YASKAWA

YASKAWA AC Drive A1000

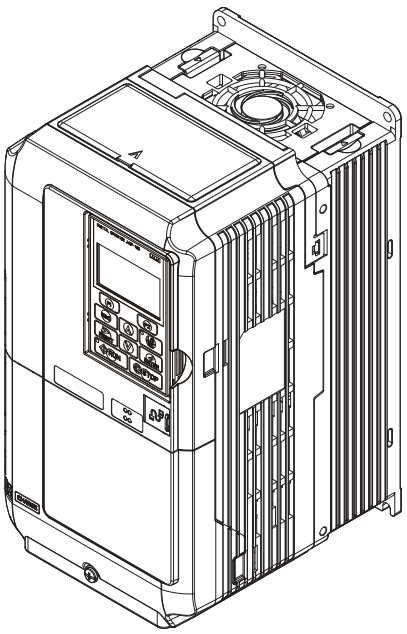
High Performance Vector Control Drive

Quick Start Guide

Type: CIMR-AC□A □□□□□□□□

Models: 200 V Class: 0.4 to 110 kW
400 V Class: 0.4 to 630 kW

To properly use the product, read this manual thoroughly and retain for easy reference, inspection, and maintenance. Ensure the end user receives this manual.



MANUAL NO. TOEP C710616 27D

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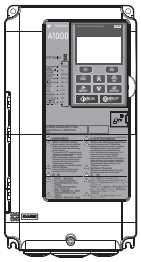
1 Safety Instructions and General Warnings

Yaskawa Electric supplies component parts for use in a wide variety of industrial applications. The selection and application of Yaskawa products remain the responsibility of the equipment designer or end user. Yaskawa accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any Yaskawa product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All products designed to incorporate a component part manufactured by Yaskawa must be supplied to the end user with appropriate warnings and instructions as to the safe use and operation of that part. Any warnings provided by Yaskawa must be promptly provided to the end user. Yaskawa offers an express warranty only as to the quality of its products in conforming to standards and specifications published in the manual. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS OFFERED. Yaskawa assumes no liability for any personal injury, property damage, losses, or claims arising from misapplication of its products.

◆ Applicable Documentation

The following manuals are available for A1000 series drives:

	**A1000 Series AC Drive Technical Manual** This manual provides detailed information on parameter settings, drive functions, and MEMOBUS/Modbus specifications. Use this manual to expand drive functionality and to take advantage of higher performance features. **A1000 Series AC Drive Quick Start Guide (this book)** Read this manual first. This guide is packaged together with the product. It contains basic information required to install and wire the drive, in addition to an overview of fault diagnostics, maintenance, and parameter settings. Use the information in this book to prepare the drive for a trial run with the application and for basic operation.

◆ General Warnings

⚠ WARNING

- **Read and understand this manual before installing, operating or servicing this drive.**
- **All warnings, cautions, and instructions must be followed.**
- **All work must be performed by qualified personnel.**
- **The drive must be installed according to this manual and local codes.**

Heed the safety messages in this manual.

The operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this manual.

The following conventions are used to indicate Safety messages in this manual:

⚠ WARNING

Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates a property damage message.

◆ Safety Warnings

⚠ WARNING

Electrical Shock Hazard

Do not attempt to modify or alter the drive in any way not explained in this manual.

Yaskawa is not responsible for the damage caused by modification of the product made by the user. Failure to comply could result in death or serious injury from operation of damaged equipment.

Do not touch any terminals before the capacitors have fully discharged.

Failure to comply could result in death or serious injury.

Before wiring terminals, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. The charge indicator LED will extinguish when the DC bus voltage is below 50 Vdc. To prevent electric shock, wait at least five minutes after all indicators are off and measure the DC bus voltage level to confirm safe level.

Do not allow unqualified personnel to use equipment.

Failure to comply could result in death or serious injury.

Maintenance, inspection, and replacement of parts must be performed only by authorized personnel familiar with installation, adjustment, and maintenance of AC drives.

Do not change wiring, remove covers, connectors or options cards, or attempt to service the drive with power applied to the drive.

Failure to comply could result in death or serious injury. Disconnect all power to the drive and check for unsafe voltages before servicing.

Always ground the motor-side grounding terminal.

Improper equipment grounding could result in death or serious injury by contacting the motor case.

Do not perform work on the drive while wearing loose clothing, jewelry or without eye protection.

Failure to comply could result in death or serious injury.

Remove all metal objects such as watches and rings, secure loose clothing, and wear eye protection before beginning work on the drive.

Never short the output circuits of the drive.

Do not short the output circuits of the drive. Failure to comply could result in death or serious injury.

Make sure the protective earthing conductor complies with technical standards and local safety regulations.

When an EMC filter is installed or with models CIMR-A□4A0414 and larger, the leakage current exceeds 3.5 mA. Therefore according to IEC 61800-5-1 automatic power supply interruption in case of discontinuity of the protective earthing conductor must be provided or a protective earthing conductor with a cross section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used.

Use appropriate equipment for residual current monitoring/detection (RCM/RCD).

This drive can cause a residual current with a DC component in the protective earthing conductor. Where a residual current operated protective or monitoring device is used for protection in case of direct or indirect contact, always use an RCM or RCD of type B according to IEC 60755.

Sudden Movement Hazard

Stay clear of the motor during rotational Auto-Tuning. The motor may start operating suddenly.

During automatic starting of equipment, the machine may start moving suddenly, which could result in death or serious injury.

System may start unexpectedly upon application of power, resulting in death or serious injury.

Clear all personnel from the drive, motor, and machine area before applying power. Secure covers, couplings, shaft keys, and machine loads before applying power to the drive.

⚠ WARNING

Fire Hazard

Do not use an improper voltage source.

Failure to comply could result in death or serious injury by fire.

Verify that the rated voltage of the drive matches the voltage of the incoming power supply before applying power.

Do not use improper combustible materials in drive installation, repair or maintenance.

Failure to comply could result in death or serious injury by fire. Attach the drive or braking resistors to metal or other noncombustible material.

Do not connect the AC power line to the output terminals of the drive.

Failure to comply could result in death or serious injury by fire as a result of drive damage from line voltage application to output terminals.

- Do not connect AC line power to output terminals U, V, and W.
- Make sure that the power supply lines are connected to main circuit input terminals R/L1, S/L2, T/L3 (or R/L1 and S/L2 for single-phase power).

Tighten all terminal screws to the specified tightening torque.

Loose electrical connections could result in death or serious injury by fire due to overheating of electrical connections.

Crush Hazard

Use a dedicated lifter when transporting the drive by a lifter.

Improper lifter may cause the drive to drop, resulting in serious injury.

Only allow qualified personnel to operate a crane or hoist to transport the drive.

Failure to comply could result in death or serious injury from falling equipment.

⚠ CAUTION

Crush Hazard

Do not carry the drive by the front cover.

Failure to comply may result in minor or moderate injury from the main body of the drive falling.

Burn Hazard

Do not touch the heatsink or braking resistor hardware until a powered-down cooling period has elapsed.

NOTICE

Equipment Hazard

Observe proper electrostatic discharge procedures (ESD) when handling the drive and circuit boards.

Failure to comply may result in ESD damage to the drive circuitry.

Never connect or disconnect the motor from the drive while the drive is outputting voltage.

Improper equipment sequencing could result in damage to the drive.

Do not perform a withstand voltage test on any part of the unit.

Failure to comply could result in damage to the sensitive devices within the drive. Use power off resistance checks to determine shortcircuits.

Do not operate damaged equipment.

Failure to comply could result in further damage to the equipment.

Do not connect or operate any equipment with visible damage or missing parts.

NOTICE

If a fuse is blown or equipment for residual current monitoring/detection (RCM/RCD) is tripped, check the wiring and the selection of the peripheral devices.

Contact your supplier if the cause cannot be identified after checking the above.

Do not restart the drive until 5 minutes passes and CHARGE lamp is OFF or immediately operate the peripheral devices if a fuse is blown or equipment for residual current monitoring/detection (RCM/RCD) is tripped.

Check the wiring and the selection of peripheral devices to identify the cause.

Contact your supplier before restarting the drive or the peripheral devices if the cause cannot be identified.

For models CIMR-A□4A0930 and 4A1200, make sure to install a fuse and equipment for residual current monitoring/detection (RCM/RCD).

Failure to comply may result in serious damage to the facilities in case the drive is defected.

Do not use unshielded cable for control wiring.

Failure to comply may cause electrical interference resulting in poor system performance. Use shielded twisted-pair wires and ground the shield to the ground terminal of the drive.

Do not carelessly connect parts or devices to the drives braking transistor terminals.

Failure to comply could result in damage to the drive or braking circuit.

Carefully review instruction manual TOBP C720600 00 when connecting a braking option to the drive.

Do not modify the drive circuitry.

Failure to comply could result in damage to the drive and will void warranty.

Yaskawa is not responsible for modification of the product made by the user. This product must not be modified.

Check all the wiring to ensure that all connections are correct after installing the drive and connecting other devices.

Failure to comply could result in damage to the drive.

Improper application of devices on drive output circuits can damage the drive

Do not connect unapproved LC or RC interference suppression filters, capacitors, ground fault circuits, or overvoltage protection devices to the drive.

Fire Hazard

Install adequate branch circuit short circuit protection per applicable codes.

The drive is suitable for circuits capable of delivering not more than 100,000 RMS symmetrical Amperes, 240 Vac maximum (200 V Class) and 480 Vac maximum (400V Class). Inadequate branch short circuit protection damage or serious injury by fire.

◆ Precautions for CE Low Voltage Directive Compliance

This drive has been tested according to European standard EN61800-5-1, and it fully complies with the Low Voltage Directive. The following conditions must be met to maintain compliance when combining this drive with other devices:

Do not use drives in areas with pollution higher than severity 2 and overvoltage category 3 in accordance with IEC664.

Ground the neutral point of the main power supply for 400 V Class drives.

2 Mechanical Installation

◆ Upon Receipt

Perform the following tasks after receiving the drive:

- Inspect the drive for damage. If the drive appears damaged upon receipt, contact your supplier.
- Verify receipt of the correct model by checking the information on the nameplate. If you have received the wrong model, contact your supplier.

◆ Installation Environment

For optimum performance life of the drive, install the drive in an environment that meets the conditions listed below.

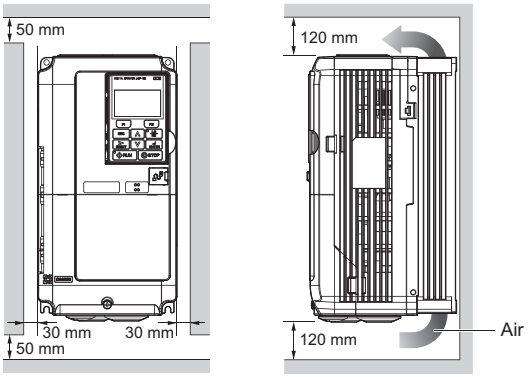
Environment	Conditions
Installation Area	Indoors
Ambient Temperature	-10°C to +40°C (IP20/NEMA Type 1 Enclosure) -10°C to +50°C (IP00 Enclosure) Drive reliability improves in environments without wide temperature fluctuations. When using the drive in an enclosure panel, install a cooling fan or air conditioner in the area to ensure that the air temperature inside the enclosure does not exceed the specified levels. Do not allow ice to develop on the drive.
Humidity	95% RH or less and free of condensation
Storage Temperature	-20 to +60°C
Surrounding Area	Install the drive in an area free from: • oil mist and dust • metal shavings, oil, water or other foreign materials • radioactive materials • combustible materials (e.g., wood) • harmful gases and liquids • excessive vibration • chlorides • direct sunlight
Altitude	1000 m, up to 3000 m with derating (for details, refer to the Technical Manual)
Vibration	10 to 20 Hz at 9.8 m/s^2 *<1>* 20 to 55 Hz at 5.9 m/s^2 (Models CIMR-☐2A0004 to 2A0211 and 4A0002 to 4A0165) or, 2.0 m/s^2 (Models CIMR-A☐2A0250 to 2A0415 and 4A0208 to 4A1200)
Orientation	Install the drive vertically to maintain maximum cooling effects.

<1> Models CIMR-A☐4A0930 and 4A1200 are rated at 5.9 m/s^2.

◆ Installation Orientation and Spacing

Always install the drive in an upright position. Leave space around the unit for proper cooling as shown in the figure on the right.

Note: Several units can be installed closer together than shown in the figure by using “Side-by-Side” mounting. For details refer to the Technical Manual.



◆ Instructions on Installation of Models CIMR-A□4A0930 and 4A1200

Read the following precautions and instructions before installing the largest-capacity models, 4A0930 and 4A1200.

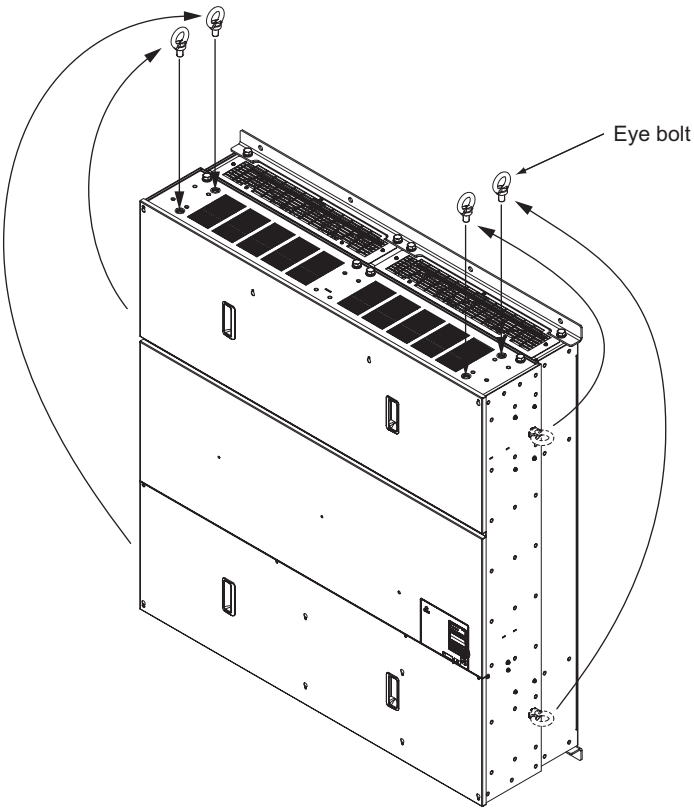
WARNING! *Be sure to observe the following instructions and precautions. Failure to comply could result in minor or moderate injury and damage to the drive from falling equipment.*

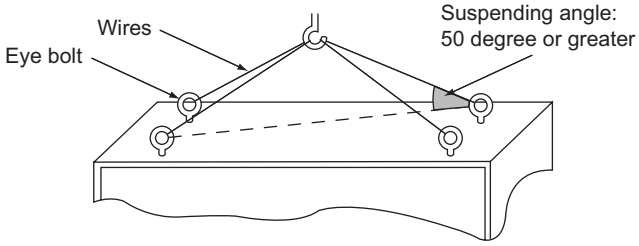
- Vertical suspension of the drive should be used only for temporarily lifting the drive for installation in the enclosure panel. Do not vertically suspend for transportation of the drive.
- Before vertical suspension, make sure that the drive front cover, terminal blocks and other drive components are securely fixed with screws.
- Do not subject the drive to vibration or impact greater than 1.96 m/s^2 (0.2 G) while it is suspended by the wires.
- Do not overturn the drive.
- Do not leave the drive for a long time while it is suspended by the wires

■ Procedure for Vertical Wire Suspension of the Drive

- Use the wire of a length that ensures a 50 degree or wider suspending angle, as illustrated in the figure below. The maximum allowable load of the eye bolts for suspension cannot be guaranteed when the drive is suspended with the wires at an angle less than 50 degrees.
- When lifting the drive with a crane after wires are passed to hold it, make sure to follow the procedure described below.

1. Remove the four eye bolts from the drive side panels, and fix them securely on the top panel (See the figure below.).
2. Pass wire through the holes of all the four eye bolts (See the figure below).
3. Take up the slack in the wires gradually with a crane, and when the wires are confirmed to have stretched tight, hoist the drive.
4. When ready to install the drive in the enclosure panel, lower the drive. Halt lowing once when the drive has reached near the floor, and then lower the drive again very slowly.





◆ Dimensions

■ IP20/NEMA Type 1 Enclosure Drives

Note: IP20/NEMA Type 1 Enclosure drives are equipped with a top protective cover. Removing this cover voids NEMA Type 1 protection but still keeps IP20 conformity.

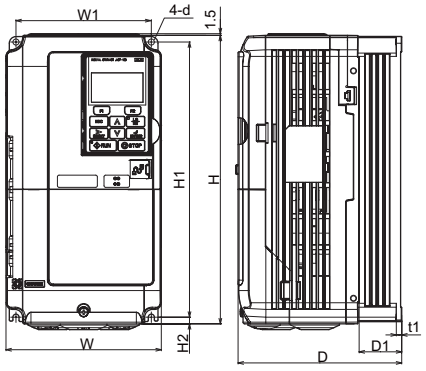


Figure 1

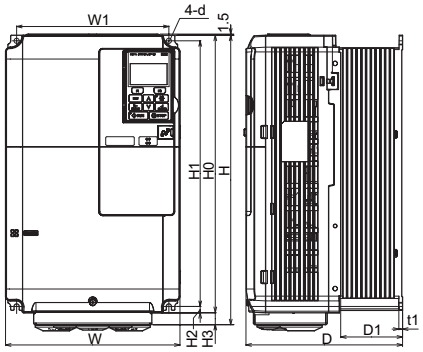


Figure 2

Model CIMR-A□	Fig.	Dimensions (mm)												Weight (kg)
		W	H	D	W1	H0	H1	H2	H3	D1	t1	t2	d	
2A0004	1	140	260	147	122	–	248	6	–	38	5	–	M5	3.1
2A0006		140	260	147	122	–	248	6	–	38	5	–	M5	3.1
2A0010		140	260	147	122	–	248	6	–	38	5	–	M5	3.2
2A0012		140	260	147	122	–	248	6	–	38	5	–	M5	3.2
2A0021		140	260	164	122	–	248	6	–	55	5	–	M5	3.5
2A0030		140	260	167	122	–	248	6	–	55	5	–	M5	4.0
2A0040		140	260	167	122	–	248	6	–	55	5	–	M5	4.0
2A0056		180	300	187	160	–	284	8	–	75	5	–	M5	5.6
2A0069		220	350	197	192	–	335	8	–	78	5	–	M6	8.7
2A0081	2	220	365	197	192	350	335	8	15	78	5	–	M6	9.7
4A0002	1	140	260	147	122	–	248	6	–	38	5	–	M5	3.2
4A0004		140	260	147	122	–	248	6	–	38	5	–	M5	3.2
4A0005		140	260	147	122	–	248	6	–	38	5	–	M5	3.2
4A0007		140	260	164	122	–	248	6	–	55	5	–	M5	3.4
4A0009		140	260	164	122	–	248	6	–	55	5	–	M5	3.5
4A0011		140	260	164	122	–	248	6	–	55	5	–	M5	3.5
4A0018		140	260	167	122	–	248	6	–	55	5	–	M5	3.9
4A0023		140	260	167	122	–	248	6	–	55	5	–	M5	3.9
4A0031		180	300	167	160	–	284	8	–	55	5	–	M5	5.4
4A0038		180	300	187	160	–	284	8	–	75	5	–	M5	5.7
4A0044		220	350	197	192	–	335	8	–	78	5	–	M6	8.3

■ IP00 Enclosure Drives

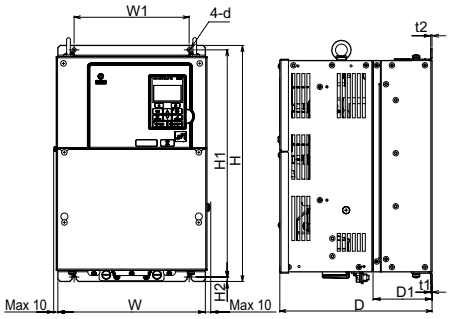


Figure 3

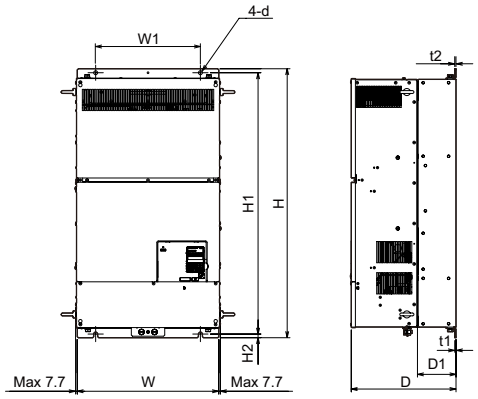


Figure 4

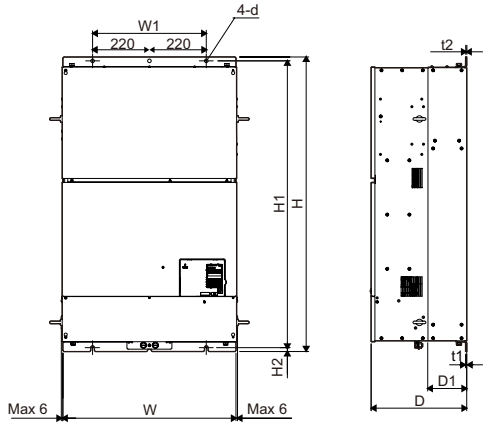


Figure 5

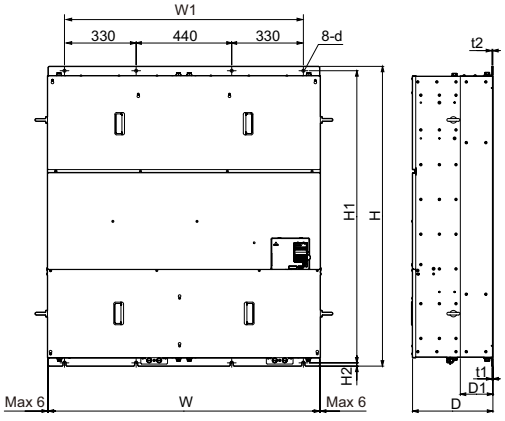
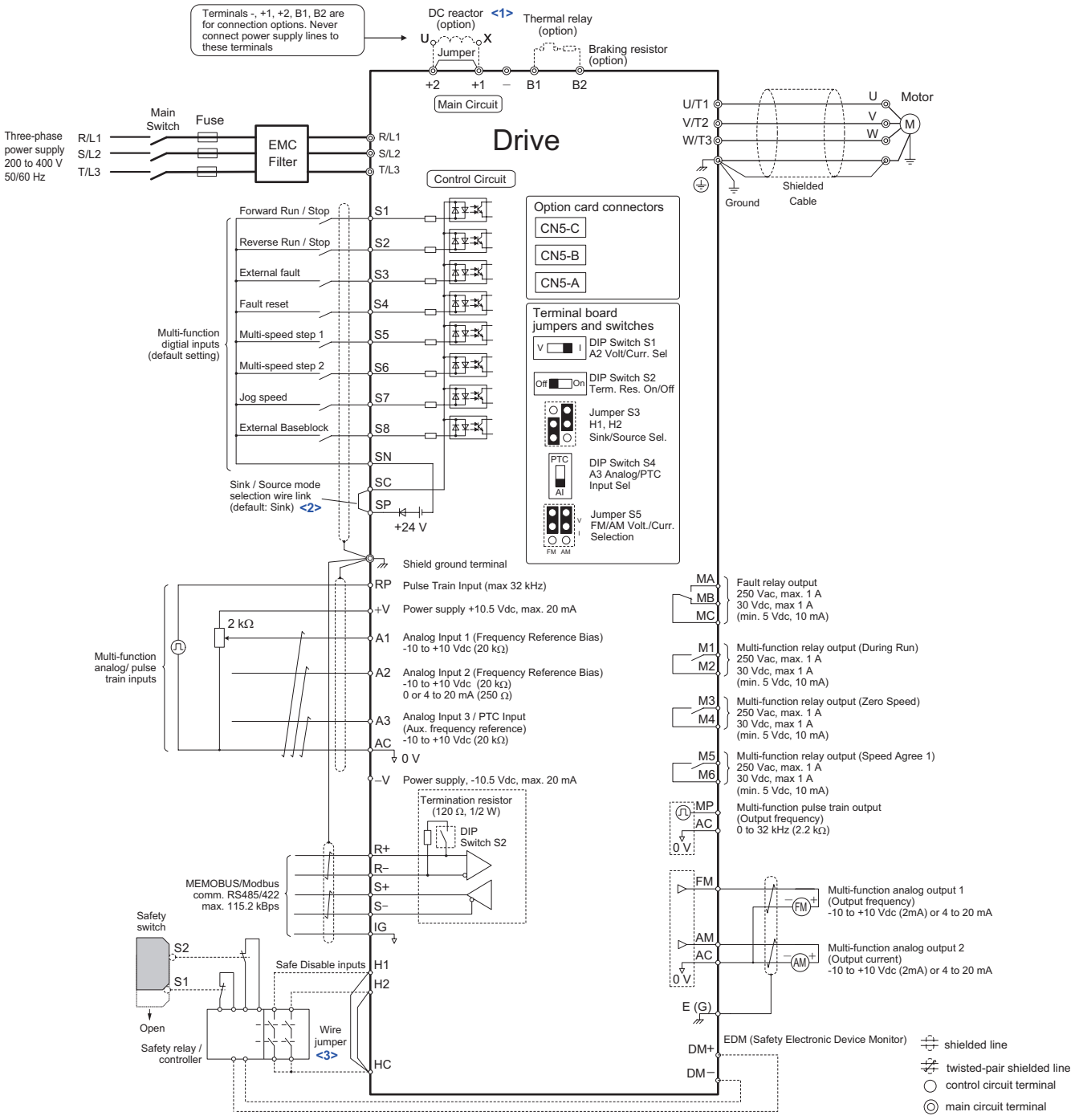


Figure 6

Model CIMR-A□	Fig.	Dimensions (mm)										Weight (kg)
		W	H	D	W1	H1	H2	D1	t1	t2	d	
2A0110	3	250	400	258	195	385	7.5	100	2.3	2.3	M6	21
2A0138		275	450	258	220	435	7.5	100	2.3	2.3	M6	25
2A0169		325	550	283	260	535	7.5	110	2.3	2.3	M6	37
2A0211		325	550	283	260	535	7.5	110	2.3	2.3	M6	38
2A0250		450	705	330	325	680	12.5	130	3.2	3.2	M10	76
2A0312		450	705	330	325	680	12.5	130	3.2	3.2	M10	80
2A0360		500	800	350	370	773	13	130	4.5	4.5	M12	98
2A0415		500	800	350	370	773	13	130	4.5	4.5	M12	99
4A0058		250	400	258	195	385	7.5	100	2.3	2.3	M6	21
4A0072		275	450	258	220	435	7.5	100	2.3	2.3	M6	25
4A0088		325	510	258	260	495	7.5	105	2.3	3.2	M6	36
4A0103		325	510	258	260	495	7.5	105	2.3	3.2	M6	36
4A0139		325	550	283	260	535	7.5	110	2.3	2.3	M6	41
4A0165		325	550	283	260	535	7.5	110	2.3	2.3	M6	42
4A0208		450	705	330	325	680	12.5	130	3.2	3.2	M10	79
4A0250		500	800	350	370	773	13	130	4.5	4.5	M12	96
4A0296		500	800	350	370	773	13	130	4.5	4.5	M12	102
4A0362		500	800	350	370	773	13	130	4.5	4.5	M12	107
4A0414	4	500	950	370	370	923	13	135	4.5	4.5	M12	125
4A0515	5	670	1140	370	440	1110	15	150	4.5	4.5	M12	216
4A0675												221
4A0930	6	1250	1380	370	1110	1345	15	150	4.5	4.5	M12	545
4A1200												555

3 Electrical Installation

The figure below shows the main and control circuit wiring.



<1> Remove the jumper when installing a DC reactor. Models CIMR-A□2A110 through 0415 and 4A0058 through 1200 come with a built-in DC reactor.
<2> Never short terminals SP and SN as doing so will damage the drive.
<3> Disconnect the wire jumper between H1 - HC and H2 - HC when utilizing the Safe Disable input.

◆ Wiring Specification

■ Main Circuit

Use the fuses and line filters listed in the table below when wiring the main circuit. Make sure not to exceed the given tightening torque values.

Model CIMR-A□	EMC Filter [Schaffner]	Main Fuse [Bussmann]	Recom. Motor cable (mm^2)	Main Circuit Terminal Sizes			
				R/L1,S/L2,T/L3, U/T1,V/T2,W/T3, – , +1, +2	+3	B1, B2	⏚
2A0004	FS5972-10-07	FWH-70B	2.5	M4	–	M4	M4
2A0006							
2A0010	FS5972-18-07						
2A0012							
2A0021	FS5972-35-07	FWH-90B					
2A0030		FWH-100B	6				M5
2A0040	FS5972-60-07	FWH-200B	10				
2A0056			16	M6		M5	M6
2A0069	FS5972-100-35			M8			
2A0081		FWH-300A	25				
2A0110	FS5972-170-40		35			M8	M8
2A0138		FWH-350A	50	M10		M10	
2A0169	FS5972-250-37	FWH-400A	70		M10	–	
2A0211			95				
2A0250	FS5972-410-99	FWH-600A	95 × 2P	M12			M12
2A0312		FWH-700A					
2A0360	FS5972-600-99	FWH-800A	240				
2A0415		FWH-1000A	300				
4A0002	FS5972-10-07	FWH-40B	2.5	M4	–	M4	M4
4A0004		FWH-50B					
4A0005		FWH-70B					
4A0007							
4A0009	FS5972-18-07	FWH-90B					
4A0011							
4A0018	FS5972-35-07	FWH-80B					M5
4A0023		FWH-100B	4				
4A0031		FWH-125B	6	M5		M5	M6
4A0038	FS5972-60-07	FWH-200B					
4A0044		FWH-250A	16	M6			M8
4A0058				M8		M8	
4A0072	FS5972-100-35		25		M10	–	
4A0088							
4A0103	FS5972-170-40		35				
4A0139		FWH-350A	50	M10			M10
4A0165		FWH-400A	70				
4A0208	FS5972-250-37	FWH-500A	95				
4A0250	FS5972-410-99	FWH-600A	120				
4A0296		FWH-700A	185	M12			M12
4A0362		FWH-800A	240				
4A0414	FS5972-600-99	FWH-800A	95 × 2P		M12		
4A0515		FWH-1000A	150 × 2P				
4A0675	FS5972-800-99	FWH-1200A	95 × 4P				
4A0930	FS5972-600-99 <1>	FWH-1200A	120 × 4P				
4A1200	FS5972-800-99 <1>	FWH-1600A	(95 × 4P) × 2				

<1> Connect two of the same filters in parallel. Refer to the Technical Manual for details.

Tightening Torque Values

Tighten the main circuit terminals using the torque values provided by the table below.

Terminal Size	M4	M5	M6	M8	M10	M12
Tightening Torque (N⩙m)	1.2 to 1.5	2.0 to 2.5	4.0 to 6.0	9.0 to 11.0	18.0 to 23.0	32.0 to 40.0

■ Control Circuit

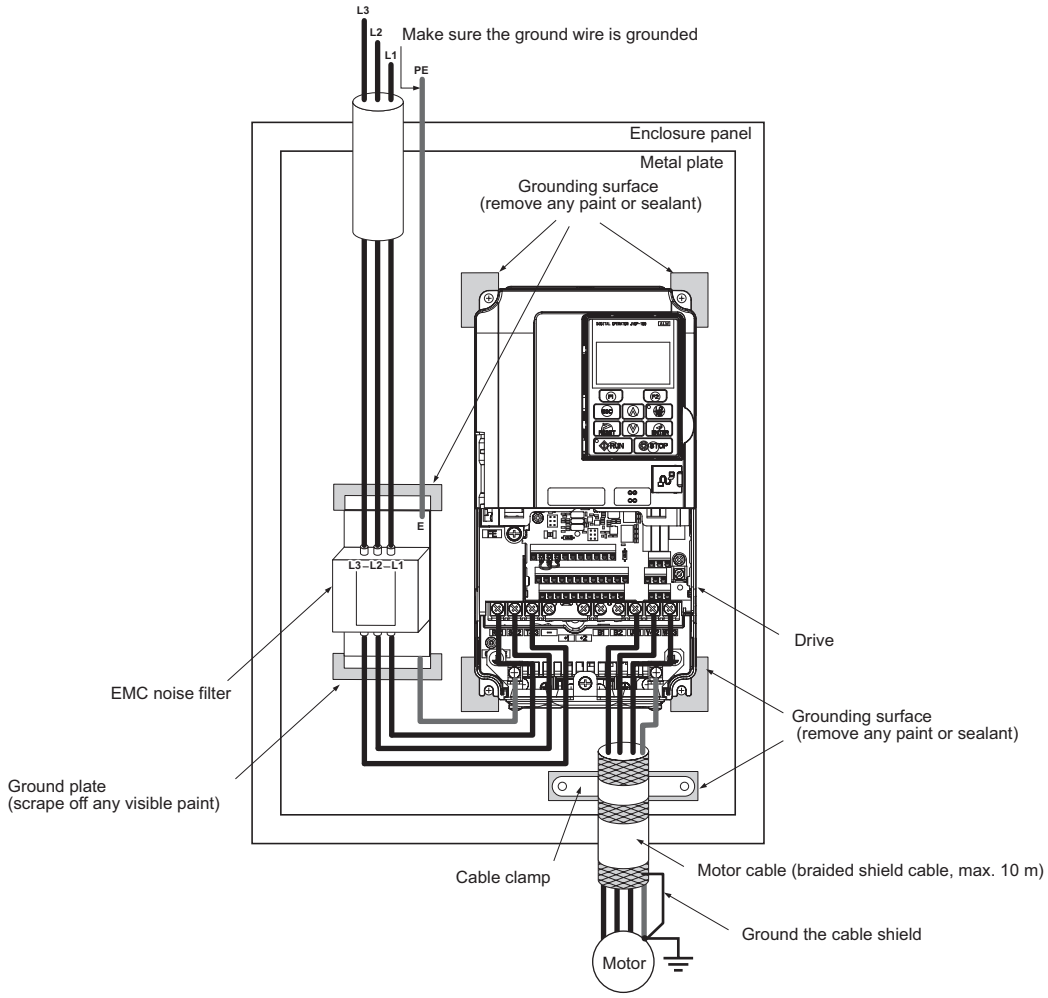
The control terminal board is equipped with screwless terminals. Always use wires within the specification listed below. For safe wiring it is recommended to use solid wires or flexible wires with ferrules. The stripping length respectively ferrule length should be 8 mm.

Wire Type	Wire size (mm²)
Solid	0.2 to 1.5
Flexible	0.2 to 1.0
Flexible with ferrule	0.25 to 0.5

◆ EMC Filter Installation

This drive has been tested in accordance with European standards EN61800-3. In order to comply to the EMC standards, wire the main circuit as described below.

1. Install an appropriate EMC noise filter to the input side. See the table in *Main Circuit on page 13* or refer to the Technical Manual for details.
2. Place the drive and EMC noise filter in the same enclosure.
3. Use braided shield cable for the drive and motor wiring.
4. Remove any paint or dirt from ground connections for minimal ground impedance.
5. Install an DC reactor at drives smaller than 1 kW for compliance with the EN61000-3-2. Refer to the Technical Manual or contact your supplier for details.



◆ Main and Control Circuit Wiring

■ Wiring the Main Circuit Input

Consider the following precautions for the main circuit input.

- Use fuses recommended in *Main Circuit on page 13* only.
- If using a ground fault circuit breaker, make sure that it can detect both DC and high frequency current.
- If using an input switch is used, make sure that the switch does not operate not more than once every 30 minutes.
- Use insulation caps when wiring the drive with crimp terminals. Take particular care to ensure that wiring does not touch neighboring terminals or the surrounding case.
- Insulation barriers are packaged with drive models CIMR-A□4A0414 through 1200 to provide added protection between terminals. Yaskawa recommends using the insulation barriers provided to ensure proper wiring.
- Use a DC reactor or AC reactor on the input side of the drive:
  –To suppress harmonic current.
  –To improve the power factor on the power supply side.
  –When using an advancing capacitor switch.
  –With a large capacity power supply transformer (over 600 kVA).

■ Wiring the Main Circuit Output

Consider the following precautions for the output circuit wiring.

- Do not connect any other load than a 3 phase motor to the drives output.
- Never connect a power source to the drives output.
- Never short or ground the output terminals.
- Do not use phase correction capacitors.
- If using a contactor between the drive and motor, it should never be operated when the drive is outputting a voltage. Operating while there is voltage output can cause large peak currents, thus tripping the over current detection or damage the drive.

■ Ground Connection

Take the following precautions when grounding the drive.

- Never share the ground wire with other devices such as welding machines, etc.
- Always use a ground wire, that complies with electrical equipment technical standards. Keep ground wires as short as possible. Leakage current is caused by the drive. Therefore, if the distance between the ground electrode and the ground terminal is too long, potential on the ground terminal of the drive will become unstable.
- When using more than one drive, do not loop the ground wire.

■ Control Circuit Wiring Precautions

Consider the following precautions for wiring the control circuits.

- Separate control circuit wiring from main circuit wiring and other high-power lines.
- Separate wiring for control circuit terminals M1-M2, M3-M4, M5-M6, MA, MB, MC (contact output) from wiring to other control circuit terminals.
- For external control power supply use a UL Listed Class 2 power supply.
- Use twisted-pair or shielded twisted-pair cables for control circuits to prevent operating faults.
- Ground the cable shields with the maximum contact area of the shield and ground.
- Cable shields should be grounded on both cable ends.
- If flexible wires with ferrules are connected they might fit tightly into the terminals. To disconnect them, grasp the wire end with a pair of pliers, release the terminal using a straight-edge screw driver, turn the wire for about 45°, and pull it gently out of the terminal. For details, refer to the Technical Manual. Use this procedure for removing the wire link between HC, H1 and H2 when the Safe Disable function is utilized.

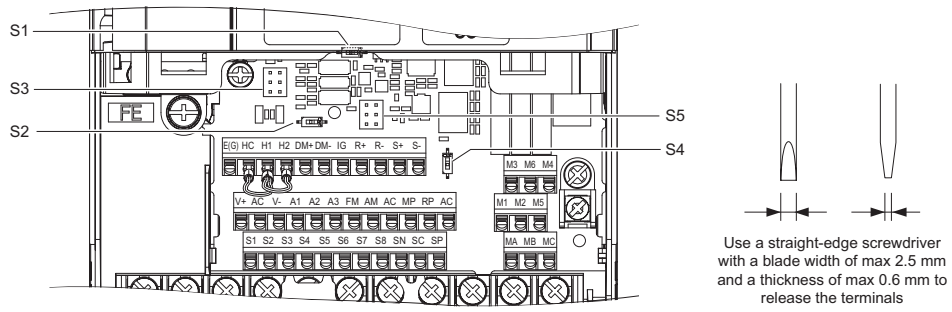
■ Main Circuit Terminals

Note: Confirm the following when wiring models CIMR-A□4A0930 and 4A1200:
✍ Remove the jumpers shorting terminals R/L1-R1/L11, S/L2-S1/L21, and T/L3-T1/L31 when operating with 12-phase rectification. Refer to the Technical Manual for more information.
✍ When operating without 12-phase rectification, properly wire terminals R1/L11, S1/L21, and T1/L31 in addition to terminals R1/L1, S1/L2, and T1/L3.

Terminal		Type				Function
200 V Class	Model CIMR-A□	2A0004 to 2A0081	2A0110 to 2A0138	2A0169 to 2A0415	–	
400 V Class		4A0002 to 4A0044	4A0058 to 4A0072	4A0088 to 4A0675	4A0930, 4A1200	
R/L1, S/L2, T/L3		Main circuit power supply input			Main circuit power supply input	Connects line power to the drive
R1/L11, S1/L21, T1/L31		not available				
U/T1, V/T2, W/T3		Drive output				Connects to the motor
B1, B2		Braking resistor		not available		Available for connecting a braking resistor or a braking resistor unit option
+2		• DC reactor connection (+1, +2) (remove the shorting bar between +1 and +2) • DC power supply input (+1, –)	not available			For connection • of the drive to a DC power supply (terminals +1 and – are not CE or UL approved) • of braking options • connection of a DC reactor
+1, –			• DC power supply input (+1, –)	• DC power supply input (+1, –) • Braking transistor connection (+3, –)		
+3		not available				
⏚		–				Grounding terminal

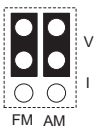
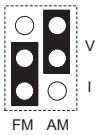
■ Control Circuit Terminals

The figure below shows the control circuit terminal arrangement. The drive is equipped with screwless terminals.



There are three DIP switches and two jumpers, S1 to S5, located on the terminal board.

S1	Terminal A2 Signal Selection	V I Current; V I Voltage
S2	RS422/485 Termination Resistor	Off On
S3	Safe Disable Input Sink/Source/External Supply Selection	Source; Sink; External 24 Vdc Power Supply
S4	Terminal A3 Analog/PTC Input Selection	PTC AI Analog Input; PTC AI PTC Input

S5	Terminal FM/AM Signal Selection	 FM/AM: Voltage Output  FM: Current Output AM: Voltage Output ...

■ Control Circuit Terminal Functions

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Multi-Function Digital Inputs	S1	Multi-function input 1 (Closed: Forward run, Open: Stop)	Photocoupler 24 Vdc, 8 mA Use the wire link between terminals SC and SN or SC and SP to select between sinking, sourcing mode, and the power supply.
	S2	Multi-function input 2 (Closed: Reverse run, Open: Stop)	
	S3	Multi-function input 3 (External fault, N.O.)	
	S4	Multi-function input 4 (Fault reset)	
	S5	Multi-function input 5 (Multi-step speed reference 1)	
	S6	Multi-function input 6 (Multi-step speed reference 2)	
	S7	Multi-function input 7 (Jog reference)	
	S8	Multi-function input 8 (External baseblock)	
	SC	Multi-function input common	–
	SN	Multi-function input 0 V	24 Vdc power supply for digital inputs, 150 mA max (if no digital input option DI-A3 is used) Never short terminals SP and SN as doing so will damage the drive.
	SP	Multi-function input 24 Vdc	
Safe Disable Inputs	H1	Safe Disable input 1	24 Vdc, 8 mA One or both open: Drive output disabled Both closed: Normal operation Internal impedance: 3.3 kΩ Off time of at least 1 ms Disconnect the wire jumpers shorting terminals H1, H2, and HC to use the Safe Disable inputs. Set the S3 jumper to select between sinking, sourcing mode, and the power supply.
	H2	Safe Disable input 2	
	HC	Safe Disable function common	Safe disable function common
Analog Inputs / Pulse Train Input	RP	Multi-function pulse train input (Frequency reference)	Input frequency range: 0 to 32 kHz Signal Duty Cycle: 30 to 70% High level: 3.5 to 13.2 Vdc, low level: 0.0 to 0.8 Vdc Input impedance: 3 kΩ
	+V	Power supply for analog inputs	10.5 Vdc (max allowable current 20 mA)
	-V	Power supply for analog inputs	-10.5 Vdc (max allowable current 20 mA)
	A1	Multi-function analog input 1 (Frequency reference bias)	-10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ)
	A2	Multi-function analog input 2 (Frequency reference bias)	-10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ) 4 to 20 mA, 0 to 20 mA (input impedance: 250 Ω) Voltage or current input must be selected by DIP switch S1 and H3-09
	A3	Multi-function analog input 3 / PTC Input (Auxiliary frequency reference)	-10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ) Use switch S4 on the control terminal board to select between analog input or PTC input. If PTC is selected, set H3-06 = E.
	AC	Frequency reference common	0 V
	E (G)	Ground for shielded lines and option cards	–
Fault Relay	MA	N.O.	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA
	MB	N.C. output	
	MC	Fault output common	

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Multi-Function Digital Output	M1	Multi-function digital output (During run)	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA
	M2		
	M3	Multi-function digital output (Zero speed)	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA
	M4		
	M5	Multi-function digital output (Speed agree 1)	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA
	M6		
Monitor Output	MP	Pulse train output (Output frequency)	32 kHz (max)
	FM	Analog monitor output 1 (Output frequency)	-10 to +10 Vdc, 0 to +10 Vdc, or 4 to 20 mA Use jumper S5 on the control terminal board to select between voltage or current output at terminals AM and FM. Set parameters H4-07 and H4-08 accordingly when changing the jumper setting.
	AM	Analog monitor output 2 (Output current)	
	AC	Monitor common	0 V
Safety Monitor Output	DM+	Safety monitor output	Outputs status of Safe Disable function. Closed when both Safe Disable channels are closed. Up to +48 Vdc 50 mA
	DM-	Safety monitor output common	

NOTICE: *The terminals HC, H1, H2 are used for the Safe Disable function. Do not remove the wire link between HC, H1, or H2 unless the Safe Disable function is used.* ***Refer to Safe Disable Input Function on page 35*** *when using this function.*

NOTICE: *The wiring length to the terminals HC, H1 and H2 should not exceed 30 m.*

4 Keypad Operation

◆ Digital Operator and Keys

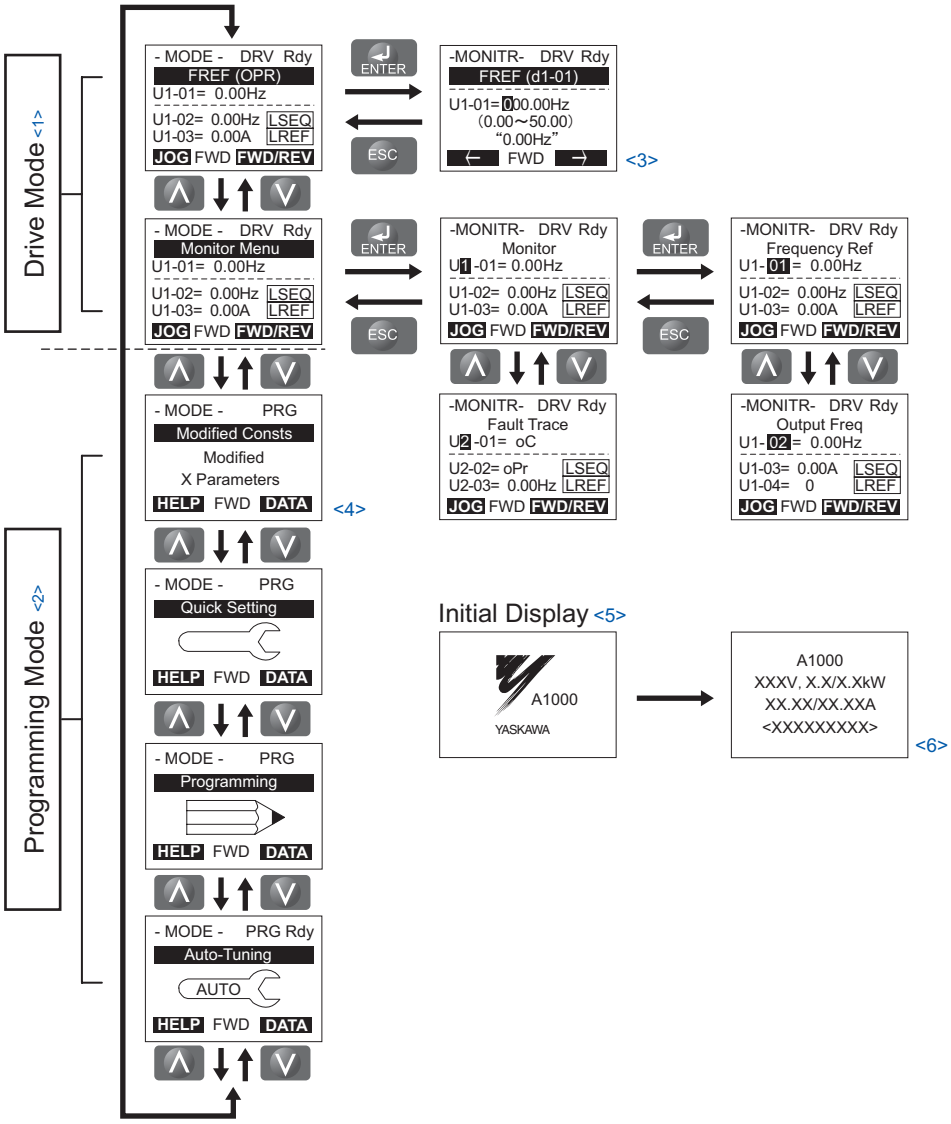
The digital operator is used to program the drive, to start/stop it, and to display fault information. The LEDs indicate the drive status.

■ Keys and Functions

Key	Name	Function
F1 F2	Function Key (F1, F2)	The functions assigned to F1 and F2 vary depending on the menu that is currently displayed. The name of each function appears in the lower half of the display window.
ESC	ESC Key	• Returns to the previous display. • Moves the cursor one space to the left. • Pressing and holding this button will return to the Frequency Reference display.
RESET	RESET Key	• Moves the cursor to the right. • Resets the drive to clear a fault situation.
RUN	RUN Key	Starts the drive in the LOCAL mode. The Run LED • is on, when the drive is operating the motor. • flashes during deceleration to stop or when the frequency reference is 0. • flashes quickly the drive is disabled by a DI, the drive was stopped using a fast stop DI or a run command was active during power up.
	Up Arrow Key	Scrolls up to display the next item, selects parameter numbers and increments setting values.
	Down Arrow Key	Scrolls down to display the previous item, selects parameter numbers and decrements setting values.
STOP	STOP Key	Stops drive operation.
ENTER	ENTER Key	• Enters parameter values and settings. • Selects a menu item to move between displays.
LO RE	LO/RE Selection Key	Switches drive control between the operator (LOCAL) and the control circuit terminals (REMOTE). The LED is on when the drive is in the LOCAL mode (operation from keypad).
ALM	ALM LED Light	On: When the drive detects a fault. Flashing: • When an alarm occurs. • When oPE is detected. • When a fault or error occurs during Auto-Tuning.

◆ Menu Structure and Modes

The following illustration explains the operator keypad menu structure.

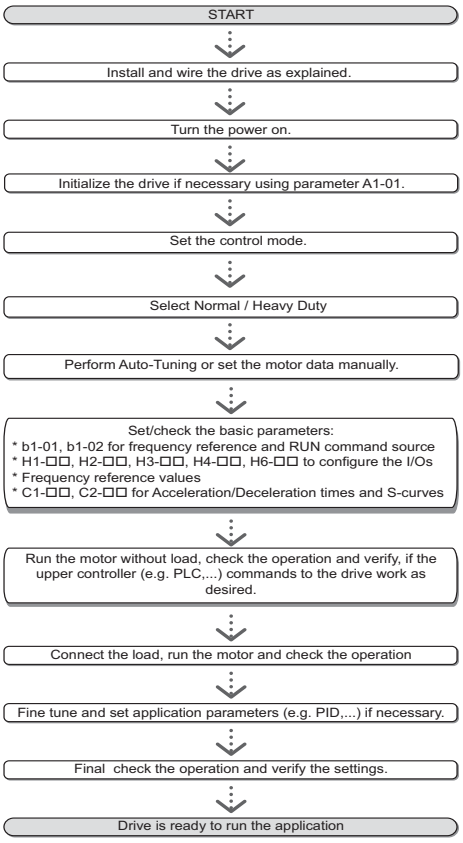


<1> Pressing RUN will start the motor.
<2> Drive cannot operate the motor.
<3> Flashing characters are shown as 0.
<4> X characters are shown in this manual. The LCD Operator will display the actual setting values.
<5> The Frequency Reference appears after the initial display which shows the product name.
<6> The information that appears on the display will vary depending on the drive.

5 Start Up

◆ Drive Setup Procedure

The illustration below shows the basic setup procedure. Each step is explained more detailed on the following pages.



◆ Power On

Before turning on the power supply,

- Make sure all wires are connected properly.
- Make sure no screws, loose wire ends or tools are left in the drive.
- After turning the power on, the drive mode display should appear and no fault or alarm should be displayed.

◆ Control Mode Selection (A1-02)

There are three control modes available. Select the control mode that best suits the application the drive will control.

Control Mode	Parameter	Main Applications
V/f Control for Induction Motors	A1-02 = 0 (default)	• General variable speed applications, particularly useful for running multiple motors from a single drive. • When replacing a drive in which parameter settings are unknown.
V/f Control with PG Speed Feedback	A1-02 = 1	• For general-purpose applications that do not require high dynamic response but high speed accuracy. • This mode should be used if the motor parameters are unknown and Auto-Tuning cannot be performed.
Open Loop Vector Control	A1-02 = 2	• General variable speed applications • Applications requiring high precision, high speed control
Closed Loop Vector Control <1>	A1-02 = 3	• For general, variable-speed applications that requiring precise speed control down to zero speed, fast torque response, or precise torque control. • A speed feedback signal from the motor is required.

Control Mode	Parameter	Main Applications
Open Loop Vector Control for PM <1>	A1-02 = 5	Derated torque-load applications employing permanent magnet motors (SPM, IPM) and energy savings.
Advanced Open Loop Vector Control for PM <1>	A1-02 = 6	This control mode can be used to operate an IPM motor for constant torque applications.
Closed Loop Vector Control for PM <1>	A1-02 = 7	• This mode can be used for high precision control of a PM motor in constant torque or variable torque applications. • A speed feedback signal is required.

<1> For explanations of these control modes, refer to the Technical Manual.

◆ Normal / Heavy Duty Selection (C6-01)

The drive supports two ratings, Normal Duty and Heavy Duty. Both have different output current ratings (refer to the catalog or the Technical Manual). Set the Duty mode in accordance with the application.

Mode	Heavy Duty Rating (HD)	Normal Duty Rating (ND)
C6-01	0	1
Application	Applications with a constant torque like extruders, conveyors and cranes. High overload capability might be needed.	Applications where the torque increases with the speed like fans or pumps. High overload tolerance is normally not needed.
Overload capability (OL2)	150% of drive rated current for 60 s	120% of drive rated current for 60 s
L3-02 Stall Prevention during Acceleration	150%	120%
L3-06 Stall Prevention during Run	150%	120%
Default carrier frequency	2 kHz	2 kHz Swing PWM

◆ Auto-Tuning (T1-☐☐)

Auto-Tuning automatically sets up the motor data relevant drive parameters. Three different modes are supported.

Type	Setting	Application Conditions and Benefits	Control Mode (A1-02)			
			V/f (0)	V/f w/PG (1)	OLV (2)	CLV (3)
Rotational Auto-Tuning	T1-01 = 0	• Motor can be decoupled from the load and rotate freely while Auto-Tuning is performed. • Motor and load can not be decoupled but the motor load is below 30%. • Rotational Auto-Tuning gives the most accurate results, and is therefore highly recommended if possible.	N/A	N/A	YES	YES
Stationary Auto-Tuning 1	T1-01 = 1	• Motor and load can not be decoupled and the load is higher than 30%. • A motor test report listing motor data is not available. • Automatically calculates motor parameters needed for vector control.	N/A	N/A	YES	YES
Stationary Auto-Tuning 2	T1-01 = 4	• Motor and load can not be decoupled and the load is higher than 30%. • A motor test report is available. Once the no-load current and the rated slip have been entered, the drive calculates and sets all other motor-related parameters.	N/A	N/A	YES	YES
Stationary Auto-Tuning for Line-to-Line Resistance	T1-01 = 2	• The drive is used in V/f Control and other Auto-Tuning selections not possible. • Drive and motor capacities differ. • Tunes the drive after the cable between the drive and motor has been replaced with a cable over 50 m long. Assumes Auto-Tuning has already been performed. • Should not be used for any vector control modes unless the motor cable has changed.	YES	YES	YES	YES

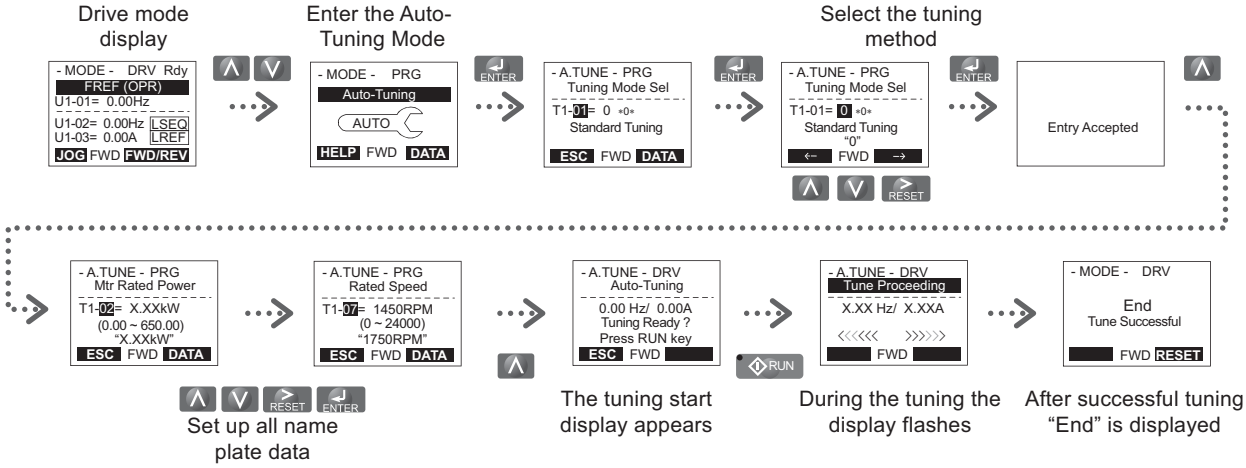
Type	Setting	Application Conditions and Benefits	Control Mode (A1-02)			
			V/f (0)	V/f w/PG (1)	OLV (2)	CLV (3)
Rotational Auto-Tuning for V/f Control	T1-01 = 3	• Recommended for applications using Speed Estimation Speed Search or using the Energy Saving function in V/f Control. • Assumes motor can rotate while Auto-Tuning is executed. Increases accuracy for certain functions like torque compensation, slip compensation, Energy Saving, and Speed Search.	YES	YES	N/A	N/A

⚠ CAUTION

Do not touch the motor until the Auto-Tuning is finished.

Failure to comply may result in minor or moderate injury. Voltage is still applied to the motor during the tuning process, even thought the motor may not be rotating.

For Auto-Tuning enter the Auto-Tuning menu and perform the steps shown in the figure below. The number of name plate data to be entered depends on the selected type of Auto-Tuning. This example shows Rotational Auto-Tuning.



If Auto-Tuning can not be performed for some reason (no-load operation impossible etc.), then set up the maximum frequency and voltage in the E1-☐☐ parameters and enter the motor data manually into the E2-☐☐ parameters.

NOTICE: *The Safe Disable inputs must be closed during Auto-Tuning.*

◆ External Reference Selection and Acceleration/ Deceleration Times

■ Frequency Reference Selection (b1-01)

Set parameter b1-01 according to the frequency reference used.

b1-01	Reference source	Frequency reference input
0	Operator keypad	Set the frequency references in the d1-☐☐ parameters and use digital inputs to switch over between different reference values.
1	Analog input	Apply the frequency reference signal to terminal A1, A2, or A3.
2	Serial Comm.	Serial Communications using the RS422/485 port
3	Option Card	Communications option card
4	Pulse input	Set the frequency reference at terminal RP using a pulse train signal.

■ Run Command Selection (b1-02)

Set parameter b1-02 according to the run command used.

b1-02	Reference source	Run command input
0	Operator keypad	RUN and STOP keys on the operator
1	Multi-Function digital input	Multi-Function digital input
2	Serial Comm.	Serial Communications using the RS422/485 port
3	Option Card	Communications option card

■ Acceleration/ Deceleration Times and S-Curves

There are four sets of acceleration and deceleration times which can be set in the C1-☐☐ parameters. The default activated accel/decel times are C1-01/02. Adjust these times to the appropriate values required by the application. If necessary S-curves can be activated in the C2-☐☐ parameters for softer accel/decel start and end.

◆ Reference and Run Source

The drive has a LOCAL and a REMOTE mode.

Status	Description
LOCAL	The Run/ Stop command and the frequency reference are entered at the operator keypad.
REMOTE	The Run command source entered in parameter b1-02 and the frequency reference source entered in parameter b1-01 are used.

If the drive is operated in the REMOTE mode, make sure that the correct sources for the frequency reference and run command are set in parameters b1-01/02 and that the drive is in the REMOTE mode.

The LED in the LO/RE key indicates where the Run command is input from.

LO/RE LED	Description
ON	Run command is issued from operator.
OFF	Run command is issued from a different source than the operator.

◆ I/O Setup

Note: The default setting functions can be seen in the connection diagram on page *12*.

■ Multi-Function Digital Inputs (H1-☐☐)

The function of each digital input can be assigned in the H1-☐☐ parameters.

■ Multi-Function Digital Outputs (H2-☐☐)

The function of each digital output can be assigned in the H2-☐☐ parameters. The setting value of these parameters consist of 3 digits, where the middle and right digit set the function and the left digit sets the output characteristics (0: Output as selected; 1: Inverse output).

■ Multi-Function Analog Inputs (H3-☐☐)

The function of each analog input can be assigned in the H3-☐☐ parameters. Input A1 and A3 are set for -10 to +10 Vdc input. A2 is set for 4-20 mA input.

NOTICE: *If the input signal level of input A2 is switched between voltage and current, make sure that DIP switch S1 is in the correct position and parameter H3-09 is set up correctly.*

NOTICE: *When using analog input A3 as PTC input, set DIP switch S4 to PTC and parameter H3-06 = E.*

■ Multi-Function Analog Outputs (H4-☐☐)

Use the H4-☐☐ parameters to set up the output value of the analog monitor outputs and to adjust the output signal levels. When changing signal levels in parameter H4-07/08, make sure jumper S5 is set accordingly.

◆ Test Run

Perform the following steps to start up the machine after all parameter settings have been done.

1. Run the motor without load and check if all input, outputs and the sequence work as desired.
2. Connect the load to the motor.
3. Run the motor with load and make sure that there is no vibrations, hunting or motor stalling occurs.

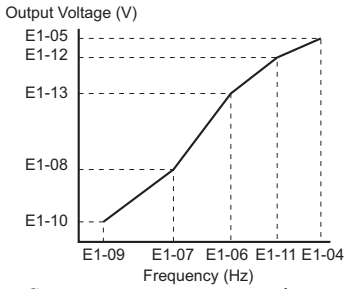
After taking the steps listed above, the drive should be ready to run the application and perform the basic functions. For special setups like PID control etc. refer to the Technical Manual.

6 Parameter Table

This parameter table shows the most important parameters. Default settings are bold type. Refer to the Technical Manual for a complete list of parameters.

No.	Name	Description
Initialization Parameters		
A1-01	Access Level Selection	0: View and set A1-01 and A1-04. U□-□□ parameters can also be viewed. 1: User Parameters (access to a set of parameters selected by the user, A2-01 to A2-32) **2: Advanced Access (access to view and set all parameters)**
A1-02	Control Method Selection	**0: V/f Control** 1: V/f Control with PG 2: Open Loop Vector Control 3: Closed Loop Vector Control 5: Open Loop Vector Control for PM 6: Advanced Open Loop Vector Control for PM 7: Closed Loop Vector Control for PM
A1-03	Initialize Parameters	**0: No initialization** 1110: User Initialize (parameter values must be stored using parameter o2-03) 2220: 2-wire initialization 3330: 3-wire initialization 5550: oPE04 error reset
Operation Mode Selection		
b1-01	Frequency Reference Selection 1	0: Digital operator **1: Analog input terminals** 2: MEMOBUS/Modbus communications 3: Option PCB 4: Pulse input (terminal RP)
b1-02	Run Command Selection 1	0: Digital operator **1: Digital input terminals** 2: MEMOBUS/Modbus communications 3: Option PCB
b1-03	Stopping Method Selection	**0: Ramp to stop** 1: Coast to stop 2: DC Injection Braking to stop 3: Coast with timer 9: Simple Positioning Stop
b1-04	Reverse Operation Selection	**0: Reverse enabled.** 1: Reverse disabled.
b1-14	Phase Order Selection	**0: Standard** 1: Switch phase order (reverses the direction of the motor)
DC Injection Braking		
b2-01	DC Injection Braking Start Frequency	Sets the frequency at which DC Injection Braking starts when “Ramp to stop” (b1-03 = 0) is selected.
b2-02	DC Injection Braking Current	Sets the DC Injection Braking current as a percentage of the drive rated current.
b2-03	DC Injection Braking Time at Start	Sets DC Injection Braking (Zero Speed Control when in CLV/PM) time at start. Disabled when set to 0.00 seconds.
b2-04	DC Injection Braking Time at Stop	Sets DC Injection Braking time at stop.

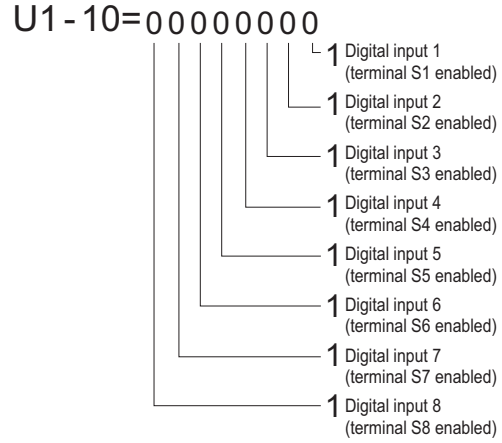
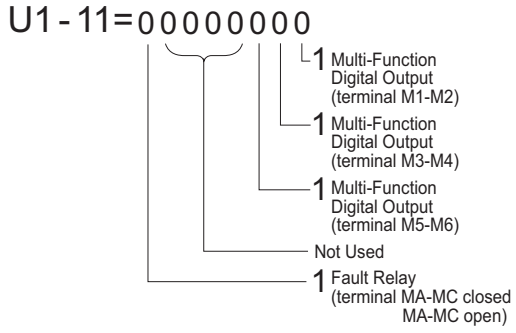
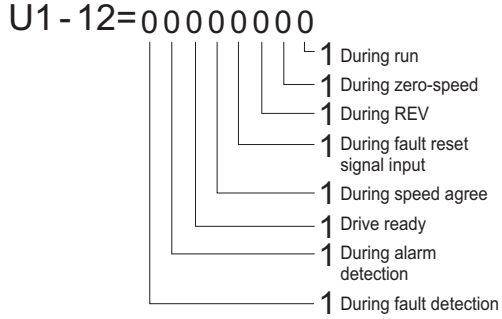
No.	Name	Description
Acceleration/ Deceleration		
C1-01	Acceleration Time 1	Sets the time to accelerate from 0 to maximum frequency.
C1-02	Deceleration Time 1	Sets the time to decelerate from maximum frequency to 0.
C1-03 to C1-08	Acceleration/ Deceleration Time 2 to 4	Set the accel/decel times 2 to 4 (set like C1-01/02).
C2-01	S-Curve Characteristic at Accel Start	S-curve at acceleration start.
C2-02	S-Curve Characteristic at Accel End	S-curve at acceleration end.
C2-03	S-Curve Characteristic at Decel Start	S-curve at deceleration start.
C2-04	S-Curve Characteristic at Decel End	S-curve at deceleration end.
Slip Compensation		
C3-01	Slip Compensation Gain	Sets the gain for the motor slip compensation function used for motor 1.
C3-02	Slip Compensation Primary Delay Time	Adjusts the slip compensation function delay time used for motor 1.
Torque Compensation		
C4-01	Torque Compensation Gain	Sets the gain for the automatic torque (voltage) boost function and helps to produce better starting torque. Used for motor 1.
C4-02	Torque Compensation Primary Delay Time	Sets the torque compensation filter time.
Carrier Frequency		
C6-01	Drive Duty Selection	**0: Heavy Duty (HD) for constant torque applications.** 1: Normal Duty (ND) for variable torque applications.
C6-02	Carrier Frequency Selection	**1: 2.0 kHz** 2: 5.0 kHz 3: 8.0 kHz 4: 10.0 kHz 5: 12.5 kHz 6: 15.0 kHz 7: Swing PWM1 (Audible sound 1) 8: Swing PWM2 (Audible sound 2) 9: Swing PWM3 (Audible sound 3) A: Swing PWM4 (Audible sound 4) B to E: No setting possible F: User defined (determined by C6-03 through C6-05)
Frequency Reference		
d1-01 to d1-16	Frequency Reference 1 to 16	Sets the frequency reference for the drive. Setting units are determined by parameter o1-03.

No.	Name	Description
d1-17	Jog Frequency Reference	Sets the Jog frequency reference. Setting units are determined by parameter o1-03.
V/f Pattern for Motor 1		
E1-01	Input Voltage Setting	This parameter must be set to the power supply voltage. WARNING! Drive input voltage (not motor voltage) must be set in E1-01 for the protective features of the drive to function properly. Failure to do so may result in equipment damage and/or death or personal injury.
E1-04	Maximum Output Frequency	These parameters are only applicable when E1-03 is set to F. To set linear V/f characteristics, set the same values for E1-07 and E1-09. In this case, the setting for E1-08 will be disregarded. Ensure that the four frequencies are set according to these rules: E1-09 ≤ E1-07 < E1-06 ≤ E1−11 ≤ E1-04  Note: Some parameters may not be available depending on the control mode. • E1-07, E1-08 and E-10 are available only in the following control modes: V/f Control, V/f with PG, Open Loop Vector. • E1-11, E1-12 and E-13 are available only in the following control modes: V/f Control, V/f with PG, Open Loop Vector, Closed Loop Vector.
E1-05	Maximum Voltage	
E1-06	Base Frequency	
E1-07	Middle Output Frequency	
E1-08	Middle Output Frequency Voltage	
E1-09	Minimum Output Frequency	
E1-10	Minimum Output Frequency Voltage	
E1-13	Base Voltage	
Motor 1 Parameters		
E2-01	Motor Rated Current	Sets the motor nameplate full load current in Amps. Automatically set during Auto-Tuning.
E2-02	Motor Rated Slip	Sets the motor rated slip. Automatically set during Auto-Tuning.
E2-03	Motor No-Load Current	Sets the no-load current for the motor. Automatically set during Auto-Tuning.
E2-04	Number of Motor Poles	Sets the number of motor poles. Automatically set during Auto-Tuning.
E2-05	Motor Line-to-Line Resistance	Sets the phase-to-phase motor resistance. Automatically set during Auto-Tuning.
E2-06	Motor Leakage Inductance	Sets the voltage drop due to motor leakage inductance as a percentage of motor rated voltage. Automatically set during Auto-Tuning.
Multi-Function Digital Inputs		
H1-01 to H1-08	Multi-Function Digital Input Terminal S1 to S8 Function Selection	Selects the function of terminals S1 to S8.
Note: Major functions are listed at the end of the table.		

No.	Name	Description
Multi-Function Digital Outputs		
H2-01	Terminal M1-M2 function selection	Set the function for the relay output M1-M2.
H2-02	Terminal M3-M4 function selection	Sets the function for the relay output M3-M4.
H2-03	Terminal M5-M6 function selection	Sets the function for the relay output M5-M6.
H2-06	Watt Hour Output Unit Selection	Outputs a 200 ms pulse signal when the watt-hour counter increases by the units selected. **0: 0.1 kWh units** 1: 1 kWh units 2: 10 kWh units 3: 100 kWh units 4: 1000 kWh units
Note: Major functions are listed at the end of the table.		
Multi-Function Analog Inputs		
H3-01	Terminal A1 Signal Level Selection	**0: 0 to 10 V** 1: –10 to 10 V
H3-02	Terminal A1 Function Selection	Sets the function of terminal A1.
H3-03	Terminal A1 Gain Setting	Sets the level of the input value selected in H3-02 when 10 V is input at terminal A1.
H3-04	Terminal A1 Bias Setting	Sets the level of the input value selected in H3-02 when 0 V is input at terminal A1.
H3-05	Terminal A3 Signal Level Selection	**0: 0 to 10 V** 1: –10 to 10 V
H3-06	Terminal A3 Function Selection	Sets the function of terminal A3.
H3-07	Terminal A3 Gain Setting	Sets the level of the input value selected in H3-06 when 10 V is input at terminal A3.
H3-08	Terminal A3 Bias Setting	Sets the level of the input value selected in H3-06 when 0 V is input at terminal A3.
H3-09	Terminal A2 Signal Level Selection	0: 0 to 10 V 1: –10 to 10 V **2: 4 to 20 mA** 3: 0 to 20 mA Note: Use DIP switch S1 to set input terminal A2 for a current or a voltage input signal.
H3-10	Terminal A2 Function Selection	Sets the function of terminal A2.
H3-11	Terminal A2 Gain Setting	Sets the level of the input value selected in H3-10 when 10 V (20 mA) is input at terminal A2.
H3-12	Terminal A2 Bias Setting	Sets the level of the input value selected in H3-10 when 0 V (0 or 4 mA) is input at terminal A2.
H3-13	Analog Input Filter Time Constant	Sets a primary delay filter time constant for terminals A1, A2, and A3. Used for noise filtering.

No.	Name	Description
H3-14	Analog Input Terminal Enable Selection	Determines which of the analog input terminals will be enabled when a digital input programmed for "Analog input enable" (H1-□□ = C) is activated. 1: Terminal A1 only 2: Terminal A2 only 3: Terminals A1 and A2 only 4: Terminal A3 only 5: Terminals A1 and A3 6: Terminals A2 and A3 **7: All terminals enabled**
Multi-Function Analog Inputs		
H4-01	Multi-Function Analog Output Terminal FM Monitor Selection	Selects the data to be output through multi-function analog output terminal FM. Set the desired monitor parameter to the digits available in U□-□□. For example, enter "103" for U1-03.
H4-02	Multi-Function Analog Output Terminal FM Gain	Sets the signal level at terminal FM that is equal to 100% of the selected monitor value.
H4-03	Multi-Function Analog Output Terminal FM Bias	Sets the signal level at terminal FM that is equal to 0% of the selected monitor value.
H4-04	Multi-Function Analog Output Terminal AM Monitor Selection	Selects the data to be output through multi-function analog output terminal AM. Set the desired monitor parameter to the digits available in U□-□□. For example, enter "103" for U1-03.
H4-05	Multi-Function Analog Output Terminal AM Gain	Sets the signal level at terminal AM that is equal to 0% of the selected monitor value.
H4-06	Multi-Function Analog Output Terminal AM Bias	Sets the bias value added to the terminal AM output signal.
H4-07	Multi-Function Analog Output Terminal FM Signal Level Selection	**0: 0 to 10 V** 1: -10 to 10 V 2: 4 to 20 mA
H4-08	Multi-Function Analog Output Terminal AM Signal Level Selection	**0: 0 to 10 V** 1: -10 to 10 V 2: 4 to 20 mA
Pulse Input Setting (Freq.)		
H6-02	Pulse Train Input Scaling	Sets the terminal RP input signal frequency that is equal to 100% of the value selected in H6-01.
H6-03	Pulse Train Input Gain	Sets the level of the value selected in H6-01 when a frequency with the value set in H6-02 is input.
H6-04	Pulse Train Input Bias	Sets the level of the value selected in H6-01 when 0 Hz is input.
Pulse Output Setting		
H6-06	Pulse Train Monitor Selection	Select the pulse train monitor output function (value of the □-□□ part of U□-□□). Example: To select U5-01, set 501.
H6-07	Pulse Train Monitor Scaling	Sets the terminal MP output signal frequency when the monitor value is 100%. To have the pulse train monitor output equal the output frequency, set H6-06 to 102 and H6-07 to 0.
Motor Protection		
L1-01	Motor Overload Protection Selection	0: Disabled **1: General purpose motor (standard fan cooled)** 2: Drive dedicated motor with a speed range of 1:10 3: Vector motor with a speed range of 1:100 4: PM motor with variable torque 5: PM motor with constant torque control 6: General purpose motor (50 Hz) The drive may not be able to provide protection when multiple motors are used, even if overload is enabled in L1-01. Set L1-01 to 0 and install separate thermal relay to each motor.
L1-02	Motor Overload Protection Time	Sets the motor thermal overload protection (oL1) time.
Stall Prevention		
L3-01	Stall Prevention Selection during Acceleration	0: Disabled. **1: General purpose. Acceleration is paused as long as the current is above the L3-02 setting.** 2: Intelligent. Accelerate in the shortest possible time without exceeding the L3-02 level. Note: Setting 2 is not available when using OLV/PM.
L3-02	Stall Prevention Level during Acceleration	Used when L3-01 = 1 or 2. 100% is equal to the drive rated current.
L3-04	Stall Prevention Selection during Deceleration	0: Disabled. Deceleration at the active deceleration rate. An ov fault may occur. **1: General purpose. Deceleration is paused when the DC bus voltage exceeds the Stall Prevention level.** 2: Intelligent. Decelerate as fast as possible while avoiding ov faults. 3: Stall Prevention with braking resistor. Stall Prevention during deceleration is enabled in coordination with dynamic braking. 4: Overexcitation Deceleration. Decelerates while increasing the motor flux. 5: Overexcitation Deceleration 2. Adjust the deceleration rate according to the DC bus voltage. 6: Enabled. Decelerates adjusting the deceleration rate according to the output current and the DC bus voltage.

No.	Name	Description
L3-05	Stall Prevention Selection during Run	0: Disabled. Drive runs at a set frequency. A heavy load may cause speed loss. **1: Decel time 1. Uses the deceleration time set to C1-02 while Stall Prevention is performed.** 2: Decel time 2. Uses the deceleration time set to C1-04 while Stall Prevention is performed.
L3-06	Stall Prevention Level during Run	Enabled when L3-05 is set to 1 or 2. 100% is equal to the drive rated current.
Induction Motor Auto-Tuning		
T1-01	Auto-Tuning Mode Selection	**0: Rotational Auto-Tuning** 1: Stationary Auto-Tuning 1 2: Stationary Auto-Tuning for Line-to-Line Resistance 3: Rotational Auto-Tuning for V/f Control (necessary for Energy Savings and Speed Estimation Speed Search) 4: Stationary Auto-Tuning 2 8: Inertia Tuning (perform Rotational Auto-Tuning prior to Inertia Tuning) 9: ASR Gain Tuning (perform Rotational Auto-Tuning prior to ASR Gain Auto-Tuning)
T1-02	Motor Rated Power	Sets the motor rated power as specified on the motor nameplate.
T1-03	Motor Rated Voltage	Sets the motor rated voltage as specified on the motor nameplate.
T1-04	Motor Rated Current	Sets the motor rated current as specified on the motor nameplate.
T1-05	Motor Base Frequency	Sets the rated frequency of the motor as specified on the motor nameplate.
T1-06	Number of Motor Poles	Sets the number of motor poles as specified on the motor nameplate.
T1-07	Motor Base Speed	Sets the rated speed of the motor as specified on the motor nameplate.
T1-08	PG Number of Pulses Per Revolution	Set the number of pulses per revolution for the PG being used (pulse generator or encoder).
T1-09	Motor No-Load Current (Stationary Auto-Tuning)	Sets the no-load current for the motor. After setting the motor capacity to T1-02 and the motor rated current to T1-04, this parameter will automatically display the no-load current for a standard 4 pole Yaskawa motor. Enter the no-load current as indicated on the motor test report.
T1-10	Motor Rated Slip (Stationary Auto-Tuning)	Sets the motor rated slip. After setting the motor capacity to T1-02, this parameter will automatically display the motor slip for a standard 4 pole Yaskawa motor. Enter the motor slip as indicated on the motor test report.
T1-11	Motor Iron Loss	Sets the iron loss for determining the Energy Saving coefficient. The value is set to E2-10 (motor iron loss) set when the power is cycled. If T1-02 is changed, a default value appropriate for the motor capacity that was entered will appear.

Monitor	Description
U1-01	Frequency Reference (Hz)
U1-02	Output Frequency (Hz)
U1-03	Output Current (A)
U1-05	Motor Speed (Hz)
U1-06	Output Voltage Reference (Vac)
U1-07	DC Bus Voltage (Vdc)
U1-08	Output Power (kW)
U1-09	Torque Reference (% of motor rated torque)
U1-10	Displays the input terminal status. 
U1-11	Displays the output terminal status. 
U1-12	Verifies the drive operation status. 
U1-13	Terminal A1 Input Level
U1-14	Terminal A2 Input Level
U1-15	Terminal A3 Input Level
U1-16	Output Frequency after Soft Starter
U1-18	oPE Fault Parameter
U1-24	Input Pulse Monitor
Fault Trace	
U2-01	Current Fault
U2-02	Previous Fault
U2-03	Frequency Reference at Previous Fault
U2-04	Output Frequency at Previous Fault

Monitor	Description
U2-05	Output Current at Previous Fault
U2-06	Motor Speed at Previous Fault
U2-07	Output Voltage at Previous Fault
U2-08	DC Bus Voltage at Previous Fault
U2-09	Output Power at Previous Fault
U2-10	Torque Reference at Previous Fault
U2-11	Input Terminal Status at Previous Fault
U2-12	Output Terminal Status at Previous Fault
U2-13	Drive Operation Status at Previous Fault
U2-14	Cumulative Operation Time at Previous Fault
U2-15	Soft Starter Speed Reference at Previous Fault
U2-16	Motor q-Axis Current at Previous Fault
U2-17	Motor d-Axis Current at Previous Fault
U2-20	Heatsink Temperature at Previous Fault
Fault History	
U3-01 to U3-04	First to 4th Most Recent Fault
U3-05 to U3-10	5th to 10th Most Recent Fault
U3-11 to U3-14	Cumulative Operation Time at 1st to 4th Most Recent Fault
U3-15 to U3-20	Cumulative Operation Time at 5th to 10th Most Recent Fault
NOTE: The following faults are not recorded in the error log. CPF00 to 03, Uv1, and Uv2	

DI/DO Sel.	Description
Digital Input Function Selections	
3	Multi-step speed reference 1
4	Multi-step speed reference 2
5	Multi-step speed reference 3
6	Jog reference selection (higher priority than multi-step speed reference)
7	Accel/decel time selection 1
F	Through mode (Set when a terminal is not used)
14	Fault reset (Reset when turned ON)
20 to 2F	External fault; Input mode: N.O. contact / N.C. contact, Detection mode: Normal/during operation
Digital Output Function Selections	
0	During Run (ON: run command is ON or voltage is being output)
1	Zero Speed
2	Speed Agree 1
6	Drive Ready
E	Fault
F	Through mode
10	Minor fault (Alarm) (ON: Alarm displayed)

7 Troubleshooting

◆ General Fault and Alarms

Faults and alarms indicate problems in the drive or in the machine.

An alarm is indicated by a code on the data display and the flashing ALM LED. The drive output is not necessarily switched off.

A fault is indicated by a code on the data display and the ALM LED is on. The drive output is always switched off immediately and the motor coast to stop.

To remove an alarm or reset a fault, trace the cause, remove it and reset the drive by pushing the Reset key on the operator or cycling the power supply.

This lists up the most important alarms and faults only. Please refer to the Technical Manual for a complete list.

Digital Operator	AL	FLT	Cause	Corrective Action
Base Block bb	❍		The software base block function is assigned to one of the digital inputs and the input is off. The drive does not accept Run commands.	• Check the digital inputs function selection. • Check the upper controller sequence.
Control Fault CF		❍	The torque limit was reached during deceleration for longer than 3 s. when in Open Loop Vector control • The load inertia is too big. • The torque limit is too low. • The motor parameters are wrong.	• Check the load. • Set the torque limit to the most appropriate setting (L7-01 through L7-04). • Check the motor parameters.
Control Circuit Fault CPF02 to CPF24		❍	There is a problem in the drive's control circuit.	• Cycle the drive power supply. • Initialize the drive. • Replace the drive if the fault occurs again.
Control Circuit Fault CPF25		❍	There is no terminal board connected to the control board.	• Check if the terminal board is installed properly. • Uninstall and Reapply the terminal board. • Change the drive.
Cannot Reset CrST	❍		Fault reset was input when a Run command was active.	Turn off the Run command and reset the drive.
Option External Fault EF0	❍	❍	An external fault was tripped by the upper controller via an option card.	• Remove the fault cause, reset the fault and restart the drive. • Check the upper controller program.
External Fault EF	❍		A forward and reverse command were input simultaneously for longer than 500 ms. This alarm stops a running motor.	• Check the sequence and make sure that the forward and reverse input are not set at the same time.
External Faults EF1 to EF8	❍	❍	• An external fault was triggered by an external device via one of the digital inputs S1 to S8. • The digital inputs are set up incorrectly.	• Find out why the device tripped the EF. Remove the cause and reset the fault. • Check the functions assigned to the digital inputs.
Ground Fault GF		❍	• Ground leakage current has exceeded 50% of the drives rated output current. • Cable or motor insulation is broken. • Excessive stray capacitance at drive output.	• Check the output wiring and the motor for short circuits or broken insulation. Replace any broken parts. • Reduce the carrier frequency.
Safe Disable Hbb	❍		Both Safe Disable inputs are open. The drive output is safely disabled and the motor can not be started.	• Check why the upper controller's safety device disabled the drive. Remove the cause and restart. • Check the wiring. • If the Safe Disable function is not utilized for the ISO13849-1, Category 3 PLd, and IEC61508, SIL2 or for disabling the drive, the terminals HC, H1, H2 must be linked.
Safe Disable Fault HbbF	❍		Drive output is disabled while only one of the Safe Disable inputs is open. (normally both input signals H1 and H2 should be open) • One channel is internally broken and does not switch off, even if the external signal is removed. • Only one channel is switched off by the upper controller.	• Check the wiring from the upper controller and make sure that both signals are set correctly by the controller. • If the signals are set correctly and the alarm does not disappear, replace the drive.

Digital Operator	AL	FLT	Cause	Corrective Action
Output Phase Loss PF		❍	Output cable is disconnected or the motor winding is damaged. Loose wires at the drive output. Motor is too small (less than 5% of drive current).	• Check the motor wiring. • Make sure all terminal screws in the drive and motor are properly tightened. • Check the motor and drive capacity.
Overcurrent oC		❍	Short circuit or ground fault on the drive output side The load is too heavy. The accel./decel. times are too short. Wrong motor data or V/f pattern settings. A magnetic contactor was switched at the output.	• Check the output wiring and the motor for short circuits or broken insulation. Replace the broken parts. • Check the machine for damages (gears, etc.) and repair any broken parts. • Check the drive parameter settings. • Check the output contactor sequence.
Heatsink Overheat oH or oH1	❍	❍	Surrounding temperature is too high. The cooling fan has stopped. The heatsink is dirty. The airflow to the heatsink is restricted.	• Check the surrounding temperature and install cooling devices if necessary. • Check the drive cooling fan. • Clean the heatsink. • Check the airflow around the heatsink.
Motor Overload oL1		❍	The motor load is too heavy. The motor is operated at low speed with heavy load. Cycle times of accel./ decel. are too short. Incorrect motor rated current has been set.	• Reduce the motor load. • Use a motor with external cooling and set the correct motor in parameter L1-01 • Check the sequence. • Check the rated current setting.
Drive Overload oL2		❍	The load is too heavy. The drive capacity is too small. Too much torque at low speed.	• Check the load. • Make sure that the drive is big enough to handle the load. • The overload capability is reduced at low speeds. Reduce the load or increase the drive size.
DC Overvoltage ov	❍	❍	DC bus voltage rose too high. The deceleration time is too short. Stall prevention is disabled. Braking chopper / resistor broken. Unstable motor control in OLV. Too high input voltage.	• Increase the deceleration time. • Enable stall prevention by parameter L3-04. • Make sure the braking resistor and braking chopper are working correctly. • Check motor parameter settings and adjust torque and slip compensation as needed. • Make sure that the power supply voltage meets the drives specifications.
Input Phase Loss LF		❍	Input voltage drop or phase imbalance. One of the input phase is lost. Loose wires at the drive input.	• Check the power supply. • Make sure that all cables are properly fixed to the correct terminals.
Braking Transistor Fault rr		❍	The internal braking transistor is broken.	• Cycle the power supply. • Replace the drive if the fault reoccurs.
Thermistor Disconnect THo	❍	❍	The motor thermistor is not connected properly.	Check the wiring for the thermistor.
DC Undervoltage Uv1	❍	❍	The voltage in the DC bus fell below the undervoltage detection level (L2-05). The power supply failed or one input phase has been lost. The power supply is too weak.	• Check the power supply. • Make sure, that the power supply is strong enough.
Controller Undervoltage Uv2		❍	The drives controller power supply voltage is too low.	• Cycle power to the drive. Check if the fault reoccurs. • Replace the drive if the fault continues to occur.
DC Charge Circuit Fault Uv3		❍	The charge circuit for the DC bus is broken.	• Cycle power to the drive. Check if the fault reoccurs. • Replace the drive if the fault reoccurs.

◆ Operator Programing Errors

An Operator Programming Error (oPE) occurs when an inapplicable parameter is set or an individual parameter setting is inappropriate. When an oPE error is displayed, press the ENTER button to display U1-18 (oPE fault constant). This monitor will display the parameter that is causing the oPE error.

Digital Operator	Cause	Corrective Action
oPE01	Drive capacity and value set to o2-04 do not match.	Correct the value set to o2-04.
oPE02	Parameters were set outside the allowable setting range.	Set parameters to the proper values.
oPE03	A contradictory setting is assigned to multi-function contact inputs H1-01 through to H1-08. • The same function is assigned to two inputs. (this excludes "External fault" and "Not used") • Input functions which require the setting of other input functions were set alone. • Input functions that are not allowed to be used simultaneously have been set.	• Fix any incorrect settings. • Refer to the Technical Manual for more details.
oPE05	• The run command source (b1-02) or frequency reference source (b1-01) is set to 3 but no option card is installed. • The frequency reference source is set to pulse input but H6-01 is not 0.	• Install the required option card. • Correct the values set to b1-01 and b1-02.
oPE07	Settings to multi-function analog inputs H3-02 and H3-10 and PID functions conflict. • H3-02 and H3-10 are set to the same value. (this excludes settings 0 and F) • PID functions have been assigned to both analog inputs and the pulse input at the same time.	• Fix any incorrect setting. • Refer to the Technical Manual for more details.
oPE08	A function has been set that cannot be used in the control mode selected.(might appear after control mode change)	• Fix any incorrect setting. • Refer to the Technical Manual for more details.
oPE10	The V/f pattern setting is incorrect.	• Check the V/f pattern settings. • Refer to the Technical Manual for more details.
oPE18	One of the following setting errors has occurred while Online Tuning is enabled in OLV (A1-02 = 2): • E2-02 has been set below 30% of the original default value • E2-06 has been set below 50% of the original default value • E2-03 = 0	Make sure E2-02, E2-03, and E2-06 are set the correct values.

◆ Auto-Tuning Errors

Digital Operator	Cause	Corrective Action
Er-01	Motor data fault The input motor data are not valid. (e.g. the base frequency and base speed do not fit).	Re-enter the data and repeat Auto-Tuning.
Er-02	Minor Fault • The wiring is faulty. • The load is too heavy.	• Check the wiring. • Check the load. Always perform Auto-Tuning with the load decoupled from the motor.
Er-03	The STOP button was pressed and Auto-Tuning was canceled.	Repeat the Auto-Tuning.
Er-04	Resistance fault • Wrong input data. • Auto tuning exceeded the given time frame. • Calculated values out of range.	• Check the input data. • Check the wiring. • Re-enter the data and repeat the Auto-Tuning.
Er-05	No-Load Current Error • Incorrect data was entered. • Auto tuning took too long. • Calculated values out of range.	
Er-08	Rated Slip Error • Wrong data input. • Auto tuning exceeded the given time frame. • Calculated values out of range.	

Digital Operator	Cause	Corrective Action
Er-09	Acceleration error The motor did not accelerate for the specified acceleration time.	• Increase the acceleration time C1-01. • Check the torque limits L7-01 and L7-02.
Er-11	Motor speed fault. The torque reference was too high.	• Increase the acceleration time (C1-01). • If possible, disconnect the load.
Er-12	Current detection error • One or all output phases are lost. • Current is either too low or exceeds the drives rating. • The current sensors are faulty.	• Check the wiring. • Make sure, that the drive rating fits to the motor. • Check the load. (Auto-Tuning should have been performed without the load connected.) • Replace the drive.
Er-13	Leakage Inductance Error Drive was unable to complete tuning for leakage inductance within 300 s.	• Check all wiring and correct any mistakes. • Double check the motor rated current value that was entered to T1-04 for Auto-Tuning. • Check the motor rated current value written on the motor nameplate and enter the correct value.
End1	Excessive V/f Setting • The torque reference exceeded 20% during Auto-Tuning. • The calculated no-load current is above 80% of the motor rated current.	• Check the V/f pattern setting. • Perform Auto-Tuning without the load connected. • Check the input data and repeat Auto-Tuning.
End2	Motor iron-core saturation alarm • Calculated core saturation values out of range. • Incorrect data was entered.	• Check the input data. • Check the motor wiring. • Perform Auto-Tuning without load connected.
End3	Rated current alarm	Check the input data and repeat tuning.
End4	Adjusted Slip Calculation Error The slip that was calculated is outside the allowable range.	• Make sure the data entered for Auto-Tuning is correct. • Execute Rotational Auto-Tuning instead. If not possible, try Stationary Auto-Tuning 2.
End5	Resistance Tuning Error The resistance value that was calculated is outside the allowable range.	• Double check the data that was entered for the Auto-Tuning process. • Check the motor and motor cable connection for faults.
End6	Leakage Inductance Alarm The leakage inductance value that was calculated is outside the allowable range.	Double check the data that was entered for the Auto-Tuning process.
End7	No-Load Current Alarm • The entered no-load current value was outside the allowable range. • Auto-Tuning results were less than 5% of the motor rated current.	• Check and correct faulty motor wiring. • Double check the data that was entered for the Auto-Tuning process.

8 Safe Disable Input Function

◆ Specifications

Inputs / Outputs		Two Safe Disable inputs and one EDM output according to ISO13849-1 Cat. 3 PLd, IEC61508 SIL2.
Operation Time		Time from input open to drive output stop is less than 1 ms.
Failure Probability	**Demand Rate Low**	PFD = $5.15E^{-5}$
	Demand Rate High or Continuous	PFH = $1.2E^{-9}$
Performance Level		The Safe Disable feature satisfies all requirements of performance level d (PLd) as defined by ISO13849-1 (this includes DC from EDM).

◆ Precautions

DANGER! *Improper use of the Safe Disable function can result in serious injury or even death. Make sure the whole system or machinery that the Safe Disable function is used in complies with safety requirements. When implementing the Safe Disable function into the safety system of a machine, a thorough risk assessment for the whole system has to be carried out to assure it complies with relevant safety norms (e.g., EN954/ISO13849, IEC61508, EN/IEC62061,...).*

DANGER! *When using a PM motor, even if the drive output is shut off by the Safe Disable function, a break down of two output transistors can cause current to flow through the motor winding, resulting in a rotor movement for a maximum angle of 180 degree (electrically). Make sure such a situation would have no effect on the safety of the application when using the Safe Disable function. This is not a concern with induction motors.*

DANGER! *The Safe Disable function can switch off the drive output, but does not cut the drive power supply and cannot electrically isolate the drive output from the input. Always shut off the drive power supply when performing maintenance or installations on the drive input side as well as the drive output side.*

DANGER! *When using the Safe Disable inputs, make sure to remove the wire links between terminals H1, H2, and HC that were installed prior to shipment. Failing to do so will keep the Safe Disable circuit from operating properly and can cause injury or even death.*

DANGER! *All safety features (including Safe Disable) should be inspected daily and periodically. If the system is not operating normally, there is a risk of serious personal injury.*

DANGER! *Only a qualified technician with a thorough understanding of the drive, the instruction manual, and safety standards should be permitted to wire, inspect, and maintain the Safe Disable input.*

NOTICE: *From the moment terminal inputs H1 and H2 have opened, it takes up to 1 ms for drive output to shut off completely. The sequence set up to trigger terminals H1 and H2 should make sure that both terminals remain open for at least 1 ms in order to properly interrupt drive output.*

NOTICE: *The Safe Disable Monitor (output terminals DM+ and DM-) should not be used for any other purpose than to monitor the Safe Disable status or to discover a malfunction in the Safe Disable inputs. The monitor output is not considered a safe output.*

NOTICE: *When utilizing the Safe Disable function, use only the EMC filters recommended in* ***EMC Filter Installation on page 14***.

◆ Using the Safe Disable Function

The Safe Disable inputs provide a stop function in compliance with “Safe Torque Off” as defined in the IEC61800-5-2. Safe Disable inputs have been designed to meet the requirements of the ISO13849-1, Category 3 PLd, and IEC61508, SIL2.

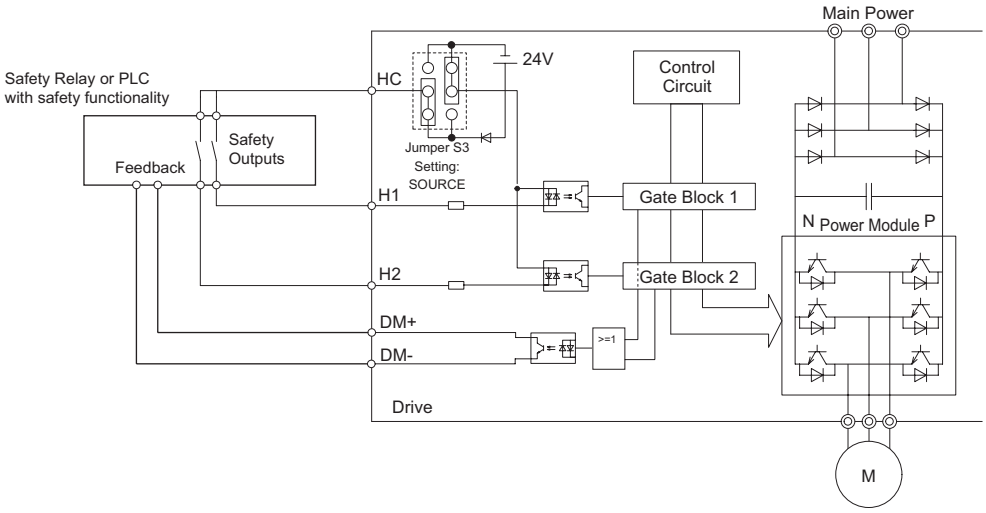
A Safe Disable Status Monitor for error detection in the safety circuit is also provided.

■ Safe Disable Circuit

The Safe Disable circuit consists of two independent input channels that can block the output transistors. In addition, it provides a monitoring channel that indicates the status of those two input channels.

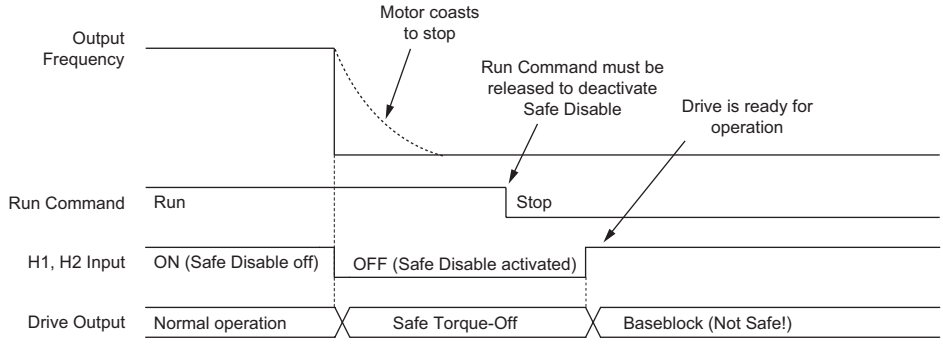
The input can either use the drive internal power supply or an external power supply. Use jumper S3 on the terminal board to select between Sink or Source mode with either internal or external power supply.

A single photocoupler output is available to monitor the status of the Safe Disable terminals. ***Refer to Control Circuit Terminal Functions on page 17*** for signal specifications when using this output.



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

The diagram below illustrates the Safe Disable input operation.



Entering the "Safe Torque Off" State

Whenever either one Safe Disable input or both inputs open, the motor torque is shut off by switching off the drive output. If the motor was running before the Safe Disable inputs opened, then the motor will coast to stop, regardless of the stopping method set in parameter b1-03.

Notice that the "Safe Torque Off" state can only be achieved using the Safe Disable function. Removing the Run command stops the drive and shuts the output off (baseblock), but does not create a "Safe Torque Off" status.

Note: To avoid an uncontrolled stop during normal operation, make sure that the Safe Disable inputs are opened first when the motor has completely stopped.

Returning to Normal Operation after Safe Disable

The Safe Disable function can only be deactivated when a Run command is not active.

When Safe Disable was activated during stop, normal operation can be resumed by simply turning on both Safe Disable inputs (i.e., by deactivating "Safe Torque Off").

When Safe Disable was activated during run, first the Run command has to be removed and then the Safe Disable inputs have to be turned on before the drive can be restarted.

■ Safe Disable Monitor Output Function and Digital Operator Display

The table below explains the drive output and Safe Disable monitor state depending on the Safe Disable inputs.

Safe Disable Input Status		Safe Disable Status Monitor, DM+ - DM-	Drive Output Status	Digital Operator Display
Input 1, H1-HC	Input 2, H2-HC			
OFF	**OFF**	OFF	Safely disabled, "Safe Torque Off"	Hbb (flashes)
ON	**OFF**	ON	Safely disabled, "Safe Torque Off"	HbbF (flashes)

Safe Disable Input Status		Safe Disable Status Monitor, DM+ - DM-	Drive Output Status	Digital Operator Display
Input 1, H1-HC	Input 2, H2-HC			
OFF	**ON**	ON	Safely disabled, “Safe Torque Off”	HbbF (flashes)
ON	**ON**	ON	Baseblock, ready for operation	Normal display

Safe Disable Status Monitor

With the Safe Disable monitor output (terminals DM+ and DM-), the drive provides a safety status feedback signal. This signal should be read by the device that controls the Safe Disable inputs (PLC or a safety relay) in order to prohibit leaving the “Safe Torque Off” status in case the safety circuit malfunctions. Refer to the instruction manual of the safety device for details on this function.

Digital Operator Display

When both Safe Disable inputs are open, Hbb will flash in the digital operator display.

Should only one of the Safe Disable channels be on while the other is off, HbbF will flash in the display to indicate that there is a problem in the safety circuit or in the drive. This display should not appear under normal conditions if the Safe Disable circuit is utilized properly. ***Refer to General Fault and Alarms on page 31*** to resolve possible errors.

9 UL Standards

◆ UL Standards Compliance

The UL/cUL mark applies to products in the United States and Canada. It indicates that UL has performed product testing and evaluation, and determined that their stringent standards for product safety have been met. For a product to receive UL certification, all components inside that product must also receive UL certification.

UL/cUL Mark

This drive is tested in accordance with UL standard UL508C and complies with UL requirements. The conditions described below must be met to maintain compliance when using this drive in combination with other equipment:

Note: Model CIMR-A☐4A1200 is UL compliant when the air entering the drive-installed panel or cabinet is 45°C or less. For more information, contact your nearest Yaskawa representative or our sales office.

■ Installation Area

Do not install the drive to an area greater than pollution degree 2 (UL standard).

■ Main Circuit Terminal Wiring

Yaskawa recommends using closed-loop crimp terminals on all drive models. UL/cUL approval requires the use of closed-loop crimp terminals when wiring the drive main circuit terminals on models CIMR-A☐2A0110 to 2A0415 and 4A0058 to 4A1200. Use only the tools recommended by the terminal manufacturer for crimping.

The wire gauges listed in the tables below are Yaskawa recommendations. Refer to local codes for proper wire gauge selections.

Note: The mark ⏚ indicates the terminals for protective ground connection. (as defined in IEC60417-5019)
Grounding impedance;
200 V: 100 Ω or less
400 V: 10 Ω or less

Model CIMR-A☐	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N⋅m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
2A0004 2A0006 2A0010	R/L1, S/L2, T/L3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5		
	–, +1, +2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	B1, B2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	⏚	2.5	2.5 to 6	10	14 to 10	2	2 to 5.5		
2A0012	R/L1, S/L2, T/L3	2.5	2.5 to 6	12	14 to 10	2	2 to 5.5	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5		
	–, +1, +2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	B1, B2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	⏚	2.5	2.5 to 6	10	14 to 10	3.5	2 to 5.5		
2A0021	R/L1, S/L2, T/L3	4	2.5 to 6	10	12 to 10	5.5	3.5 to 5.5	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 6	10	12 to 10	3.5	3.5 to 5.5		
	–, +1, +2	–	4 to 6	–	12 to 10	5.5	3.5 to 5.5		
	B1, B2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	⏚	4	4 to 6	10	12 to 10	3.5	3.5 to 5.5		

Model CIMR-A□	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N⍰m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
2A0030	R/L1, S/L2, T/L3	6	4 to 16	8	10 to 6	14	5.5 to 14	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	6	4 to 16	8	10 to 6	8	5.5 to 14		
	–, +1, +2	–	6 to 16	–	10 to 6	14	5.5 to 14		
	B1, B2	–	4 to 6	–	14 to 10	3.5	2 to 5.5		
	⏚	6	6 to 10	8	10 to 8	5.5	5.5 to 8	M5	2 to 2.5 (17.7 to 22.1)
2A0040	R/L1, S/L2, T/L3	10	6 to 16	6	8 to 6	14	14	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	10	6 to 16	8	8 to 6	14	8 to 14		
	–, +1, +2	–	16	–	6	14	14		
	B1, B2	–	4 to 6	–	12 to 10	5.5	3.5 to 5.5		
	⏚	10	6 to 10	8	10 to 8	5.5	5.5 to 8	M5	2 to 2.5 (17.7 to 22.1)
2A0056	R/L1, S/L2, T/L3	16	16 to 25	4	6 to 4	22	14 to 22	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	16	16 to 25	4	6 to 4	14	14 to 22		
	–, +1, +2	–	16 to 25	–	6 to 4	22	14 to 22		
	B1, B2	–	6 to 10	–	10 to 6	14	5.5 to 14	M5	2 to 2.5 (17.7 to 22.1)
	⏚	16	10 to 16	6	8 to 6	8	8 to 14	M6	4 to 6 (35.4 to 53.1)
2A0069	R/L1, S/L2, T/L3	25	16 to 25	3	4 to 3	30	22 to 30	M8	9 to11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	16	16 to 25	3	4 to 3	22	14 to 30		
	–, +1, +2	–	25	–	4 to 3	30	22 to 30		
	B1, B2	–	10 to 16	–	8 to 6	14	8 to 14	M5	2 to 2.5 (17.7 to 22.1)
	⏚	16	16 to 25	6	6 to 4	8	8 to 22	M6	4 to 6 (35.4 to 53.1)
2A0081	R/L1, S/L2, T/L3	35	25 to 35	2	3 to 2	38	30 to 38	M8	9 to11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	25	25 to 35	2	3 to 2	30	22 to 38		
	–, +1, +2	–	25 to 35	–	3 to 2	38	30 to 38		
	B1, B2	–	16	–	6	14	14	M5	2 to 2.5 (17.7 to 22.1)
	⏚	16	16 to 25	6	6 to 4	14	14 to 22	M6	4 to 6 (35.4 to 53.1)
2A0110 <4>	R/L1, S/L2, T/L3	35	25 to 50	1/0	3 to 1/0	38	30 to 50	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	35	25 to 50	1/0	3 to 1/0	38	30 to 50		
	–, +1	–	35 to 50	–	2 to 1/0	60	38 to 60		
	B1, B2	–	16 to 50	–	6 to 1/0	22	14 to 50		
	⏚	16	16 to 25	6	6 to 4	14	14 to 38		
2A0138 <4>	R/L1, S/L2, T/L3	50	35 to 70	2/0	1 to 2/0	60	50 to 60	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	50	35 to 70	2/0	1 to 2/0	60	50 to 60		
	–, +1	–	50 to 70	–	1/0 to 3/0	80	60 to 80		
	B1, B2	–	25 to 70	–	4 to 2/0	30	22 to 60		
	⏚	25	25	4	4	22	22 to 38	M8	9 to 11 (79.7 to 97.4)

Model CIMR-A☐	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N⩙m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
2A0169 <4>	R/L1, S/L2, T/L3	70	50 to 95	4/0	2/0 to 4/0	80	60 to 100	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	70	50 to 95	4/0	3/0 to 4/0	80	60 to 100		
	–, +1	–	35 to 95	–	1 to 4/0	50 × 2P	50 to 100		
	+3	–	50 to 95	–	1/0 to 4/0	60	50 to 100		
	⏚	35	25 to 35	4	4 to 2	22	22 to 60		9 to 11 (79.7 to 97.4)
2A0211 <4>	R/L1, S/L2, T/L3	95	70 to 95	1/0 × 2P	1/0 to 2/0	100	80 to 100	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	95	70 to 95	1/0 × 2P	1/0 to 2/0	50 × 2P	50 to 60		
	–, +1	–	35 to 95	–	1 to 4/0	50 × 2P	50 to 100		
	+3	–	50 to 95	–	1/0 to 4/0	80	60 to 100		
	⏚	50	25 to 50	4	4 to 1/0	22	22 to 60		9 to 11 (79.7 to 97.4)
2A0250 <4>	R/L1, S/L2, T/L3	95 × 2P	95 to 150	3/0 × 2P	3/0 to 300	80 × 2P	38 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	95 × 2P	95 to 150	3/0 × 2P	3/0 to 300	80 × 2P	38 to 150		
	–, +1	–	70 to 150	–	3/0 to 300	80 × 2P	80 to 150		
	+3	–	35 to 150	–	2 to 300	80 × 2P	30 to 150	M10	18 to 23 (159 to 204)
	⏚	95	95 to 150	3	3 to 300	22	22 to 150	M12	32 to 40 (283 to 354)
2A0312 <4>	R/L1, S/L2, T/L3	95 × 2P	95 to 150	4/0 × 2P	3/0 to 300	80 × 2P	70 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	95 × 2P	95 to 150	3/0 × 2P	3/0 to 300	80 × 2P	70 to 200		
	–, +1	–	70 to 150	–	3/0 to 300	150 × 2P	80 to 150		
	+3	–	70 to 150	–	3/0 to 300	80 × 2P	80 to 150	M10	18 to 23 (159 to 204)
	⏚	95	95 to 150	2	2 to 300	38	38 to 150	M12	32 to 40 (283 to 354)
2A0360 <4>	R/L1, S/L2, T/L3	240	95 to 300	250 × 2P	4/0 to 600	100 × 2P	80 to 325	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	240	95 to 300	4/0 × 2P	4/0 to 600	100 × 2P	80 to 325		
	–, +1	–	125 to 300	–	250 to 600	150 × 2P	125 to 325		
	+3	–	70 to 300	–	3/0 to 600	80 × 2P	80 to 325	M10	18 to 23 (159 to 204)
	⏚	120	120 to 240	1	1 to 350	38	38 to 200	M12	32 to 40 (283 to 354)
2A0415 <4>	R/L1, S/L2, T/L3	120 × 2P	95 to 300	350 × 2P	250 to 600	125 × 2P	100 to 325	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	300	95 to 300	300 × 2P	300 to 600	125 × 2P	125 to 325		
	–, +1	–	150 to 300	–	300 to 600	200 × 2P	150 to 325		
	+3	–	70 to 300	–	3/0 to 600	100 × 2P	80 to 325	M10	18 to 23 (159 to 204)
	⏚	120	120 to 240	1	1 to 350	60	60 to 200	M12	32 to 40 (283 to 354)

<1> Gauges listed here are for use in Europe and China.
<2> Gauges listed here are for use in the United States.
<3> Gauges listed here are for use in Asia except for China.
<4> Drive models CIMR-A☐2A0110 to 4A0415 require the use of closed-loop crimp terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

Note: Use crimp insulated terminals or insulated tubing for wiring these connections. Wires should have a continuous maximum allowable temperature of 75°C 600 V UL approved vinyl sheathed insulation. Ambient temperature should not exceed 40°C.

Model CIMR-A□	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N✍m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
4A0002 4A0004	R/L1, S/L2, T/L3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5		
	–, +1, +2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	B1, B2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	⏚	2.5	2.5 to 4	12	14 to 12	2	2 to 5.5		
4A0005 4A0007 4A0009	R/L1, S/L2, T/L3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5		
	–, +1, +2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	B1, B2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	⏚	2.5	2.5 to 6	10	14 to 10	3.5	2 to 5.5		
4A0011	R/L1, S/L2, T/L3	2.5	2.5 to 6	12	14 to 10	2	2 to 5.5	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 6	14	14 to 10	2	2 to 5.5		
	–, +1, +2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	B1, B2	–	2.5 to 6	–	14 to 10	2	2 to 5.5		
	⏚	2.5	2.5 to 6	10	14 to 10	3.5	2 to 5.5		
4A0018	R/L1, S/L2, T/L3	2.5	2.5 to 16	10	12 to 6	3.5	2 to 14	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	2.5	2.5 to 16	10	12 to 6	3.5	2 to 14		
	–, +1, +2	–	4 to 16	–	12 to 6	3.5	2 to 14		
	B1, B2	–	4 to 6	–	12 to 10	2	2 to 5.5		
	⏚	2.5	2.5 to 6	10	14 to 10	3.5	2 to 5.5	M5	2 to 2.5 (17.7 to 22.1)
4A0023	R/L1, S/L2, T/L3	4	2.5 to 16	10	10 to 6	5.5	3.5 to 14	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	4	2.5 to 16	10	10 to 6	5.5	3.5 to 14		
	–, +1, +2	–	4 to 16	–	12 to 6	5.5	3.5 to 14		
	B1, B2	–	4 to 6	–	12 to 10	2	2 to 5.5		
	⏚	4	4 to 6	10	12 to 10	3.5	3.5 to 5.5	M5	2 to 2.5 (17.7 to 22.1)
4A0031	R/L1, S/L2, T/L3	6	6 to 16	8	8 to 6	14	5.5 to 14	M5	2 to 2.5 (17.7 to 22.1)
	U/T1, V/T2, W/T3	6	6 to 16	8	10 to 6	8	5.5 to 8		
	–, +1, +2	–	6 to 16	–	10 to 6	14	5.5 to 14		
	B1, B2	–	6 to 10	–	10 to 8	3.5	2 to 8	M5	2 to 2.5 (17.7 to 22.1)
	⏚	6	6 to 10	8	10 to 8	5.5	5.5 to 8	M6	4 to 6 (35.4 to 53.1)
4A0038	R/L1, S/L2, T/L3	10	10 to 16	6	8 to 6	14	14	M5	2 to 2.5 (17.7 to 22.1)
	U/T1, V/T2, W/T3	6	6 to 16	8	8 to 6	14	8 to 14		
	–, +1, +2	–	6 to 16	–	6	14	14		
	B1, B2	–	6 to 10	–	10 to 8	5.5	3.5 to 8	M5	2 to 2.5 (17.7 to 22.1)
	⏚	10	6 to 16	6	10 to 6	8	5.5 to 14	M6	4 to 6 (35.4 to 53.1)

Model CIMR-A☐	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N⩓m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
4A0044	R/L1, S/L2, T/L3	16	16 to 25	6	6 to 4	14	14 to 22	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	16	16 to 25	6	6 to 4	14	14 to 22		
	–, +1, +2	–	16 to 25	–	6 to 4	14	14 to 22		
	B1, B2	–	6 to 10	–	10 to 8	8	5.5 to 8	M5	2 to 2.5 (17.7 to 22.1)
	⏚	16	10 to 16	6	8 to 6	8	8 to 14	M6	4 to 6 (35.4 to 53.1)
4A0058 <4>	R/L1, S/L2, T/L3	16	10 to 16	4	6 to 4	14	14	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	16	10 to 16	4	6 to 4	14	14		
	–, +1	–	16 to 35	–	6 to 1	22	14 to 38		
	B1, B2	–	10 to 16	–	8 to 4	14	8 to 14		
	⏚	16	10 to 16	6	8 to 6	8	8 to 14		
4A0072 <4>	R/L1, S/L2, T/L3	16	16 to 25	3	4 to 3	22	14 to 22	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	25	16 to 25	3	4 to 3	22	14 to 22		
	–, +1	–	25 to 35	–	4 to 1	30	22 to 38		
	B1, B2	–	16 to 25	–	6 to 3	14	14 to 22		
	⏚	16	16 to 25	6	6	14	14 to 22		
4A0088 <4>	R/L1, S/L2, T/L3	25	16 to 50	2	3 to 1/0	30	22 to 60	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	25	25 to 50	2	3 to 1/0	30	22 to 60		
	–, +1	–	25 to 50	–	3 to 1/0	38	30 to 60		
	+3	–	16 to 50	–	6 to 1/0	22	14 to 60		
	⏚	16	16 to 25	4	6 to 4	22	14 to 22		
4A0103 <4>	R/L1, S/L2, T/L3	35	25 to 50	1/0	2 to 1/0	38	30 to 60	M8	9 to 11 (79.7 to 97.4)
	U/T1, V/T2, W/T3	35	25 to 50	1	2 to 1/0	38	30 to 60		
	–, +1	–	25 to 50	–	3 to 1/0	60	30 to 60		
	+3	–	25 to 50	–	4 to 1/0	30	22 to 60		
	⏚	16	16 to 25	4	6 to 4	22	14 to 22		
4A0139 <4>	R/L1, S/L2, T/L3	50	35 to 95	3/0	1/0 to 4/0	60	38 to 100	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	50	35 to 95	2/0	1/0 to 4/0	60	50 to 100		
	–, +1	–	50 to 95	–	1/0 to 4/0	100	60 to 100		
	+3	–	25 to 95	–	3 to 4/0	50	30 to 100		
	⏚	25	25	4	4	22	22		
4A0165 <4>	R/L1, S/L2, T/L3	70	50 to 95	4/0	3/0 to 4/0	80	60 to 100	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	70	70 to 95	4/0	3/0 to 4/0	80	80 to 100		
	–, +1	–	35 to 95	–	1 to 4/0	50 × 2P	50 to 100		
	+3	–	50 to 95	–	1/0 to 4/0	60	50 to 100		
	⏚	35	25 to 35	4	4 to 2	22	22 to 30		
4A0208 <4>	R/L1, S/L2, T/L3	95	35 to 95	300	2 to 300	150	30 to 150	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	95	35 to 95	300	2 to 300	150	30 to 150		
	–, +1	–	35 to 150	–	1 to 250	80 × 2P	38 to 150		
	+3	–	25 to 70	–	3 to 3/0	80	22 to 80		
	⏚	50	50 to 150	4	4 to 300	22	22 to 150		

Model CIMR-A□	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N⍰m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
4A0250 <4>	R/L1, S/L2, T/L3	120	95 to 300	400	1 to 600	150	38 to 325	M10	18 to 23 (159 to 204)
	U/T1, V/T2, W/T3	120	95 to 300	400	1/0 to 600	150	38 to 325		
	–, +1	–	70 to 300	–	3/0 to 600	200	80 to 325		
	+3	–	35 to 300	–	1 to 325	125	38 to 325		
	⏚	70	70 to 240	2	2 to 350	22	22 to 200		
4A0296 <4>	R/L1, S/L2, T/L3	185	95 to 300	500	2/0 to 600	200	80 to 325	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	185	95 to 300	500	2/0 to 600	200	80 to 325		
	–, +1	–	70 to 300	–	3/0 to 600	325	80 to 325		
	+3	–	35 to 300	–	1 to 325	150	38 to 325	M10	18 to 23 (159 to 204)
	⏚	95	95 to 240	2	2 to 350	30	30 to 200	M12	32 to 40 (283 to 354)
4A0362 <4>	R/L1, S/L2, T/L3	240	95 to 300	4/0 × 2P	3/0 to 600	250	80 to 325	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	240	95 to 300	4/0 × 2P	3/0 to 600	250	80 to 325		
	–, +1	–	95 to 300	–	4/0 to 600	325	100 to 325		
	+3	–	70 to 300	–	3/0 to 600	200	80 to 325	M10	18 to 23 (159 to 204)
	⏚	120	120 to 240	1	1 to 350	30	30 to 200	M12	32 to 40 (283 to 354)
4A0414 <4>	R/L1, S/L2, T/L3	95 × 2P	95 to 150	300 × 2P	4/0 to 300	100 × 2P	80 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	95 × 2P	95 to 150	300 × 2P	4/0 to 300	125 × 2P	80 to 150		
	–, +1	–	70 to 150	–	3/0 to 300	150 × 2P	80 to 150		
	+3	–	70 to 150	–	3/0 to 300	80 × 2P	80 to 150		
	⏚	95	35 to 95	1	1 to 3/0	38	38 to 100		
4A0515 <4>	R/L1, S/L2, T/L3	120 × 2P	95 to 150	3/0 × 4P	3/0 to 300	125 × 2P	80 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	150 × 2P	95 to 150	4/0 × 4P	3/0 to 300	150 × 2P	80 to 150		
	–, +1	–	70 to 150	–	1/0 to 300	60 × 4P	60 to 150		
	+3	–	70 to 150	–	1/0 to 300	100 × 2P	60 to 150		
	⏚	150	50 to 150	1/0	1/0 to 300	60	50 to 150		
4A0675 <4>	R/L1, S/L2, T/L3	95 × 4P	95 to 150	300 × 4P	4/0 to 300	80 × 4P	80 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	95 × 4P	95 to 150	300 × 4P	4/0 to 300	80 × 4P	80 to 150		
	–, +1	–	70 to 150	–	1/0 to 300	125 × 4P	60 to 150		
	+3	–	70 to 150	–	1/0 to 300	60 × 4P	60 to 150		
	⏚	95 × 2P	60 to 150	2/0	2/0 to 300	60	70 to 150		
4A0930 <4>	R/L1, S/L2, T/L3, R1/L11, S1/L21, T1/L31	120 × 4P	95 to 150	(4/0 × 4P) × 2	3/0 to 300	150 × 4P	125 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	120 × 4P	95 to 150	(4/0 × 4P) × 2	3/0 to 300	150 × 4P	125 to 150		
	–, +1	–	95 to 150	–	4/0 to 300	(125 × 4P) × 2	100 to 150		
	+3	–	95 to 150	–	4/0 to 300	125 × 4P	100 to 150		
	⏚	120 × 2P	70 to 120	3/0	3/0 to 250	100	80 to 125		

Model CIMR-A☐	Terminal	For Europe and China <1>		For U.S.A <2>		For Asia <3>		Screw Size	Tightening Torque N⩙m (lb.in.)
		Recommended Gauge mm²	Applicable Gauge mm²	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Recommended Gauge mm²	Applicable Gauge mm²		
4A1200 <4>	R/L1, S/L2, T/L3, R1/L11, S1/L21, T1/L31	(95 × 4P) × 2	95 to 150	(300 × 4P) × 2	4/0 to 300	(125 × 4P) × 2	100 to 150	M12	32 to 40 (283 to 354)
	U/T1, V/T2, W/T3	(95 × 4P) × 2	95 to 150	(300 × 4P) × 2	4/0 to 300	(125 × 4P) × 2	100 to 150		
	–, +1	–	120 to 150	–	250 to 300	(150 × 4P) × 2	125 to 150		
	+3	–	95 to 150	–	4/0 to 300	(100 × 4P) × 2	100 to 150		
	⏚	95 × 4P	95 to 120	4/0	4/0 to 250	125	100 to 125		

<1> Gauges listed here are for use in Europe and China.
<2> Gauges listed here are for use in the United States.
<3> Gauges listed here are for use in Asia except for China.
<4> Drive models CIMR-A☐4A0058 to 4A1200 require the use of closed-loop crimp terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

Note: **1.** Model CIMR-A☐4A1200 is UL compliant when the air entering the drive-installed panel or cabinet is 45°C or less. For more information, contact your nearest Yaskawa representative or our sales office.

2. Use crimp insulated terminals or insulated tubing for wiring these connections. Wires should have a continuous maximum allowable temperature of 75°C 600 V UL approved vinyl sheathed insulation. Ambient temperature should not exceed 40°C.

Closed-Loop Crimp Terminal Recommendations

Yaskawa recommends using closed-loop crimp terminals on all drive models. UL approval requires the use of crimp terminals when wiring the drive main circuit terminals on models CIMR-A□2A0110 to 2A0415 and 4A0058 to 4A1200. Use only crimping tools as specified by the crimp terminal manufacturer. Yaskawa recommends crimp terminals made by JST and Tokyo DIP (or equivalent) for the insulation cap.

The table below matches the wire gauges and terminal screw sizes with Yaskawa - recommended crimp terminals, tools, and insulation caps. Refer to the appropriate Wire Gauge and Torque Specifications table for the wire gauge and screw size for your drive model. Place orders with a Yaskawa representatives the Yaskawa sales department.

Wire Gauge	Terminal Screws	Crimp Terminal Model Number	Tool		Insulation Cap Model No.	Code <1>
			Machine No.	Die Jaw		
2 mm² 14 AWG	M4	R2-4	YA-4	AD-900	TP-003	100-054-028
3.5 / 5.5 mm² 12 / 10 AWG	M4	R5.5-4	YA-4	AD-900	TP-005	100-054-029
	M5	R5.5-5	YA-4	AD-900	TP-005	100-054-030
8 mm² 8 AWG	M4	8-4	YA-4	AD-901	TP-008	100-054-031
	M5	R8-5	YA-4	AD-901	TP-008	100-054-032
14 mm² 6 AWG	M4	14-NK4	YA-4	AD-902	TP-014	100-054-033
	M5	R14-5	YA-4	AD-902	TP-014	100-054-034
	M6	R14-6	YA-5	AD-952	TP-014	100-051-261
	M8	R14-8	YA-5	AD-952	TP-014	100-054-035
22 mm² 4 AWG	M6	R22-6	YA-5	AD-953	TP-022	100-051-262
	M8	R22-8	YA-5	AD-953	TP-022	100-051-263
30 / 38 mm² 3 / 2 AWG	M8	R38-8	YA-5	AD-954	TP-038	100-051-264
50 / 60 mm² 1 AWG 1/0 AWG 1/0 AWG × 2P	M8	R60-8	YA-5	AD-955	TP-060	100-051-265
	M10	R60-10	YF-1, YET-300-1	TD-321, TD-311	TP-060	100-051-266
1 AWG × 2P 2 AWG × 2P	M10	38-L10	YF-1, YET-150-1	TD-224, TD-212	TP-038	100-051-556
80 mm² 2/0 / 3/0 AWG 2/0 AWG × 2P	M10	80-10	YF-1, YET-300-1	TD-323, TD-312	TP-080	100-051-267
3/0 AWG × 2P 3/0 AWG × 4P	M10	80-L10	YF-1, YET-150-1	TD-227, TD-214	TP-080	100-051-557
	M12	80-L12	YF-1, YET-300-1	TD-323, TD-312	TP-080	100-051-558
100 mm² 4/0 AWG	M10	R100-10	YF-1, YET-300-1 YF-1, YET-150-1	TD-324, TD-312 TD-228, TD-214	TP-100	100-051-269
4/0 AWG × 2P 4/0 AWG × 4P	M10	100-L10	YF-1, YET-150-1	TD-228, TD-214	TP-100	100-051-559
	M12	100-L12	YF-1, YET-300-1	TD-324, TD-312	TP-100	100-051-560
150 mm² 250 / 300 kcmil	M10	R150-10	YF-1. YET-150-1	TD-229, TD-215	TP-150	100-051-272
	M12	R150-12	YF-1, YET-300-1	TD-325, TD-313	TP-150	100-051-273
250 kcmil × 2P 250 kcmil × 4P 300 kcmil × 2P 300 kcmil × 4P	M10	150-L10	YF-1, YET-150-1	TD-229, TD-215	TP-150	100-051-561
	M12	150-L12	YF-1, YET-300-1	TD-325, TD-313	TP-150	100-051-562
200 mm² 350 kcmil 400 kcmil	M10	200-10	YF-1, YET-300-1	TD-327, TD-314	TP-200	100-051-563
	M12	R200-12	YF-1, YET-300-1	TD-327, TD-314	TP-200	100-051-275
350 kcmil × 2P 400 kcmil × 2P	M12	200-L12	YF-1, YET-300-1	TD-327, TD-314	TP-200	100-051-564
325 mm² 500 kcmil 600 / 650 kcmil 500 kcmil × 2P 600 kcmil × 2P	M10	325-10	YF-1, YET-300-1	TD-328, TD-315	TP-325	100-051-565
	M12	325-12	YF-1, YET-300-1	TD-328, TD-315	TP-325	100-051-277

<1> Codes refer to a set of three crimp terminals and three insulation caps. Prepare input and output wiring using two sets for each connection.
Example 1: Models with 300 kcmil for both input and output require one set for input terminals and one set for output terminals, so the user should order two sets of [100-051-272].
Example 2: Models with 4/0 AWG × 2P for both input and output require two sets for input terminals and two sets for output terminals, so the user should order four sets of [100-051-560].

Input Fuse Installation

The installation manual specifies that branch circuit protection should be provided by fuses listed in the table below.

Model CIMR-A□	Fuse Type	
	Manufacturer: Bussmann	
	Model	Fuse Ampere Rating (A)
Three-Phase 200 V Class		
2A0004	FWH-70B	70
2A0006	FWH-70B	70
2A0010	FWH-70B	70
2A0012	FWH-70B	70
2A0021	FWH-90B	90
2A0030	FWH-100B	100
2A0040	FWH-200B	200
2A0056	FWH-200B	200
2A0069	FWH-200B	200
2A0081	FWH-300A	300
2A0110	FWH-300A	300
2A0138	FWH-350A	350
2A0169	FWH-400A	400
2A0211	FWH-400A	400
2A0250	FWH-600A	600
2A0312	FWH-700A	700
2A0360	FWH-800A	800
2A0415	FWH-1000A	1000
Three-Phase 400 V Class		
4A0002	FWH-40B	40
4A0004	FWH-50B	50
4A0005	FWH-70B	70
4A0007	FWH-70B	70
4A0009	FWH-90B	90
4A0011	FWH-90B	90
4A0018	FWH-80B	80
4A0023	FWH-100B	100
4A0031	FWH-125B	125
4A0038	FWH-200B	200
4A0044	FWH-250A	250
4A0058	FWH-250A	250
4A0072	FWH-250A	250
4A0088	FWH-250A	250
4A0103	FWH-250A	250
4A0139	FWH-350A	350
4A0165	FWH-400A	400
4A0208	FWH-500A	500
4A0250	FWH-600A	600
4A0296	FWH-700A	700
4A0362	FWH-800A	800
4A0414	FWH-800A	800
4A0515	FWH-1000A	1000
4A0675	FWH-1200A	1200
4A0930	FWH-1200A	1200
4A1200	FWH-1600A	1600

Note: Model CIMR-A□4A1200 is UL compliant when the air entering the drive-installed panel or cabinet is 45°C or less. For more information, contact your nearest Yaskawa representative or our sales office.

■ Low Voltage Wiring for Control Circuit Terminals

Wire low voltage wires with NEC Class 1 circuit conductors. Refer to national state or local codes for wiring. Use a class 2 power supply for the control circuit terminal when not using the internal control power supply of the drive. Refer to NEC Article 725 Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power Limited Circuits for requirements concerning class 1 circuit conductors and class 2 power supplies.

Input / Output	Terminal Signal	Power Supply Specifications
Open Collector Outputs	DM+, DM-	Requires class 2 power supply.
Digital inputs	S1-S8, SN, SC, SP, HC, H1, H2	Use the internal LVLC power supply of the drive. Use class 2 for external power supply.
Analog inputs / outputs	+V, -V, A1, A2, A3, AC, AM, FM	Use the internal LVLC power supply of the drive. Use class 2 for external power supply.

■ Drive Short-Circuit Rating

This drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes, 600 Vac maximum (Up to 240 V in 200 V class drives , up to 480 V for 400 V class drives) when protected by Bussmann Type FWH fuses as specified in *Input Fuse Installation on page 46*.

◆ Drive Motor Overload Protection

Set parameter E2-01 (motor rated current) to the appropriate value to enable motor overload protection. The internal motor overload protection is UL listed and in accordance with the NEC and CEC.

■ E2-01 Motor Rated Current

Setting Range: Model Dependent

Default Setting: Model Dependent

Parameter E2-01 (motor rated current) protects the motor if parameter L1-01 is not set to 0 (default is 1, enabling protection for standard induction motors).

If Auto-Tuning has been performed successfully, the motor data entered to T1-04 is automatically written into parameter E2-01. If Auto-Tuning has not been performed, manually enter the correct motor rated current to parameter E2-01.

■ L1-01 Motor Overload Protection Selection

The drive has an electronic overload protection function (oL1) based on time, output current, and output frequency, which protects the motor from overheating. The electronic thermal overload function is UL-recognized, so it does not require an external thermal relay for single motor operation.

This parameter selects the motor overload curve used according to the type of motor applied.

Setting	Description	
0	Disabled	Disabled the drive's internal motor overload protection.
1	Standard fan cooled motor (default)	Selects protection characteristics for a standard self cooled motor with limited cooling capabilities when running below the rated speed. The motor overload detection level (oL1) is automatically reduces when running below the motor rated speed.
2	Drive duty motor with a speed range of 1:10	Selects protection characteristics for a motor with self-cooling capability within a speed range of 10:1. The motor overload detection level (oL1) is automatically reduced when running below 1/10 of the motor rated speed.
3	Vector motor with a speed range of 1:100	Selects protection characteristics for a motor capable of cooling itself at any speed — including zero speed (externally cooled motor). The motor overload detection level (oL1) is constant over the entire speed range.
4	Permanent Magnet motor with variable torque	Selects protection characteristics for a variable torque PM motor. The motor overload detection level (oL1) is automatically reduces when running below the motor rated speed.
5	Permanent Magnet motor with constant torque	Selects protection characteristics for a constant torque PM motor. The motor overload detection level (oL1) is constant over the whole speed range.
6	Standard fan cooled motor (50 Hz)	Selects protection characteristics for a standard self cooled motor with limited cooling capabilities when running below the rated speed. The motor overload detection level (oL1) is automatically reduces when running below the motor rated speed.

When connecting the drive to more than one motor for simultaneous operation, disable the electronic overload protection (L1-01 = 0) and wire each motor with its own motor thermal overload relay.

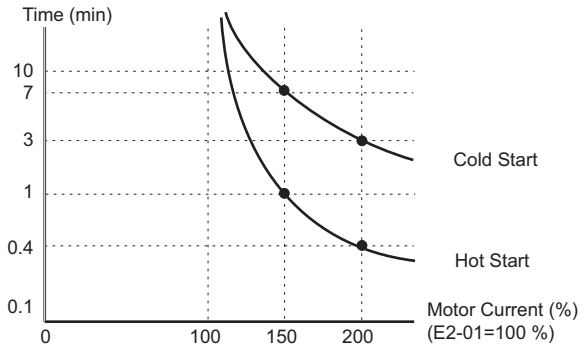
Enable the motor overload protection (L1-01 = 1 to 5) when connecting the drive to a single motor, unless another motor overload preventing device is installed. The drive electronic thermal overload function causes an oL1 fault, which shuts off the output of the drive and prevents additional overheating of the motor. The motor temperature is continually calculated as long as the drive is powered up.

■ L1-02 Motor Overload Protection Time

Setting Range: 0.1 to 5.0 min

Factory Default: 1.0 min

Parameter L1-02 determines how long the motor is allowed to operate before the oL1 fault occurs when the drive is running at 50 Hz and at 150% of the full load amp rating (E2-01) of the motor. Adjusting the value of L1-02 can shift the set of oL1 curves up the y axis of the diagram below, but will not change the shape of the curves.



◆ Precautionary Notes on External Heatsink (IP00 Enclosure)

When using an external heatsink, UL compliance requires that exposed capacitors in the main circuit are covered to prevent injury to surrounding personnel.

The portion of the external heatsink that projects out can either be protected with the enclosure, or with the appropriate capacitor cover after drive installation is complete. Use the table below to match drive models and capacitor cover. Capacitor covers can be ordered from a Yaskawa representative or directly from the Yaskawa sales department. The table below lists available capacitor covers.

Drive Model CIMR-A☐	Code Number	Model	Figure
2A0110	100-061-273	ECAT31875-11	7
2A0138	100-061-274	ECAT31876-11	
2A0169	100-061-275	ECAT31877-11	
2A0211			
2A0250	100-061-277	ECAT31726-11	
2A0312			
2A0360	100-061-278	ECAT31698-11	
2A0415			
4A0058	100-061-273	ECAT31875-11	
4A0072	100-061-274	ECAT31876-11	
4A0088	100-061-276	ECAT31878-11	
4A0103			
4A0139	100-061-275	ECAT31877-11	
4A0165			
4A0208	100-061-277	ECAT31726-11	
4A0250	100-061-278	ECAT31698-11	
4A0296			
4A0362			
4A0414	100-061-279	ECAT31740-11	
4A0515	100-061-280	ECAT31746-11	
4A0675			
4A0930	100-061-281 <1>	ECAT31741-11	8
4A1200			

<1> Requires two sets.

Note: Model CIMR-A☐4A1200 is UL compliant when the air entering the drive-installed panel or cabinet is 45° or less. For more information, contact your nearest Yaskawa representative or our sales office.

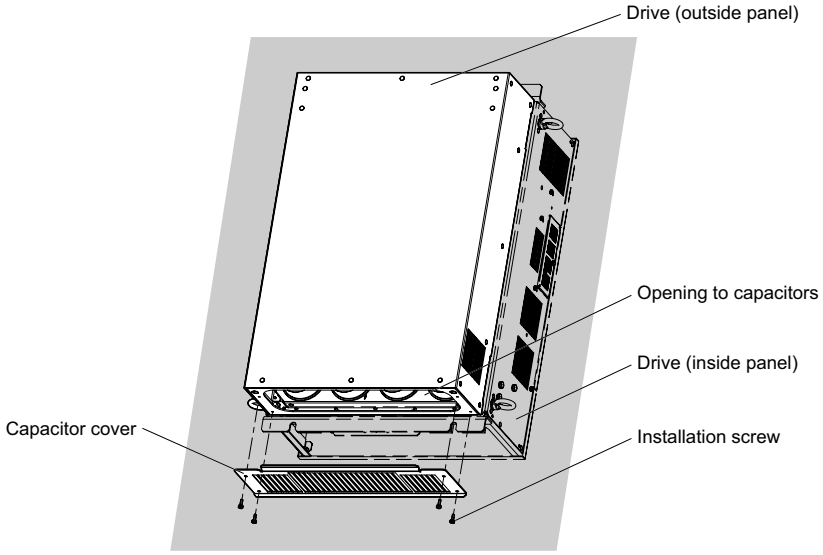


Figure 7

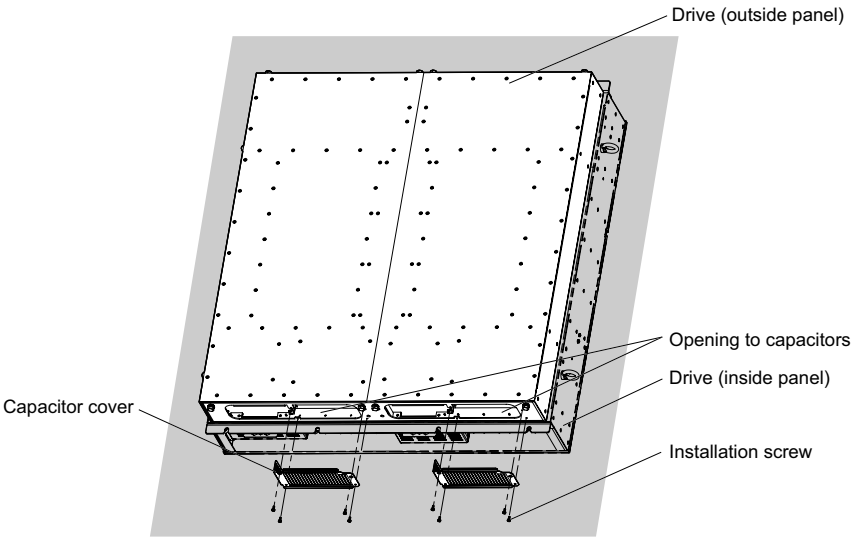
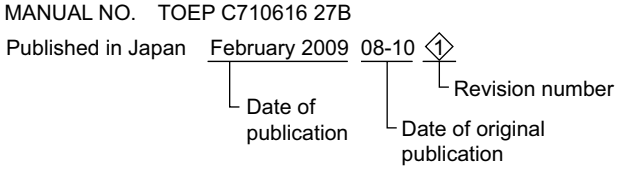

Drive (outside panel)
Opening to capacitors
Drive (inside panel)
Capacitor cover
Installation screw

Figure 8

Revision History

The revision dates and the numbers of the revised manuals appear on the bottom of the back cover.



Date of Publication	Rev. No.	Section	Revised Content
August 2010	◇3	All	Revision: Review and corrected entire documentation
		Chapter 1	Deletion: Descriptions on UL/cUL standards compliance
		Chapter 2 Chapter 3	Addition: Larger drive capacities added along with corresponding data Three-phase 400V: CIMR-AC4A0930 and 1200
		Chapter 8	Revision: Safe Disable Input Function
		Chapter 9	Addition: UL Standards
June 2009	◇2	All	Revision: Review and corrected entire documentation
		Chapter 2 Chapter 3	Addition: Larger drive capacities added along with corresponding data Three-phase 400V: CIMR-AC4A0414 to 0675
February 2009	◇1	All	Revision: Review and corrected entire documentation
		Chapter 2 Chapter 3	Addition: Larger drive capacities added along with corresponding data Three-phase 200V: CIMR-AC2A0250 to 0415 Three-phase 400V: CIMR-AC4A0208 to 0362
October 2008	–	–	First edition

YASKAWA AC Drive A1000

High Performance Vector Control Drive

Quick Start Guide

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YASKAWA

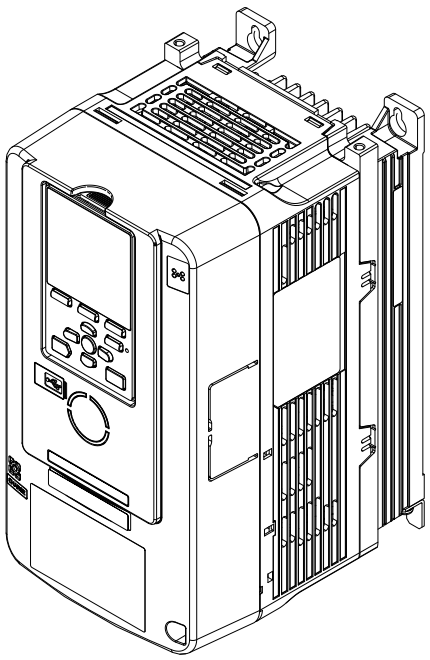
YASKAWA AC Drive GA700

High Performance General Applications Drive

Standards Compliance

Type: CIPR-GA70Cxxxxxxxx
Models: 200 V class: 0.55 to 110 kW
400 V class: 0.55 to 355 kW

To properly use the product, read this manual thoroughly and retain for easy reference, inspection, and maintenance. Ensure the end user receives this manual.



MANUAL NO. TOEP C710617 18B

1 European Standards

Figure 1.1 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 1.1 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	• EN ISO 13849-1/AC:2009 (PL e (Cat.III)) • IEC 62061/A1:2012 (SIL CL 3) • EN 62061/A1:2013 (SIL CL 3) • IEC/EN 61800-5-2:2007 (SIL3)

*1 Approval pending for models 2169 to 2415, 4371 to 4675.

Note:

Indicates that the device or machine containing this product is covered by the CE Mark.

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 which are defined by IEC/EN 60664.

■ Wiring Diagram

Figure 1.2 shows an example of a drive that is wired for compliance with the CE Low Voltage Directive.

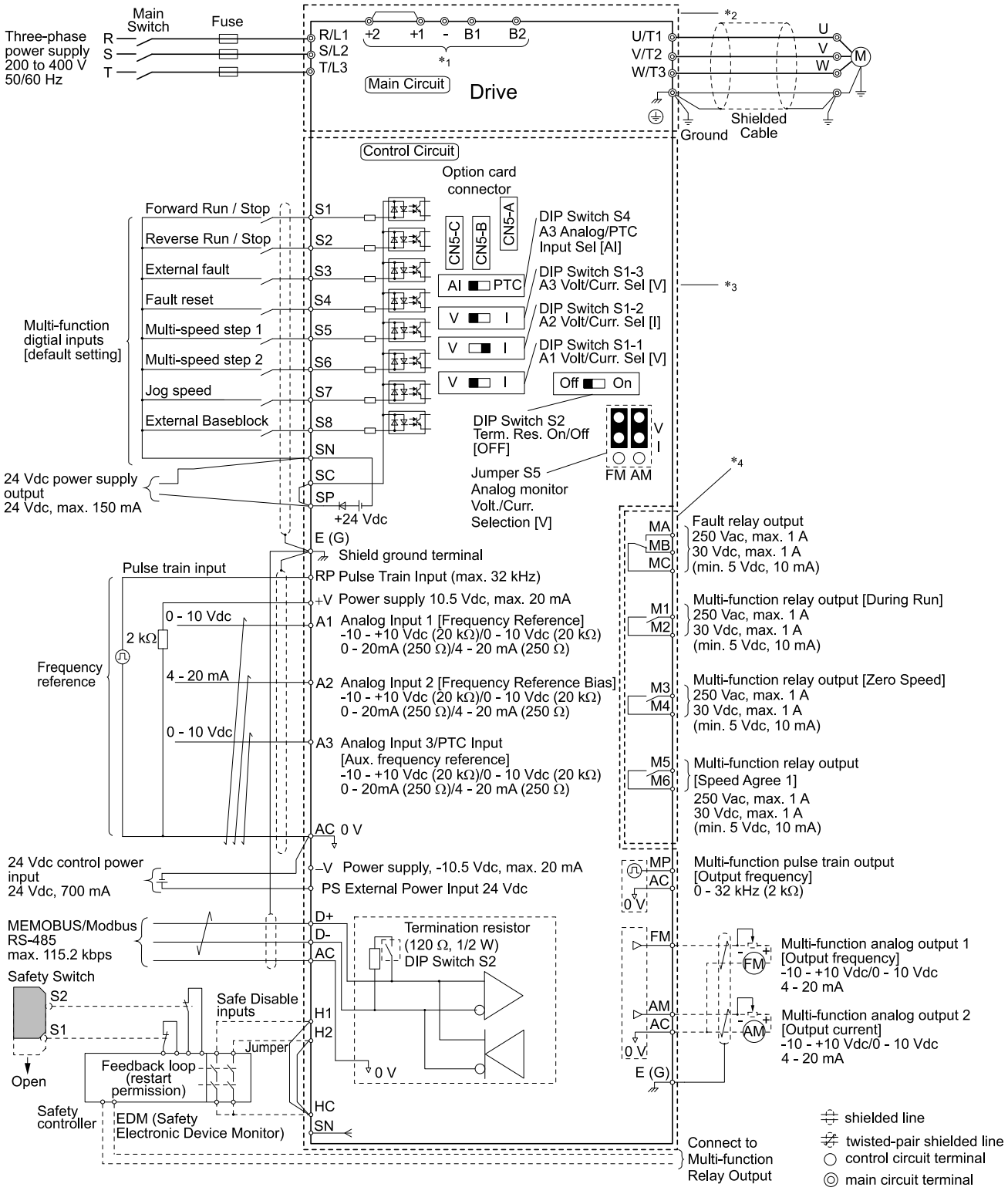


Figure 1.2 Wiring Diagram for Low Voltage Directive Compliance

*1 Use terminals -, +1, +2, B1, and B2 to connect options to the drive. Never connect 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, and therefore the control circuit 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.

■ Main Circuit Wire Gauges and Tightening Torques

Note:

- Wire gauge recommendations 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 (ND) 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.
- When connecting peripheral devices or options to terminals +1,+2, +3, -, B1, and B2, refer to the specific instruction manual of each device for wire gauges. Contact Yaskawa or your nearest sales representative if the wire gauge recommended for the peripheral device or optional recommended gauge is out of the range of the applicable gauge for the drive.

Table 1.2 Wire Gauges and Tightening Torques for 200 V Class Drives

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
2004	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2006	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2010	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
2012	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2018	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	4	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2021	R/L1, S/L2, T/L3	6	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	6	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6 *3	4 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2030	R/L1, S/L2, T/L3	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	6	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	10	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10 *3	6 - 10	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
2042	R/L1, S/L2, T/L3	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	16	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	4	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	6 - 10	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)
2056	R/L1, S/L2, T/L3	25	10 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	16	6 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	35	10 - 35	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	10 - 16	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
2070	R/L1, S/L2, T/L3	35	25 - 35	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	16	16	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	50	35 - 50	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	16 - 25	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
2082	R/L1, S/L2, T/L3	35	25 - 35	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	25	16 - 25	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	50	35 - 50	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	16	2.5 - 16	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	16 - 25	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
2110	R/L1, S/L2, T/L3	35	25 - 35	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	35	25 - 35	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	50	25 - 50	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	25	6 - 25	21	M6	Hex socket cap (WAF: 5 mm)	3 - 3.5 (27 - 31)
	⏚	16	16 - 25	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
2138	R/L1, S/L2, T/L3	50	50	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	50	50	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	70	50 - 70	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	35	6 - 35	21	M6	Hex socket cap (WAF: 5 mm)	3 - 3.5 (27 - 31)
	⏚	25	25	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
2169	R/L1, S/L2, T/L3	70 *4	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	70 *4	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5	35 *3 *4	50 *3 *4	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3	50	50 - 70	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	35	25 - 35	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2211	R/L1, S/L2, T/L3	95	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	95	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5	50 *3 *4	50 *3 *4	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3	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)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
2257	R/L1, S/L2, T/L3	50 × 2P *4	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P *4	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	70 × 2P	70 - 120 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	35 × 2P	35 - 70 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	95	95 - 150	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2313	R/L1, S/L2, T/L3	70 × 2P	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	70 × 2P	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	95 × 2P	70 - 120 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	50 × 2P	35 - 70 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	95	95 - 150	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2360	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
2415	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						

*1 Remove the insulator from the tips of wires to the length shown in “Wire Stripping Length.”
*2 When using wire with a gauge over 30 mm², tighten to a tightening torque of 4.1 to 4.5 N·m (36 to 40 lb·in.).
*3 Install RCM/RCD to maintain compliance with IEC/EN 61800-5-1:2007 with use of wire of this gauge.
*4 Use cables in the range of applicable gauges to meet the IP20 protective level.
*5 Terminals - and + have two screws. Recommended Gauge indicates the wire gauge per one terminal.

Table 1.3 Wire Gauges and Tightening Torques for 400 V Class Drives

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4002	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 4	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4004	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 4	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4005	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4007	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4009	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4012	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	2.5	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4018	R/L1, S/L2, T/L3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	4	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	2.5 *3	2.5 - 6	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)
4023	R/L1, S/L2, T/L3	6	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	4	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	6	2.5 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	2.5	2.5 - 4	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6 *3	4 - 6	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4031	R/L1, S/L2, T/L3	10	10 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	6	6 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	10	10 - 35	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	2.5	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10 *3	6 - 10	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
4038	R/L1, S/L2, T/L3	10	10 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	6	6 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	16	10 - 35	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	4	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	6 - 16	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
4044	R/L1, S/L2, T/L3	16	4 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	10	6 - 10	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	25	6 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	6	2.5 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	10 - 16	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
4060	R/L1, S/L2, T/L3	16	4 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	16	6 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1	25	6 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	10 - 16	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4075	R/L1, S/L2, T/L3	25	2.5 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	25	2.5 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1	25	4 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	10	2.5 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	16	16 - 25	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
4089	R/L1, S/L2, T/L3	25	10 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	25	10 - 25	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1	35	16 - 35	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	16	4 - 16	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	⏚	16	16 - 25	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
4103	R/L1, S/L2, T/L3	35 *4	50	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	35 *4	50	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	50	50 - 70	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	25	6 - 35	21	M6	Hex socket cap (WAF: 5 mm)	3 - 3.5 (27 - 31)
	⏚	16	16 - 25	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
4140	R/L1, S/L2, T/L3	50 *4	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	50 *4	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5	25 *3 *4	50 *3	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2	50	50 - 70	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	25	25	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4168	R/L1, S/L2, T/L3	70 *4	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	70 *4	95	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *5	35 *3 *4	50 *3	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2	50	50 - 70	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	35	25 - 35	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4208	R/L1, S/L2, T/L3	50 × 2P *4	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P *4	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	70 × 2P	70 - 120 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	35 × 2P	35 - 70 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	50	50 - 150	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4250	R/L1, S/L2, T/L3	50 × 2P *4	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	50 × 2P *4	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	70 × 2P	70 - 120 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	50 × 2P	35 - 70 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	70	70 - 240	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4296	R/L1, S/L2, T/L3	70 × 2P	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	70 × 2P	70 - 95 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	95 × 2P	70 - 120 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	70 × 2P	35 - 70 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	95	95 - 240	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4371	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						

Model	Terminal	Recommended Gauge mm²	Applicable Gauge mm²	Wire Stripping Length mm *1	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4389	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
4453	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
4568	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
4675	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						

*1 Remove the insulator from the tips of wires to the length shown in “Wire Stripping Length.”
*2 When using wire with a gauge over 30 mm², tighten to a tightening torque of 4.1 to 4.5 N·m (36 to 40 lb·in.).
*3 Install RCM/RCD to maintain compliance with IEC/EN 61800-5-1:2007 with use of wire of this gauge.
*4 Use cables in the range of applicable gauges to meet the IP20 protective level.
*5 Terminals - and + have two screws. Recommended Gauge indicates the wire gauge per one terminal.

■ Drive Circuit Protection and Short Circuit Current Rating

Install the drive circuit protection devices listed in the following tables on the input side of the drive to comply with IEC/EN61800-5-1:2007 and in the event of a short circuit in the internal circuitry.

NOTICE *Do not energize or operate equipment soon after a fuse blows or RCM/RCD trips. Check the condition of cable wiring and peripheral devices to identify the root cause. If the root cause cannot be determined, do not turn on the power or operate equipment. Contact Yaskawa Support immediately.*

Three-phase 200 V Class

Table 1.4 Drive Circuit Protection and Short Circuit Rating (200 V class)

Model	Semiconductor Fuse Rated Current Manufacturer: EATON/Bussmann
2004	FWH-45B
2006	FWH-45B
2010	FWH-45B
2012	FWH-50B
2018	FWH-80B
2021	FWH-80B
2030	FWH-125B
2042	FWH-150B
2056	FWH-200B
2070	FWH-225A
2082	FWH-225A FWH-250A *1
2110	FWH-225A FWH-250A *1
2138 *2	FWH-275A FWH-300A *1
2169 *2	FWH-275A FWH-350A *1
2211 *2	FWH-325A FWH-450A *1
2257 *2	FWH-600A
2313 *2	FWH-800A
2360 *2	FWH-1000A
2415 *2	FWH-1400A

*1 Fuses with larger rated currents are recommended for application with repetitive operations.
*2 Approval pending. Contact Yaskawa or your nearest sales representative for more information.

Three-phase 400 V Class

Table 1.5 Drive Circuit Protection and Short Circuit Rating (400 V class)

Model	Semiconductor Fuse Rated Current Manufacturer: EATON/Bussmann
4002	FWH-50B
4004	FWH-50B
4005	FWH-50B
4007	FWH-60B
4009	FWH-60B
4012	FWH-60B
4018	FWH-80B
4023	FWH-90B
4031	FWH-150B
4038	FWH-200B
4044	FWH-200B
4060	FWH-225A
4075	FWH-250A

Model	Semiconductor Fuse Rated Current Manufacturer: EATON/Bussmann
4089	FWH-275A
4103 *1	FWH-275A
4140 *1	FWH-300A
4168 *1	FWH-325A FWH-400A *2
4208 *1	FWH-500A
4250 *1	FWH-600A
4296 *1	FWH-700A
4371 *1	FWH-800A
4414 *1	FWH-1000A
4453 *1	FWH-1200A
4568 *1	FWH-1200A
4675 *1	FWH-1400A FWH-1600A *2

*1 Approval pending. Contact Yaskawa or your nearest sales representative for more information.
*2 Fuses with larger rated currents are recommended for application with repetitive operations.

■ CE Standards Compliance for DC Power Supply Input

Fuses must be installed for DC power input to comply with the CE Standards.

Figure 1.3 illustrates a wiring example when using the DC power supply with 2 drives connected in parallel.

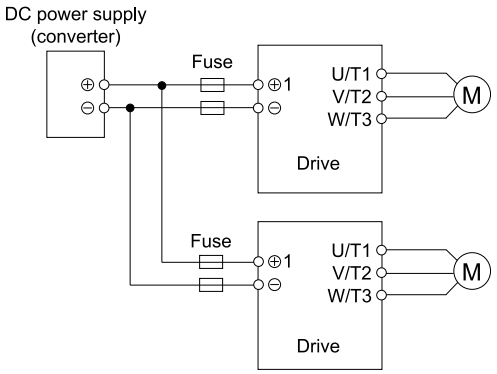


Figure 1.3 Wiring Example for DC Power Input

Note:
- Install a fuse for each drive when using multiple drives. Replace all the fuses if any of them is blown out.
- Install the external filter (system) to maintain compliance with the EMC Directive.
- Do not ground the main circuit bus.

Refer to Table 1.6 and Table 1.7 for the recommended fuses.

Three-Phase 200 V Class

Table 1.6 Recommended Fuse (Three-Phase 200 V Class)

Drive Model	Fuse Manufacturer: Bussmann	
	Model	Qty
2004	FWH-45B	2
2006	FWH-45B	2
2010	FWH-45B	2
2012	FWH-50B	2
2018	FWH-80B	2
2021	FWH-80B	2

Drive Model	Fuse Manufacturer: Bussmann	
	Model	Qty
2030	FWH-125B	2
2042	FWH-150B	2
2056	FWH-200B	2
2070	FWH-250A	2
2082	FWH-250A FWH-300A *1	2
2110	FWH-250A FWH-275A *1	2
2138	FWH-300A FWH-350A *1	2
2169 *2	FWH-350A FWH-450A *1	2
2211 *2	FWH-450A FWH-600A *1	2
2257 *2	FWH-600A FWH-700A *1	2
2313 *2	FWH-800A FWH-1000A *1	2
2360 *2	FWH-1000A	2
2415 *2	FWH-1400A	2

*1 We recommend a fuse with a large rated current for applications involving repeated loads.
*2 Approval pending. Contact Yaskawa or your nearest sales representative.

Three-Phase 400 V Class

Table 1.7 Recommended Fuse (Three-Phase 400 V Class)

Drive Model	Fuse Manufacturer: Bussmann	
	Model	Qty
4002	FWH-50B	2
4004	FWH-50B	2
4005	FWH-50B	2
4007	FWH-60B	2
4009	FWH-60B	2
4012	FWH-60B	2
4018	FWH-80B	2
4023	FWH-90B	2
4031	FWH-150B	2
4038	FWH-200B	2
4044	FWH-200B	2
4060	FWH-225A	2
4075	FWH-250A	2
4089	FWH-275A	2
4103	FWH-275A	2
4140	FWH-300A FWH-325A *1	2

Drive Model	Fuse Manufacturer: Bussmann	
	Model	Qty
4168	FWH-400A FWH-450A *1	2
4208	FWH-500A FWH-600A *1	2
4250	FWH-600A FWH-700A *1	2
4296	FWH-700A FWH-800A *1	2
4371 *2	FWH-800A FWH-1000A *1	2
4389 *2	FWH-1000A FWH-1200A *1	2
4453 *2	FWH-1200A FWH-1400A *1	2
4568 *2	FWH-1200A FWH-1600A *1	2
4675 *2	FWH-1600A	2

*1 We recommend a fuse with a large rated current for applications involving repeated loads.
*2 Approval pending. Contact Yaskawa or your nearest sales representative.

◆ EMC Directive

The drive was tested in accordance with European standard EN 61800-3:2004+A1:2012, and is compliant 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 a Drive to Conform to the EMC Directive on page 18* for the installation of the EMC filter.

■ Ground Wiring

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch the circuit boards while the power is on. Failure to comply could cause death or serious injury.*

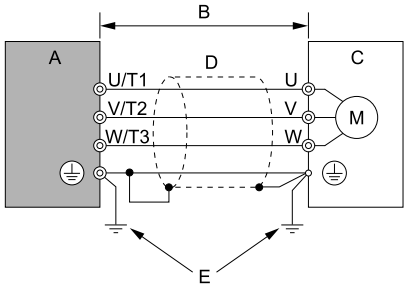
⚠ WARNING *Electrical Shock Hazard. Ground the neutral point on the power supply of drive models 2xxxB/C and 4xxxA/B/C to comply with the EMC Directive before turning on the EMC filter or if there is high resistance grounding. Failure to obey can cause death or serious injury.*

■ Installing a Drive to Conform to the EMC Directive

Install drive models 2xxxB/C and 4xxxB/C as described in the following procedure to comply with the EMC Directive when the drive is a single unit or integrated into a larger device.

1. Attach the drive to a metal plate or other noncombustible material.
2. Wire the drive and motor.

3. Ground the shield braid of the braided shield cable to the metal plate. Yaskawa recommends using cable clamps.



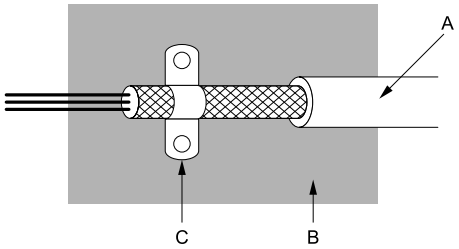
A - Drive
B - 10 m (32.8 ft.) max.
C - Motor
D - Metal conduit
E - Ground wire

Figure 1.4 Wiring the drive and motor

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

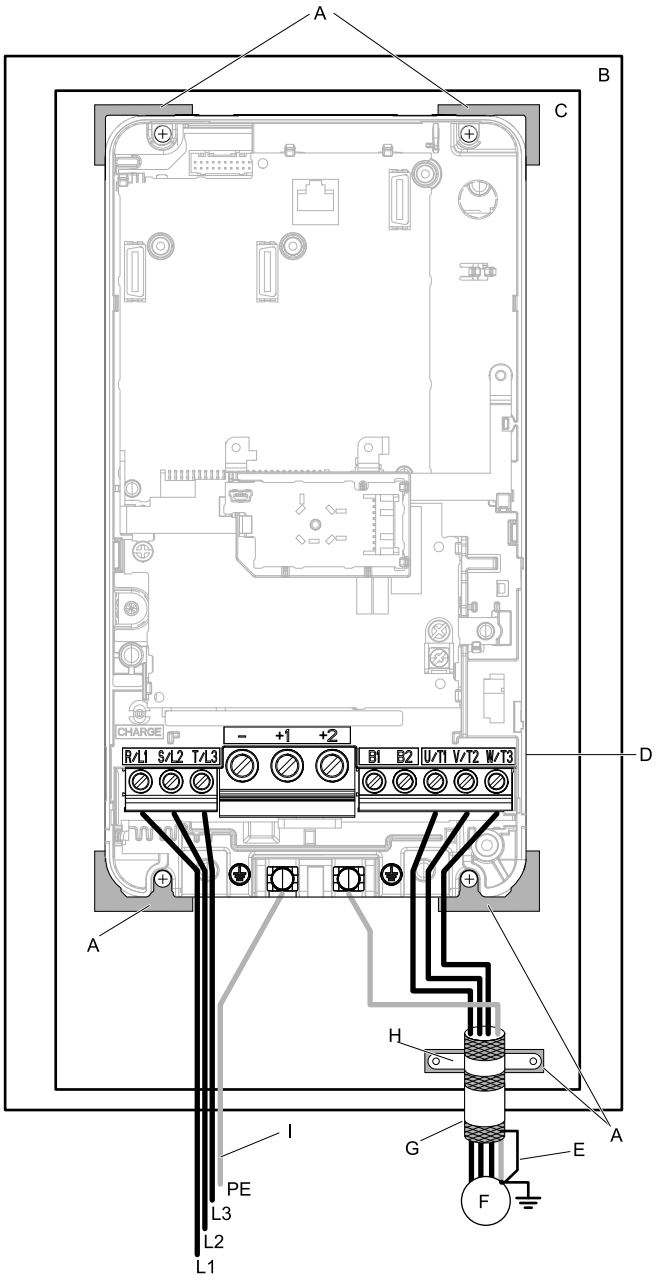
4. Ground the motor cable using cable clamp to affix to the metal plate.

Note:
Make sure the protective earthing conductor complies with technical standards and local safety regulations.



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

Figure 1.5 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 - Ground wire

Figure 1.6 Install a drive with a built-in EMC filter

5. Connect a DC reactor to reduce harmonic distortion. *Refer to DC Reactor on page 25* for details.

Note:
- Install a DC reactor specified in this manual for compliance with IEC/EN 61000-3-2 for drive models 2004, 2006, 4002, or 4004.
- The terminal blocks are different between the drive and the DC reactor. The drive has European type terminal blocks, and the DC reactor has screw type terminal blocks. Correctly prepare the ends of the wiring.

◆ Enabling the Internal EMC Filter

To turn on (enable) and off (disable) the EMC filter built in the drive models 2xxxB, 2xxxC, 4xxxB, and 4xxxC, change the mounting position of the screw.

⚠ WARNING *Electrical Shock Hazard. Confirm that the power to the drive is OFF and the CHARGE LED light is off before moving the EMC switch screws. Failure to comply could cause death or serious injury.*

⚠ WARNING *Electrical Shock Hazard. Do not remove covers or touch the circuit boards while the power is on. Failure to comply could cause death or serious injury.*

⚠ WARNING *Electrical Shock Hazard. Ground the neutral point on the power supply of drive models 2xxxB/C and 4xxxA/B/C to comply with the EMC Directive before turning on the EMC filter or if there is high resistance grounding. Failure to obey can cause death or serious injury.*

⚠ WARNING *Electrical Shock Hazard. Connect the ground cable correctly. Failure to comply could cause death or serious injury.*

NOTICE *Do not completely remove the screws or tighten the screws to an incorrect torque when disabling the EMC filter. Failure to comply could cause drive failure.*

NOTICE *Move the EMC switch screws to the OFF position for networks that are not symmetrically grounded. Failure to comply could cause damage to the drive.*

To make this product comply with the EMC Directive, confirm that the symmetric grounding network is applied, and mount the screw of the EMC filter switch to the ON position to turn on (enable) the built-in EMC filter. The screw of the EMC filter switch is set to OFF position by default.

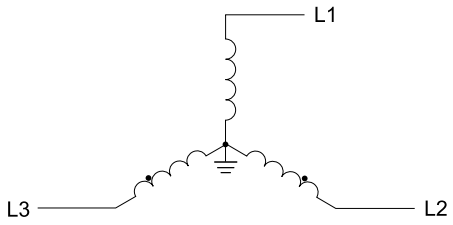


Figure 1.7 Symmetric Grounding

NOTICE *When using a drive with a non-grounding network, high resistance grounding, asymmetric grounding network, place the screw for the EMC filter switch in the OFF position and disable the built-in EMC filter. Failure to follow the instructions may damage the drive.*

Table 1.8 shows the asymmetric grounding network.

Table 1.8 Asymmetric Grounding

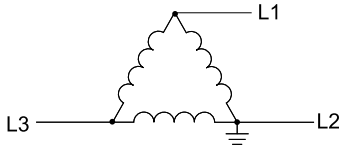
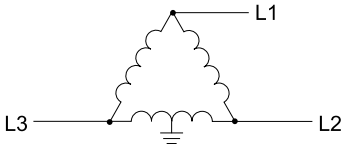
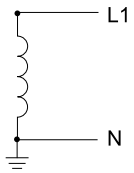
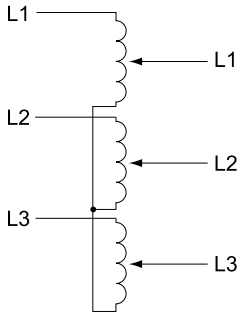
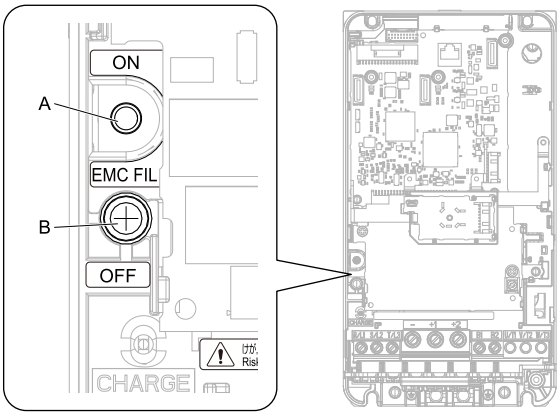
Type of Grounding	Description
Grounding on a corner of the delta connection	
Grounding on a line of the delta connection	
Grounding on an end of the single-phase connection	
Thee-phase variable transformer without neutral grounding	

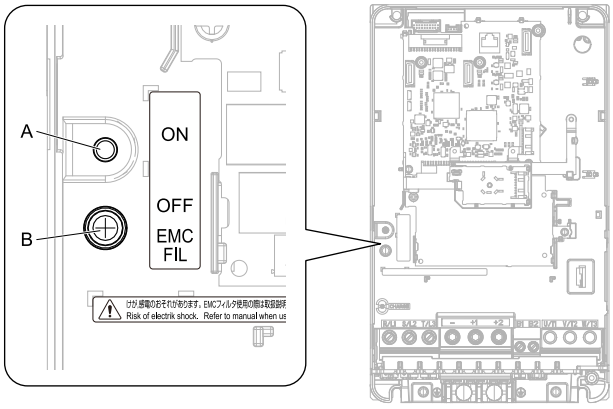
Table 1.9 EMC Filter Switch Layout Drawing

Model	Switch layout drawing
2004B - 2042B, 4002B - 4023B 2004C - 2042C, 4002C - 4023C	Figure 1.8
2056B, 4031B, 4038B 2056C, 4031C, 4038C	Figure 1.9
2070B, 2082B, 4044B, 4060B 2070C, 2082C, 4044C, 4060C	Figure 1.10
2110B, 4075B, 2138B - 2211B, 4089B - 4168B 2110C, 4075C, 2138C - 2211C, 4089C - 4168C	Figure 1.11
2257B - 2415B, 4208B - 4675B 2257C - 2415C, 4208C - 4675C	Figure 1.12



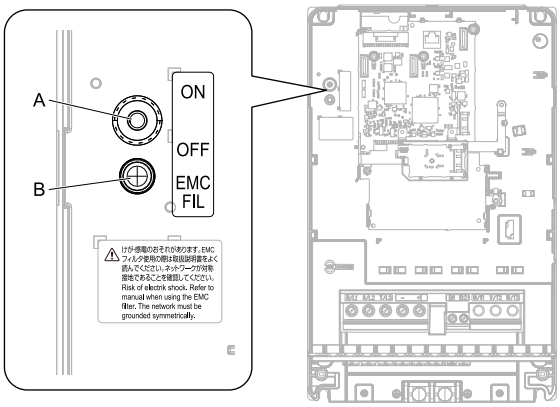
A - SW (ON) **B - Screw (OFF)**

Figure 1.8 EMC Filter Switch Layout Drawing 1



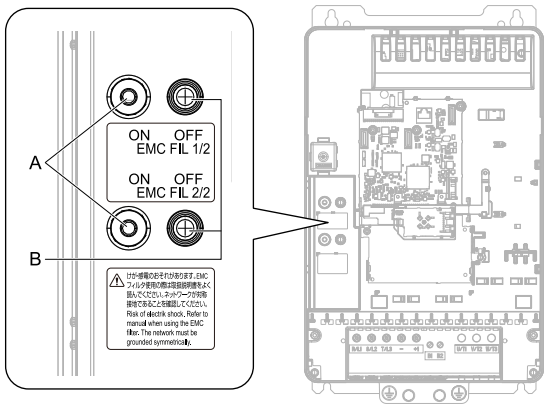
A - SW (ON) **B - Screw (OFF)**

Figure 1.9 EMC Filter Switch Layout Drawing 2



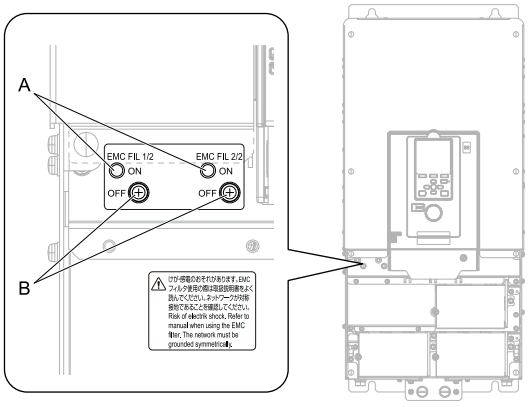
A - SW (ON) **B - Screw (OFF)**

Figure 1.10 EMC Filter Switch Layout Drawing 3



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

Figure 1.11 EMC Filter Switch Layout Drawing 4



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

Figure 1.12 EMC Filter Switch Layout Drawing 5

If the screw of the EMC filter switch is lost, use a new one and tighten it to the specified tightening torque according the following table.

NOTICE *Use only the screws specified in this manual. Do not use different screws than what is recommended. Failure to comply could damage the drive.*

Table 1.10 Screw Sizes and Tightening Torques

Model	Screw Size	Tightening Torque N·m
2004 - 2042, 4002 - 4023	M4 × 20	1.0 - 1.3
2056, 2070, 2082, 4031 - 4038, 4044, 4060	M4 × 20	1.0 - 1.3

Model	Screw Size	Tightening Torque N·m
2110 - 2211, 4075 - 4168	M4 × 25	1.0 - 1.3
2257 - 2415, 4208 - 4675	M5 × 25	2.0 - 2.5

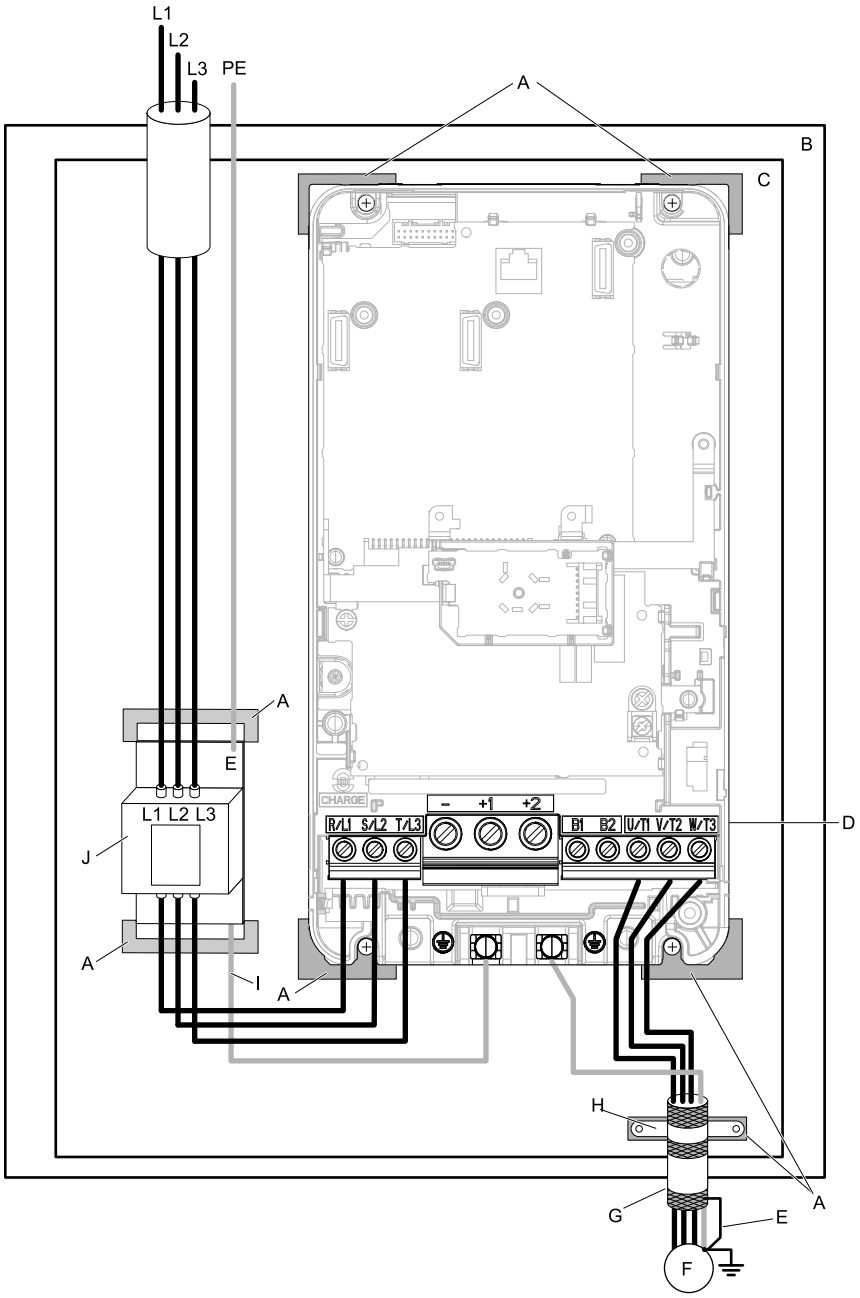
◆ External EMC Filter

Install the external EMC filter to the drive input side when using models 2xxxA and 4xxxA to comply with EN 61800-3:2004+A1:2012. *Refer to External EMC Filter Installation on page 24* for the selection of the EMC filters.

■ External EMC Filter Installation

⚠ WARNING *Electrical Shock Hazard. Ground the drive to comply with EMC guidelines. Ground the power supply line neutral for 400 V class drives. Failure to comply could cause death or serious injury.*

Refer to Figure 1.13 for instruction on wiring the external EMC filter and the drive.



A - Grounding surface (remove any paint or sealant)
B - Enclosure panel
C - Metal plate
D - Drive
E - Cable shield ground
F - Motor
G - Motor cable (braided shield cable, max. 10 m (32.8 ft.))
H - Cable clamp
I - Ground wire
J - External EMC filter

Figure 1.13 External EMC Filter and Drive Installation for CE Compliance

◆ DC Reactor

Install a DC reactor for drive models 2004, 2006, 4002, and 4004 when using an internal or external EMC filter to comply with IEC/EN 61000-3-2. Refer to Table 1.11 to select a DC reactor.

Table 1.11 DC Reactors for Harmonic Suppression (Manufacturer: Yaskawa Electric)

Drive Model	DC Reactor Model	DC Reactor Rating
2004	UZDA-B	5.4 A, 8 mH
2006	UZDA-B	5.4 A, 8 mH

Drive Model	DC Reactor Model	DC Reactor Rating
4002	UZDA-B	3.2 A, 28 mH
4004	UZDA-B	3.2 A, 28 mH

2 UL Standards

Figure 2.1 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. UL-approved parts must be used for all major components that are built into electrical appliances that obtain 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 and use this product in a location of overvoltage category III and pollution degree 2 (UL standard) or less.

■ Ambient Temperature Setting

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

- Enclosed wall-mounted type (UL Type 1): -10 °C to +40 °C (14 °F to 104 °F)
- Open chassis type (IP20): -10 °C to +50 °C (14 °F to 122 °F)

◆ Main Circuit Terminal Wiring

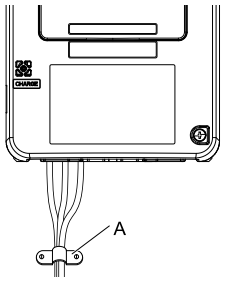
Follow the instructions in this manual when wiring the main circuit terminals.

Read through the following notes before wiring the screw clamp terminal blocks.

■ Notes on Wiring the Main Circuit Terminal Block

Note:

- Use copper wire. Non-copper wire such as aluminum wire cannot be used.
- Be sure remove any foreign objects on the wire connections for the terminal block.
- Remove the insulator from the connection wires to the wire stripping lengths listed in the manual.
- Do not use a wire with bent or crushed conductor. If a deformed wire is used for connection, cut off the bent end of the wire before using it.
- When using stranded wire, do not solder the conductor portion.
- When stranded wire is used, wire it so that no wire fibers protrude out of the connection. Do not excessively twist the stranded wire.
- Insert the wire until it is completely inside the terminal block. Once the insulator from the wire is removed to the suggested wire stripping length, the insulator will fit within the plastic housing.
- The tightening torque is different for each terminal. Tighten the screws to the specified tightening torque.
- Use a torque driver, torque ratchet or torque wrench that is designed for the screws. A flat end driver or a hex tool will be needed when wiring the screw clamp terminal. Refer to the recommended conditions listed in the product manual and provide tools accordingly.
- When using an electric driver to tighten, be especially careful and tighten at low speed, 300 to 400 r/min.
- Wiring tools can be purchased from Yaskawa. Contact Yaskawa or your nearest sales representative for details.
- When replacing your existing drive with this one, the existing wires may have wire gauges that are out of range of some of the gauges applicable to the new drive. For the usable and unusable wire gauges, contact Yaskawa or your nearest sales representative.
- After connecting the wires, gently pull on the wires to check that they do not pull out.
- Cut off an appropriate section of the wiring cover to facilitate the wiring.
- Regularly tighten any loose terminal block screws to their specified tightening torques.
- To protect the wiring connections from strain forces, be sure to secure wires near wiring parts using some sort of strain relief system. Refer to the following diagram.



A - Strain relief

Figure 2.2 Wiring Example Using Strain Relief

Table 2.1 Recommended Wiring Tools

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

*1 When wiring the drive models 2056 and 4089 or below, select tools correctly based on the wire gauges.
*2 Use 6.35 mm bit socket holder.
*3 Use torque wrench that its torque measurement range includes this value.

■ Main Circuit Wire Gauges and Tightening Torques

Refer to Table 2.2 and Table 2.3 for the recommended wire gauges and tightening torques of the main circuit terminals.

Comply with the local regulations applicable to the drive with regard to the correct wire gauges.

Note:

- Wire gauge recommendations 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 (ND) 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.
- When connecting peripheral devices or options to terminals +1,+2, +3, -, B1, and B2, refer to the specific instruction manual of each device for wire gauges. Contact Yaskawa or your nearest sales representative if the wire gauge recommended for the peripheral device or optional recommended gauge is out of the range of the applicable gauge for the drive.
- Use UL approved closed-loop crimp terminals for wires that connect to the main circuit terminal of drive models 2257 to 2415 and 4208 to 4675. Crimp the crimp terminal using a tool that is recommended by the manufacturer of the terminal.

Three-Phase 200 V Class

Table 2.2 Main Circuit Wire Gauges and Tightening Torques (Three-phase 200 V Class)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Terminal Screw Size	Shape	
2004	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2006	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2010	R/L1, S/L2, T/L3	12	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	12	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Terminal Screw Size	Shape	
2012	R/L1, S/L2, T/L3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	12	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	10	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2018	R/L1, S/L2, T/L3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2021	R/L1, S/L2, T/L3	8	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	12 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
2030	R/L1, S/L2, T/L3	6	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	8	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	6	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	12	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	10 - 8	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Terminal Screw Size	Shape	
2042	R/L1, S/L2, T/L3	6	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	6	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	3	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	10	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	10 - 8	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)
2056	R/L1, S/L2, T/L3	3	8 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	4	10 - 4	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	1	8 - 1	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	8	14 - 8	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	8 - 6	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
2070	R/L1, S/L2, T/L3	1	6 - 1	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	U/T1, V/T2, W/T3	3	6 - 3	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	1/0	4 - 1/0	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	8	14 - 8	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	6 - 4	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
2082	R/L1, S/L2, T/L3	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	6 - 2	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	-, +1, +2	2/0	4 - 2/0	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	6	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	6 - 4	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Terminal Screw Size	Shape	
2110	R/L1, S/L2, T/L3	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	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	2/0	6 - 2/0	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	4	10 - 4	21	M6	Hex socket cap (WAF: 5 mm)	3 - 3.5 (27 - 31)
	⏚	6	6 - 4	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
2138	R/L1, S/L2, T/L3	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	2 - 2/0	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	4/0	2 - 4/0	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	3	10 - 3	21	M6	Hex socket cap (WAF: 5 mm)	3 - 3.5 (27 - 31)
	⏚	4	4	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
2169	R/L1, S/L2, T/L3	4/0	2/0 - 250	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	4/0	3/0 - 300	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *3	1 *4	1/0 - 2/0	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3	1/0	1 - 2/0	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4 - 2	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
2211	R/L1, S/L2, T/L3	250	2/0 - 250	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	300	3/0 - 300	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *3	2/0	1/0 - 2/0	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	+3	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)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Terminal Screw Size	Shape	
2257	R/L1, S/L2, T/L3	2/0 × 2P	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	2/0 × 2P	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	4/0 × 2P	4/0 - 250 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	1 × 2P *4	1/0 - 2/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	3	3 - 300	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2313	R/L1, S/L2, T/L3	4/0 × 2P	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	3/0 × 2P	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	250 × 2P	4/0 - 250 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	1/0 - 2/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	2	2 - 300	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
2360	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
2415	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						

*1 Remove the insulator from the tips of wires to the length shown in “Wire Stripping Length.”
*2 When using wire with AWG 8 or higher, tighten to a tightening torque of 4.1 to 4.5 N·m (36 to 40 lb·in.).
*3 Terminals - and + have two screws. Recommended Gauge indicates the wire gauge per one terminal.
*4 Use cables in the range of applicable gauges to meet the IP20 protective level.

Three-Phase 400 V Class

Table 2.3 Main Circuit Wire Gauges and Tightening Torques (Three-phase 400 V Class)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4002	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	12	14 - 12	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4004	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	12	14 - 12	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4005	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4007	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	14	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4009	R/L1, S/L2, T/L3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	12	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4012	R/L1, S/L2, T/L3	12	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	14	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	10	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M4	Phillips/slot combo	1.2 - 1.5 (10.6 - 13.3)
4018	R/L1, S/L2, T/L3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	14	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	14 - 10	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)
4023	R/L1, S/L2, T/L3	8	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	U/T1, V/T2, W/T3	10	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	-, +1, +2	8	14 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	12	14 - 10	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	10	12 - 10	-	M5	Phillips/slot combo	2.0 - 2.5 (17.7 - 22.1)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4031	R/L1, S/L2, T/L3	6	8 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	8	10 - 4	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	6	8 - 1	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	14 - 8	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	8	10 - 8	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
4038	R/L1, S/L2, T/L3	6	8 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	8	10 - 4	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	4	8 - 1	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	10	14 - 8	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	10 - 6	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
4044	R/L1, S/L2, T/L3	4	10 - 4	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	6	10 - 6	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1, +2	3	10 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	8	14 - 8	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	8 - 6	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)
4060	R/L1, S/L2, T/L3	4	10 - 4	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	4	10 - 4	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1	3	10 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	8	14 - 8	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	8 - 6	-	M6	Phillips/slot combo	5.4 - 6.0 (47.8 - 53.1)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4075	R/L1, S/L2, T/L3	3	12 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	3	12 - 3	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1	2	10 - 2	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	B1, B2	6	14 - 6	10	M4	Slot (-)	1.5 - 1.7 (13.5 - 15)
	⏚	6	6	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
4089	R/L1, S/L2, T/L3	2	10 - 2	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	U/T1, V/T2, W/T3	2	10 - 2	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	-, +1	1/0	6 - 1/0	20	M6	Hex socket cap (WAF: 5 mm)	5 - 5.5 (45 - 49)
	B1, B2	6	14 - 6	18	M5	Slot (-)	2.3 - 2.5 (19.8 - 22) *2
	⏚	4	6 - 4	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
4103	R/L1, S/L2, T/L3	1/0	2 - 2/0	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	U/T1, V/T2, W/T3	1	2 - 2/0	27	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	-, +1	2/0	2 - 4/0	27	M8	Hex socket cap (WAF: 6 mm)	10 - 12 (89 - 107)
	B1, B2	3	10 - 3	21	M6	Hex socket cap (WAF: 5 mm)	3 - 3.5 (27 - 31)
	⏚	4	6 - 4	-	M6	Hex bolt (cross-slotted)	5.4 - 6.0 (47.8 - 53.1)
4140	R/L1, S/L2, T/L3	3/0	2/0 - 250	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	2/0 *3	3/0 - 300	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4	2 *3	1/0 - 2/0	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2	1	1 - 2/0	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4168	R/L1, S/L2, T/L3	4/0	2/0 - 250	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	U/T1, V/T2, W/T3	4/0	3/0 - 300	37	M10	Hex socket cap (WAF: 8 mm)	12 - 14 (107 - 124)
	-, -, +1, +1 *4	1/0	1/0 - 2/0	28	M6	Hex socket cap (WAF: 5 mm)	8 - 9 (71 - 80)
	B1, B2	1/0	1 - 2/0	28	M8	Hex socket cap (WAF: 6 mm)	8 - 9 (71 - 80)
	⏚	4	4 - 2	-	M8	Hex bolt (slotted)	9.0 - 11 (79.7 - 97.4)
4208	R/L1, S/L2, T/L3	1/0 × 2P *3	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	1/0 × 2P *3	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	3/0 × 2P *3	4/0 - 250 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	1 × 2P *3	1/0 - 2/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	4	4 - 300	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4250	R/L1, S/L2, T/L3	2/0 × 2P	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	2/0 × 2P	2/0 - 4/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	3/0 × 2P *3	4/0 - 250 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	1 × 2P *3	1/0 - 2/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	2	2 - 350	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4296	R/L1, S/L2, T/L3	3/0 × 2P	2/0 - 3/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	U/T1, V/T2, W/T3	3/0 × 2P	2/0 - 3/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	-, +1	4/0 × 2P	4/0 - 250 × 2P	-	M10	Hex self-locking nut	20 (177)
	+3	1/0 × 2P	1/0 - 2/0 × 2P	-	M10	Hex self-locking nut	20 (177)
	⏚	2	2 - 350	-	M10	Hex bolt (slotted)	18 - 23 (159 - 204)
4371	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						

Model	Terminal	Recommended Gauge AWG, kcmil	Applicable Gauge AWG, kcmil	Wire Stripping Length *1 mm	Terminal Screw		Tightening Torque N·m (lb·in)
					Size	Shape	
4389	R/L1, S/L2, T/L3	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
4453	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
4568	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						
4675	R/L1, S/L2, T/L3 R1/L11, S1/L21, T1/L31	Preparing					
	U/T1, V/T2, W/T3						
	-, +1						
	+3						
	⏚						

*1 Remove the insulator from the tips of wires to the length shown in “Wire Stripping Length.”
*2 When using wire with AWG 8 or higher, tighten to a tightening torque of 4.1 to 4.5 N·m (36 to 40 lb·in.).
*3 Use cables in the range of applicable gauges to meet the IP20 protective level.
*4 Terminals - and + have two screws. Recommended Gauge indicates the wire gauge per one terminal.

■ Closed-Loop Crimp Terminals

Yaskawa recommends closed-loop crimp terminals from J.S.T.MFG. Co., Ltd., and insulation caps from Tokyo DIP Co., Ltd.

Contact Yaskawa or your nearest sales representative for details on selection of closed-loop crimp terminals and insulation caps.

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

Note:

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

■ Factory Recommended Branch Circuit Protection

To maintain compliance with UL61800-5-1, execute branch circuit protection when a short occurs in the internal circuit. Yaskawa recommends connecting a semiconductor protective type fuses to the input side for branch circuit protection. Refer to Table 2.4 to Table 2.7 for the recommended fuses.

NOTICE *Do not energize or operate equipment soon after a fuse blows or RCM/RCD trips. Check the condition of cable wiring and peripheral devices to identify the root cause. If the root cause cannot be determined, do not turn on the power or operate equipment. Contact Yaskawa Support immediately.*

- 200 V class
  The drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes and 240 Vac during short circuit of the power supply, when protected by fuses as specified in this document.
- 400 V class
  The drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes and 480 Vac during short circuit of the power supply, when protected by fuses as specified in this document.

Drive's built-in short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the NEC (National Electric Code) the CEC (Canadian Electric Code, Part I), and any additional local codes.

Three-Phase 200 V Class

Table 2.4 Factory Recommended Drive Branch Circuit Protection (Normal Duty)

Drive Model	Maximum Applicable Motor Output kW (HP)	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/ Bussmann
2004	0.75 (0.75)	4.8	FWH-45B
2006	1.1 (1.5)	6.7	FWH-45B
2010	2.2 (3)	12.7	FWH-45B
2012	3 (4)	17	FWH-100B
2018	3.7 (5)	20.7	FWH-100B
2021	5.5 (7.5)	30	FWH-100B
2030	7.5 (10)	40.3	FWH-125B
2042	11 (15)	52	FWH-150B
2056	15 (20)	78.4	FWH-200B
2070	18.5 (25)	96	FWH-225A
2082	22 (30)	114	FWH-225A FWH-250A *2
2110	30 (40)	111	FWH-225A FWH-250A *2
2138	37 (50)	136	FWH-275A FWH-300A *2
2169 *1	45 (60)	164	FWH-275A FWH-350A *2
2211 *1	55 (75)	200	FWH-325A FWH-450A *2
2257 *1	75 (100)	271	FWH-600A
2313 *1	90 (125)	324	FWH-800A
2360 *1	110 (150)	394	FWH-1000A
2415 *1	-	-	FWH-1400A

*1 Approval pending. Contact Yaskawa or your nearest sales representative.
*2 We recommend a fuse with a large rated current for applications involving repeated loads.

Table 2.5 Factory Recommended Drive Branch Circuit Protection (Heavy Duty)

Drive Model	Maximum Applicable Motor Output kW (HP)	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/ Bussmann
2004	0.55 (0.5)	3.6	FWH-45B
2006	0.75 (1)	4.8	FWH-45B
2010	1.5 (2)	8.9	FWH-45B
2012	2.2 (3)	12.7	FWH-50B
2018	3 (4)	17	FWH-80B
2021	3.7 (5)	20.7	FWH-80B
2030	5.5 (7.5)	30	FWH-125B
2042	7.5 (10)	40.3	FWH-150B
2056	11 (15)	58.2	FWH-200B
2070	15 (20)	78.4	FWH-225A
2082	18.5 (25)	96	FWH-225A FWH-250A *2
2110	22 (30)	82	FWH-225A FWH-250A *2
2138	30 (40)	111	FWH-275A FWH-300A *2
2169 *1	37 (50)	136	FWH-275A FWH-350A *2
2211 *1	45 (60)	164	FWH-325A FWH-450A *2
2257 *1	55 (75)	200	FWH-600A
2313 *1	75 (100)	271	FWH-800A
2360 *1	90 (125)	324	FWH-1000A
2415 *1	110 (150)	394	FWH-1400A

*1 Approval pending. Contact Yaskawa or your nearest sales representative.
*2 We recommend a fuse with a large rated current for applications involving repeated loads.

Three-Phase 400 V Class

Table 2.6 Factory Recommended Drive Branch Circuit Protection (Normal Duty)

Drive Model	Maximum Applicable Motor Output kW (HP) Input Voltage < 460 V	Maximum Applicable Motor Output kW (HP) Input Voltage ≥ 460 V	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/ Bussmann
4002	0.75 (1)	0.75 (1)	2.5	FWH-50B
4004	1.5 (2)	1.5 (2)	4.7	FWH-50B
4005	2.2 (3)	2.2 (3)	6.7	FWH-50B
4007	3.0 (4)	3 (4)	8.9	FWH-60B
4009	3.7 (5)	4.0 (5)	11.7	FWH-60B
4012	5.5 (7.5)	5.5 (7.5)	15.8	FWH-60B
4018	7.5 (10)	7.5 (10)	21.2	FWH-80B
4023	11 (15)	11 (15)	30.6	FWH-90B
4031	15 (20)	15 (20)	41.3	FWH-150B
4038	18.5 (25)	18.5 (25)	50.5	FWH-200B
4044	22 (30)	22 (30)	59.7	FWH-200B

Drive Model	Maximum Applicable Motor Output kW (HP) Input Voltage < 460 V	Maximum Applicable Motor Output kW (HP) Input Voltage ≥ 460 V	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/ Bussmann
4060	30 (40)	30 (40)	58.3	FWH-225A
4075	37 (50)	37 (50)	71.5	FWH-250A
4089	45 (60)	45 (60)	86.5	FWH-275A
4103	55 (75)	55 (75)	105	FWH-275A
4140	75 (100)	75 (100)	142	FWH-300A
4168	90 (125)	90 (125)	170	FWH-325A FWH-400A *2
4208	110 (150)	110 (150)	207	FWH-500A
4250	150 (200)	132 (175)	248	FWH-600A
4296	185 (250)	160 (200)	300	FWH-700A
4371 *1	220 (300)	200 (250)	373	FWH-800A
4389 *1	260 (350)	220 (300)	410	FWH-1000A
4453 *1	300 (400)	250 (335)	465	FWH-1200A
4568 *1	335 (450)	315 (400)	584	FWH-1200A
4675 *1	450 (600)	355 (450)	657	FWH-1400A FWH-1600A *2

*1 Approval pending. Contact Yaskawa or your nearest sales representative.
*2 We recommend a fuse with a large rated current for applications involving repeated loads.

Table 2.7 Factory Recommended Drive Branch Circuit Protection (Heavy Duty)

Drive Model	Maximum Applicable Motor Output kW (HP) Input Voltage < 460 V	Maximum Applicable Motor Output kW (HP) Input Voltage ≥ 460 V	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/ Bussmann
4002	0.55 (0.75)	0.55 (0.75)	1.9	FWH-50B
4004	0.75 (1)	1.1 (1.5)	3.5	FWH-50B
4005	1.5 (2)	1.5 (2)	4.7	FWH-50B
4007	2.2 (3)	2.2 (3)	6.7	FWH-60B
4009	3 (4)	3 (4)	8.9	FWH-60B
4012	3.7 (5)	4.0 (5)	11.7	FWH-60B
4018	5.5 (7.5)	5.5 (7.5)	15.8	FWH-80B
4023	7.5 (10)	7.5 (10)	21.2	FWH-90B
4031	11 (15)	11 (15)	30.6	FWH-150B
4038	15 (20)	15 (20)	41.3	FWH-200B
4044	18.5 (25)	18.5 (25)	50.5	FWH-200B
4060	22 (30)	22 (30)	43.1	FWH-225A
4075	30 (40)	30 (40)	58.3	FWH-250A
4089	37 (50)	37 (50)	71.5	FWH-275A
4103	45 (60)	45 (60)	86.5	FWH-275A
4140	55 (75)	55 (75)	105	FWH-300A
4168	75 (100)	75 (100)	142	FWH-325A FWH-400A *2
4208	90 (125)	90 (125)	170	FWH-500A
4250	110 (150)	110 (150)	207	FWH-600A

Drive Model	Maximum Applicable Motor Output kW (HP) Input Voltage < 460 V	Maximum Applicable Motor Output kW (HP) Input Voltage ≥ 460 V	Input Current Rating A	Semiconductor Protection Fuse Rated Current Manufacturer: EATON/ Bussmann
4296	150 (200)	132 (175)	248	FWH-700A
4371 *1	185 (250)	160 (200)	300	FWH-800A
4389 *1	220 (300)	200 (250)	373	FWH-1000A
4453 *1	260 (350)	220 (300)	410	FWH-1200A
4568 *1	300 (400)	250 (335)	465	FWH-1200A
4675 *1	370 (500)	315 (400)	584	FWH-1400A FWH-1600A *2

*1 Approval pending. Contact Yaskawa or your nearest sales representative.
*2 We recommend a fuse with a large rated current for applications involving 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 2.8 Power Supply Used for Control Circuit Terminals

Input/Output	Terminal sign	Power supply specifications
Digital inputs	S1 to S8, 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.
Pulse Train Output	MP, AC	The LVLC power supply in the drive is used. Use the UL approved class 2 power supply for external power supply.
Pulse train input	RP, AC	The LVLC power supply in the drive is used. Use the UL approved class 2 power supply for external power supply.
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.
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.

◆ 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 through L1-04 *[Motor Overload Protection Select]* properly to enable motor overload and overheat protection.

Set the motor rated current according to the control method using *E2-01 [Motor Rated Current (FLA)]*, *E5-03 [PM Motor Rated Current (FLA)]*, or *E9-06 [Motor Rated FLA]*.

■ E2-01: Motor Rated Current (FLA)

No. (Hex.)	Name	Description	Default Setting (Range)
E2-01 (030E)	Motor Rated Current	Sets the motor rated current in amps.	Determined by o2-04 and C6-01 (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.
  - 2004 to 2042, 4002 to 4023: 0.01 A units
  - 2056 to 2415, 4031 to 4675: 0.1 A units

The value set in *E2-01* becomes the base value for motor protection, the torque limit, and torque control. Enter the motor rated current as written 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.

■ E5-03: PM Motor Rated Current (FLA)

No. (Hex.)	Name	Description	Default Setting (Range)
E5-03 (032B)	PM Motor Rated Current (FLA)	Sets the motor rated current (FLA) for PM motors.	Determined by E5-01 (10 to 200% of the drive rated current)

The value of *E5-03* is automatically set to the value input for [PM Motor Rated Current] by the Auto-Tuning process when the following types of Auto-Tuning processes are performed.

- PM Motor Parameter Settings
- PM Stationary Auto-Tuning
- PM StaTun for Stator Resistance
- PM Rotational Auto-Tuning

Note:

Display is in the following units:
- 2004 to 2042, 4002 to 4023: 0.01 A units
- 2056 to 2415, 4031 to 4675: 0.1 A units

■ E9-06: Motor Rated Current

No. (Hex.)	Name	Description	Default Setting (Range)
E9-06 (11E9)	Motor Rated Current	Sets the motor rated current in amperes.	Determined by E9-01 and o2-04 (10% to 200% of the drive rated current)

Note:

Values appear in the following units.
- 2004 to 2042, 4002 to 4023: 0.01 A units
- 2056 to 2415, 4031 to 4675: 0.1 A units

The setting value of *E9-06* is the reference value for motor protection. Enter the motor rated current as written on the motor nameplate. The value of *E9-06* is automatically set to the value input for *[Motor Rated Current]* by the Auto-Tuning process for motor parameter settings.

■ L1-01: Motor Overload Protection Select

No. (Hex.)	Name	Description	Default Setting (Range)
L1-01 (0480)	Motor Overload (oL1) Protection	Sets the motor overload protection function that uses electronic thermal protectors.	Determined by A1-02 (0 - 6)

Enables or disables the motor overload protection using electronic thermal protectors.

Cooling capability varies depending on the speed control range of the motor. Select motor protection using an electronic thermal protector that matches the allowable load characteristics of the motor being used.

The drive has overload protection for the motor using an electronic thermal protector. The electronic thermal protector of the drive calculates motor overload tolerance based on output current, output frequency, motor thermal characteristics, and time characteristics to provide overload protection for the motor. The drive triggers an *oL1[Motor Overload]* and shuts off the drive output when the drive detects motor overload.

It is also possible to set a motor overload alarm. Set *H2-01 = 1F [Terminal M1-M2 Function Selection = Motor overload alarm (oL1)]* to set a motor overload alarm. When the motor overload level rises above 90% of the *oL1* detection level, the output terminal switches ON and triggers an overload alarm.

Note:

Set *L1-01 = 1 to 6 [Enabled]* when only one motor is connected to a drive. External thermal relays are not necessary in such cases.

0 : Disabled

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

The following diagram shows an example of the circuit configuration when connecting multiple motors to a single drive.

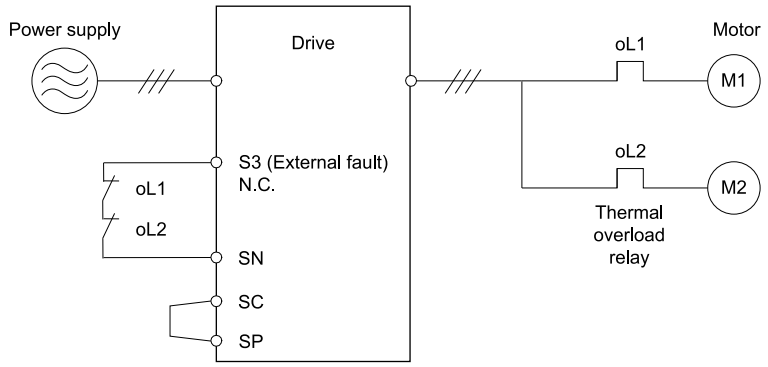


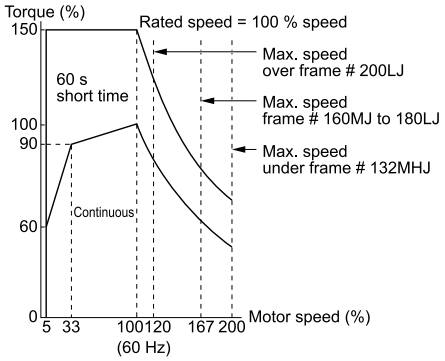
Figure 2.3 Protection Circuit Configuration when Connecting Multiple Motors to Single Drive

NOTICE *The motor cannot be protected by electronic thermal protection when one drive is running two or more motors simultaneously or the motor has a rated current significantly larger than that of standard motors (underwater motors, for example). Add thermal relays to each motor after setting L1-01 = 0 [Motor Overload Protection Select = Disabled] and configure circuits to protect each motor. The motor may fail if handled improperly.*

1 : Variable Torque

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

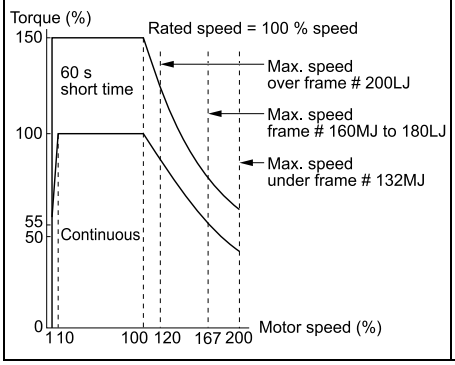
The motor has less cooling capability in the low speed range because the cooling fan slows down and there is lower overload tolerance as the speed drops. Therefore, there is lower overload tolerance as the speed drops. The trigger point for the electronic thermal protector changes according to the overload tolerance characteristics of the motor. This provides motor overheat protection from low speed to high speed across the entire speed range.

Load tolerance	Cooling Ability	Overload Characteristics (at 100% motor load)
	This motor is designed to operate using commercial line power. The motor has maximum cooling capability when operating at a 60 Hz base frequency.	The drive detects oL1 when operating at frequencies lower than 60 Hz. 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.

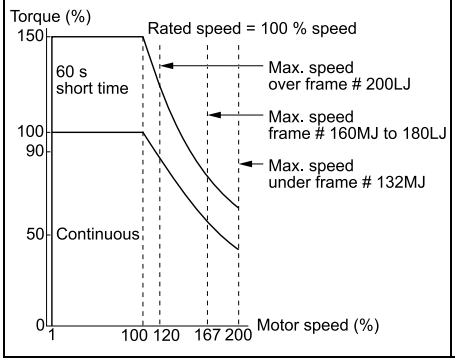
The speed control for this motor is 10% to 100% when at 100% load. Operating slower than 10% speed at 100% load will trigger motor overload.

Load tolerance	Cooling Ability	Overload Characteristics (at 100% motor load)
	This motor is designed to withstand increasing temperature during continuous operation even 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.

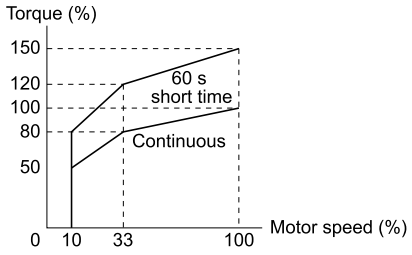
The speed control for this motor is 1 % to 100% when at 100% load. Operating slower than 1% speed at 100% load will trigger motor overload.

Load tolerance	Cooling Ability	Overload Characteristics (at 100% motor load)
	This motor is designed to withstand increasing temperature during continuous operation even in the low speed range (1% base frequency).	The motor operates continuously at 1% to 100% base frequency. Motor overload is triggered when operating slower than 1% speed at 100% load.

4 : PM Variable Torque

Use this setting for PM motors with derated torque characteristics.

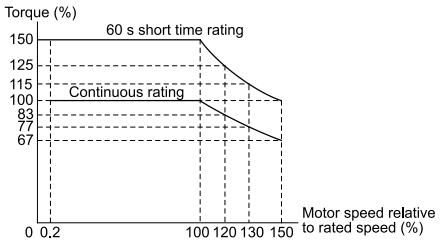
The motor has less cooling capability in the low speed range because the cooling fan slows down and there is lower overload tolerance as the speed drops. Therefore, there is lower overload tolerance as the speed drops. The trigger point for the electronic thermal protector changes according to the overload tolerance characteristics of the motor. This provides motor overheat protection from low speed to high speed across the entire speed range.

Load tolerance	Cooling Ability	Overload Characteristics (at 100% motor load)
	This motor is designed to withstand increasing temperature during continuous operation at both rated speed and rated torque.	The drive detects *oL1* when the motor operates continuously at lower speed than rated rotation speed at over 100% torque. The drive triggers a fault relay output and the motor coasts to stop.

5 : PM Constant Torque

Use this setting with a PM motor for constant torque that has a speed range for constant torque of 1:500.

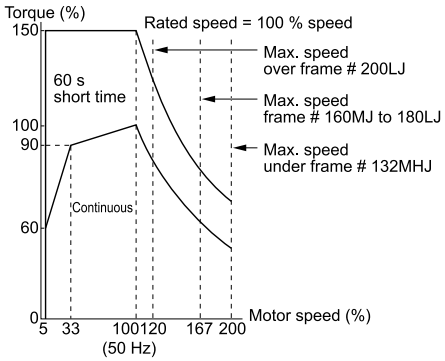
The speed control for this motor is 0.2 % to 100% when at 100% load. Operating slower than 0.2% speed at 100% load will trigger motor overload.

Load tolerance	Cooling Ability	Overload Characteristics (at 100% motor load)
	This motor is designed to withstand increasing temperature during continuous operation even in the low speed range (0.2% base frequency).	The motor operates continuously at 0.2% to 100% rated speed. Motor overload is triggered when operating slower than 0.2% speed at 100% load.

6 : Variable Torque (50Hz)

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

The motor has less cooling capability in the low speed range because the cooling fan slows down and there is lower overload tolerance as the speed drops. Therefore, there is lower overload tolerance as the speed drops. The trigger point for the electronic thermal protector changes according to the overload tolerance characteristics of the motor. This provides motor overheat protection from low speed to high speed across the entire speed range.

Load tolerance	Cooling Ability	Overload Characteristics (at 100% motor load)
	This motor is designed to operate using commercial line power. The motor has maximum cooling capability when operating at a 50 Hz base frequency.	The drive detects *oL1* when operating at frequencies lower than commercial line power. The drive triggers a fault relay output and the motor coasts to stop.

■ L1-02: Motor Overload Protection Time

No. (Hex.)	Name	Description	Default Setting (Range)
L1-02 (0481)	Motor Overload Protection Time	Sets the motor thermal overload protection (oL1) time. 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 is allowed to operate at 150% load from continuous operation at 100% load.

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

The following diagram is 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.

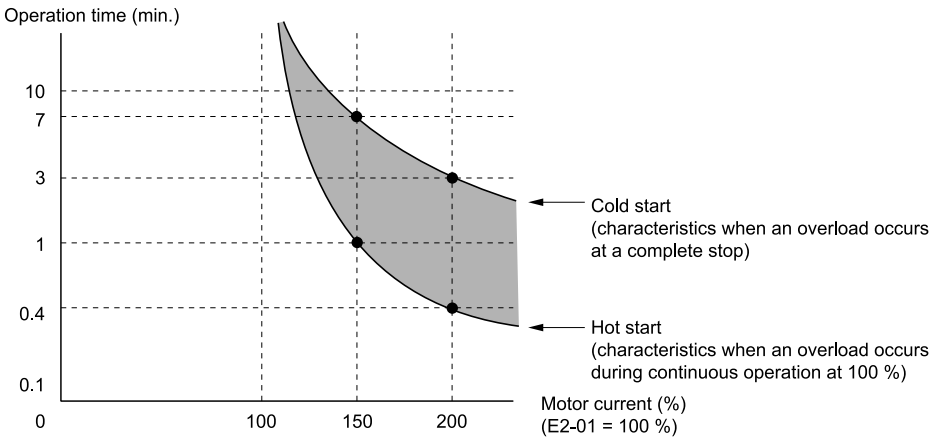


Figure 2.4 Protection Operation Time for a General-purpose Motor at Rated Output Frequency

■ L1-03: Motor OH Alarm Operation Select

No. (Hex.)	Name	Description	Default Setting (Range)
L1-03 (0482)	Motor OH Alarm Operation Select	Selects the drive operation when the PTC input signal input into the drive reaches the detection level of *oH3 [Motor Overheat Alarm]*.	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 : Baseblock (motor coasts)

The 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 Minor Fault (*H2-01 to H2-04 = 10*) switches ON.

■ L1-04: Motor OH Fault Operation Select

No. (Hex.)	Name	Description	Default Setting (Range)
L1-04 (0483)	Motor OH Fault Operation Select	Selects the drive operation when the PTC input signal input into the drive reaches the detection level of *oH4 [Motor Overheat Failure]*.	1 (0 - 2)

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

2 : Fast Stop

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 Safe Disable Input

Figure 3.1 TUV Mark

The TUV mark indicates that the product complies with the safety standards.

This section describes precautions for supporting the Safe Disable input. Contact us for more information.

The safety function complies with the standards shown in Table 3.1.

Table 3.1 Safety Standards and Unified Standards Applied

Safety Standards	Unified Standards Applied *1
Functional Safety	IEC/EN 61508:2010 (SIL3)
	IEC 62061:2012 / EN 62061:2013 (SILCL3)
	IEC/EN 61800-5-2:2007 (SIL3)
Machine Safety	ISO 13849-1:2006 (Cat.III, PL e) / EN ISO 13849-1/AC:2009 (Cat.III, PL e)
EMC	IEC 61000-6-7:2014/FprEN 61000-6-7:2014, IEC/EN61326-3-1:2008

*1 Approval pending for models 2169 to 2415, 4371 to 4675.

Note:

SIL is an abbreviation of Safety Integrity Level.

◆ Specification

The Safe Disable input provides the stop function compliant to “Safe Torque Off” defined in IEC/EN 61800-5-2:2007. The Safe Disable input is designed to meet the requirements of EN ISO 13849-1 and IEC/EN 61508. It is also equipped with the safety status monitor to detect safety circuit errors.

The following table lists the specifications for the safety function.

Table 3.2 Specifications for the Safety Function

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 Safety monitor output EDM (MFDO)
Response time from opening the input to stopping the drive output		3 ms or less
Response time from opening H1 and H2 terminal inputs to operating the EDM signal		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 in consideration of the self-diagnostic function.
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

◆ Notes

DANGER *Sudden Movement Hazard. Make sure the whole system or machinery in which the Safe Disable function is used complies with safety requirements. When implementing the Safe Disable function into the safety system of a machine, perform a thorough risk assessment for the entire system to assure compliance with relevant safety norms. Improper use of the Safe Disable function will cause serious injury or even death.*

DANGER *Sudden Movement Hazard. An external holding brake and dynamic break are not considered to be safety components for drives. Even when using an external holding brake or dynamic brake with a drive output signal (including EDM), it is still not considered a safe system because the drive output signal is not a safety component. A system is required that satisfies safety requirements. Failure to comply will cause death or serious injury.*

DANGER *Sudden Movement Hazard. Connect the Safe Disable inputs to the devices in compliance with safety requirements. Failure to comply will cause death or serious injury.*

WARNING *Sudden Movement Hazard. When using a PM motor, even if the drive output is shut off by the Safe Disable function, a breakdown of two output transistors can cause current to flow through the motor winding, resulting in a motor output axis movement for a maximum angle of 180 degrees (electrically). Make sure such a situation would have no effect on the safety of the application when using the Safe Disable function. Failure to comply could cause serious injury or death.*

WARNING *Electrical Shock Hazard. The Safe Disable function can switch off the drive output, but does not cut the drive power supply and cannot electrically isolate the drive output from the input. Always shut off the drive power supply when performing maintenance or installations on the drive input side as well as the drive output side. Failure to comply could cause serious injury or death.*

WARNING *Sudden Movement Hazard. The motor will move when an external gravitational force in the vertical axis is applied even if the Safe Disable function is in operation. Failure to comply could cause serious injury or death.*

WARNING *Sudden Movement Hazard. When using the Safe Disable inputs, make sure to remove the wire links between terminals H1, H2, and HC that were installed prior to shipment. Failure to do so will keep the Safe Disable circuit from operating properly and could cause death or serious injury.*

WARNING *Sudden Movement Hazard. All safety features (including Safe Disable) should be inspected daily and periodically. If the system is not operating normally, this could cause death or serious injury.*

WARNING *Sudden Movement Hazard. Only a qualified technician with a thorough understanding of the drive, the instruction manual, and safety standards should be permitted to wire, inspect, and maintain the Safe Disable input. Failure to comply could cause death or serious injury.*

NOTICE *From the moment terminal inputs H1 and H2 have opened, it takes up to 3 ms for drive output to shut off completely. The sequence set up to trigger terminals H1 and H2 should make sure that both terminals remain open for at least 3 ms in order to properly interrupt drive output.*

NOTICE *The Safe Disable Monitor (multi-function output terminal assigned to the EDM function) should not be used for any other purpose than to monitor the Safe Disable status or to discover a malfunction in the Safe Disable inputs. The monitor output is not considered a safe output.*

NOTICE *Replace drives with a built-in safety function 10 years after its first used.*

◆ Using the Safe Disable Function

■ Safe Disable Circuit

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

Set the EDM function to one of the multifunction digital output terminals *[H2-xx = 21 or 121]* to monitor the status of the Safe Disable function. This is called the “Safe Disable monitor output function.”

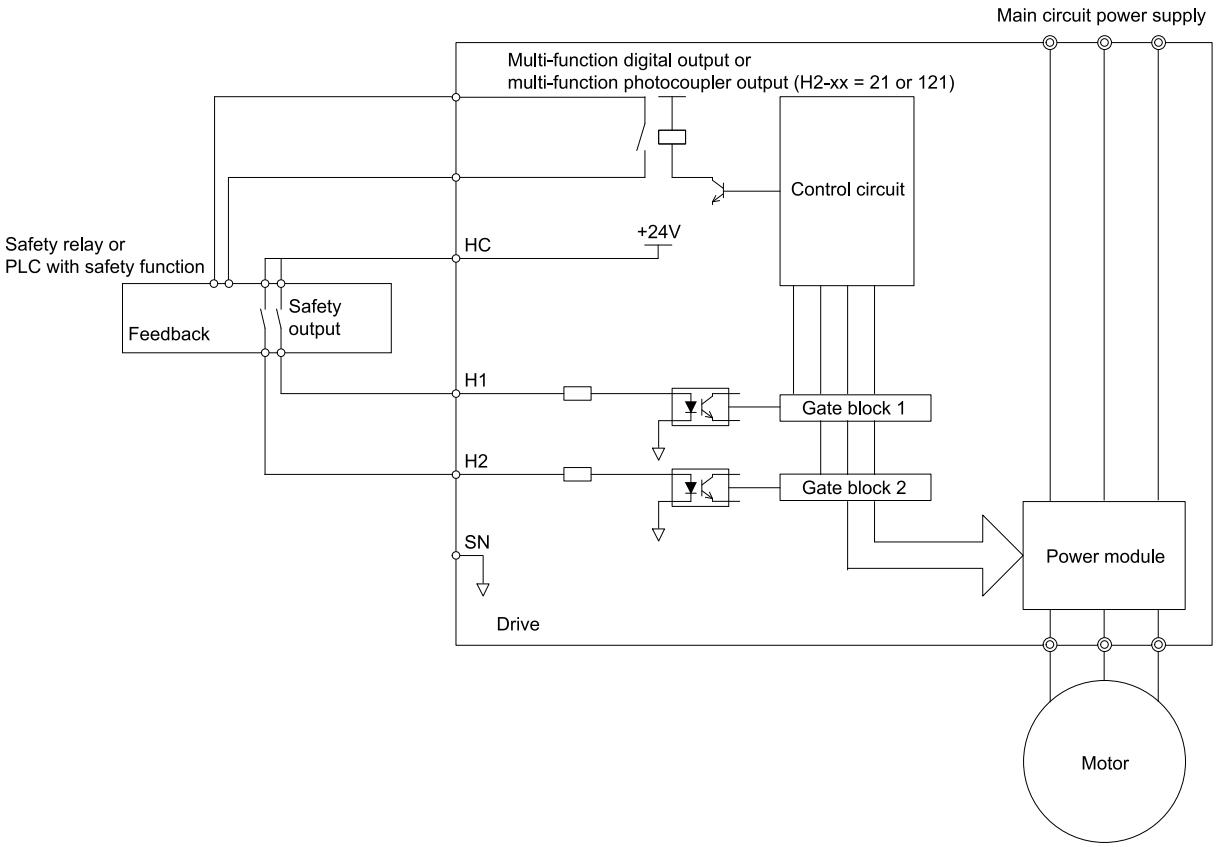


Figure 3.2 Safe Disable Function Wiring Example

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

Refer to Figure 3.3 for an example of drive operation when switching from the “Safe Torque Off” status until reaching normal operation.

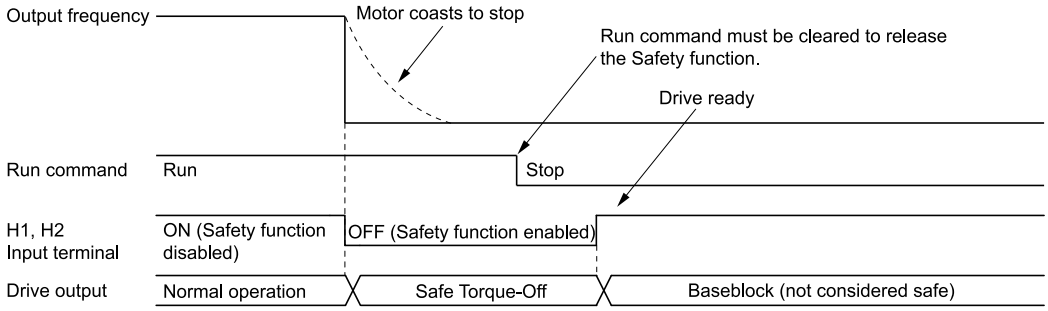


Figure 3.3 Safe Disable operation

Switching from Normal Operation to “Safe Torque Off”

Turning OFF (opening) either safety input terminal H1 or H2 will enable the Safe Disable function. Triggering the Safe Disable function while the motor is running will shut off the drive output and motor torque and the motor will coast to stop regardless of the *b1-03 [Stopping Method Selection]* setting value.

The “Safe Torque Off” status is only possible when using the Safe Disable function. Clear the Run command to stop the drive. Shutting off the drive output, as in a baseblock condition, is not the same as "Safe Torque Off".

Note:

- 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 2 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 2 ms.
- Switch OFF terminals H1 and H2 after the motor has come to a complete stop to prevent the motor from coasting to stop during normal operation.

Returning to Normal Operation from “Safe Torque Off”

The safety input releases only when the Run command is not present.

- During Stop:

Place one short circuit between terminals H1-HC and one between terminals H2-HC to disable “Safe Torque Off” when the Safe Disable function is triggered during stop. Enter the Run command after the drive stops normally.

- During run:
  Place one short circuit between terminals H1-HC and one between terminals H2-HC to disable "Safe Torque Off" after clearing the Run command when the Safe Disable function is triggered during stop. Enter the Run command after entering the STOP command regardless of whether terminals H1 and H2 are ON.

■ Safe Disable Monitor Output Function and Keypad Display

Refer to Table 3.3 for information on the relationship between each status of the input channel, Safety monitor output, and drive output.

Table 3.3 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)	Multi-function Digital Output Terminal (H2-xx = 21)	Multi-function Digital Output Terminal (H2-xx = 121)			
ON (Short circuit)	ON (Short circuit)	OFF	ON	Baseblock (Drive ready)	Normally displayed	Ready: Lit
OFF (Open)	ON (Short circuit)	OFF	ON	Safety status (STo)	SToF (Flashing)	ALM/ERR: Flashing
ON (Short 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 regarding the Safety function status. The Safety monitor output is one of the possible settings available for the multi-function digital output terminals. A controller (PTC or safety relay) must read this signal as an input signal to maintain the “Safe Torque Off” status in the event that the Safe Disable circuit is damaged. Refer to the manual for the safety device for more information on the Safety function.

It is possible to switch polarity of the Safety monitor output signal using the multi-function digital output functions settings. Refer to Table 3.3 for setting instructions.

Keypad Display

The keypad will flash *STo [Safe Disable Signal Input]* when both input channels are OFF (Open).

The keypad flashes *SToF [Safe Disable Signal Fault]* when one input channel is OFF (Open), and the other is ON (Short circuit) to indicate that either the Safe disable circuit or the drive are damaged. The keypad will never display *SToF* when the Safe disable circuit is used correctly. Refer to the chapter on Troubleshooting for more information.

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

■ Validating Safe Disable Function

Perform the following Safe Disable input test when replacing parts or performing maintenance after completing all necessary wiring to start the drive. Keep a record of the test results.

- Ensure that the keypad flashes *STo [Safe Disable Signal Input]* when both input channels are OFF (Open) and confirm that the motor is not running. Also check that the motor is not running.
- Monitor the ON/OFF status of the input channels and ensure that multi-function digital output assigned to the EDM function operates as shown in Table 3.3.
  The ON/OFF status of the multi-function digital output may not display correctly on the keypad if one or more of the following are true:
  - Incorrect parameter settings
  - A problem with an external device
  - There is a short or disconnection in the external wiring.

– The device is damaged.

Identify the cause and fix the problem to display the status properly.

- Ensure that the EDM signal operates during normal operation as described in Table 3.3.

4 Disposal and Environmental Compatibility

- Dispose or recycle electronic waste in accordance with local laws and regulations.
- Do not dispose electronic waste with household waste.

YASKAWA AC Drive GA700

High Performance General Applications Drive

Standards Compliance

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