-	-	-	3/0 × 2P	-		80-10		TD-323, TD-312	TP-080
	250 × 2P	250 × 2P	-	-	-		R150-10		TD-325, TD-313	TP-150
	-	-	350 × 2P	-	-		R200-10		TD-327, TD-314	TP-200
2415	-	-	-	-	1	M12	R60-10	YF-1 YET-300-1	TD-321, TD-311	TP-060
	-	-	-	3/0 × 2P	-		80-10		TD-323, TD-312	TP-080
	250 × 2P	-	-	-	-		R150-10		TD-325, TD-313	TP-150
	-	300 × 2P								
	-	-	350 × 2P	-	-		R200-10		TD-327, TD-314	TP-200
4002, 4003	-	-	-	-	12	M4	R5.5-4	YA-4	AD-900	TP-005
4005 - 4009	-	-	-	-	10	M4	R5.5-4	YA-4	AD-900	TP-005
4015, 4018	-	-	-	-	10	M5	R5.5-5	YA-4	AD-900	TP-005
4024	-	-	-	-	8	M6	R8-6	YA-4	AD-901	TP-008
4031	-	-	-	-	6	M6	R14-6	YA-4	AD-902	TP-014
4039, 4045	-	-	-	-	6	M6	R14-6	YA-4	AD-902	TP-014
4060	-	-	-	-	6	M6	R14-6	YA-4	AD-902	TP-014
4075, 4091	-	-	-	-	4	M6	R22-6	YA-5	AD-953	TP-022
4112, 4150	-	-	-	-	4	M8	R22-8	YA-5	AD-953	TP-022
4180	-	-	-	-	4	M10	R22-10	YF-1 YET-150-1	TD-223, TD-212	TP-022
	1/0 × 2P	1/0 × 2P	-	1/0 × 2P	-		R60-10		TD-225, TD-213	TP-060
	-	-	3/0 × 2P	-	-		80-10		TD-227, TD-214	TP-080
4216	-	-	-	-	2	M10	R38-10	YF-1 YET-150-1	TD-224, TD-212	TP-038
	-	-	-	1/0 × 2P	-		R60-10		TD-225, TD-213	TP-060
	2/0 × 2P	2/0 × 2P	-	-	-		80-10		TD-227, TD-214	TP-080
	-	-	3/0 × 2P							

Model	Recomm. Gauge (AWG, kcmil)					Terminal Screw Size	Crimp Terminal Model	Crimping Tool		Insulation Cap Model
	R/L1, S/L2, T/L3	U/T1, V/T2, W/T3	-, +1	+3	⏚			Tool Model	Die Jaw	
4260	-	-	-	-	2	M10	R38-10	YF-1 YET-150-1	TD-224, TD-212	TP-038
	-	-	-	1/0 × 2P	-		R60-10		TD-225, TD-213	TP-060
	3/0 × 2P	3/0 × 2P	-	-	-		80-10		TD-227, TD-214	TP-080
	-	-	4/0 × 2P	-	-		R100-10		TD-228, TD-214	TP-100
4304	-	-	-	-	1	M12	R60-12	YF-1 YET-300-1	TD-321, TD-311	TP-060
	-	-	-	3/0 × 2P	-		80-12		TD-323, TD-312	TP-080
	250 × 2P	250 × 2P	-	-	-		R150-12		TD-325, TD-313	TP-150
	-	-	350 × 2P	-	-		R200-12		TD-327, TD-314	TP-200
4371	-	-	-	-	1	M12	R60-12	YF-1 YET-300-1	TD-321, TD-311	TP-060
	-	-	-	4/0 × 2P	-		R100-12		TD-324, TD-312	TP-100
	300 × 2P	300 × 2P	-	-	-		R150-12		TD-325, TD-313	TP-150
	-	-	400 × 2P	-	-		R200-12		TD-327, TD-314	TP-200
4414	-	-	-	-	1/0	M12	R60-12	YF-1 YET-300-1	TD-321, TD-311	TP-060
	-	-	-	3/0 × 4P	-		80-12		TD-323, TD-312	TP-080
	-	4/0 × 4P	4/0 × 4P	-	-		R100-12		TD-324, TD-312	TP-100
	250 × 4P	-	-	-	-		R150-12		TD-325, TD-313	TP-150
4453	-	-	-	-	2/0	M12	80-12	YF-1 YET-300-1	TD-323, TD-312	TP-080
				3/0 × 4P	-					
	-	4/0 × 4P	-	-	-		R100-12		TD-324, TD-312	TP-100
	250 × 4P	-	-	-	-		R150-12		TD-325, TD-313	TP-150
	-		300 × 4P							
4605	-	-	-	-	2/0	M12	80-12	YF-1 YET-300-1	TD-323, TD-312	TP-080
	-	-	-	4/0 × 4P	-		R100-12		TD-324, TD-312	TP-100
	300 × 4P	300 × 4P	-	-	-		R150-12		TD-325, TD-313	TP-150
	-	-	400 × 4P	-	-		R200-12		TD-327, TD-314	TP-200

*1 Contact Yaskawa or your nearest sales representative for more information.

■ Factory-Recommended Branch Circuit Protection

Use branch circuit protection to protect against short circuits and to maintain compliance with UL61800-5-1. Yaskawa recommends connecting semiconductor protection fuses on the input side for branch circuit protection. Refer to Table 16.5 to Table 16.6for the recommended fuses.

⚠ WARNING *Electrical Shock Hazard. After the drive blows a fuse or trips an RCM/RCD, do not immediately energize the drive or operate peripheral devices. Wait for the time specified on the warning label at a minimum and make sure that all indicators are OFF. Then check the wiring and peripheral device ratings to find the cause of the problem. If you do not know the cause of the problem, contact Yaskawa before you energize the drive or peripheral devices. If you do not fix the problem before you operate the drive or peripheral devices, it can cause serious injury or death.*

- 200 V Class
  Use the fuses specified in this document to prepare the drive for use on a circuit that supplies not more than 100,000 RMS and not more than 240 Vac when there is a short circuit in the power supply.

EN

- 400 V Class
  Use the fuses specified in this document to prepare the drive for use on a circuit that supplies not more than 100,000 RMS and not more than 480 Vac when there is a short circuit in the power supply.

The built-in short circuit protection of the drive does not provide branch circuit protection. The user must provide branch circuit protection as specified by the National Electric (NEC), the Canadian Electric Code, Part I (CEC), and local codes.

Three-Phase 200 V Class

Table 16.5 Factory-Recommended Branch Circuit Protection

Drive Model	Maximum Applicable Motor Output kW (HP)	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/Bussmann
2003	0.55 (0.5)	3.6	FWH-45B
2005	0.75 (1)	4.8	FWH-45B
2008	1.5 (2)	8.9	FWH-45B
2011	2.2 (3)	12.7	FWH-50B
2014	3 (4)	17	FWH-80B
2018	4.0 (5)	20.7	FWH-80B
2025	5.5 (7.5)	30	FWH-125B
2033	7.5 (10)	40.3	FWH-150B
2047	11 (15)	58.2	FWH-200B
2060	15 (20)	78.4	FWH-225A
2075	18.5 (25)	96	FWH-225A FWH-250A *1
2088	22 (30)	82	FWH-225A FWH-250A *1
2115	30 (40)	111	FWH-275A FWH-300A *1
2145	37 (50)	136	FWH-275A FWH-350A *1
2180	45 (60)	164	FWH-325A FWH-450A *1
2215	55 (75)	200	FWH-600A
2283	75 (100)	271	FWH-800A
2346	90 (125)	324	FWH-1000A
2415	110 (150)	394	FWH-1400A

*1 Yaskawa recommends a fuse with a large rated current for applications with repeated loads.

Three-Phase 400 V Class

Table 16.6 Factory-Recommended Branch Circuit Protection

Drive Model	Maximum Applicable Motor Output kW (HP)	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/Bussmann
4002	0.55 (0.75)	1.9	FWH-50B
4003	1.1 (1)	3.5	FWH-50B
4005	1.5 (2)	4.7	FWH-50B
4006	2.2 (3)	6.7	FWH-60B
4007	3 (4)	8.9	FWH-60B
4009	4.0 (5)	11.7	FWH-60B
4015	5.5 (7.5)	15.8	FWH-80B
4018	7.5 (10)	21.2	FWH-90B
4024	11 (15)	30.6	FWH-150B
4031	15 (20)	41.3	FWH-200B
4039	18.5 (25)	50.5	FWH-200B

Drive Model	Maximum Applicable Motor Output kW (HP)	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/Bussmann
4045	22 (30)	43.1	FWH-225A
4060	30 (40)	58.3	FWH-250A
4075	37 (50)	71.5	FWH-275A
4091	45 (60)	86.5	FWH-275A
4112	55 (75)	105	FWH-300A
4150	75 (100)	142	FWH-325A FWH-400A *1
4180	90 (125)	170	FWH-500A
4216	110 (150)	207	FWH-600A
4260	132 (175)	248	FWH-700A
4304	160 (200)	300	FWH-800A
4371	200 (250)	373	FWH-1000A
4414	220 (300)	410	FWH-1200A
4453	250 (335)	465	FWH-1200A
4605	315 (400)	584	FWH-1400A FWH-1600A *1

*1 Yaskawa recommends a fuse with a large rated current for applications with repeated loads.

◆ Low Voltage Wiring for Control Circuit Terminals

Low voltage wiring must be provided in accordance with the NEC (National Electric Code), the CEC (Canadian Electric Code, Part I), and any additional local codes. The NEC class 1 circuit conductor is recommended. Use the UL approved class 2 power supply for external power supply.

Table 16.7 Power Supply Used for Control Circuit Terminals

Input/Output	Terminal Sign	Power Supply Specifications
Digital inputs	S1 to S10, SN, SC, SP	The LVLC power supply in the drive is used. Use the UL approved class 2 power supply for external power supply.
Analog input	A1 to A3, AC, +V, -V	The LVLC power supply in the drive is used. Use the UL approved class 2 power supply for external power supply.
Analog output	FM, AM, AC	The LVLC power supply in the drive is used.
Safe disable Input	H1, H2, HC	The LVLC power supply in the drive is used. Use the UL approved class 2 power supply for external power supply.
Open-collector output	P1, C1, P2, C2	Use the UL approved class 2 power supply.
Serial communication input/output	D+, D-, AC	The LVLC power supply in the drive is used. Use the UL approved class 2 power supply for external power supply.
24 V external power supply	PS, AC	Use the UL approved class 2 power supply.

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◆ Drive Motor Overload and Overheat Protection

The drive motor overload and overheat protection function complies with the NEC (National Electric Code) and the CEC (Canadian Electric Code, Part I).

Set the *Motor Rated Current* and *L1-01 to L1-04 [Motor Overload Protection Select]* properly to enable motor overload and overheat protection.

Set the motor rated current with *E2-01 [Motor Rated Current (FLA)]*.

■ E2-01: Motor Rated Current (FLA)

No. (Hex.)	Name	Description	Default (Range)
E2-01 (030E)	Motor Rated Current (FLA)	V/f CL-V/f OLV CLV AOLV Sets the motor rated current in amps.	Determined by o2-04 (10% to 200% of the drive rated current)

Note:
- If parameter *E2-01 < E2-03 [Motor No-Load Current]* is set, *oPE02 [Parameter Range Setting Error]* will be detected.
- The units for the default setting and setting range vary depending on the model of the drive.
  - –2003 to 2033, 4002 to 4018: 0.01 A units
  - –2047 to 2415, 4024 to 4605: 0.1 A units

The value set for *E2-01* becomes the reference value for motor protection and the torque limit. Enter the motor rated current as shown on the motor nameplate. The value of *E2-01* is automatically set to the value input for "Motor Rated Current" by the Auto-Tuning process.

■ L1-01: Motor Overload (oL1) Protection

No. (Hex.)	Name	Description	Default (Range)
L1-01 (0480)	Motor Overload (oL1) Protection	V/f CL-V/f OLV CLV AOLV Sets the motor overload protection with electronic thermal protectors.	Determined by A1-02 (0 - 3, 6)

Parameter *L1-01* enables and disables the motor overload protection with electronic thermal protectors.

The cooling capability of the motor changes when the speed control range of the motor changes. Use an electronic thermal protector that aligns with the permitted load characteristics of the motor to select motor protection.

The electronic thermal protector of the drive uses Output current, Output frequency, Motor thermal characteristics, and Time characteristics to calculate motor overload tolerance and supply overload protection for the motor. If the drive detects motor overload, the drive will trigger an *oL1 [Motor Overload]* and stop the drive output.

You can set a motor overload alarm. Set *H2-02 = 1F [Term M3-M4 Function Selection = Motor Overload Alarm (oL1)]* to enable this function. If the motor overload level is more than 90% of the *oL1* detection level, the output terminal activates and triggers an overload alarm.

Note:

When you connect only one motor to a drive, set *L1-01 = 1 to 3 or 6 [Enabled]*. External thermal relays are not necessary in these conditions.

0 : Disable

Disable motor protection when motor overload protection is not necessary or when the drive is operating more than one motor.

Refer to the figure for an example of the circuit configuration to connect more than one motor to one drive.

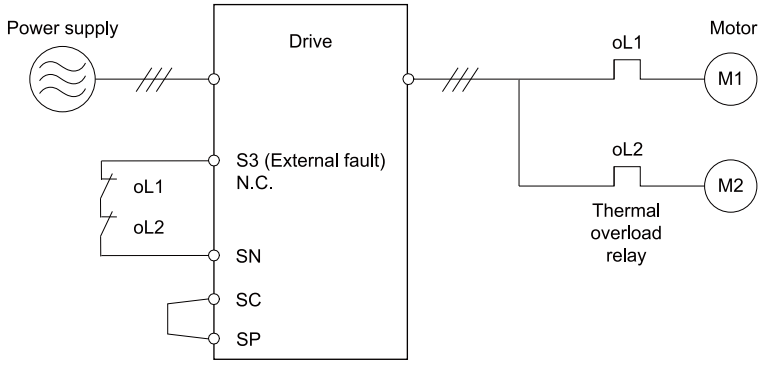


Figure 16.5 Protection Circuit Configuration to Connect More than One Motor to One Drive

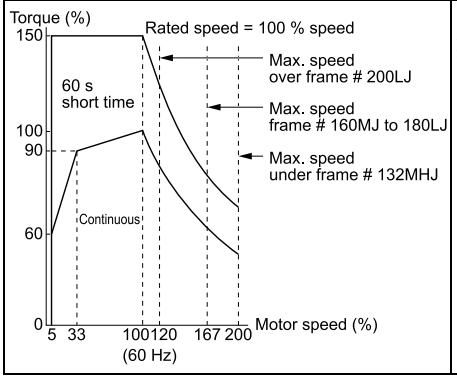
NOTICE *When you connect more than one motor to one drive or when the motor amp rating is higher than the drive amp rating, set L1-01 =0 [Motor Overload (oL1) Protection = Disabled] and install thermal overload relays for each motor. The electronic thermal protection of the drive will not function and it can cause damage to the motor.*

1 : Variable Torque

Use this setting for general-purpose motors with a 60 Hz base frequency.

The overload tolerance decreases as Run decreases because the cooling fan speed decreases and the ability of the motor to cool decreases in the low speed range. The overload tolerance characteristics of the motor change the

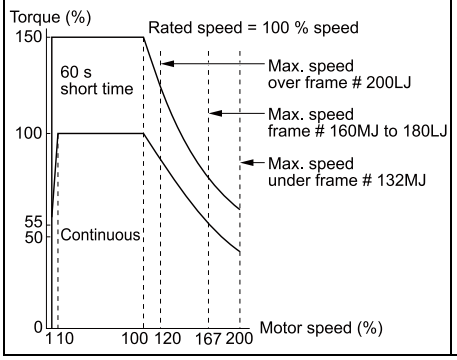
trigger point for the electronic thermal protector. This provides motor overheat protection from low speed to high speed across the full speed range.

Load Tolerance	Cooling Capability	Overload Characteristics (at 100% motor load)
	This motor is designed to operate with commercial line power. Operate at a 60 Hz base frequency to maximize the motor cooling ability.	If the motor operates at frequencies less than 60 Hz, the drive will detect *oL1*. The drive triggers a fault relay output and the motor coasts to stop.

2 : Constant Torque 10:1 Speed Range

Use this setting for drive-dedicated motors with a speed range for constant torque of 1:10.

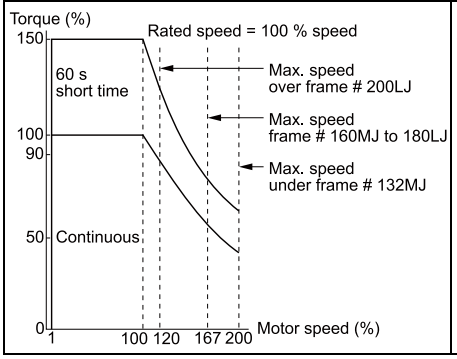
The speed control for this motor is 10% to 100% when at 100% load. Operating slower than 10% speed at 100% load will cause motor overload.

Load Tolerance	Cooling Capability	Overload Characteristics (at 100% motor load)
	This motor is designed to withstand increased temperatures during continuous operation in the low speed range (10% base frequency).	The motor operates continuously at 10% to 100% base frequency.

3 : Constant Torque 100:1 SpeedRange

Use this setting for vector motors with a speed range for constant torque of 1:100.

The speed control for this motor is 1% to 100% when at 100% load. Operating slower than 1% speed at 100% load will cause motor overload.

Load Tolerance	Cooling Capability	Overload Characteristics (at 100% motor load)
	This motor is designed to withstand increased temperatures during continuous operation in the more low speed range (1% base frequency).	The motor operates continuously at 1% to 100% base frequency. Operating slower than 1% speed at 100% load will cause motor overload.

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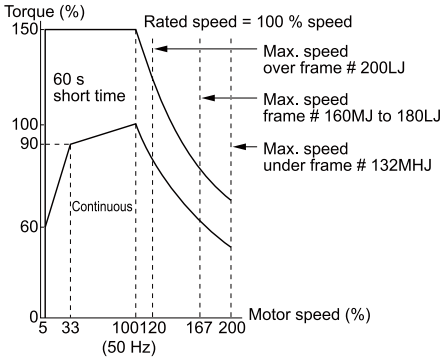
6 : Variable Torque (50Hz)

Use this setting for general-purpose motors with a 50 Hz base frequency.

The overload tolerance decreases as Run decreases because the cooling fan speed decreases and the ability of the motor to cool decreases in the low speed range. The overload tolerance characteristics of the motor change the trigger point for the electronic thermal protector. This provides motor overheat protection from low speed to high speed across the full speed range.

Load Tolerance	Cooling Capability	Overload Characteristics (at 100% motor load)
	This motor is designed to operate with commercial line power. Operate at a 50 Hz base frequency to maximize the motor cooling ability.	If the motor operates at frequencies less than commercial line power, the drive will detect *oL1*. The drive triggers a fault relay output and the motor coasts to stop.

■ L1-02: Motor Overload Protection Time

No. (Hex.)	Name	Description	Default (Range)
L1-02 (0481)	Motor Overload Protection Time	V/f CL-V/f OLV CLV AOLV Sets the operation time for the electronic thermal protector of the drive to prevent damage to the motor. Usually it is not necessary to change this setting.	1.0 min (0.1 - 5.0 min)

Set the overload tolerance time to the length of time that the motor can operate at 150% load from continuous operation at 100% load.

When the motor operates at 150% load continuously for 1 minute after continuous operation at 100% load (hot start), the default setting triggers the electronic thermal protector.

Figure 16.6 shows an example of the electronic thermal protector operation time. Motor overload protection operates in the range between a cold start and a hot start.

This example shows a general-purpose motor operating at the base frequency with *L1-02* set to 1.0 min.

- Cold start
  Shows the motor protection operation time characteristics when the overload occurs immediately after starting operation from a complete stop.
- Hot start
  Shows the motor protection operation time characteristics when overload occurs from continuous operation below the motor rated current.

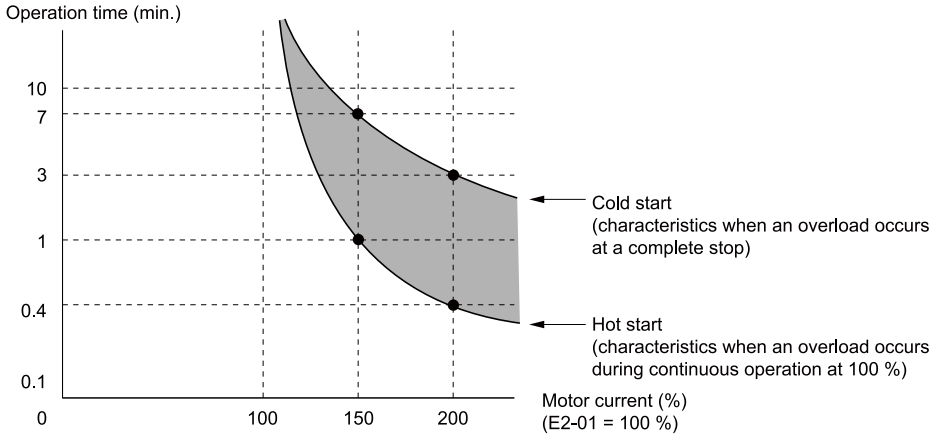


Figure 16.6 Protection Operation Time for a General-purpose Motor at Rated Output Frequency

■ L1-03: Motor Thermistor oH Alarm Select

No. (Hex.)	Name	Description	Default (Range)
L1-03 (0482)	Motor Thermistor oH Alarm Select	V/f CL-V/f OLV CLV AOLV Sets the drive operation when the PTC input signal to the drive is at the *oH3 [Motor Overheat (PTC Input)]* detection level.	3 (0 - 3)

0 : Ramp to Stop

The drive ramps the motor to stop according to the deceleration time. Fault relay output terminal MA-MC will turn ON, and MB-MC will turn OFF.

1 : Coast to Stop

The drive output shuts off and the motor coasts to stop. Fault relay output terminal MA-MC will turn ON, and MB-MC will turn OFF.

2 : Fast Stop (Use C1-09)

The drive stops the motor using the deceleration time set in *C1-09 [Fast Stop Time]*. Fault relay output terminal MA-MC will turn ON, and MB-MC will turn OFF.

3 : Alarm Only

oH3 appears on the keypad, and operation continues. The output terminal set for *Alarm [H2-01 to H2-05 = 10]* switches ON.

■ L1-04: Motor Thermistor oH Fault Select

No. (Hex.)	Name	Description	Default (Range)
L1-04 (0483)	Motor Thermistor oH Fault Select	V/f CL-V/f OLV CLV AOLV Sets the drive operation when the PTC input signal to the drive is at the *oH4 [Motor Overheat Fault (PTC Input)]* detection level.	1 (0 - 2)

0 : Ramp to Stop

The drive ramps the motor to stop in the deceleration time. Fault relay output terminal MA-MC turns ON, and MB-MC turns OFF.

1 : Coast to Stop

The output turns OFF and the motor coasts to stop. Fault relay output terminal MA-MC turns ON, and MB-MC turns OFF.

2 : Fast Stop (Use C1-09)

The drive stops the motor in the deceleration time set in *C1-09 [Fast Stop Time]*. Fault relay output terminal MA-MC turns ON, and MB-MC turns OFF.

17 China RoHS Compliance

Figure 17.1 China RoHS Mark

The China RoHS mark is displayed on products containing six specified hazardous substances that are in excess of regulatory limits, based on the “Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products” and “Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products” (SJ/T 11364-2014), which were promulgated on January 26, 2016. The number displayed in the center of the mark indicates the environment-friendly use period (number of years) in which electrical and electronic products that are being produced, sold, or imported to China can be used. The date of manufacture of the electrical and electronic product is the starting date of the environment-friendly use period for the product. The six specified hazardous substances contained in the product will not leak outside of the product during normal use within this period and will have no serious impact on the environment, the human body, or property.

The environment-friendly use period for this product is 15 years. This period is not the product warranty period.

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◆ Information on Hazardous Substances in This Product

Table 17.1 shows the details on hazardous substances contained in this product.

Table 17.1 Contents of Hazardous Substances in This Product

Parts Name	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
Circuit Board	×	○	○	○	○	○
Electronic Parts	×	○	○	○	○	○

Parts Name	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr(VI))	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
Brass Screw	×	○	○	○	○	○
Aluminum Die Casting	×	○	○	○	○	○

This table has been prepared in accordance with the provisions outlined in SJ/T 11364.
○: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below or equal to the limit requirement of GB/T 26572.
×: Indicates that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.
Note:
This product complies with EU RoHS directives. In this table, "×" indicates that hazardous substances that are exempt from EU RoHS directives are contained.

18 对应中国RoHS指令

图 18.1 中国RoHS标志

中国RoHS标志依据2016年1月26日公布的《电器电子产品有害物质限制使用管理办法》，以及《电子电气产品有害物质限制使用标识要求》（SJ/T 11364-2014）作成。电子电气产品中特定6种有害物质的含量超过规定值时，应标识此标志。中间的数字为在中国生产销售以及进口的电子电气产品的环保使用期限（年限）。电子电气产品的环保使用期限从生产日期算起。在期限内，正常使用产品的过程中，不会有特定的6种有害物质外泄进而对环境、人和财产造成深刻影响。

本产品的环保使用期限为15年。但需要注意的是环保使用期限并非产品的质量保证期限。

◆ 本产品中含有有害物质的信息

本产品中所含有害物质的详细信息如表 18.1所示。

表 18.1 本产品中有害物质的名称及含量

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
实装基板	×	○	○	○	○	○
电子元件	×	○	○	○	○	○
黄铜螺钉	×	○	○	○	○	○
铝压铸	×	○	○	○	○	○

本表格依据SJ/T 11364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/T 26572规定的限量要求以下。
×:表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572规定的限量要求。
（注） 本产品符合欧盟RoHS指令。上表中的“×”表示含有欧盟RoHS指令豁免的有害物质。

19 Safe Disable Input

Figure 19.1 TUV Mark

The TUV mark identifies that the product complies with the safety standards.
This section gives precautions to support the Safe Disable input. Contact Yaskawa for more information.
The safety function complies with the standards shown in Table 19.1.

Table 19.1 Applied Safety Standards and Unified Standards

Safety Standards	Unified Standards
Functional Safety	IEC/EN 61508:2010 (SIL3)
	IEC/EN 62061/A2:2015 (SILCL3)
	IEC/EN 61800-5-2:2007 (SIL3)
Machine Safety	ISO/EN ISO 13849-1:2015 (Cat.3, PL e)
EMC	IEC/EN 61000-6-7:2015, IEC/EN61326-3-1:2008

Note:
SIL = Safety Integrity Level.

◆ Safe Disable Specifications

The Safe Disable input provides the stop function that complies with "Safe Torque Off" as specified by IEC/EN 61800-5-2:2007. The Safe Disable input meets the requirements of EN ISO 13849-1 and IEC/EN 61508. It also has a safety status monitor to detect safety circuit errors.

When you install the drive as a component in a system, you must make sure that the system complies with the applicable safety standards.

Refer to Table 19.2 for safety function specifications.

Table 19.2 Safe Disable Specifications

Item		Description
Input/Output		• Input: 2 Safe Disable input (H1, H2) Signal ON level: 18 Vdc to 28 Vdc Signal OFF level: -4 Vdc to +4 Vdc • Output: 1 MFDO safety monitor output for external device monitor (EDM)
Response time from when the input opens to when the drive output stops		3 ms or less
Response time from when the H1 and H2 terminal inputs open to when the EDM signal operates		20 ms or less
Failure probability	Less frequent operation request mode	PFD = $4.65E^{-6}$
	Frequent operation request mode or continuous mode	PFH = $1.11E^{-9}$
Performance level		The Safe Disable input complies with the performance level requirements of EN ISO 13849-1.
HFT (hardware fault tolerance)		N = 1
Type of subsystem		Type B

Note:
EDM = External Device Monitoring
PFD = Probability of Failure on Demand
PFH = Probability of Dangerous Failure per Hour

EN

◆ Precautions

DANGER *Sudden Movement Hazard. When you use the Safe Disable function in the safety system of a machine, do a full risk assessment for the system to make sure that all parts of the system comply with applicable safety standards. Incorrect application of the Safe Disable function can cause serious injury or death.*

DANGER *Sudden Movement Hazard. If the output circuit of the drive is damaged and the Safe Disable function turns OFF the drive output to a permanent magnet (PM) motor, the motor can rotate 180 electrical degrees. Prevent damage to equipment and injury to personnel during this condition. Sudden motor movement can cause serious injury or death. It is possible for current to flow through the motor winding in these conditions.*

DANGER *Electrical Shock Hazard. You cannot depend on the Safe Disable function to prevent electrical shock. Disconnect all power to the drive and wait for the time specified on the warning label before you remove covers. Check the drive for dangerous voltages before servicing or repair work. If you do work on the drive when it is energized and there is no cover over the electronic circuits, it can cause serious injury or death.*

WARNING *Sudden Movement Hazard. To use the Safe Disable inputs, remove the jumpers between terminals H1-HC and H2-HC. If the Safe Disable circuit does not work correctly, it can cause serious injury or death.*

WARNING *Sudden Movement Hazard. Regularly examine the Safe Disable input and all other safety features. A system that does not operate correctly can cause serious injury or death.*

⚠ WARNING *Sudden Movement Hazard. Only let approved personnel who know about the drive, instruction manual, and safety standards wire, examine, and maintain the Safe Disable input. If personnel are not approved, it can cause serious injury or death.*

⚠ WARNING *Sudden Movement Hazard. Do not use the drive output signals to control external holding brakes or dynamic brakes for functional safety. Use a system that conforms to the functional safety requirements. Incorrect application of the Safe Disable function can cause serious injury or death. Systems that use drive output signals (including EDM) for safety are not safe because drive output signals are not safety components.*

⚠ WARNING *Sudden Movement Hazard. Connect the Safe Disable inputs to the devices as specified by the safety requirements. If you connect the Safe Disable inputs incorrectly, it can cause serious injury or death.*

⚠ WARNING *Sudden Movement Hazard. Although the Safe Disable function is in operation, gravity or other external forces in the vertical axis can move the motor. Incorrect application of the Safe Disable function can cause serious injury or death.*

Note:

- When terminals H1 or H2 deactivate, it will be a maximum of 3 ms before the drive will switch to "Safe Torque Off" status. Set the OFF status for terminals H1 and H2 to hold for 2 ms minimum. If terminals H1 and H2 are activated for less than 2 ms, it is possible that the drive will not switch to “Safe Torque Off” status.
- Only use the Safe Disable Monitor (multi-function output terminal set to the EDM function) to monitor the Safe Disable status or to find a malfunction in the Safe Disable inputs. The monitor output is not a safety output.
- Drives that have a built-in safety function must be replaced 10 years after the first use.

◆ Using the Safe Disable Function

■ Safe Disable Circuit

The Safe Disable circuit has two isolated channels (terminals H1 and H2). The input channels block the output transistors. The input can use the internal power supply of the drive.

Set the EDM function to one of the MFDO terminals *[H2-xx = 51 or 151]* to monitor the status of the Safe Disable function. This is the “Safe Disable monitor output function.”

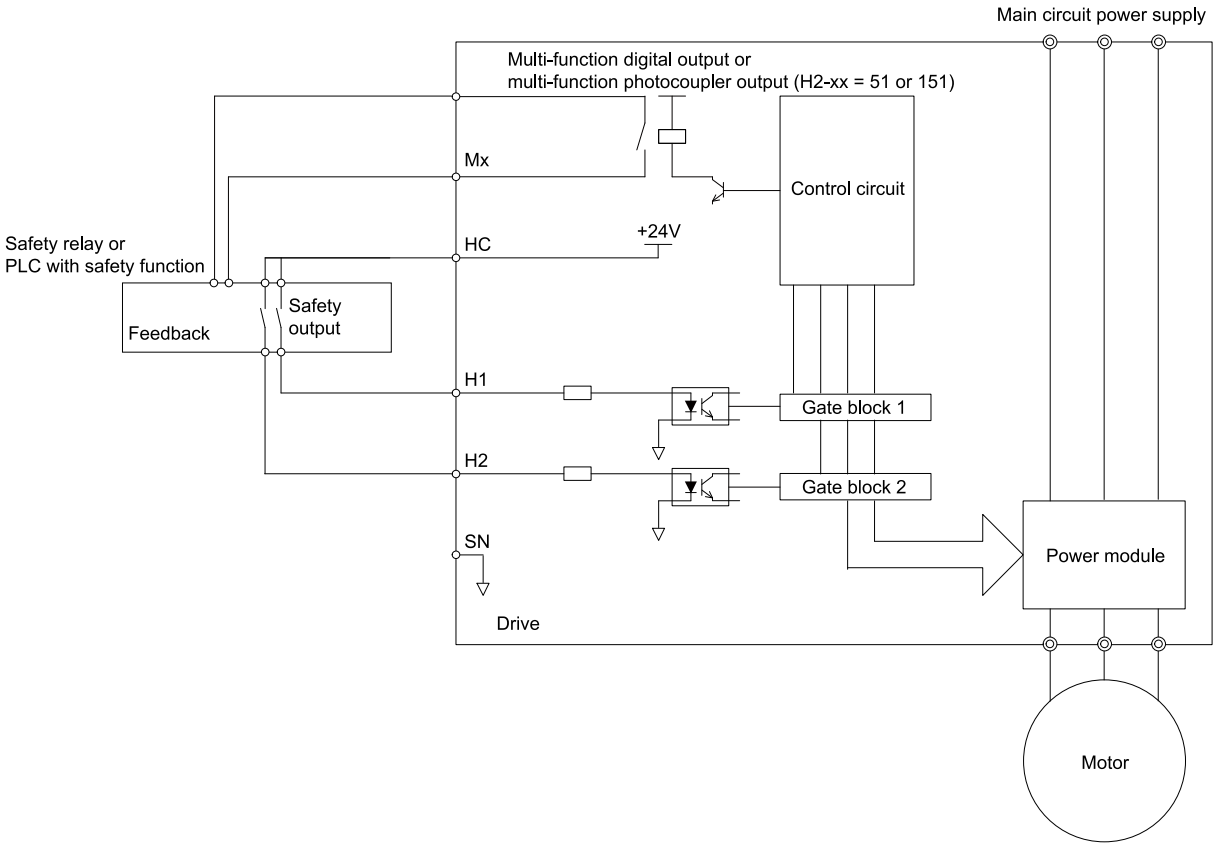

Figure 19.2 Safe Disable Function Wiring Example

■ Enabling and Disabling the Drive Output (“Safe Torque Off”)

Refer to Figure 19.3 for an example of drive operation when the drive changes from “Safe Torque Off” status to usual operation.

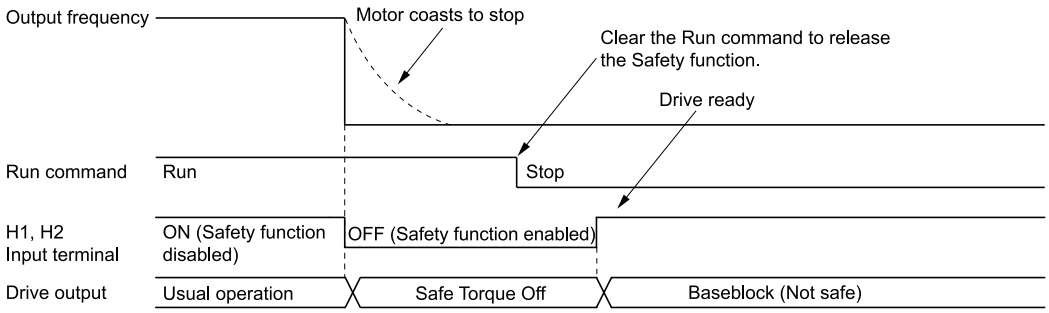

Figure 19.3 Safe Disable Operation

Switching from Usual Operation to "Safe Torque Off"

Turn OFF (open) safety input terminal H1 or H2 to enable the Safe Disable function. When the Safe Disable function is enabled while the motor is operating, the drive output and motor torque turn off and the motor always coasts to stop. The *b1-03 [Stopping Method Selection]* setting does not have an effect on the stopping method.

The "Safe Torque Off" status is only possible with the Safe Disable function. Clear the Run command to stop the drive. Turning off drive output (a baseblock condition) ≠ "Safe Torque Off".

Note:
- When it is necessary to ramp to stop the motor, do not turn off terminals H1 and H2 until the motor fully stops. This will prevent the motor from coasting to stop during usual operation.
- A maximum of 3 ms will elapse from when terminals H1 or H2 shut off until the drive switches to the "Safe Torque Off" status. Set the OFF status for terminals H1 and H2 to hold for at least 3 ms. The drive may not be able to switch to the "Safe Torque Off" status if terminals H1 and H2 are only open for less than 3 ms.

Going from "Safe Torque Off" to Usual Operation

The safety input will only release when there is no Run command.

- During Stop
  When the Safe Disable function is triggered during stop, close the circuit between terminals H1-HC and H2-HC to disable "Safe Torque Off". Enter the Run command after the drive stops correctly.
- During Run
  If you trigger the Safe Disable function during run, clear the Run command, then close the circuit between terminals H1-HC and H2-HC to disable "Safe Torque Off". Enter the Stop command, then enter the Run command when terminals H1 and H2 are activated.

■ Safe Disable Monitor Output Function and Keypad Display

Refer to Table 19.3 for information about the relation between the input channel status, Safety monitor output status, and drive output status.

Table 19.3 Safe Disable Input and EDM Terminal Status

Input Channel Status		Safety Monitor Output		Drive Output Status	Keypad Display	LED Status Ring
Input 1 (H1 - HC)	Input 2 (H2 - HC)	MFDO Terminal (H2-xx = 51)	MFDO Terminal (H2-xx = 151)			
ON (Close the circuit)	ON (Close the circuit)	OFF	ON	Baseblock (Drive ready)	Normally displayed	Ready: Illuminated
OFF (Open)	ON (Close the circuit)	OFF	ON	Safety status (STo)	StoF (Flashing)	ALM/ERR: Flashing
ON (Close the circuit)	OFF (Open)	OFF	ON	Safety status (STo)	StoF (Flashing)	ALM/ERR: Flashing
OFF (Open)	OFF (Open)	ON	OFF	Safety status (STo)	STo (Flashing)	Ready: Flashing

Safety Function Status Monitor

The drive Safety monitor output sends a feedback signal about the status of the Safety function. The Safety monitor output is one of the possible settings available for the MFDO terminals. If there is damage to the Safe Disable circuit, a controller (PLC or safety relay) must read this signal as an input signal to hold the "Safe Torque Off" status. Refer to the manual for the safety device for more information about the Safety function.

It is possible to switch polarity of the Safety monitor output signal with the MFDO function settings. Refer to Table 19.3 for setting instructions.

Keypad Display

If the two input channels are OFF (Open), the keypad will flash *STo [Safe Torque OFF]*.

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The keypad flashes *SToF [Safe Torque OFF Hardware]* when one input channel is OFF (Open), and the other is ON (Close the circuit). This indicates that either the Safe disable circuit or the drive are damaged. When you use the Safe disable circuit correctly, the keypad will not show *SToF*. Refer to the chapter on Troubleshooting for more information.

The keypad will show *SCF [Safety Circuit Fault]* when the drive detects a fault in the Safe disable circuit. This indicates that the drive is damaged. Refer to the chapter on Troubleshooting for more information.

■ Validating the Safe Disable Function

After you replace parts or do maintenance on the drive, first complete all necessary wiring to start the drive, then test the Safe Disable input with these steps. Keep a record of the test results.

1. When the two input channels are OFF (Open), make sure that the keypad flashes *STo [Safe Torque OFF]*, and make sure that the motor is not running.
2. Monitor the ON/OFF status of the input channels and make sure that MFDO set to the EDM function operates as shown in *Safe Disable Monitor Output Function and Keypad Display on page 125*.
   If one or more of the these items are true, the ON/OFF status of the MFDO may not display correctly on the keypad:
   - Incorrect parameter settings.
   - A problem with an external device.
   - The external wiring has a short circuit or is disconnected.
   - There is damage to the device.

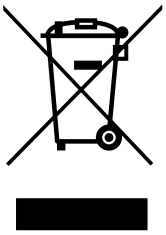
   Find the cause and repair the problem to correctly display the status.
3. Make sure that the EDM signal operates during usual operation as shown in *Safe Disable Monitor Output Function and Keypad Display on page 125*.

20 Disposal Instructions

Correctly discard the drive, packing material, battery, and microSD card as specified by regional, local, and municipal laws and regulations for this product.

Note:
- Remove the battery and microSD card from the keypad before you discard the drive.
- You cannot recycle the battery. Discard used batteries as specified by the battery manufacturer.
- Customers are responsible for microSD card data protection.
  PC functions that format and delete the data may not be sufficient to fully erase the microSD card data. Yaskawa recommends that customers physically destroy the microSD card in a shredder or use data wipe software to fully erase the card.

◆ WEEE Directive



The wheelie bin symbol on this product, its manual, or its packaging identifies that you must recycle it at the end of its product life.

You must discard the product at an applicable collection point for electrical and electronic equipment (EEE). Do not discard the product with usual waste.

Revision History

Date of Publication	Revision Number	Section	Revised Content
July 2021	–	–	First Edition

YASKAWA AC Drive CR700

Quick Start Guide

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In the event that the end user of this product is to be the military and said product is to be employed in any weapons systems or the manufacture thereof, the export will fall under the relevant regulations as stipulated in the Foreign Exchange and Foreign Trade Regulations. Therefore, be sure to follow all procedures and submit all relevant documentation according to any and all rules, regulations and laws that may apply.
Specifications are subject to change without notice for ongoing product modifications and improvements.

Original instructions.

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