YASKAWA

Low Harmonic Regenerative Drive for Industrial Applications

U1000 Industrial MATRIX Drive
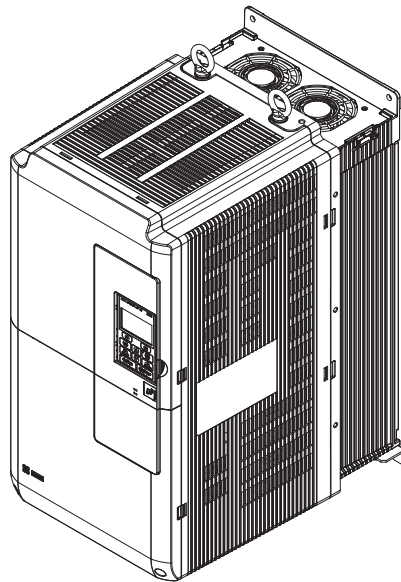## Quick Start Guide

Type: CIMR-UU☐☐☐☐☐☐
Models: 200 V Class: 7.5 to 75 kW (10 to 100 HP ND)
　　　　400 V Class: 5.5 to 580 kW (7.5 to 775 HP ND)

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

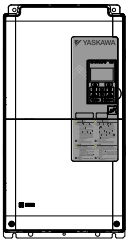**This Page Intentionally Blank**

U1000 MATRIX Quick Start Guide

i.1   Preface

Yaskawa manufactures products used as components in a wide variety of industrial systems and equipment. The selection and application of Yaskawa products remain the responsibility of the equipment manufacturer or end user. Yaskawa accepts no responsibility for the way its products are incorporated into the final system design. In all cases, Yaskawa products should not be incorporated into a product or design as the exclusive or sole safety control function. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All systems or equipment designed to incorporate a product 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 Yaskawa 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.

This manual is designed to ensure correct and suitable application of U1000-Series Drives. Read this manual before attempting to install, operate, maintain, or inspect a drive and keep it in a safe, convenient location for future reference. Be sure you understand all precautions and safety information before attempting application.

◆ Applicable Documentation

The following manuals are available for U1000-series drives:

	U1000 Industrial MATRIX Drive Quick Start Guide
	Read this guide first. This guide is packaged together with the product and contains basic safety information, wiring information, and a list of models. Use this manual for basic settings and trial operation. The most recent version of this manual is available for download on our documentation website, www.yaskawa.com.
	U1000 Industrial MATRIX Drive Technical Manual
	This manual contains information required to install and wire the drive, and gives an overview of fault diagnostics, maintenance safety, and parameter settings. The most recent version of this manual is available for download on our documentation website, www.yaskawa.com. Contact Yaskawa or a Yaskawa representative to obtain a printed and bound version of the manual.

◆ Supplemental Safety Information

General Precautions
• The diagrams in this manual may be indicated without covers or safety shields to show details. Replace the covers or shields before operating the drive and run the drive according to the instructions described in this manual.
• Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.
• The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.
• When ordering a new copy of the manual due to damage or loss, contact Yaskawa or a Yaskawa representative and provide the manual number shown on the front cover.
• If nameplate becomes worn or damaged, order a replacement from Yaskawa or a Yaskawa representative.

⚠ **WARNING**
Read and understand this manual before installing, operating or servicing this drive. The drive must be installed according to this manual and local codes. The following conventions are used to indicate safety messages in this manual. Failure to heed these messages could result in serious or fatal injury or damage to the products or to related equipment and systems.

⚠ **DANGER**
Indicates a hazardous situation, which, if not avoided, will result in death or serious injury.

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

WARNING! *may also be indicated by a bold key word embedded in the text followed by an italicized safety message.*

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

CAUTION! *may also be indicated by a bold key word embedded in the text followed by an italicized safety message.*

NOTICE
Indicates a property damage message.

NOTICE: *may also be indicated by a bold key word embedded in the text followed by an italicized safety message.*

◆ Safety Messages

⚠ DANGER
Heed the safety messages in this manual.
Failure to comply will result in death or serious injury.
The operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this manual.
Electrical Shock Hazard
Before servicing, disconnect all power to the equipment.
The output terminals remain charged even after the power supply is turned off. The charge indicator LED will extinguish when the control circuit DC voltage is below 50 Vdc. To prevent electric shock, wait for at least the time specified on the warning label, once all indicators are OFF, measure for unsafe voltages to confirm the drive is safe prior to servicing.
Failure to comply will result in death or serious injury.

⚠ WARNING
Sudden Movement Hazard
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.
Arc Flash Hazard
It is possible that there is more than one source of power for the equipment.
Obey the requirements for Electrical Safety in the Workplace and local codes for safe work procedures and applicable personal protective equipment (PPE).
Failure to obey can cause serious injury or death.
Electrical Shock Hazard
Do not attempt to modify or alter the drive in any way not explained in this manual.
Failure to comply could result in death or serious injury.
Yaskawa is not responsible for any modification of the product made by the user. This product must not be modified.
Do not allow unqualified personnel to use equipment.
Failure to comply could result in death or serious injury.
Installation, maintenance, inspection, and service must be performed only by authorized personnel familiar with installation, adjustment and maintenance of AC drives.

<div style="border:1px solid black">

⚠ WARNING

Do not remove covers or touch circuit boards while the power is on.

Failure to comply could result in death or serious injury.

Do not turn on the power for only the Filer Module and Stand-Alone EMC Filter.

Failure to comply could result in death or serious injury. The output terminals remain charged even after the power supply is turned off. Always connect the Filter Module and Stand-Alone EMC Filter as shown in the standard connection diagram and turn on the Filter Module and Stand-Alone EMC filter according to the diagram. *Refer to Drive Models 4☐0720 to 4☐0930 and Filter Modules on page 30* for details on wiring the Filter Module. *Refer to EMC Guidelines Compliance for Models U☐☐☐E☐☐☐☐ and U☐☐☐W☐☐☐☐ on page 104* for details on wiring the Stand-Alone EMC Filter.

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

Because the leakage current exceeds 3.5 mA in models 4☐0302 and larger, IEC/EN 61800-5-1 states that either the power supply must be automatically disconnected in case of discontinuity of the protective earthing conductor or a protective earthing conductor with a cross-section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used. Failure to comply may result in death or serious injury.

Always use appropriate equipment for Ground Fault Circuit Interrupters (GFCIs).

The 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 a type B GFCI according to IEC/EN 60755.

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.

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

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.

Install adequate branch circuit protection according to applicable local codes and this manual. Failure to comply could result in fire and damage to the drive or injury to personnel.

The device is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes, 240 Vac maximum (200 V class), 480 Vac maximum (400 V class: 4E☐☐☐☐ and 4W☐☐☐☐), and 500 Vac maximum (400 V class: 4A☐☐☐☐ and 4P☐☐☐☐) when protected by branch circuit protection devices specified in this document.

Crush Hazard

Do not use this drive in lifting applications without installing external safety circuitry to prevent accidental dropping of the load. The drive does not possess built-in load drop protection for lifting applications.

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

Install electrical and/or mechanical safety circuit mechanisms independent of drive circuitry.

</div>

<div style="border:1px solid black">

⚠ 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.

</div>

NOTICE
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.
Do not do a withstand voltage test or use a megohmmeter or megger insulation tester on the drive.
Failure to comply could result in damage to the sensitive devices within the drive.
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.
If a fuse is blown or a Ground Fault Circuit Interrupter (GFCI) is tripped, check the wiring and the selection of the peripheral devices.
Check for short circuits or ground faults on the secondary side of fuses and GFCIs and check the wiring and the selection of peripheral devices. Remove the cause of the problem and then turn the power supply off and on again. If the cause cannot be identified, do not turn on the power supply or attempt to operate the equipment.
Do not restart the drive immediately operate the peripheral devices if a fuse is blown or a GFCI is tripped.
Check the wiring and the selection of peripheral devices to identify the cause. Contact Yaskawa or a Yaskawa representative before restarting the drive or the peripheral devices if the cause cannot be identified.
Do not expose the drive to halogen group disinfectants.
Failure to comply may cause damage to the electrical components in the drive.
Do not pack the drive in wooden materials that have been fumigated or sterilized. Do not sterilize the entire package after the product is packed.

■ General Application Precautions

Selection

Drive Rated Output Current

Make sure that the motor rated current is less than the rated output current for the drive.

When 2 Seconds is Required for Momentary Power Loss Ride-Thru Time

Use the units listed below when continuing drive operation after the power is restored even after a momentary loss of power of 2 seconds occurs:
• 200 V class Momentary Power Loss Ride-Thru unit: Model no. P0010
• 400 V class Momentary Power Loss Ride-Thru unit: Model no. P0020

Drive Start-Up Time

The drive requires 1.5 seconds to prepare for operation after the power is turned on. Be mindful of this delay when using an external reference input.

> **Note:** 1.5 seconds is the required time when no optional devices are used with the drive. When using an optional communication device, the time required for the drive to be ready for operation will vary in accordance with the start up time of the communication card.

Selection of Power Supply Capacity

Use a power supply greater than the rated input capacity (kVA) of the drive. If the power supply is lower than the rated capacity of the drive, the device will be unable to run the application properly and will trigger a fault.

The rated input capacity of the drive, S_{CONV} (kVA), can be calculated by the following formula:

$S_{CONV} = \sqrt{3} \times I_{in} \times V_{in} / 1000$

(I_{in}: Rated input current [A], V_{in}: Applicable power supply voltage [V])

Connection to Power Supply

The total impedance of the power supply and wiring for the rated current of the drive is %Z = 10% or more. Power voltage distortion may occur when the impedance of the power supply is too large. When wiring over long distances, be sure to take preventative measures such as using thick cables or series wiring to lower the impedance of wiring. Also, tie the cables for three phases together at the power supply side (do not isolate the cable for each phase). If not, increased cable inductance will increase the voltage of the main circuit power supply input terminal. Contact Yaskawa or a Yaskawa representative for details.

Grounding the Power Supply

Yaskawa recommends using a dedicated ground for the power supply, as the drive is designed to run with a 1:1 ratio relative to the power supply. Ground other devices as directed in the specifications for those devices. Take particular care when connecting sensitive electronic devices. Separate ground lines and install a noise filter to prevent problems from noise.

When Using a Generator as a Power Supply

Select the generator capacity approximately twice as large as the drive input power supply capacity. Set the deceleration time or load so that the regenerative power from the motor will be 10% or less of the generator capacity. For further information, contact Yaskawa or a Yaskawa representative.

When a Phase Advance Capacitor or Thyristor Controller is Provided for the Power Supply

Do not install a phase advancing capacitor to the drive.

For the phase advance capacitor that has already been installed on the same power supply system as the drive, switch to a phase-advanced capacitor with a series reactor to prevent oscillation with the drive.

Contact Yaskawa or a Yaskawa representative when a device generating voltage surge or voltage distortion such as DC motor drive thyristor controller or magnetic agitator is installed on the same power supply system.

Prevention Against EMC or High Frequency Leakage Current

Use units with built-in EMC filters that have the CE marking.

Use a stand-alone EMC filter for models 4☐0477 to 4☐0930.

Use a zero-phase reactor as a noise filter when a device that will be affected by noise is near the drive.

Effects of Power Supply Distortion

Distortion of the power supply voltage increases the harmonics contents due to power supply harmonics entering the drive.

Starting Torque

The startup and acceleration characteristics of the motor are restricted to the drive overload current rating (HD: 150% 60 s, ND: 120% 60 s).

The overload rating for the drive determines the starting and accelerating characteristics of the motor. Expect lower torque than when running from line power. To achieve a higher starting torque, use a larger drive or a drive and motor with larger capacity.

Emergency Stop

During a drive fault condition, the output shuts off but the motor does not stop immediately. A mechanical brake may be required when it is necessary to stop the motor faster than the ability of the Fast Stop function of the drive.

Repetitive Starting/Stopping

Laundry machines, punching presses, and other applications with frequent starts and stops often approach 150% of their rated output current values. Heat stress generated from repetitive high current will shorten the life span of the IGBTs. The expected life span of the IGBTs is about 8 million start and stop cycles with a 4 kHz carrier frequency (3 kHz carrier frequency for models 4☐0477 to 4☐0930) and a 150% peak current.

Run only one motor from each drive when using vector control. It is not possible to run more than one motor from one drive with vector control.

■ Carrier Frequency Derating

Reduce the rated output current of the drive when increasing the carrier frequency above the factory default setting. Refer to the Technical Manual for details.

Installation

Enclosure Panels

Keep the drive in a clean environment by installing the drive in an enclosure panel or selecting an installation area free of airborne dust, lint, and oil mist. Be sure to leave the required space between drives to provide for cooling, and take proper measures so the ambient temperature remains within allowable limits and keep flammable materials away from the drive. Yaskawa offers protective designs for drives that must be used in areas subjected to oil mist and excessive vibration. Contact Yaskawa or a Yaskawa representative for details.

Installation Direction

NOTICE: *Install the drive upright as specified in the manual. Refer to the Mechanical Installation section for more information on installation. Failure to comply may damage the drive due to improper cooling.*

Settings

Motor Code

When using a permanent magnet motor, set the proper motor code to parameter E5-01 before performing a trial run.

Upper Limits

NOTICE: *The drive is capable of running the motor up to 400 Hz. Be sure to set the upper limit for the frequency of the drive to prevent the possible danger of accidentally operating equipment at higher than rated speed. The default setting for the maximum output frequency is 60 Hz.*

DC Injection Braking

NOTICE: *Excessive current during DC Injection Braking and excessive duration of DC Injection Braking can cause motor overheat.*

Acceleration/Deceleration Times

Acceleration and deceleration times are affected by the amount of torque generated by the motor, the load torque, and the moment of inertia. Set a longer accel/decel time when Stall Prevention is enabled. The accel/decel times are lengthened for as long as the Stall Prevention function is in operation. Install one of the available braking options or increase the capacity of the drive for faster acceleration and deceleration.

General Handling

Wiring Check

NOTICE: *Be sure to perform a final check of all sequence wiring and other connections before turning on the power and also check for short circuits on the control terminals, which may damage the drive.*

Selecting a Circuit Breaker or Circuit Interrupter

Yaskawa recommends installing a Ground Fault Circuit Interrupter (GFCI) to the power supply side. The GFCI should be designed for use with AC drives (e.g., Type B according to IEC/EN 60755).

Select a Molded Case Circuit Breaker (MCCB) or GFCI with a rated current 1.5 to 2 times higher than the drive rated current to avoid nuisance trips caused by harmonics in the drive input current.

Magnetic Contactor Installation

WARNING! *Fire Hazard. Shut off the drive with a magnetic contactor (MC) when a fault occurs in any external equipment such as braking resistors. Failure to comply may cause resistor overheating, fire, and injury to personnel.*

NOTICE: *To get the full performance life out of the capacitor for the control power supply and circuit relays, refrain from switching the drive power supply off and on more than once every 30 minutes. Frequent use can damage the drive. Use the drive to stop and start the motor.*

Inspection and Maintenance

WARNING! *Electrical Shock Hazard. Capacitors in the drive do not immediately discharge after shutting off the power. Wait for at least the amount of time specified on the drive before touching any components after shutting off the power. Failure to comply may cause injury to personnel from electrical shock.*

WARNING! *Electrical Shock Hazard. When a drive is running a PM motor, voltage continues to be generated at the motor terminals after the drive is shut off while the motor coasts to stop. Take the precautions described below to prevent shock and injury:*
· In applications where the machine can still rotate after the drive has fully stopped a load, install a switch to the drive output side to disconnect the motor and the drive.
· Do not allow an external force to rotate the motor beyond the maximum allowable speed or to rotate the motor when the drive has been shut off.
· Wait for at least the time specified on the warning label after opening the load switch on the output side before inspecting the drive or performing any maintenance.
· Do not open and close the load switch while the motor is running.
· If the motor is coasting, make sure the power to the drive is turned on and the drive output has completely stopped before closing the load switch.

WARNING! *Burn Hazard. Because the heatsink can get very hot during operation, take proper precautions to prevent burns. When replacing the cooling fan, shut off the power and wait at least 15 minutes to be sure that the heatsink has cooled down. Failure to comply may cause burn injury to personnel.*

Wiring

All wire ends should use ring terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

Transporting the Drive

NOTICE: *Never steam clean the drive. During transport, keep the drive from coming into contact with salts, fluorine, bromine, phthalate ester, and other such harmful chemicals.*

■ Motor Application Precautions

Life of the Motor Bearing

In applications involving constant speed over long periods, such as fans, pumps, extruders, and textile machinery, the life of the motor bearing may be shortened. This is called bearing electrolytic corrosion. The installation of a zero-phase reactor between the drive and motor, and the utilization of a motor with insulated bearings are effective countermeasures. Details can be found in the technical documentation.

Contact Yaskawa or a Yaskawa representative for more information.

Standard Induction Motors

Low-Speed Range

The cooling fan of a standard motor should sufficiently cool the motor at the rated speed. As the self-cooling capability of such a motor decreases with the speed, applying full torque at low speed will possibly damage the motor. Reduce the load torque as the motor slows to prevent motor damage from overheat. *Figure i.1* shows the allowable load characteristics for a Yaskawa standard motor. Use a motor designed specifically for operation with a drive when 100% continuous torque is needed at low speeds.
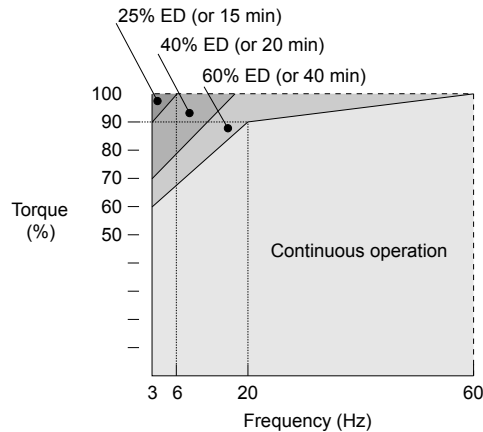

Figure i.1 Allowable Load Characteristics for a Yaskawa Motor

Insulation Tolerance
NOTICE: *Consider motor voltage tolerance levels and motor insulation in applications with an input voltage of over 440 V or particularly long wiring distances.*

High-Speed Operation
NOTICE: *Problems may occur with the motor bearings and dynamic balance of the machine when operating a motor beyond its rated speed. Contact the motor or machine manufacturer.*

Torque Characteristics

Torque characteristics differ compared to operating the motor directly from line power. The user should have a full understanding of the load torque characteristics for the application.

Vibration and Shock

The drive allows selection of high carrier PWM control. Selecting Closed Loop Vector control can help reduce motor oscillation.

- Take particular caution when adding a variable speed drive to an application running a motor from line power at a constant speed. If resonance occurs, install shock-absorbing rubber around the base of the motor and enable the Jump Frequency function to prevent continuous operation in the resonant frequency range.
- Mechanical resonance can occur with long motor shafts and in applications such as turbines, blowers, and fans with high inertia loads.

Audible Noise

The audible noise of the motor varies based on the carrier frequency setting. However, drive current derating may be required. When using a high carrier frequency, audible noise from the motor is comparable to the motor noise generated when running from line power.

Synchronous Motors

- Contact Yaskawa or a Yaskawa representative when planning to use a synchronous motor not endorsed by Yaskawa.

- Use a standard induction motor when running multiple synchronous motors simultaneously. A single drive does not have this capability.
- A synchronous motor may rotate slightly in the opposite direction of the Run command at start depending on parameter settings and rotor position.
- The amount of generated starting torque differs depending on the control mode and motor type. Set up the motor with the drive after verifying the starting torque, allowable load characteristics, impact load tolerance, and speed control range.

  Contact Yaskawa or a Yaskawa representative when planning to use a motor that does not fall within these specifications:

- In Open Loop Vector Control for PM motors, the allowable load inertia is approximately 50 times higher than the motor inertia.

  Contact Yaskawa or a Yaskawa representative for questions concerning applications with larger inertia.

- When using a holding brake in Open Loop Vector Control for PM motors, release the brake prior to starting the motor. Failure to set the proper timing can cause speed loss.
- Use the Speed Search function to restart a coasting motor rotating over 200 Hz while in V/f Control.

Specialized Motors

Multi-Pole Motor

The rated current of a multi-pole motor differs from that of a standard motor, so be sure to check the maximum current when selecting a drive. Always stop the motor before switching between the number of motor poles. The motor will coast to stop if a regenerative overvoltage (ov) fault occurs or if overcurrent (oC) protection is triggered.

Submersible Motor

The rated current of a submersible motor is greater than that of a standard motor, so select the drive accordingly. Use a motor cable large enough to avoid decreasing the maximum torque level from voltage drop caused by a long motor cable.

Explosion-Proof Motor

The motor and the drive must be tested together to be certified as explosion-proof. The drive is not designed for explosion-proof areas.

When attaching an encoder to an explosion-proof motor, make sure the encoder is also explosion-proof. Use an insulating signal converter to connect the encoder signal lines to the speed feedback option card.

Geared Motor

Make sure that the gear and the lubricant are rated for the desired speed range to avoid gear damage when operating at low speeds or very high speeds. Consult with the manufacturer for applications that require operation outside the rated speed range of the motor or gear box.

Single-Phase Motor

Variable speed drives are not designed to operate with single phase motors. Using capacitors to start the motor causes a high-frequency current to flow to the capacitors and can damage the capacitors. A split-phase start or a repulsion start can burn out the starter coils because the internal centrifugal switch is not activated. The drive is for use with three-phase motors only.

Motor with Brake

Take caution when using the drive to operate a motor with a built-in holding brake. If the brake is connected to the output side of the drive, it may not release at start due to low voltage levels, so be sure to install a separate power supply for the motor brake. Note that motors with built-in brakes tend to generate a fair amount of noise when running at low speeds.

Notes on Power Transmission Machinery

Installing an AC drive in machinery that was previously connected directly to the power supply will allow the machine to operate at variable speeds. Continuous operation outside of the rated speeds can wear out lubrication material in gear boxes and other power transmission parts. Make sure that lubrication is sufficient within the entire speed range to avoid machine damage. Note that operation above the rated speed can increase the noise generated by the machine.

◆ Drive Label Warning Example

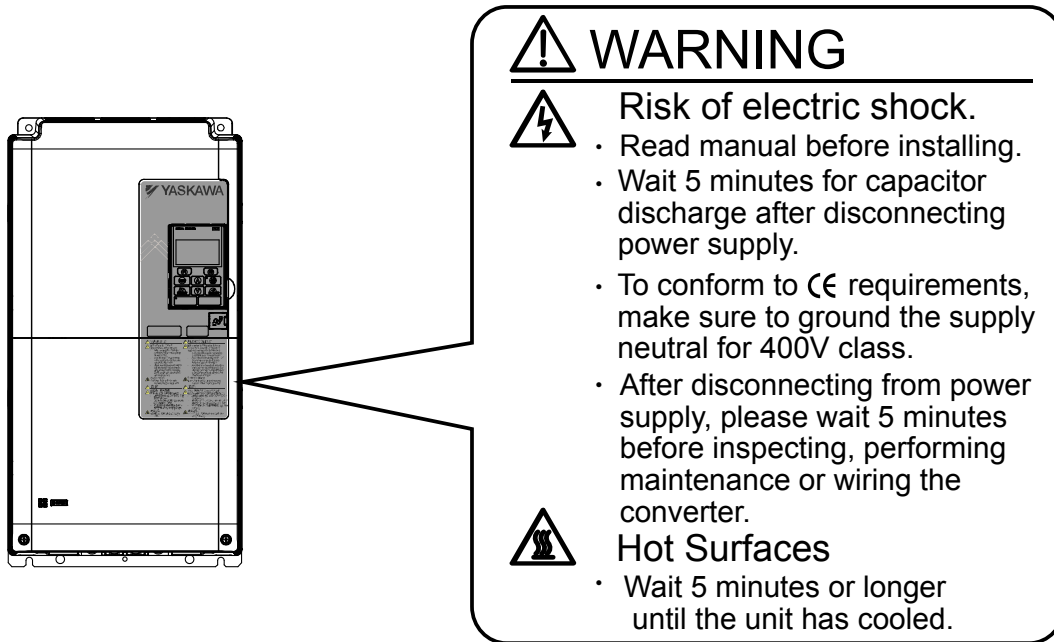Always heed the warning information listed in *Figure i.2*.

⚠ **WARNING**

⚡ Risk of electric shock.
· Read manual before installing.
· Wait 5 minutes for capacitor discharge after disconnecting power supply.
· To conform to C€ requirements, make sure to ground the supply neutral for 400V class.
· After disconnecting from power supply, please wait 5 minutes before inspecting, performing maintenance or wiring the converter.

⚠ Hot Surfaces
· Wait 5 minutes or longer until the unit has cooled.

Figure i.2 Warning Information Example and Position

◆ Warranty Information

■ Restrictions

The drive is not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health.

Customers who intend to use the product described in this manual for devices or systems relating to transportation, health care, space aviation, atomic power, electric power, or in underwater applications must first contact Yaskawa or a Yaskawa representative.

WARNING! *Injury to Personnel. This product has been manufactured under strict quality-control guidelines. However, if this product is to be installed in any location where failure of this product could involve or result in a life-and-death situation or loss of human life or in a facility where failure may cause a serious accident or physical injury, safety devices must be installed to minimize the likelihood of any accident.*

i.2 Receiving

◆ Model Number and Nameplate Check

Please perform the following tasks after receiving the drive:

• Inspect the drive for damage.

  If the drive appears damaged upon receipt, contact the shipper immediately.

• Verify receipt of the correct model by checking the information on the nameplate.

• If you have received the wrong model or the drive does not function properly, contact Yaskawa or a Yaskawa representative.

◆ Nameplate

■ Drive Models 2☐0028 to 2☐0248 and 4☐0011 to 4☐0590
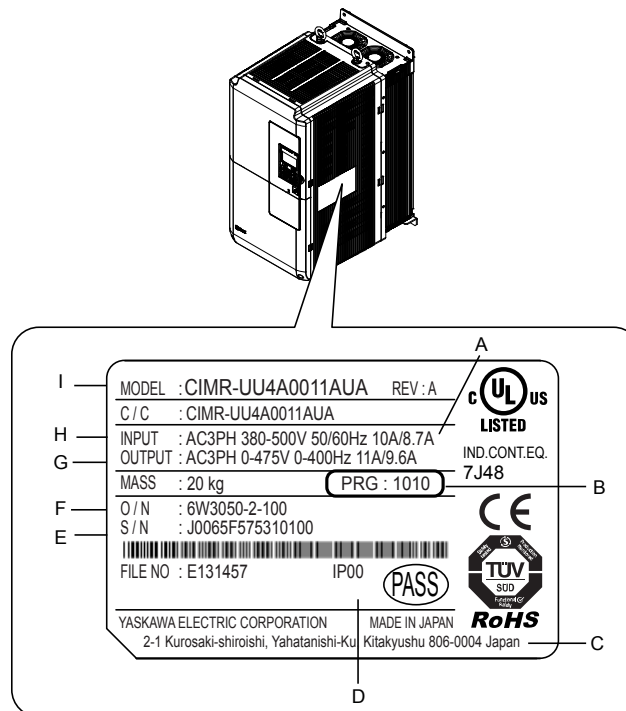
A – Normal Duty amps / Heavy Duty amps
B – Software version
C – Address [1]
D – Enclosure type
E – Serial number
F – Lot number
G – Output specifications
H – Input specifications
I – AC drive model
  Refer to *Figure i.6* for details.

Figure i.3 Drive Nameplate Information Example

[1] The address of the head office of Yaskawa Electric Corporation (responsible for product liability) is shown on the nameplate.

■ **Drive Models 4□0720 to 4□0930**

A – **Normal Duty amps / Heavy Duty amps**
B – **Software version**
C – **Address** [1]
D – **Enclosure type**
E – **Serial number**
F – **Lot number**
G – **Output specifications**
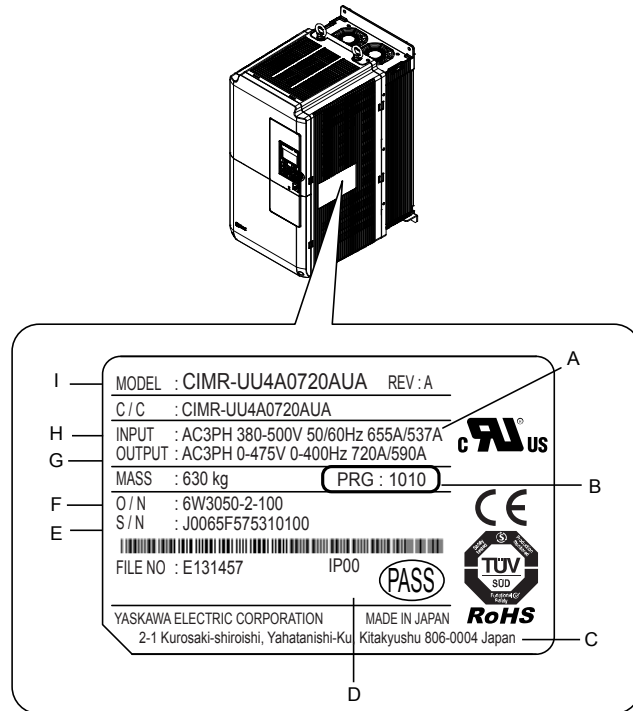H – **Input specifications**
I – **AC drive model**
Refer to *Figure i.6* for details.

Figure i.4 Drive Nameplate Information Example

<1>   The address of the head office of Yaskawa Electric Corporation (responsible for product liability) is shown on the nameplate.

■ **Filter Module**

A – Model number
B – Input specifications
C – Output specifications
D – Lot number

E – Serial number
F – Address <1>
G – Enclosure type

Figure i.5 Filter Module Nameplate Information Example

<1>   The address of the head office of Yaskawa Electric Corporation (responsible for product liability) is shown on the nameplate.
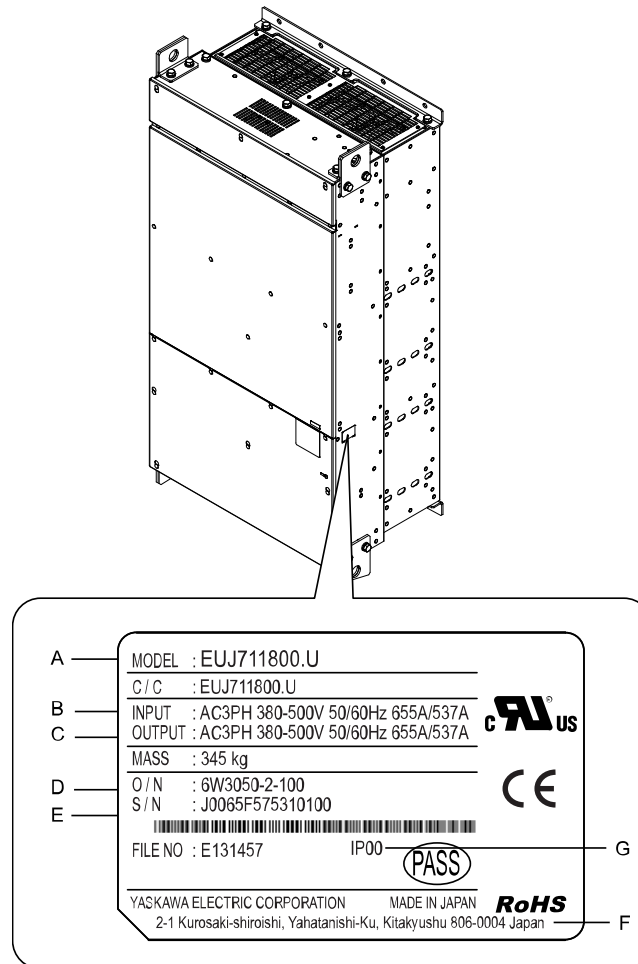
◆ Model Number

■ Drive Models 2□0028 to 2□0248 and 4□0011 to 4□0930
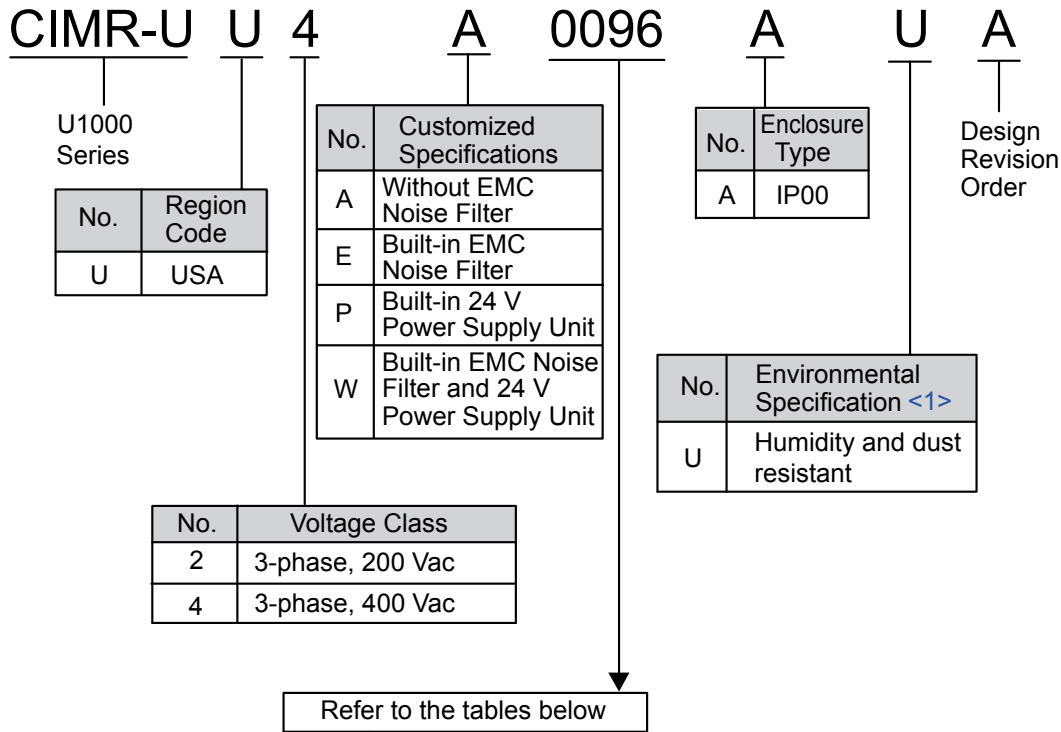

Figure i.6 Drive Model Number Definition

<1> Drives with these specifications do not guarantee complete protection for the environmental conditions indicated.

■ Three-Phase 200 V Class

Table i.1 Model Number and Specifications (200 V Class)

Normal Duty (ND) C6-01 = 1			Heavy Duty (HD) C6-01 = 0		
Drive Model	Reference Motor Capacity kW (HP)	Rated Output Current A	Drive Model	Reference Motor Capacity kW (HP)	Rated Output Current A
2□0028	7.5 (10)	28	2□0028	5.5 (7.5)	22
2□0042	11 (15)	42	2□0042	7.5 (10)	28
2□0054	15 (20)	54	2□0054	11 (15)	42
2□0068	18.5 (25)	68	2□0068	15 (20)	54
2□0081	22 (30)	81	2□0081	18.5 (25)	68
2□0104	30 (40)	104	2□0104	22 (30)	81
2□0130	37 (50)	130	2□0130	30 (40)	104
2□0154	45 (60)	154	2□0154	37 (50)	130
2□0192	55 (75)	192	2□0192	45 (60)	154
2□0248	75 (100)	248	2□0248	55 (75)	192

■ Three-Phase 400 V Class

Table i.2 Model Number and Specifications (400 V Class)

Normal Duty (ND) C6-01 = 1			Heavy Duty (HD) C6-01 = 0		
Drive Model	Reference Motor Capacity kW (HP)	Rated Output Current A	Drive Model	Reference Motor Capacity kW (HP)	Rated Output Current A
4□0011	5.5 (7.5)	11	4□0011	3.7 (5)	9.6
4□0014	7.5 (10)	14	4□0014	5.5 (7.5)	11
4□0021	11 (15)	21	4□0021	7.5 (10)	14

Normal Duty (ND) C6-01 = 1			Heavy Duty (HD) C6-01 = 0		
Drive Model	Reference Motor Capacity kW (HP)	Rated Output Current A	Drive Model	Reference Motor Capacity kW (HP)	Rated Output Current A
4□0027	15 (20)	27	4□0027	11 (15)	21
4□0034	18.5 (25)	34	4□0034	15 (20)	27
4□0040	22 (30)	40	4□0040	18.5 (25)	34
4□0052	30 (40)	52	4□0052	22 (30)	40
4□0065	37 (50)	65	4□0065	30 (40)	52
4□0077	45 (60)	77	4□0077	37 (50)	65
4□0096	55 (75)	96	4□0096	45 (60)	77
4□0124	75 (100)	124	4□0124	55 (75)	96
4□0156	90 (125)	156	4□0156	75 (100)	124
4□0180	110 (150)	180	4□0180	90 (125)	156
4□0216	132 (175)	216	4□0216	110 (150)	180
4□0240	150 (200)	240	4□0240	132 (175)	216
4□0302	185 (250)	302	4□0302	150 (200)	240
4□0361	220 (300)	361	4□0361	185 (250)	302
4□0414	260 (350)	414	4□0414	220 (300)	361
4□0477	300 (400)	477	4□0477	260 (350)	414
4□0590	375 (500)	590	4□0590	300 (400)	477
4□0720	450 (600)	720	4□0720	375 (500)	590
4□0900	560 (750)	900	4□0900	450 (600)	720
4□0930	580 (800)	930	4□0930	560 (750)	900

i.3 Mechanical Installation

This section outlines specifications, procedures, and the environment for proper mechanical installation of the drive and filter module.

◆ Installation Environment

Install the drive and filter module in an environment matching the specifications in *Table i.3* and *Table i.4* to help prolong optimum performance life.

■ Drive Models 2□0028 to 2□0248 and 4□0011 to 4□0930

Table i.3 Drive Installation Environment

Environment	Conditions
Installation Area	Indoors
Ambient Temperature	IP00/Open Type enclosure: -10 °C to +50 °C (14 °F to 122 °F) IP20/ UL Type 1 enclosure: -10 °C to +40 °C (14 °F to 104 °F) 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 °C to +60 °C (-4 °F to +104 °F)
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 (3281 ft.) or lower, up to 3000 m (9843 ft.) with derating
Vibration	10 to 20 Hz: 9.8 m/s^2 (4□0477 to 4□0930: 5.9 m/s^2) 20 to 55 Hz: 5.9 m/s^2 (2□0104 to 2□0248, 4□0096 to 4□0930: 2.0 m/s^2)
Orientation	Install the drive vertically to maintain maximum cooling effects.

NOTICE: *Avoid placing peripheral devices, transformers, or other electronics near the drive, as the noise created can lead to erroneous operation. Take proper steps to shield the drive from noise if such devices must be used in close proximity.*

NOTICE: *Prevent foreign matter such as metal shavings and wire clippings from falling into the drive during installation. Failure to comply could result in damage to the drive. Place a temporary cover over the top of the drive during installation. Remove the temporary cover before start-up, as the cover will reduce ventilation and cause overheat.*

■ Filter Module

Table i.4 Filter Module Installation Environment

Environment	Conditions
Installation Area	Indoors
Ambient Temperature	IP00/Open Type enclosure: -10 °C to +50 °C (14 °F to 122 °F) Filter module reliability improves in environments without wide temperature fluctuations. When using the filter module 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 filter module.
Humidity	95% RH or less and free of condensation
Storage Temperature	-20 °C to +60 °C (-4 °F to +104 °F)
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 (3281 ft.) or lower, up to 3000 m (9843 ft.) with derating
Vibration	10 to 20 Hz: 5.9 m/s^2 20 to 55 Hz: 2.0 m/s^2
Orientation	Install the filter module vertically to maintain maximum cooling effects.

NOTICE: *Avoid placing peripheral devices, transformers, or other electronics near the filter module, as the noise created can lead to erroneous operation. Take proper steps to shield the filter module from noise if such devices must be used in close proximity.*

NOTICE: *Prevent foreign matter such as metal shavings and wire clippings from falling into the filter module during installation. Failure to comply could result in damage to the filter module. Place a temporary cover over the top of the filter module during installation. Remove the temporary cover before start-up, as the cover will reduce ventilation and cause overheat.*

◆ Installation Orientation and Spacing

NOTICE: *Install the drive upright as illustrated in Figure i.7. Failure to comply may damage the drive due to improper cooling.*
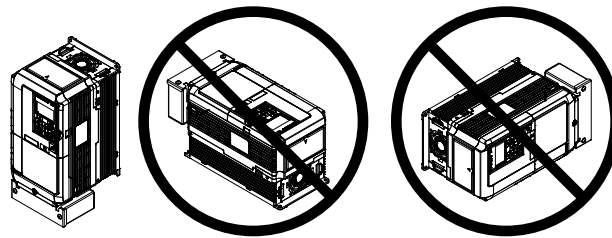

Figure i.7 Correct Installation Orientation

NOTICE: *Install the drive upright as specified in the manual. Failure to comply may damage the drive due to improper cooling.*

■ Single Drive Installation

Figure i.8 and *Figure i.9* show the installation distance required to maintain sufficient space for airflow and wiring.

Drive Models 2☐0028 to 2☐0248 and 4☐0011 to 4☐0590

Side Clearance   Top/Bottom Clearance

A – 50 mm (1.97 in) minimum   D – 120 mm (4.72 in) minimum
B – 30 mm (1.18 in) minimum   E – Airflow direction
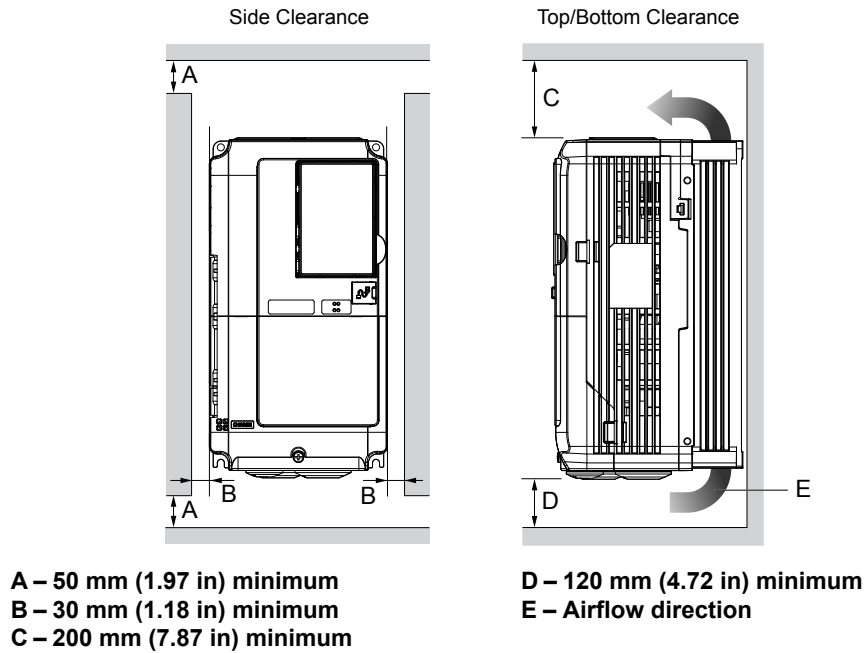C – 200 mm (7.87 in) minimum

Figure i.8 Correct Drive Installation Spacing

Note: IP20/UL Type 1 enclosure and IP00/Open Type enclosure models require the same amount of space above and below the drive for installation.

Drive Models 4☐0720 to 4☐0930 and Filter Module

Side Clearance   Top/Bottom Clearance

Drive Model 4☐0720

Filter Module

A – 50 mm (1.97 in) minimum   D – 120 mm (4.72 in) minimum
B – 30 mm (1.18 in) minimum   E – 60 mm (2.36 in) minimum
C – 200 mm (7.87 in) minimum   F – Airflow direction
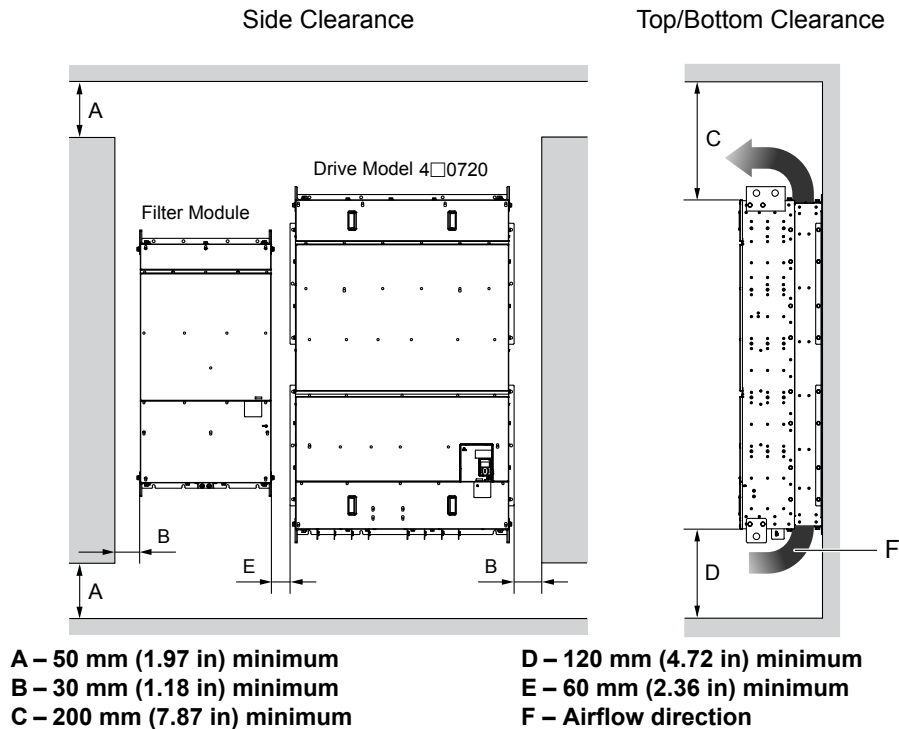
Figure i.9 Correct Drive Model 4☐0720 and Filter Module Installation Spacing

◆ Instructions on Installation Using the Eye Bolts and Hanging Brackets

Eye bolts and hanging brackets are used to install the drive or to temporarily lift the drive during drive replacement. Using the eye bolts and hanging brackets, the drive can be installed in an enclosure panel or on a wall. Do not leave the drive suspended by the wires in a horizontal or vertical position for long periods of time. Do not transport the drive over long distances. Read the following precautions and instructions before installing the drive.

WARNING! *Crush Hazard. Observe the following instructions and precautions. Failure to comply could result in serious injury or death from falling equipment.*
Only use vertical suspension to temporarily lift the drive during installation to an enclosure panel. Do not use vertical suspension to transport the drive.
Confirm that the spring washer is completely closed prior to lifting to prevent damage to the drive.
Use screws to securely affix the drive front cover, terminal blocks, and other drive components prior to vertical suspension.
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 leave the drive unattended while it is suspended by the wires.
Do not attempt to flip the drive over while it is suspended by the wires.

A – **No space between drive and washer**
B – **Spring washer fully closed**
C – **Space between drive and washer**
D – **Spring washer open**
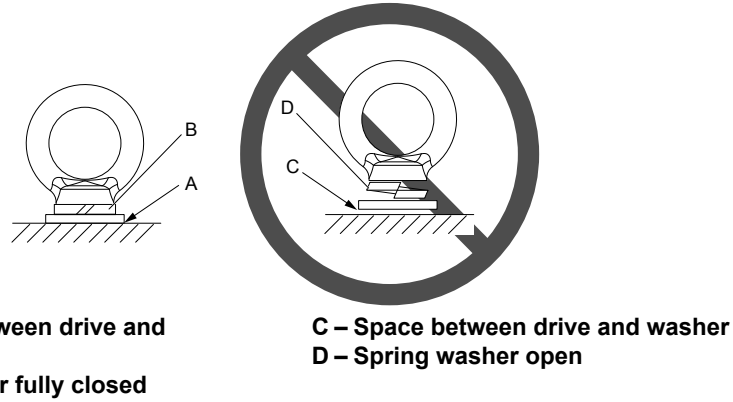
Figure i.10 Spring Washer

◼ Horizontal Suspension of Drive Models 2☐0154 to 2☐0248, 4☐0156 to 4☐0930, and Filter Module

To make a wire hanger or frame for use when lifting the drive with a crane, lay the drive in a horizontal position and pass a wire through the hanging brackets.

NOTICE: *Use the hanging brackets on the top and hanging holes of the bottom cover when lifting drive models 2☐0154F, 2☐0192F, 4☐0156F, and 4☐0180F.*

2☐0154A, 2☐0192A, 2☐0248,

4☐0156A, 4☐0180A, and 4☐0216 to 4☐0590,

4☐0720A to 4☐0930A,

and Filter Module

2☐0154F, 2☐0192F, 4☐0156F, and 4☐0180F

Figure i.11 Horizontal Suspension of Drive Model 2☐0154

◼ Vertical Suspension of the Drive and Filter Module

Follow the procedure described below when suspending the drive or filter module with eye bolts or hanging brackets.

Drive Models 2☐0028 to 2☐0130 and 4☐0011 to 4☐0124

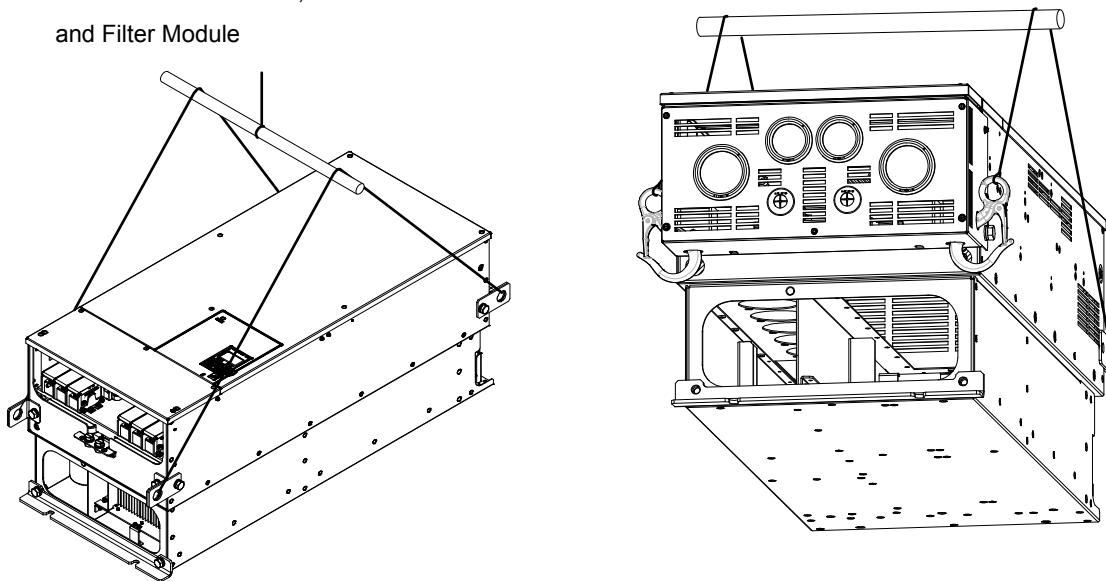**WARNING!** *Crush Hazard. Use an adequate length of wire to ensure a 50° or wider suspension angle as illustrated in Figure i.12. The maximum allowable load of the eye bolts cannot be guaranteed when the drive or filter module is suspended with the wires at angles less than 50°. Failure to comply may result in serious injury or death from falling equipment.*

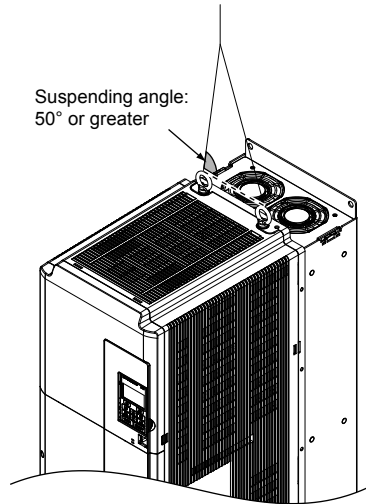**1.** Pass wire through the holes of the two eye bolts.

Suspending angle:
50° or greater

Figure i.12 Suspension Using Wires and Eye Bolts

2. Gradually take up the slack in the wires and hoist the drive or filter module after the wires are stretched tight.
3. Lower the drive or filter module when ready to install in the enclosure panel. Stop lowering when near the floor, then slowly begin lowering the drive or filter module again until the drive or filter module is placed correctly.

Drive Models 2□0154 to 2□0248 and 4□0156 to 4□0414

WARNING! *Crush Hazard. Use an adequate length of wire to ensure a 50° or wider suspension angle as illustrated in Figure i.13. The maximum allowable load of the eye bolts cannot be guaranteed when the drive is suspended with the wires at angles less than 50°. Failure to comply may result in serious injury or death from falling equipment.*

1. Remove the two hanging brackets from the drive lower side panels and bolt them on the top panel.

> **Note:** **1.** Tighten the hanging brackets with the specified tightening torque: M10: 18 to 23 N·m (159 to 204 in-lb), M12: 32 to 40 N·m (283 to 354 in-lb).
> **2.** Four hanging brackets are attached to the top of IP20/UL Type 1 drives 2□0154F, 2□0192F, 4□0156F, and 4□0180F.
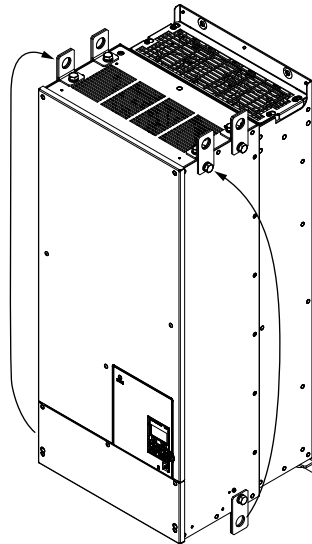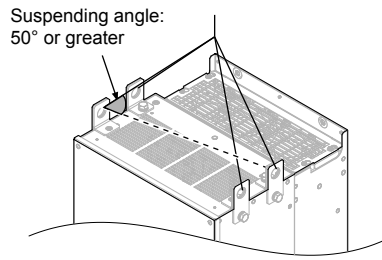
Figure i.13 Location of Hanging Brackets (Drive Models 2□0154 to 2□0248 and 4□0156 to 4□0414)

2. Pass wire through the holes of all four hanging brackets.

**Figure i.14 Drive Suspension Using Wires and Hanging Brackets
(Drive Models 2☐0154 to 2☐0248 and 4☐0156 to 4☐0414)**

3. Gradually take up the slack in the wires and hoist the drive after the wires are stretched tight.
4. Lower the drive when ready to install in the enclosure panel. Stop lowering the drive when it is near the floor, then slowly begin lowering the drive again until the drive is placed correctly.

Drive Models 4☐0477 to 4☐0930

1. Pass wire through the holes of all four hanging brackets.
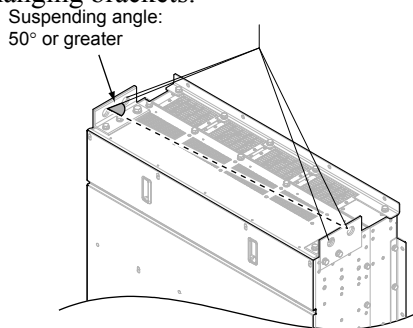
Figure i.15 Drive Suspension Using Wires and Hanging Brackets (Models 4☐0477 to 4☐0930)

2. Gradually take up the slack in the wires and hoist the drive after the wires are stretched tight.
3. Lower the drive when ready to install in the enclosure panel. Stop lowering the drive when it is near the floor, then slowly begin lowering the drive again very slowly until the drive is placed correctly.

Filter Module

1. Pass wire through the holes of all four hanging brackets.
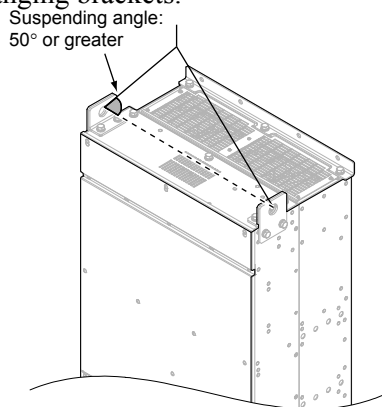
Figure i.16 Filter Module Suspension Using Wires and Hanging Brackets (EUJ7118☐☐.☐)

2. Gradually take up the slack in the wires and hoist the filter module after the wires are stretched tight.
3. Lower the filter module when ready to install in the enclosure panel. Stop lowering the filter module when it is near the floor, then slowly begin lowering the filter module again very slowly until the filter module is placed correctly.

◆ **Drive and Filter Module Dimensions**

NOTICE
Refer to the U1000 Industrial MATRIX Drive Technical Manual SIEP C710636 04 for IP20/UL Type 1 and IP00/Open Chassis dimensions. The U1000 Industrial MATRIX Drive Technical Manual is posted on the Yaskawa website, www.yaskawa.com.

i.4   Electrical Installation

◆ Standard Connection Diagram

Connect the drive and peripheral devices as shown in *Figure i.17* and *Figure i.18*. It is possible to set and run the drive via the digital operator without connecting digital I/O wiring.

Note: Drive models 4☐0720 to 4☐0930 require main circuit wiring and a connection to the module communications connector. *Refer to Module Communications Connector on page 46* for details.

WARNING! *Sudden Movement Hazard. Do not close the wiring for the control circuit unless the multifunction input terminal parameters are properly set. Improper sequencing of run/stop circuitry could result in death or serious injury from moving equipment.*

WARNING! *Sudden Movement Hazard. Ensure start/stop and safety circuits are wired properly and in the correct state before energizing the drive. Failure to comply could result in death or serious injury from moving equipment. When programmed for 3-Wire control, a momentary closure on terminal S1 may cause the drive to start.*

WARNING! *Sudden Movement Hazard. When using a 3-Wire sequence, set the drive to 3-Wire sequence prior to wiring the control terminals and set parameter b1-17 to 0 so the drive will not accept a Run command at power up (default). If the drive is wired for a 3-Wire sequence but set up for a 2-Wire sequence (default), and parameter b1-17 is set to 1 so the drive accepts a Run command at power up, the motor will rotate in reverse direction at drive power up and may cause injury.*

WARNING! *Sudden Movement Hazard. Confirm the drive I/O signals and external sequence before executing the application preset function. Executing the application preset function or setting A1-06 ≠ 0 will change the drive I/O terminal functions and may cause unexpected equipment operation. Failure to comply may cause death or serious injury.*

WARNING! *When using the automatic fault restart function with wiring designed to shut off the power supply upon drive fault, make sure the drive does not trigger a fault output during fault restart (L5-02 = 0, default). Failure to comply will prevent the automatic fault restart function from working properly.*

NOTICE: *Inadequate wiring could result in damage to the drive. Install adequate branch circuit protection per applicable codes. The drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes, 240 Vac maximum (200 V class), 480 Vac maximum (400 V class: 4E☐☐☐☐ and 4W☐☐☐☐), and 500 Vac maximum (400 V class: 4A☐☐☐☐ and 4P☐☐☐☐) when protected by branch circuit protection devices specified in this document.*

NOTICE: *Do not connect AC control circuit ground to drive enclosure. Improper drive grounding can cause control circuit malfunction.*

NOTICE: *Route motor leads U/T1, V/T2, and W/T3 separate from all other leads to reduce possible interference related issues. Failure to comply may result in abnormal operation of drive and nearby equipment.*

NOTICE: *Correctly set Sink/Source jumper S3 for internal power supply. Failure to comply may result in damage to the drive.*

NOTICE: *Install the wire link between terminals SC-SP for Sink mode and SC-SN for Source mode. Leave it out for external power supply. Never short terminals SP and SN as doing so will damage the drive.*

Note: The minimum load for the relay outputs M1-M2, M3-M4, M5-M6, and MA-MB-MC is 10 mA.

NOTICE: *Create a sequence to shut off power on the power supply side by using a fault relay output as shown in the standard connection diagram, or create a sequence that prevents the motor shaft from being turned by an external force. If you continue to input power from a power supply with a large distortion or if an external force causes the motor shaft to continue turning even after an SoH (Snubber Discharge Resistor Overheat) occurs, the snubber resistor may break.*

NOTICE: *Do not connect more than one multi-function input to one terminal. Improper wiring may result in drive malfunction. Use an external power supply when sharing a terminal with more than one input. Do not use the built-in +24 V power supply.*

NOTICE: *When using an external power supply with the sequence inputs and not using the Safe Disable inputs, remove the wire jumpers connected to the HC terminal by default. The external power supply will be short-circuited if the wire jumpers are not removed.*

Drive Models 2□0028 to 2□0248 and 4□0011 to 4□0590
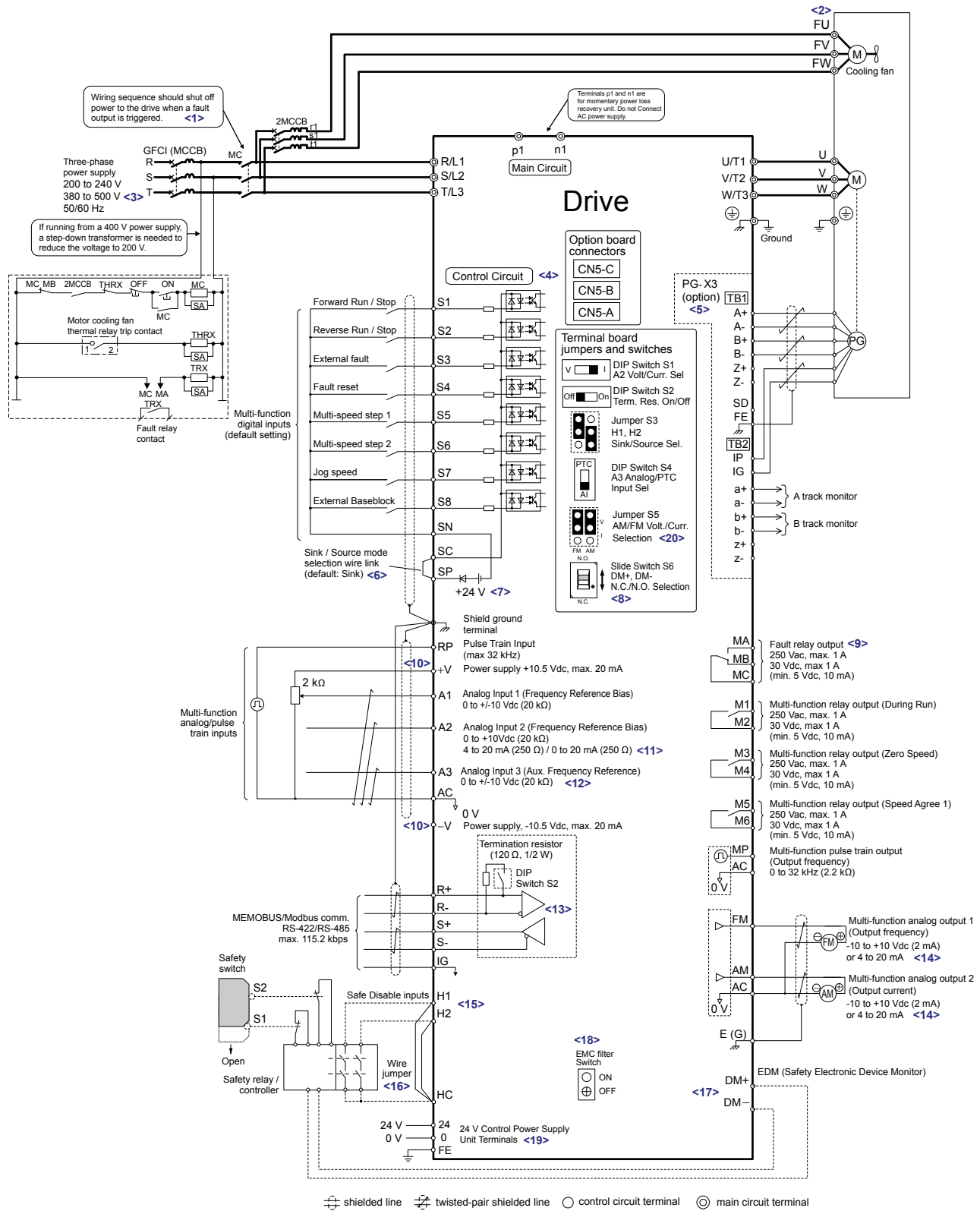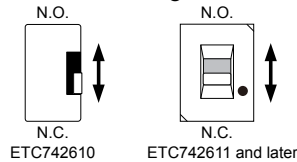

Figure i.17 Drive Standard Connection Diagram (Example: Model 2□0028)

<1> When setting L5-02 to 1 to trigger a fault output whenever the fault restart function is activated, a sequence to interrupt power when a fault occurs will turn off power to the drive as the drive attempts to restart. The default setting for L5-02 is 0 (Fault output not active during restart attempt).

<2> Self-cooling motors do not require wiring that is necessary for motors using a cooling fan.

<3> Use a three-phase power supply with a voltage of 380 to 480 V for drive models 4☐0011 to 4☐0414 (built-in EMC filter) and 4☐0477 to 4☐0590 (with stand-alone EMC filter).

<4> Supplying power to the control circuit separately from the main circuit requires 24 V power supply (option).

<5> PG option card wiring is not necessary for control modes that do not use a motor speed feedback signal.

<6> This figure illustrates an example of a sequence input to S1 through S8 using a non-powered relay or an NPN transistor. Install the wire link between terminals SC-SP for Sink mode, between SC-SN for Source mode, or leave the link out for external power supply. Never short terminals SP and SN, as it will damage the drive. *Refer to Sinking/Sourcing Mode for Digital Inputs on page 48* for details.

<7> This voltage source supplies a maximum current of 150 mA when not using a digital input card DI-A3.

<8> Slide switch S6 design differs based on PCB model number.

N.O.   N.O.

N.C.   N.C.
ETC742610   ETC742611 and later

<9> Wire the fault relay output separately from the main circuit power supply and other power lines.

<10> The maximum output current capacity for the +V and -V terminals on the control circuit is 20 mA. Never short terminals +V, -V, and AC, as it can cause erroneous operation or damage the drive.

<11> Set DIP switch S1 to select between a voltage or current input signal to terminal A2. The default setting is for current input.

<12> Set DIP switch S4 to select between analog or PTC input for terminal A3.

<13> Set DIP switch S2 to the ON position to enable the termination resistor in the last drive in a MEMOBUS/Modbus network.

<14> Monitor outputs work with devices such as analog frequency meters, ammeters, voltmeters, and wattmeters. They are not intended for use as a feedback-type signal.

<15> Use jumper S3 to select between Sink mode, Source mode, and external power supply for the Safe Disable inputs.

<16> Disconnect the wire jumper between H1 - HC and H2 - HC when utilizing the Safe Disable input.

<17> Slide switch S6 to select N.C. or N.O. as the state of the DM+ and DM- terminals for EDM output.

<18> Models UU☐E☐☐☐☐ and UU☐W☐☐☐☐ have a built-in EMC filter switch. Use a stand-alone EMC filter for models 4☐0477 to 4☐0590, which do not have an EMC filter switch.

<19> Models UU☐P☐☐☐☐ and UU☐W☐☐☐☐ have terminals 24, 0, and FE to provide board-level component voltages for the drive from an external, customer-supplied 24 Vdc source. These terminals also maintain drive control power and network communications when the main three-phase input power is removed.

<20> Use jumper S5 to select between voltage or current output signals at terminals AM and FM. Set parameters H4-07 and H4-08 accordingly.

■ Drive Models 4□0720 to 4□0930

<2>

FU
FV
FW — M Cooling fan

Wiring sequence should shut off power to the drive when a fault output is triggered. <1>

2MCCB

Terminals p1 and n1 are for momentary power loss recovery unit. Do not connect to AC power supply.

Three-phase power supply
380 to 500 V <3>
50/60 Hz

GFCI (MCCB) MC Filter Module
R/L1 X X
S/L2 Y Y
T/L3 Z Z
r1/ℓ11 r1/ℓ11
s1/ℓ21 s1/ℓ21
t1/ℓ31 t1/ℓ31
X1 X1
Y1 Y1
Z1 Z1
p2 p2
n2 n2

CN500 (20pin) <5> CN500 (20pin)

p1 n1
Main Circuit

U/T1 U
V/T2 V M
W/T3 W
Ground

Drive

Option board connectors
CN5-C
CN5-B
CN5-A

PG-X3 (option) <7>

Control Circuit <6>

Terminal board jumpers and switches

V [ ] I DIP Switch S1 A2 Volt/Curr. Sel
Off [ ] On DIP Switch S2 Term. Res. On/Off
Jumper S3 H1, H2 Sink/Source Sel.
PTC / AI DIP Switch S4 A3 Analog/PTC Input Sel
Jumper S5 AM/FM Volt./Curr. Selection <21> FM AM
Slide Switch S6 DM+, DM- N.C./N.O. Selection <10> N.C.

TB1
A+
A-
B+
B-
Z+
Z-
SD
FE
TB2
IP
IG

PG

Multi-function digital inputs (default setting)

Forward Run / Stop S1
Reverse Run / Stop S2
External fault S3
Fault reset S4
Multi-speed step 1 S5
Multi-speed step 2 S6
Jog speed S7
External Baseblock S8
SN
SC
SP
+24 V <9>

a+
a- A track monitor
b+
b- B track monitor
z+
z-

Sink / Source mode selection wire link (default: Sink) <8>

Shield ground terminal

RP Pulse Train Input (max 32 kHz)
+V Power supply +10.5 Vdc, max. 20 mA <12>

2 kΩ

Multi-function analog/pulse train inputs

A1 Analog Input 1 (Frequency Reference Bias) 0 to +/-10Vdc (20 kΩ) 4 to 20 mA (250 Ω) / 0 to 20 mA (250 Ω)
A2 Analog Input 2 (Frequency Reference Bias) 0 to +10Vdc (20 kΩ) 4 to 20 mA (250 Ω) / 0 to 20 mA (250 Ω) <13>
A3 Analog Input 3 (Aux. Frequency Reference) 0 to +/-10Vdc (20 kΩ) 4 to 20 mA (250 Ω) / 0 to 20 mA (250 Ω) <14>
AC 0 V
-V Power supply, -10.5 Vdc, max. 20 mA <12>

MA Fault relay output <11>
MB 250 Vac, max. 1 A
MC 30 Vdc, max 1 A (min. 5 Vdc, 10 mA)

M1 Multi-function relay output (During Run)
M2 250 Vac, max. 1 A 30 Vdc, max 1 A (min. 5 Vdc, 10 mA)

M3 Multi-function relay output (Zero Speed)
M4 250 Vac, max. 1 A 30 Vdc, max 1 A (min. 5 Vdc, 10 mA)

M5 Multi-function relay output (Speed Agree 1)
M6 250 Vac, max. 1 A 30 Vdc, max 1 A (min. 5 Vdc, 10 mA)

Termination resistor (120 Ω, 1/2 W) DIP Switch S2

R+
R-
S+
S-
IG

MEMOBUS/Modbus comm. RS-422/RS-485 max. 115.2 kbps <15>

MP Multi-function pulse train output (Output frequency)
AC 0 to 32 kHz (2.2 kΩ)
0 V

FM Multi-function analog output 1 (Output frequency) -10 to +10 Vdc (2 mA) or 4 to 20 mA <16>
AM Multi-function analog output 2 (Output current) -10 to +10 Vdc (2 mA) or 4 to 20 mA <16>
AC
0 V
E (G)

Safety switch

S2
S1
Open

Safety relay / controller

Safe Disable inputs H1 <17>
H2
Wire jumper <18>
HC

24 V 24 24 V Control Power Supply Unit Terminals <20>
0 V 0
FE

EDM (Safety Electronic Device Monitor)
DM+ <19>
DM−

━┿━ shielded line   ━╫━ twisted-pair shielded line   ○ control circuit terminal   ◎ main circuit terminal
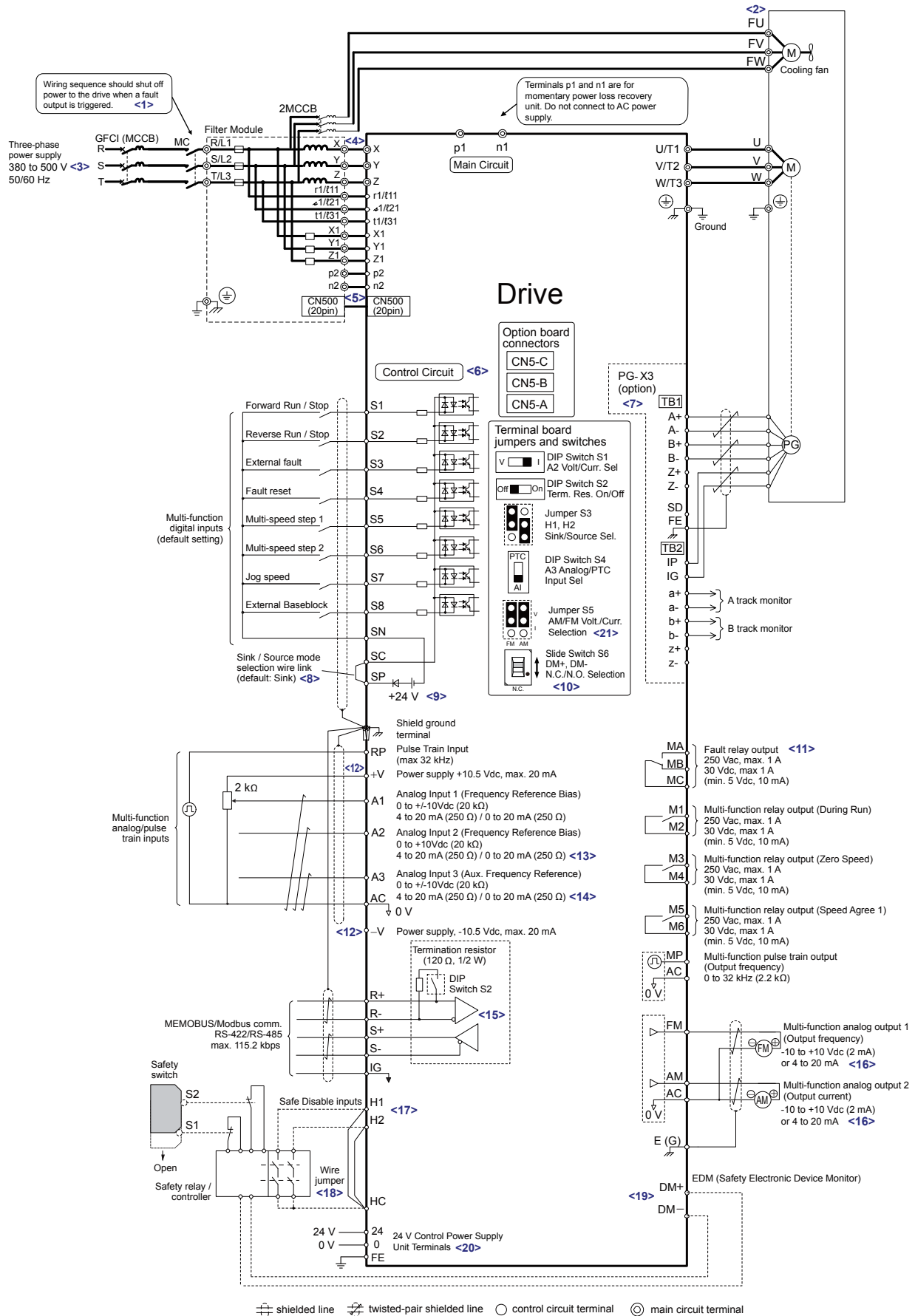
Figure i.18 Drive Standard Connection Diagram (Example: Model 4□0720)

<1> When setting L5-02 to 1 to trigger a fault output whenever the fault restart function is activated, a sequence to interrupt power when a fault occurs will turn off power to the drive as the drive attempts to restart. The default setting for L5-02 is 0 (Fault output not active during restart attempt).

<2> Self-cooling motors do not require wiring that is necessary for motors using a cooling fan.

<3> Use a three-phase power supply with a voltage of 380 to 480 V for drive models 4☐0720 to 4☐0930 (with stand-alone EMC filter).

<4> The cable between models 4☐0720 to 4☐0930 and the filter module should not exceed 5 m (16.4 ft.).

<5> Wire module connector CN500 to connect the standard configuration device (filter module) before turning on or operating models 4☐0720 to 4☐0930.

<6> Supplying power to the control circuit separately from the main circuit requires 24 V power supply (option).

<7> PG option card wiring is not necessary for control modes that do not use a motor speed feedback signal.

<8> This figure illustrates an example of a sequence input to S1 through S8 using a non-powered relay or an NPN transistor. Install the wire link between terminals SC-SP for Sink mode, between SC-SN for Source mode, or leave the link out for external power supply. Never short terminals SP and SN, as it will damage the drive. *Refer to Sinking/Sourcing Mode for Digital Inputs on page 48* for details.

<9> This voltage source supplies a maximum current of 150 mA when not using a digital input card DI-A3.

<10> Slide switch S6 design differs based on PCB model number.

N.O.　　　N.O.

N.C.　　　N.C.
ETC742610　ETC742611 and later
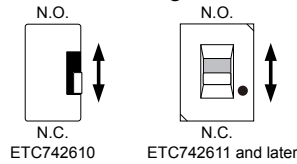
<11> Wire the fault relay output separately from the main circuit power supply and other power lines.

<12> The maximum output current capacity for the +V and -V terminals on the control circuit is 20 mA. Never short terminals +V, -V, and AC, as it can cause erroneous operation or damage the drive.

<13> Set DIP switch S1 to select between a voltage or current input signal to terminal A2. The default setting is for current input.

<14> Set DIP switch S4 to select between analog or PTC input for terminal A3.

<15> Set DIP switch S2 to the ON position to enable the termination resistor in the last drive in a MEMOBUS/Modbus network.

<16> Monitor outputs work with devices such as analog frequency meters, ammeters, voltmeters, and wattmeters. They are not intended for use as a feedback-type signal.

<17> Use jumper S3 to select between Sink mode, Source mode, and external power supply for the Safe Disable inputs.

<18> Disconnect the wire jumper between H1 - HC and H2 - HC when utilizing the Safe Disable input.

<19> Slide switch S6 to select N.C. or N.O. as the state of the DM+ and DM- terminals for EDM output.

<20> Models UU☐P☐☐☐☐ and UU☐W☐☐☐☐ have terminals 24, 0, and FE to provide board-level component voltages for the drive from an external, customer-supplied 24 Vdc source. These terminals also maintain drive control power and network communications when the main three-phase input power is removed.

<21> Use jumper S5 to select between voltage or current output signals at terminals AM and FM. Set parameters H4-07 and H4-08 accordingly.

Note: Use a stand-alone EMC filter for models 4☐0720 to 4☐0930.

◆ Main Circuit Connection Diagram

Refer to *Figure i.19* or *Figure i.20* when wiring the main circuit of the drive.

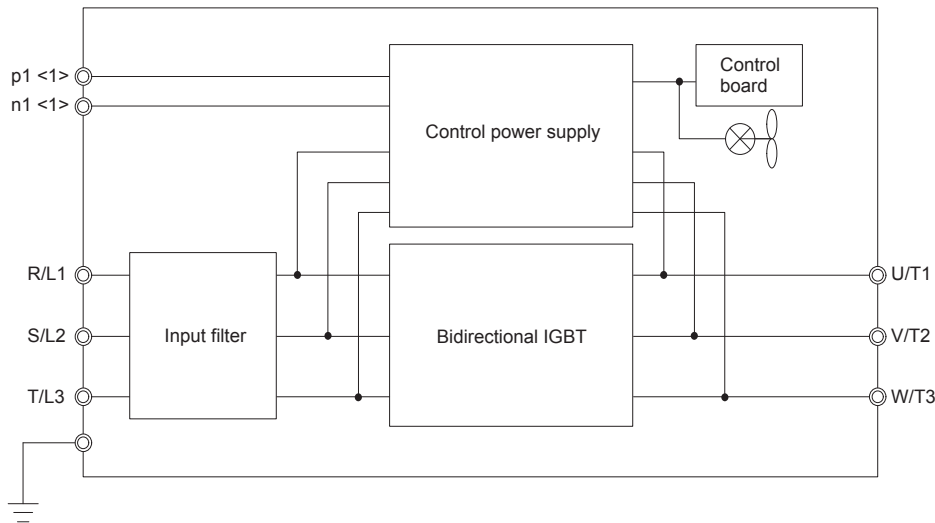## ◆ Drive Models 2□0028 to 2□0248 and 4□0011 to 4□0590

Figure i.19 Connecting Main Circuit Terminals

<1> A Momentary Power Loss Recovery Unit can be connected as an option. Do not connect an AC power supply to these terminals.

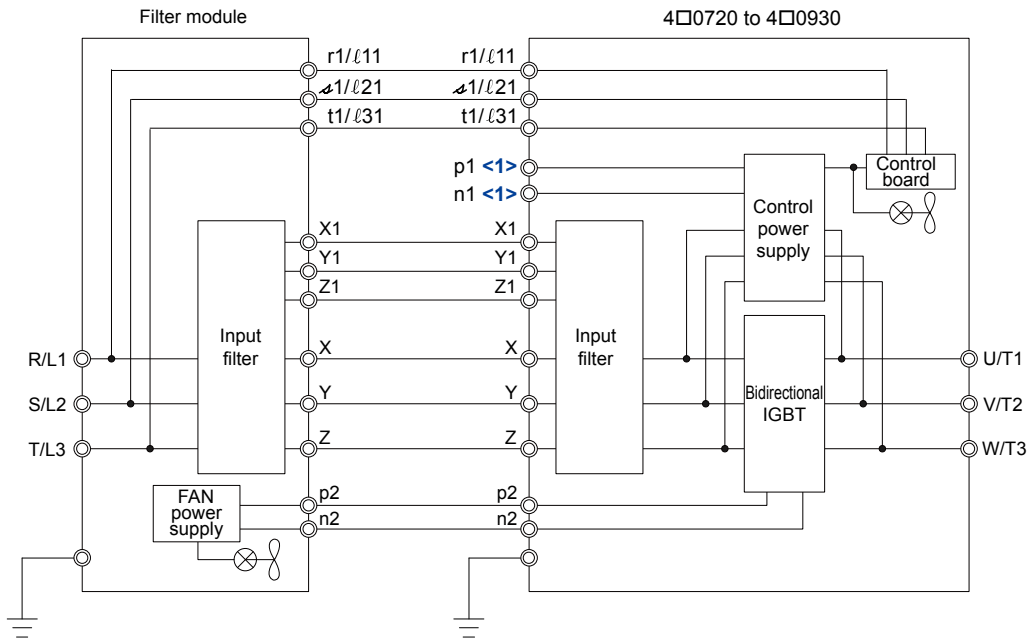## ◆ Drive Models 4□0720 to 4□0930 and Filter Modules

Figure i.20 Connecting Main Circuit Terminals

<1> A Momentary Power Loss Recovery Unit can be connected as an option. Do not connect an AC power supply to these terminals.

◆ Main Circuit Wiring

This section describes the functions, specifications, and procedures required to safely and properly wire the main circuit in the drive.

NOTICE: *Do not solder the ends of wire connections to the drive. Soldered wiring connections can loosen over time. Improper wiring practices could result in drive malfunction due to loose terminal connections.*

NOTICE: *Do not switch the drive input to start or stop the motor. Frequently switching the drive on and off shortens the lifetime of drive components, and can cause premature drive failures. For the full performance life, refrain from switching the drive on and off more than once every 30 minutes.*

◆ Main Circuit Terminal Functions

■ Drive Models 2☐0028 to 2☐0248 and 4☐0011 to 4☐0590

Table i.5 Main Circuit Terminal Functions

Voltage Class	Three-Phase 200 V Class	Three-Phase 400 V Class	Function	Page
Drive Model	2☐0028 to 2☐0248	4☐0011 to 4☐0590		
Terminal	Type			
R/L1, S/L2, T/L3	Main circuit power supply input		Connects line power to the drive	
U/T1, V/T2, W/T3	Drive output		Connects to the motor	26
p1, n1	Momentary power loss recovery unit input		DC voltage terminals that connect to a momentary power loss recovery unit	
⏚	100 Ω or less	10 Ω or less	Grounding terminal	41

■ Drive Models 4☐0720 to 4☐0930

Table i.6 Main Circuit Terminal Functions

Voltage Class	Three-Phase 400 V Class	Function	Page
Drive Model	4☐0720 to 4☐0930		
Terminal	Type		
X, Y, Z	Main circuit power supply input 1	Power supply input terminals that connect to the filter module.	
X1, Y1, Z1	Main circuit power supply input 2		
r1/ℓ11, ∡1/ℓ21, t1/ℓ31	Power supply voltage detection input	Connects to the filter module to detects the power supply voltage order and voltage levels.	28
U/T1, V/T2, W/T3	Drive output	Connects to the motor	
p1, n1	Momentary power loss recovery unit input	DC voltage terminals that connect to a momentary power loss recovery unit	
p2, n2	DC voltage output	DC voltage terminals that connect to the filter module	
⏚	100 Ω or less	Grounding terminal	41

■ Filter Module

Table i.7 Filter Module Main Circuit Terminal Functions

Terminal	Type	Function	Page
R/L1, S/L2, T/L3	Main circuit power supply input	Connects line power to the filter module	*28*
r1/ℓ11, ∡1/ℓ21, t1/ℓ31	Power supply voltage detection input	Connects to drive models 4□0720 to 4□0930 to detect the power supply voltage order and voltage levels	
X, Y, Z	Filter module output 1	Filter module output terminals that connect to drive models 4□0720 to 4□0930.	
X1, Y1, Z1	Filter module output 2		
p2, n2	DC voltage output	DC voltage terminals that connect to the drive models 4□0720 to 4□0930	
⏚	100 Ω or less	Grounding terminal	*41*

◆ Protecting Main Circuit Terminals

■ Insulation Caps or Sleeves

Use insulation caps or sleeves when wiring the drive with crimp terminals. Take particular care to ensure that the wiring does not touch nearby terminals or the surrounding case.

Insulation Barrier

Insulation barriers are packaged with drive models 4□0477 to 4□0930 to provide added protection between terminals. Yaskawa recommends using the provided insulation barriers to ensure proper wiring. Refer to *Figure i.21* for instructions on placement of the insulation barriers.
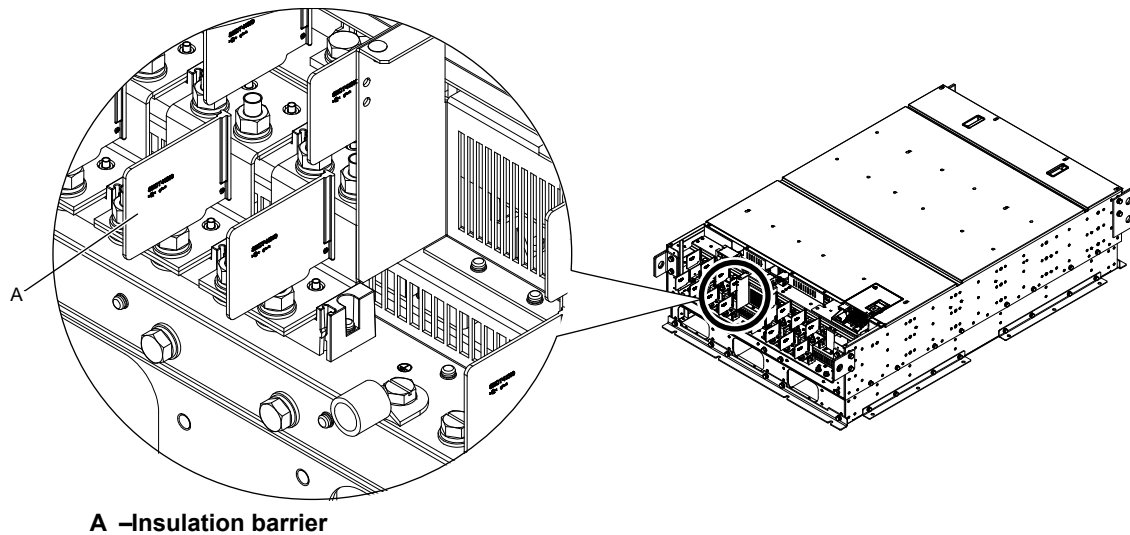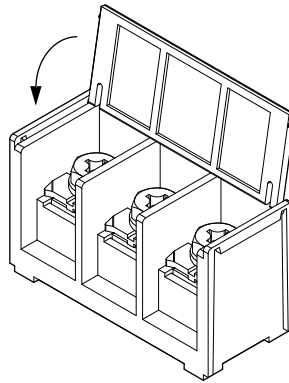

A –Insulation barrier

Figure i.21 Installing Insulation Barriers

■ Main Circuit Protective Cover

Close the protective cover after wiring the main circuit terminals on drive models 2□0028 to 2□0081 and 4□0011 to 4□0077.
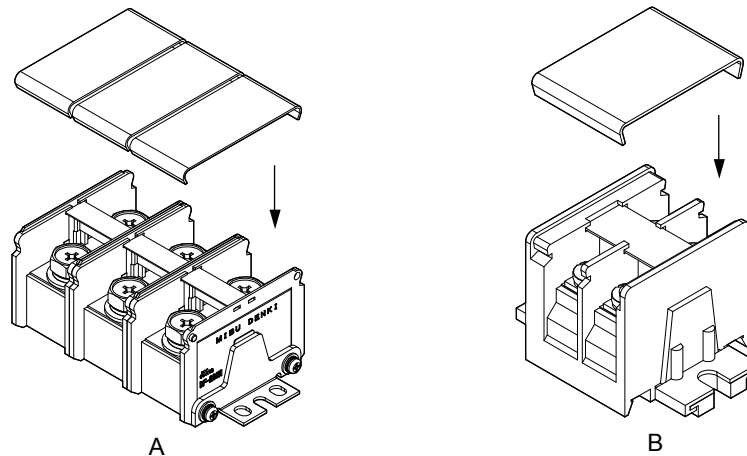
Figure i.22 Main Circuit Protective Cover (Drive Models 2☐0028 to 2☐0081 and 4☐0011 to 4☐0077)

Attach the protective covers after wiring the main circuit terminals and p1, and n1 terminals on drive models 2☐0104 to 2☐0248 and 4☐0096 to 4☐0590.

Attach the protective covers after wiring the main circuit terminals and the p1, n1, p2, n2, r1, ⊿1, and t1 terminals on drive models 4☐0720 to 4☐0930.

| A – Main circuit terminal | B – Terminals p1 and n1 |

Figure i.23 Protective Cover Example (Drive Model 2☐0104)

◆ Main Circuit Wire Gauges and Tightening Torque

Use the tables in this section to select the appropriate wires and crimp terminals.

Gauges listed in the tables are for use in the United States.

Note: The recommended wires for the main circuit are 600 V, Class 2 vinyl-insulated copper wires with a continuous maximum operating temperature of 75 °C (167 °F). Assume these conditions:
- Ambient temperature: 40 °C (104 °F) maximum
- Wiring distance: 100 m (328 ft) maximum
- Normal Duty rated current value

Consider the amount of voltage drop when selecting wire gauges. Increase the wire gauge when the voltage drop is greater than 2% of motor rated voltage. Ensure the wire gauge is suitable for the terminal block. Use the following formula to calculate the amount of voltage drop:

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

Refer to UL Standards Compliance on page 114 for information on UL compliance.

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

■ Three-Phase 200 V Class Drives

Table i.8 Drive Wire Gauge and Torque Specifications (Three-Phase 200 V Class)

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
2□0028	R/L1, S/L2, T/L3	10 (8)	6 to 10 (10 to 8)	4 (12)	2.5 to 10 (14 to 8)	M5	2.3 to 2.7 (20.4 to 23.9)
	U/T1, V/T2, W/T3	10 (8)	6 to 10 (10 to 8)	4 (12)	2.5 to 10 (14 to 8)	M5	
	⏚	10 (8)	6 to 16 (10 to 6)	6 (10)	6 to 16 (10 to 5)	M6	3.9 to 4.9 (34.7 to 43.4)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
2□0042	R/L1, S/L2, T/L3	16 (6)	10 to 25 (8 to 3)	10 (8)	6 to 25 (10 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	16 (6)	10 to 25 (8 to 3)	10 (8)	6 to 25 (10 to 3)	M6	
	⏚	10 (8)	6 to 25 (10 to 3)	10 (8)	6 to 25 (10 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
2□0054	R/L1, S/L2, T/L3	25 (4)	16 to 25 (6 to 3)	16 (5)	10 to 25 (8 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	25 (4)	16 to 25 (6 to 3)	16 (5)	10 to 25 (8 to 3)	M6	
	⏚	16 (6)	10 to 25 (8 to 3)	10 (8)	10 to 25 (8 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
2□0068	R/L1, S/L2, T/L3	25 (4)	25 (4 to 3)	16 (5)	16 to 25 (5 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	25 (4)	25 (4 to 3)	16 (5)	16 to 25 (5 to 3)	M6	
	⏚	16 (6)	16 to 25 (6 to 3)	16 (5)	16 to 25 (5 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
2□0081	R/L1, S/L2, T/L3	16 × 2 (6 × 2P)	16 to 25 × 2 (6 to 3 × 2P)	25 (3)	16 to 25 (5 to 3 × 2P)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	16 × 2 (6 × 2P)	16 to 25 × 2 (6 to 3 × 2P)	25 (3)	16 to 25 (5 to 3 × 2P)	M6	
	⏚	16 (6)	16 to 25 (6 to 3)	16 (5)	16 to 25 (5 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
2□0104	R/L1, S/L2, T/L3	35 (1)	16 to 50 × 2 (6 to 1/0 × 2P)	35 (1)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	8 to 10 (70.8 to 88.5)
	U/T1, V/T2, W/T3	35 (1)	16 to 50 × 2 (6 to 1/0 × 2P)	35 (1)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	
	⏚	25 (4)	25 to 35 (4 to 1)	25 (3)	10 to 35 (8 to 1)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
2☐0130	R/L1, S/L2, T/L3	25 × 2 (4 × 2P)	16 to 50 × 2 (6 to 1/0 × 2P)	16 × 2P (5 × 2P)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	8 to 10 (70.8 to 88.5)
	U/T1, V/T2, W/T3	25 × 2 (4 × 2P)	16 to 50 × 2 (6 to 1/0 × 2P)	16 × 2P (5 × 2P)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	
	⏚	25 (4)	25 to 35 (4 to 1)	16 (5)	16 to 35 (5 to 1)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
2☐0154	R/L1, S/L2, T/L3	25 × 2 (3 × 2P)	25 to 95 × 2 (4 to 4/0 × 2P)	25 × 2P (3 × 2P)	16 to 95 × 2P (5 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	25 × 2 (3 × 2P)	25 to 95 × 2 (4 to 4/0 × 2P)	25 × 2P (3 × 2P)	16 to 95 × 2P (5 to 4/0 × 2P)	M10	
	⏚	25 (4)	25 to 70 (4 to 2/0)	25 (3)	25 to 70 (3 to 2/0)	M10	17.7 to 22.6 (156 to 200)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
2☐0192	R/L1, S/L2, T/L3	35 × 2 (1 × 2P)	25 to 95 × 2 (3 to 4/0 × 2P)	35 × 2P (1 × 2P)	25 to 95 × 2P (3 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	35 × 2 (1 × 2P)	25 to 95 × 2 (3 to 4/0 × 2P)	35 × 2P (1 × 2P)	25 to 95 × 2P (3 to 4/0 × 2P)	M10	
	⏚	25 (3)	25 to 70 (4 to 2/0)	25 (3)	25 to 70 (3 to 2/0)	M10	17.7 to 22.6 (156 to 200)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
2☐0248	R/L1, S/L2, T/L3	70 × 2 (2/0 × 2P)	35 to 95 × 2 (1 to 4/0 × 2P)	50 × 2P (1/0 × 2P)	35 to 95 × 2P (1 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	70 × 2 (2/0 × 2P)	35 to 95 × 2 (1 to 4/0 × 2P)	50 × 2P (1/0 × 2P)	35 to 95 × 2P (1 to 4/0 × 2P)	M10	
	⏚	25 (3)	25 to 95 (4 to 4/0)	35 (1)	25 to 95 (3 to 4/0)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

■ Three-Phase 400 V Class Drives

Table i.9 Drive Wire Gauge and Torque Specifications (Three-Phase 400 V Class)

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
4☐0011	R/L1, S/L2, T/L3	2.5 (14)	2.5 to 10 (14 to 8)	2.5 (14)	2.5 to 10 (14 to 8)	M5	2.3 to 2.7 (20.4 to 23.9)
	U/T1, V/T2, W/T3	2.5 (14)	2.5 to 10 (14 to 8)	2.5 (14)	2.5 to 10 (14 to 8)	M5	
	⏚	6 (10)	4 to 16 (12 to 6)	2.5 (14)	2.5 to 16 (14 to 5)	M6	3.9 to 4.9 (34.7 to 43.4)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4☐0014	R/L1, S/L2, T/L3	4 (12)	2.5 to 10 (14 to 8)	2.5 (14)	2.5 to 10 (14 to 8)	M5	2.3 to 2.7 (20.4 to 23.9)
	U/T1, V/T2, W/T3	4 (12)	2.5 to 10 (14 to 8)	2.5 (14)	2.5 to 10 (14 to 8)	M5	
	⏚	6 (10)	4 to 16 (12 to 6)	2.5 (14)	2.5 to 16 (14 to 5)	M6	3.9 to 4.9 (34.7 to 43.4)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)

i.4 Electrical Installation

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
4□0021	R/L1, S/L2, T/L3	6 (10)	4 to 10 (12 to 8)	2.5 (14)	2.5 to 10 (14 to 8)	M5	2.3 to 2.7 (20.4 to 23.9)
	U/T1, V/T2, W/T3	6 (10)	4 to 10 (12 to 8)	2.5 (14)	2.5 to 10 (14 to 8)	M5	
	⏚	6 (10)	4 to 16 (12 to 6)	2.5 (14)	2.5 to 16 (14 to 5)	M6	3.9 to 4.9 (34.7 to 43.4)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4□0027	R/L1, S/L2, T/L3	10 (8)	6 to 10 (10 to 8)	4 (12)	2.5 to 10 (14 to 8)	M5	2.3 to 2.7 (20.4 to 23.9)
	U/T1, V/T2, W/T3	10 (8)	6 to 10 (10 to 8)	4 (12)	2.5 to 10 (14 to 8)	M5	
	⏚	10 (8)	4 to 16 (12 to 6)	4 (12)	4 to 16 (12 to 5)	M6	3.9 to 4.9 (34.7 to 43.4)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4□0034	R/L1, S/L2, T/L3	10 (8)	10 (8)	6 (10)	4 to 10 (12 to 8)	M5	2.3 to 2.7 (20.4 to 23.9)
	U/T1, V/T2, W/T3	10 (8)	10 (8)	6 (10)	4 to 10 (12 to 8)	M5	
	⏚	10 (8)	6 to 16 (10 to 6)	6 (10)	6 to 16 (10 to 5)	M6	3.9 to 4.9 (34.7 to 43.4)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4□0040	R/L1, S/L2, T/L3	10 (8)	10 to 25 (8 to 3)	10 (8)	6 to 25 (10 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	10 (8)	10 to 25 (8 to 3)	10 (8)	6 to 25 (10 to 3)	M6	
	⏚	10 (8)	10 to 25 (10 to 3)	10 (8)	6 to 25 (10 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4□0052	R/L1, S/L2, T/L3	16 (6)	10 to 25 (8 to 3)	10 (8)	10 to 25 (8 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	16 (6)	10 to 25 (8 to 3)	10 (8)	10 to 25 (8 to 3)	M6	
	⏚	16 (6)	10 to 25 (8 to 3)	10 (8)	10 to 25 (8 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4□0065	R/L1, S/L2, T/L3	25 (4)	16 to 25 (6 to 3)	16 (5)	10 to 25 (8 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	25 (4)	16 to 25 (6 to 3)	16 (5)	10 to 25 (8 to 3)	M6	
	⏚	16 (6)	16 to 25 (6 to 3)	16 (5)	16 to 25 (5 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)
4□0077	R/L1, S/L2, T/L3	25 (3)	25 (4 to 3)	25 (3)	16 to 25 (5 to 3)	M6	4 to 6 (35.4 to 53.1)
	U/T1, V/T2, W/T3	25 (3)	25 (4 to 3)	25 (3)	16 to 25 (5 to 3)	M6	
	⏚	16 (6)	16 to 25 (6 to 3)	16 (5)	16 to 25 (5 to 3)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1 to 1.4 (8.9 to 12.4)

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
4□0096	R/L1, S/L2, T/L3	35 (1)	10 to 50 (8 to 1/0 × 2P)	35 (1)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	8 to 10 (70.8 to 88.5)
	U/T1, V/T2, W/T3	35 (1)	10 to 50 (8 to 1/0 × 2P)	35 (1)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	
	⏚	25 (4)	25 to 35 (4 to 1)	25 (3)	10 to 35 (8 to 1)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0124	R/L1, S/L2, T/L3	25 × 2 (4 × 2P)	16 to 50 × 2 (6 to 1/0 × 2P)	16 × 2P (5 × 2P)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	8 to 10 (70.8 to 88.5)
	U/T1, V/T2, W/T3	25 × 2 (4 × 2P)	16 to 50 × 2 (6 to 1/0 × 2P)	16 × 2P (5 × 2P)	10 to 50 × 2P (8 to 1/0 × 2P)	M8	
	⏚	25 (4)	25 to 35 (4 to 1)	16 (5)	16 to 35 (5 to 1)	M8	8.8 to 10.8 (78.1 to 95.5)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0156	R/L1, S/L2, T/L3	25 × 2 (3 × 2P)	25 to 95 × 2 (4 to 4/0 × 2P)	25 × 2P (3 × 2P)	16 to 95 × 2P (5 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	25 × 2 (3 × 2P)	25 to 95 × 2 (4 to 4/0 × 2P)	25 × 2P (3 × 2P)	16 to 95 × 2P (5 to 4/0 × 2P)	M10	
	⏚	25 (4)	25 to 70 (4 to 2/0)	25 (3)	25 to 70 (3 to 2/0)	M10	17.7 to 22.6 (156 to 200)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0180	R/L1, S/L2, T/L3	35 × 2 (2 × 2P)	25 to 95 × 2 (3 to 4/0 × 2P)	25 × 2P (3 × 2P)	25 to 95 × 2P (3 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	35 × 2 (2 × 2P)	25 to 95 × 2 (3 to 4/0 × 2P)	25 × 2P (3 × 2P)	25 to 95 × 2P (3 to 4/0 × 2P)	M10	
	⏚	25 (3)	25 to 70 (4 to 2/0)	25 (3)	25 to 70 (3 to 2/0)	M10	17.7 to 22.6 (156 to 200)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0216	R/L1, S/L2, T/L3	50 × 2 (1/0 × 2P)	35 to 95 × 2 (2 to 4/0 × 2P)	35 × 2P (1 × 2P)	25 to 95 × 2P (3 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	50 × 2 (1/0 × 2P)	35 to 95 × 2 (2 to 4/0 × 2P)	35 × 2P (1 × 2P)	25 to 95 × 2P (3 to 4/0 × 2P)	M10	
	⏚	25 (3)	25 to 95 (4 to 4/0)	35 (1)	25 to 95 (3 to 4/0)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0240	R/L1, S/L2, T/L3	50 × 2 (1/0 × 2P)	50 to 95 × 2 (1/0 to 4/0 × 2P)	50 × 2P (1/0 × 2P)	35 to 95 × 2P (1 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	50 × 2 (1/0 × 2P)	50 to 95 × 2 (1/0 to 4/0 × 2P)	50 × 2P (1/0 × 2P)	35 to 95 × 2P (1 to 4/0 × 2P)	M10	
	⏚	35 (2)	35 to 95 (2 to 4/0)	50 (1/0)	35 to 95 (1 to 4/0)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0302 <1>	R/L1, S/L2, T/L3	70 × 2 (3/0 × 2P)	50 to 95 × 2 (1/0 to 4/0 × 2P)	70 × 2P (3/0 × 2P)	50 to 95 × 2P (1/0 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	70 × 2 (3/0 × 2P)	50 to 95 × 2 (1/0 to 4/0 × 2P)	70 × 2P (3/0 × 2P)	50 to 95 × 2P (1/0 to 4/0 × 2P)	M10	
	⏚	35 (1)	35 to 150 (1 to 300)	70 (3/0)	35 to 150 (1 to 300)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
4□0361 <1>	R/L1, S/L2, T/L3	95 × 2 (4/0 × 2P)	70 to 95 × 2 (3/0 to 4/0 × 2P)	95 × 2P (4/0 × 2P)	70 to 95 × 2P (3/0 to 4/0 × 2P)	M10	15 to 20 (130 to 173)
	U/T1, V/T2, W/T3	95 × 2 (4/0 × 2P)	70 to 95 × 2 (3/0 to 4/0 × 2P)	95 × 2P (4/0 × 2P)	70 to 95 × 2P (3/0 to 4/0 × 2P)	M10	
	⏚	50 (1/0)	50 to 150 (1/0 to 300)	95 (4/0)	70 to 150 (3/0 to 300)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0414 <1>	R/L1, S/L2, T/L3	150 × 2 (300 × 2P)	95 to 150 × 2 (4/0 to 300 × 2P)	95 × 2P (4/0 × 2P)	95 to 150 × 2P (4/0 to 300 × 2P)	M12	25 to 35 (217 to 304)
	U/T1, V/T2, W/T3	150 × 2 (300 × 2P)	95 to 150 × 2 (4/0 to 300 × 2P)	95 × 2P (4/0 × 2P)	95 to 150 × 2P (4/0 to 300 × 2P)	M12	
	⏚	50 (1/0)	50 to 240 (1/0 to 400)	95 (4/0)	70 to 240 (3/0 to 400)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0477 <1>	R/L1, S/L2, T/L3	95 × 4P (3/0 × 4P)	150 × 2P 70 to 150 × 4P (300 × 2P 2/0 to 300 × 4P)	120 × 2P (250 × 2P)	95 to 150 × 2P (4/0 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	U/T1, V/T2, W/T3	95 × 4P (3/0 × 4P)	150 × 2P 70 to 150 × 4P (300 × 2P 2/0 to 300 × 4P)	120 × 2P (250 × 2P)	95 to 150 × 2P (4/0 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	⏚	50 (1/0)	50 to 150 (1/0 to 300)	120 (250)	95 to 150 (4/0 to 300)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0590 <1>	R/L1, S/L2, T/L3	120 × 4P (250 × 4P)	95 to 150 × 4P (3/0 to 300 × 4P)	95 × 4P (4/0 × 4P)	120 to 150 × 2P 70 to 150 × 4P (250 to 300 × 2P 2/0 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	U/T1, V/T2, W/T3	120 × 4P (250 × 4P)	95 to 150 × 4P (3/0 to 300 × 4P)	95 × 4P (4/0 × 4P)	120 to 150 × 2P 70 to 150 × 4P (250 to 300 × 2P 2/0 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	⏚	70 (2/0)	70 to 150 (2/0 to 300)	95 × 2P (4/0 × 2P)	120 to 150 95 to 150 × 2P (250 to 300 4/0 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	p1, n1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0720 <1>	X, Y, Z	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	120 × 4P (250 × 4P)	95 to 150 × 4P (4/0 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X1, Y1, Z1	50 (1/0)	50 to 70 (1/0 to 2/0)	35 (1)	35 to 50 (1 to 1/0)	M8	5.4 to 6.0 (47.8 to 53.0)
	U/T1, V/T2, W/T3	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	120 × 4P (250 × 4P)	95 to 150 × 4P (4/0 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	⏚	95 (3/0)	95 to 150 (3/0 to 300)	120 × 2P (250 × 2P)	95 to 150 × 2P (4/0 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	r1, s1, t1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
	p1, n1	2.5 (14)	2.5 to 16 (14 to 6)	2.5 (14)	2.5 to 16 (14 to 6)	M5	2.0 to 2.5 (17.4 to 21.7)
	p2, n2	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

Drive Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
4□0900 <1>	X, Y, Z	95 × 8P (4/0 × 8P)	150 × 4P / 70 to 150 × 8P (300 × 4P / 2/0 to 300 × 8P)	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X1, Y1, Z1	50 (1/0)	50 to 70 (1/0 to 2/0)	35 (1)	35 to 50 (1 to 1/0)	M8	5.4 to 6.0 (47.8 to 53.0)
	U/T1, V/T2, W/T3	95 × 8P (4/0 × 8P)	150 × 4P / 70 to 150 × 8P (300 × 4P / 2/0 to 300 × 8P)	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	⏚	95 (4/0)	95 to 150 (4/0 to 300)	150 × 2P (300 × 2P)	120 to 150 × 2P (250 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	r1, s1, t1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
	p1, n1	2.5 (14)	2.5 to 16 (14 to 6)	2.5 (14)	2.5 to 16 (14 to 6)	M5	2.0 to 2.5 (17.4 to 21.7)
	p2, n2	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
4□0930 <1>	X, Y, Z	95 × 8P (4/0 × 8P)	95 to 150 × 8P (4/0 to 300 × 8P)	150 × 4P (300× 4P)	150 × 4P (300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X1, Y1, Z1	50 (1/0)	50 to 70 (1/0 to 2/0)	35 (1)	35 to 50 (1 to 1/0)	M8	5.4 to 6.0 (47.8 to 53.0)
	U/T1, V/T2, W/T3	95 × 8P (4/0 × 8P)	95 to 150 × 8P (4/0 to 300 × 8P)	150 × 4P (300 × 4P)	150 × 4P (300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	⏚	95 (4/0)	95 to 150 (4/0 to 300)	150 × 2P (300 × 2P)	150 × 2P (300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	r1, s1, t1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
	p1, n1	2.5 (14)	2.5 to 16 (14 to 6)	2.5 (14)	2.5 to 16 (14 to 6)	M5	2.0 to 2.5 (17.4 to 21.7)
	p2, n2	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

<1> Take additional measures in accordance with IEC/EN 61800-5-1 when wiring an EMC filter is installed. *Refer to Internal EMC Filter Installation on page 104* for details.

■ Filter Modules

Table i.10 Filter Module Wire Gauge and Torque Specifications for Models 4□0720 to 4□0930

Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
EUJ71180□.□ <1>	R/L1, S/L2, T/L3	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	120 × 4P (250 × 4P)	95 to 150 × 4P (4/0 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	X, Y, Z	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	120 × 4P (250 × 4P)	95 to 150 × 4P (4/0 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	X1, Y1, Z1	50 (1/0)	50 to 70 (1/0 to 2/0)	35 (1)	35 to 50 (1 to 1/0)	M8	5.4 to 6.0 (47.8 to 53.0)
	⏚	95 (3/0)	95 to 150 (3/0 to 300)	120 × 2P (250 × 2P)	95 to 150 × 2P (4/0 to 300)	M12	31.4 to 39.2 (278 to 347)
	r1, s1, t1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
	p2, n2	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

Model	Terminal	For USA and Canada		For South America		Screw Size	Tightening Torque N·m (lb.in.)
		Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)	Recomm. Gauge mm² (AWG, kcmil)	Applicable Gauge mm² (AWG, kcmil)		
EUJ71181□.□ *<1>*	R/L1, S/L2, T/L3	95 × 8P (4/0 × 8P)	150 × 4P 70 to 150 × 8P (300 × 4P 2/0 to 300 × 8P)	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X, Y, Z	95 × 8P (4/0 × 8P)	150 × 4P 70 to 150 × 8P (300 × 4P 2/0 to 300 × 8P)	150 × 4P (300 × 4P)	120 to 150 × 4P (250 to 300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X1, Y1, Z1	50 (1/0)	50 to 70 (1/0 to 2/0)	35 (1)	35 to 50 (1 to 1/0)	M8	5.4 to 6.0 (47.8 to 53.0)
	⏚	95 (4/0)	95 to 150 (4/0 to 300)	150 × 2P (300 × 2P)	120 to 150 × 2P (250 to 300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	r1, s1, t1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
	p2, n2	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
EUJ71182□.□ *<1>*	R/L1, S/L2, T/L3	95 × 8P (4/0 × 8P)	95 to 150 × 8P (4/0 to 300 × 8P)	150 × 4P (300 × 4P)	150 × 4P (300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X, Y, Z	95 × 8P (4/0 × 8P)	95 to 150 × 8P (4/0 to 300 × 8P)	150 × 4P (300 × 4P)	150 × 4P (300 × 4P)	M12	31.4 to 39.2 (278 to 347)
	X1, Y1, Z1	50 (1/0)	50 to 70 (1/0 to 2/0)	35 (1)	35 to 50 (1 to 1/0)	M8	5.4 to 6.0 (47.8 to 53.0)
	⏚	95 (4/0)	95 to 150 (4/0 to 300)	150 × 2P (300 × 2P)	150 × 2P (300 × 2P)	M12	31.4 to 39.2 (278 to 347)
	r1, s1, t1	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)
	p2, n2	2.5 (14)	2.5 to 4 (14 to 12)	2.5 (14)	2.5 to 4 (14 to 12)	M4	1.2 to 2.0 (10.4 to 17.4)

<1> Take additional measures in accordance with IEC/EN 61800-5-1 when wiring an EMC filter is installed. *Refer to Internal EMC Filter Installation on page 104* for details.

◆ Precautions on Reactive Current When Waiting to Run

This product features a built-in harmonic filter and circulating current (reactive current) flows against the harmonic filter when waiting to run.

Select wiring, circuit breakers, and magnetic contactors that take into consideration the circulating current values given below in *Table i.11* when temporarily turning ON the power supply, such as to set the parameters.

■ Circulating Current

The circulating current values shown in the following table are calculated with 240 V as 100% for 200 V class drives and 480 V as 100% for 400 V class drives. The circulating current values at other voltages vary as a proportion of the voltage.

For example, when the power supply voltage is 200 V, the circulating current value is 200 / 240 = 0.83-times.

Table i.11 Circulating Current Values

3-Phase 200 V Class			3-Phase 400 V Class		
Model CIMR-U□	Circulating Current [A]		Model CIMR-U□	Circulating Current [A]	
	50 Hz	60 Hz		50 Hz	60 Hz
2□0028	1.3	1.6	4□0011	0.9	1.0
2□0042	2.2	2.6	4□0014	1.3	1.6
2□0054	3.1	3.7	4□0021	1.7	2.1
2□0068	3.1	3.7	4□0027	2.2	2.6
2□0081	3.1	3.7	4□0034	2.6	3.1
2□0104	3.9	4.7	4□0040	4.4	5.2
2□0130	3.9	4.7	4□0052	6.1	7.3
2□0154	6.1	7.3	4□0065	6.1	7.3

3-Phase 200 V Class			3-Phase 400 V Class		
Model CIMR-U☐	Circulating Current [A]		Model CIMR-U☐	Circulating Current [A]	
	50 Hz	60 Hz		50 Hz	60 Hz
2☐0192	6.1	7.3	4☐0077	6.1	7.3
2☐0248	9.2	11.0	4☐0096	7.8	9.4
–	–	–	4☐0124	7.8	9.4
–	–	–	4☐0156	12.2	14.7
–	–	–	4☐0180	12.2	14.7
–	–	–	4☐0216	18.3	22.0
–	–	–	4☐0240	18.3	22.0
–	–	–	4☐0302	47.1	56.6
–	–	–	4☐0361	47.1	56.6
–	–	–	4☐0414	47.1	56.6
–	–	–	4☐0477	70.8	85.1
–	–	–	4☐0590	70.7	85.0
–	–	–	4☐0720	115.4	138.7
–	–	–	4☐0900	115.3	138.6
–	–	–	4☐0930	115.3	138.6

■ Countermeasure for Reactive Current When Waiting to Run

When waiting to run, the power factor of power supply drops due to the circulating current. If it is necessary to prevent this drop in the power factor of the power supply when waiting to run, shut OFF the main circuit power supply when waiting as shown in *Figure i.24*. In this case, select a model of 24 V Power Supply Unit Built-in (code: P) or a model of EMC Noise Filter and 24 V Power Supply Unit Built-in (code: W) as the customized specifications.
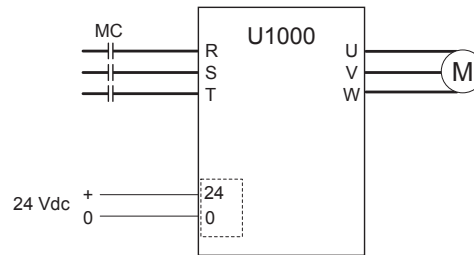
Figure i.24 Recommended Circuit as Countermeasure for Circulating Current

◆ Main Circuit Terminal and Motor Wiring

This section outlines the various steps, precautions, and checkpoints for wiring the main circuit terminals and motor terminals.

NOTICE: *When connecting the motor to the drive output terminals U/T1, V/T2, and W/T3, the phase order for the drive and motor should match. Failure to comply with proper wiring practices may cause the motor to run in reverse if the phase order is backward.*

NOTICE: *Route motor leads U/T1, V/T2, and W/T3 separate from all other leads to reduce possible interference related issues. Failure to comply may result in abnormal operation of drive and nearby equipment.*

■ Ground Wiring

Follow the precautions below when wiring the ground for one drive or a series of drives.

WARNING! *Electrical Shock Hazard. Always use a ground wire that complies with technical standards on electrical equipment and minimize the length of the ground wire. Improper equipment grounding may cause dangerous electrical potentials on equipment chassis, which could result in death or serious injury.*

WARNING! *Electrical Shock Hazard. Be sure to ground the drive ground terminal (200 V class: ground to 100 Ω or less; 400 V class: ground to 10 Ω or less). Improper equipment grounding could result in death or serious injury by contacting ungrounded electrical equipment.*

NOTICE: *Do not share the ground wire with other devices such as welding machines or large-current electrical equipment. Improper equipment grounding could result in drive or equipment malfunction due to electrical interference.*

NOTICE: *When using more than one drive, ground multiple drives according to instructions. Improper equipment grounding could result in abnormal operation of drive or equipment.*

Refer to *Figure i.25* when using multiple drives or when using multiple drive models 4□0720 to 4□0930 that are connected with filter module. Do not loop the ground wire.
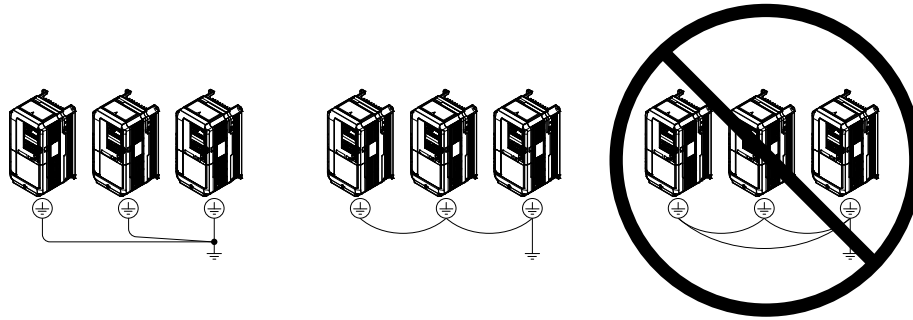
Figure i.25 Multiple Drive Wiring

◆ Control Circuit Terminal Block Functions

Drive parameters determine which functions apply to the multi-function digital inputs (S1 to S8), multi-function digital outputs (M1 to M6), multi-function analog inputs (A1 to A3), and multi-function analog monitor outputs (FM, AM). The default setting is listed next to each terminal in *Figure i.17* on page *26*.

WARNING! *Sudden Movement Hazard. Always check the operation and wiring of control circuits after being wired. Operating a drive with untested control circuits could result in death or serious injury.*

WARNING! *Sudden Movement Hazard. Confirm the drive I/O signals and external sequence before starting test run. Setting parameter A1-06 may change the I/O terminal function automatically from the factory setting. Failure to comply may result in death or serious injury.*

■ Input Terminals

Table i.12 lists the input terminals on the drive. Text in parenthesis indicates the default setting for each multi-function input.

Table i.12 Control Circuit Input Terminals

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 • *Refer to Sinking/Sourcing Mode for Digital Inputs on page 48*.
	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 (Baseblock command (N.O.))	
	SC	Multi-function input common	Multi-function input common
	SP	Digital input power supply +24 Vdc	24 Vdc power supply for digital inputs, 150 mA max (only when not using digital input option DI-A3)
	SN	Digital input power supply 0 V	**NOTICE:** *Do not jumper or short terminals SP and SN. Failure to comply will damage the drive.*

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Safe Disable Inputs	H1	Safe Disable input 1	• 24 Vdc, 8 mA
	H2	Safe Disable input 2	• One or both open: 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 as explained on page *48*.
	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 (Auxiliary frequency reference)/PTC Input	• -10 to 10 Vdc, 0 to 10 Vdc (input impedance: 20 kΩ) • Use DIP switch S4 on the terminal board to select between analog and PTC input.
	AC	Frequency reference common	0 V
	E (G)	Ground for shielded lines and option cards	–

■ Output Terminals

Table i.13 lists the output terminals on the drive. Text in parenthesis indicates the default setting for each multi-function output.

Table i.13 Control Circuit Output Terminals

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Fault Relay Output	MA	N.O. output (Fault)	30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA
	MB	N.C. output (Fault)	
	MC	Fault output common	
Multi-Function Digital Output *<1>*	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)	
	M4		
	M5	Multi-function digital output (Speed Agree 1)	
	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
	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	
External Power Supply	24V	External power supply	24 V (Max. 150 mA)

<1> Refrain from assigning functions to digital relay outputs that involve frequent switching, as doing so may shorten relay performance life. Switching life is estimated at 200,000 times (assumes 1 A, resistive load).

■ Serial Communication Terminals

Table i.14 Control Circuit Terminals: Serial Communications

Type	No.	Signal Name	Function (Signal Level)	
MEMOBUS/Modbus Communication [1]	R+	Communications input (+)	MEMOBUS/Modbus communication: Use an RS-422 or RS-485 cable to connect the drive.	RS-422/RS-485 MEMOBUS/Modbus communication protocol 115.2 kbps (max.)
	R-	Communications input (-)		
	S+	Communications output (+)		
	S-	Communications output (-)		
	IG	Shield ground	0 V	

<1> Enable the termination resistor in the last drive in a MEMOBUS/Modbus network by setting DIP switch S2 to the ON position. *Refer to Sinking/Sourcing Mode for Digital Inputs on page 48* for more information.

◆ Terminal Configuration

The control circuit terminals should be arranged as shown in *Figure i.26*.

A – Terminal Block (TB 2)
B – Terminal Block (TB 5)
C – Terminal Block (TB 1)
D – Terminal Block (TB 3)
E – Terminal Block (TB 4)
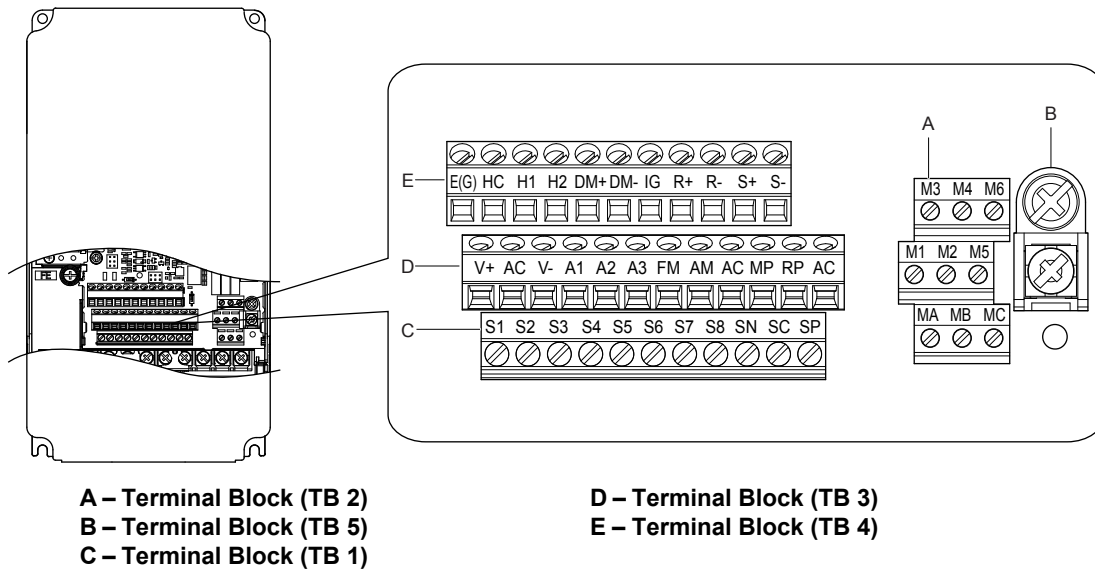
Figure i.26 Control Circuit Terminal Arrangement

■ Wire Size and Torque Specifications

Select appropriate wire type and gauges from *Table i.15*. For simpler and more reliable wiring, use crimp ferrules on the wire ends.

Table i.15 Wire Gauges and Torque Specifications

Terminal Block	Terminal	Screw Size	Tightening Torque N•m (lb. in)	Bare Wire Terminal		Ferrule-Type Terminal		Wire Type
				Recomm. Gauge mm² (AWG)	Applicable Gauge mm² (AWG)	Recomm. Gauge mm² (AWG)	Applicable Gauge mm² (AWG)	
TB1, TB2, TB3, TB4	FM, AC, AM, P1, P2, PC, SC, A1, A2, A3, +V, -V, S1-S8, MA, MB, MC, M1, M2, HC, H1, H2, DM+, DM-, IG, R+, R-, S+, S-, RP, MP	M3	0.5 to 0.6 (4.4 to 5.3)	0.75 (18)	Stranded wire: 0.2 to 1.0 (24 to 17) Solid wire: 0.2 to 1.5 (24 to 16)	0.5 (20)	0.25 to 0.5 (24 to 20)	Shielded wire, etc.
	E(G)			1.0 (16)				
TB5	E(G)	M3.5	0.5 to 1.0 (4.4 to 8.9)	1.25 (12)	0.5 to 2 (20 to 14)	–	–	

■ Ferrule-Type Wire Terminals

Yaskawa recommends using CRIMPFOX 6, a crimping tool manufactured by PHOENIX CONTACT, to prepare wire ends with insulated sleeves before connecting to the drive. See *Table i.16* for dimensions.
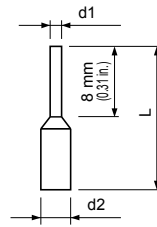
Figure i.27 Ferrule Dimensions

Table i.16 Ferrule Terminal Types and Sizes

Size mm² (AWG)	Type	L mm (in)	d1 mm (in)	d2 mm (in)	Manufacturer
0.25 (24)	AI 0.25-8YE	12.5 (0.49)	0.8 (0.03)	2.0 (0.08)	
0.34 (22)	AI 0.34-8TQ	12.5 (0.49)	0.8 (0.03)	2.0 (0.08)	PHOENIX CONTACT
0.5 (20)	AI 0.5-8WH AI 0.5-8OG	14.0 (0.55)	1.1 (0.04)	2.5 (0.10)	

◆ Wiring the Control Circuit Terminal

This section describes the proper procedures and preparations for wiring the control terminals.

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

NOTICE: *Separate control circuit wiring from main circuit wiring and other high-power lines. Improper wiring practices could result in drive malfunction due to electrical interference.Main circuit terminals vary by drive model. Refer to Main Circuit Terminal Functions on page 31 for details.*

NOTICE: *Separate wiring for digital output terminals MA, MB, MC, and M1 to M6 from wiring to other` control circuit lines. Improper wiring practices could result in drive or equipment malfunction or nuisance trips.*

NOTICE: *Use a class 2 power supply when connecting to the control terminals. Improper application of peripheral devices could result in drive performance degradation due to improper power supply. Refer to NEC Article 725 Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power Limited Circuits for requirements concerning class 2 power supplies.*

NOTICE: *Insulate shields with tape or shrink tubing to prevent contact with other signal lines and equipment. Improper wiring practices could result in drive or equipment malfunction due to short circuit.*

NOTICE: *Connect the shield of shielded cable to the appropriate ground terminal. Improper equipment grounding could result in drive or equipment malfunction or nuisance trips.*

NOTICE: *Do not tighten screws beyond the specified tightening torque. Failure to comply may result in erroneous operation, damage to the terminal block, or cause a fire.*

NOTICE: *Use shielded twisted-pair cables as indicated to prevent operating faults. Improper wiring practices could result in drive or equipment malfunction due to electrical interference.*

Wire the control circuit only after terminals have been properly grounded and main circuit wiring is complete. *Refer to Terminal Board Wiring Guide on page 46* for details. Prepare the ends of the control circuit wiring as shown in *Figure i. 30*. *Refer to Wire Gauges and Torque Specifications on page 44*.

Connect control wires as shown in *Figure i.28* and *Figure i.29*.
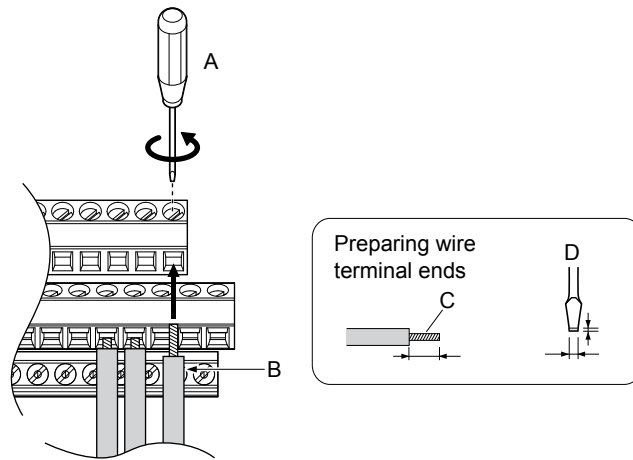
A – Loosen screw to insert wire.
B – Single wire or stranded wire

C – Avoid fraying wire strands when stripping insulation from wire. Strip length 5.5 mm.
D – Blade depth of 0.4 mm or less Blade width of 2.5 mm or less

Figure i.28 Terminal Board Wiring Guide
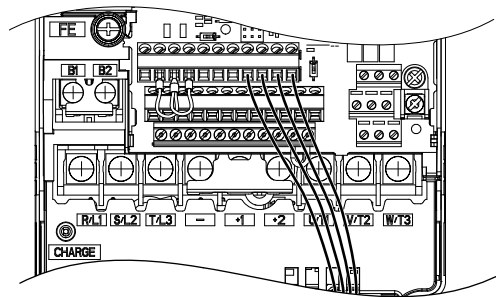
Figure i.29 Terminal Board Location Inside the Drive

When setting the frequency by analog reference from an external potentiometer, use shielded twisted-pair wires (preparing wire ends as shown in *Figure i.30*) and connect the shield to the ground terminal of the drive.
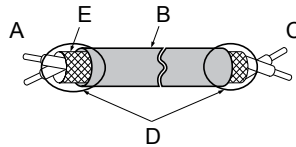
A – Drive side
B – Insulation
C – Control device side

D – Shield sheath (insulate with tape)
E – Shield

Figure i.30 Preparing the Ends of Shielded Cables

NOTICE: *The analog signal wiring between the drive and the operator station or peripheral equipment should not exceed 50 meters when using an analog signal from a remote source to supply the frequency reference. Failure to comply could result in poor system performance.*

◆ Module Communications Connector

The module communications connector port allows the transfer of information to enable turning on and operating drive models 4□0720 to 4□0930 and the filter module.

   Note: Connect the drive and filter module before turning on or operating models 4□0720 to 4□0930.

Refer to Drive Standard Connection Diagram (Example: Model 4□0720) on page 28 for more information on module communications connector functions.

■ **Module Communications Connector Locations**

Connect drive models 4□0720 to 4□0930 to the filter module using the module communications connector cable packaged with the filter module.

Connect one end of the cable to the module communications connector port CN500 of the drive and the other end of the cable to the module communications connector port CN500 of the filter module.

Insert both ends of the cable then gently pull the cable to ensure a secure connection.

Drive Models 4□0720 to 4□0930
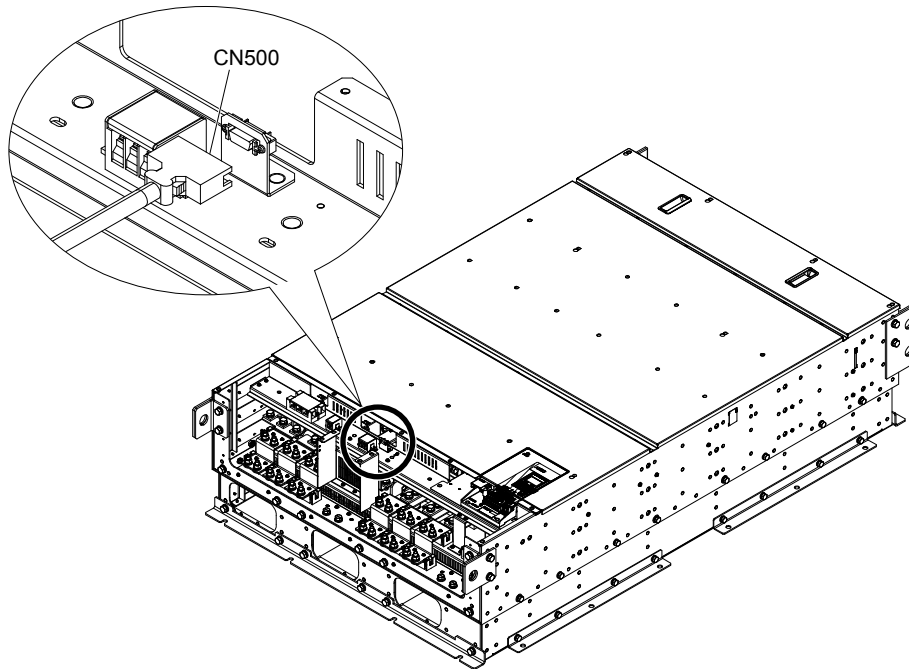
Figure i.31 Module Communications Connector Port CN500 Location

Filter Module
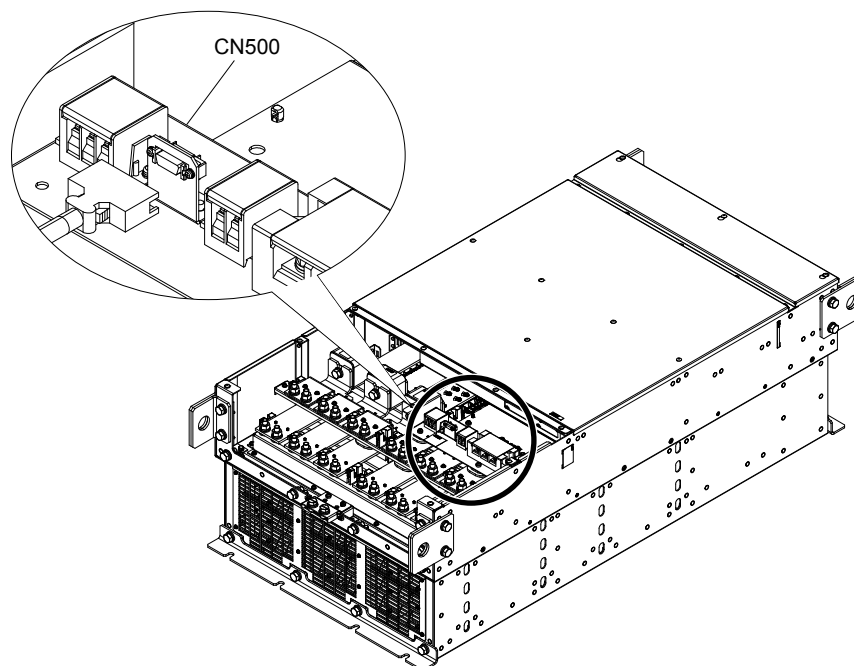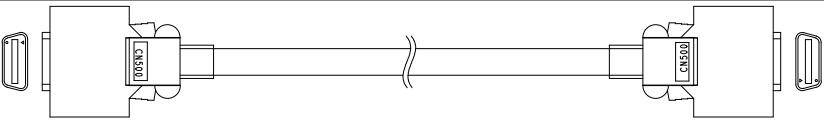
Figure i.32 Module Communications Connector Port CN500 Location

■ Cable Specifications

Table i.17 Module Communications Connector Cable Specifications
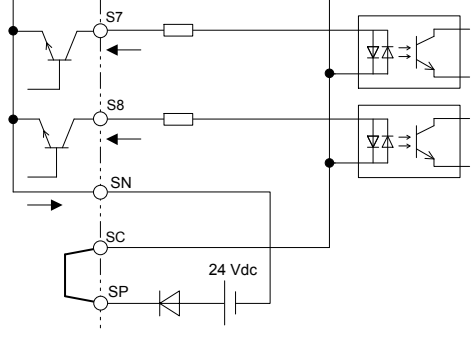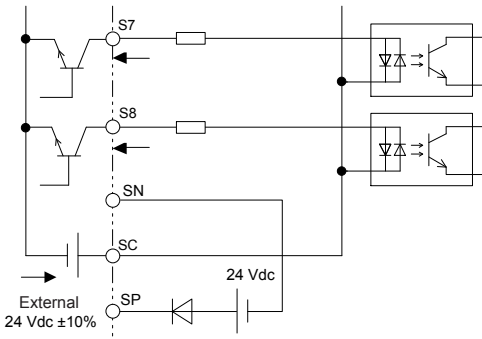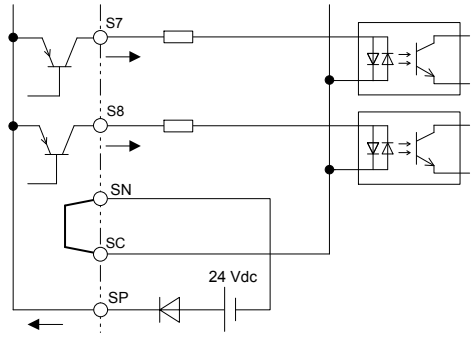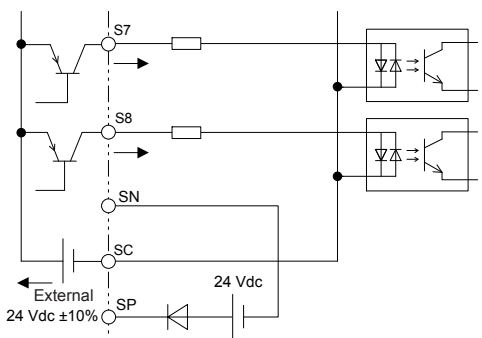
Cable Length	Cable Connector Exterior	Cable Example
Approximately 5 m (16.4 ft)	Half-pitch I/O connector (1.27 mm [0.05 in.])	

◆ Sinking/Sourcing Mode for Digital Inputs

Use the wire jumper between terminals SC and SP or SC and SN to select between Sink mode, Source mode or external power supply for the digital inputs S1 to S8 as shown in *Table i.18* (Default: Sink mode, internal power supply).

NOTICE: *Do not short terminals SP and SN. Failure to comply will damage the drive.*

Table i.18 Digital Input Sink/Source/External Power Supply Selection

Mode	Drive Internal Power Supply (Terminals SN and SP)	External 24 Vdc Power Supply
Sinking Mode (NPN)		
Sourcing Mode (PNP)		

◆ Sinking/Sourcing Mode Selection for Safe Disable Inputs

Use jumper S3 on the terminal board to select between Sink mode, Source mode or external power supply for the Safe Disable inputs H1 and H2 as shown in *Table i.19* (Default: Source mode, internal power supply).

Remove the jumper wire connected to the HC terminals and connect terminals H1 and H2 as shown in *Table i.19* to use an external power supply for a sequence input without using a safety input.

WARNING! *Electrical Shock Hazard. Be sure to remove the jumper wire connected to the HC terminals if using en external power supply for a sequence input without using a safety input. Failure to comply will short circuit the external power supply.*

Table i.19 Safe Disable Input Sink/Source/External Power Supply Selection

Mode	Drive Internal Power Supply	External 24 Vdc Power Supply
Sinking Mode		
Sourcing Mode		

◆ Using the Pulse Train Output

The pulse train output terminal MP can supply power or be used with an external power supply.

NOTICE: *Connect peripheral devices in accordance with the specifications. Failure to comply may cause unexpected drive operation, and can damage the drive or connected circuits.*

■ Using Power from the Pulse Output Terminal (Source Mode)

The high voltage level of the pulse output terminal depends on the load impedance.

Load Impedance R_L (kΩ)	Output Voltage V_{MP} (V) (insulated)
1.5 kΩ	5 V
4 kΩ	8 V
10 kΩ	10 V

Note: The load resistance needed in order to get a certain high level voltage V_{MP} can be calculated by: $R_L = V_{MP} \cdot 2 / (12 - V_{MP})$
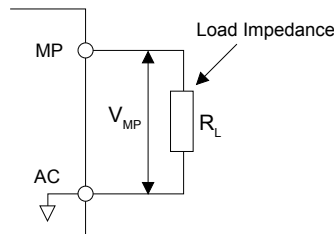
Figure i.33 Pulse Output Connection Using Internal Voltage Supply

■ Using External Power Supply (Sink Mode)

The high voltage level of the pulse output signal depends on the external voltage applied. The voltage must be between 12 and 15 Vdc. The load resistance must be adjusted so that the current is lower than 16 mA.

External Power Supply (V)	Load Impedance (kΩ)
12 to 15 Vdc ±10%	1.0 kΩ or higher
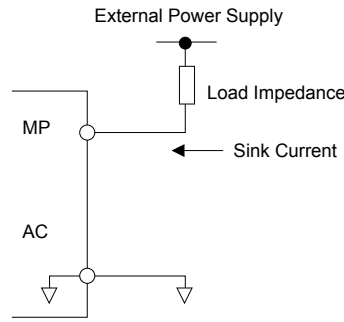
Figure i.34 Pulse Output Connection Using External Voltage Supply

◆ Terminal A2 Input Signal Selection

Terminal A2 can be used to input either a voltage or a current signal. Select the signal type using switch S1 as explained in *Table i.20*. Set parameter H3-09 accordingly as shown in *Table i.21*.

Note: If terminals A1 and A2 are both set for frequency bias (H3-02 = 0 and H3-10 = 0), both input values will be combined to create the frequency reference.

Table i.20 DIP Switch S1 Settings

Setting	Description
V (left position)	Voltage input (-10 to +10 V or 0 to 10 V)
I (right position)	Current input (4 to 20 mA or 0 to 20 mA): default setting

Table i.21 Parameter H3-09 Details

No.	Parameter Name	Description	Setting Range	Default Setting
H3-09	Terminal A2 Signal Level Selection	Selects the signal level for terminal A2. 0: 0 to 10 Vdc 1: -10 to 10 Vdc 2: 4 to 20 mA 3: 0 to 20 mA	0 to 3	2

◆ Terminal A3 Analog/PTC Input Selection

Terminal A3 can be configured either as multi-function analog input or as PTC input for motor thermal overload protection. Use switch S4 to select the input function as described in *Table i.22*.

Table i.22 DIP Switch S4 Settings

Setting	Description
AI (lower position) (default)	Analog input for the function selected in parameter H3-06
PTC (upper position)	PTC input. Parameter H3-06 must be set to E (PTC input)

◆ Terminal AM/FM Signal Selection

The signal type for terminals AM and FM can be set to either voltage or current output using jumper S5 on the terminal board as explained in *Table i.23*. When changing the setting of jumper S5, parameters H4-07 and H4-08 must be set accordingly. The default selection is voltage output for both terminals.

Table i.23 Jumper S5 Settings

Terminal	Voltage Output	Current Output
Terminal AM		
Terminal FM		

Table i.24 Parameter H4-07 and H4-08 Details

No.	Parameter Name	Description	Setting Range	Default Setting
H4-07	Terminal FM signal level selection	0: 0 to 10 Vdc	0 to 2	0
H4-08	Terminal AM signal level selection	1: -10 to 10 Vdc 2: 4 to 20 mA		

◆ MEMOBUS/Modbus Termination

This drive is equipped with a built-in termination resistor for the RS-422/RS-485 communication port. DIP switch S2 enables or disabled the termination resistor as shown in *Table i.25*. The OFF position is the default. The termination resistor should be placed to the ON position when the drive is the last in a series of slave drives.

Table i.25 MEMOBUS/Modbus Switch Settings

S2 Position	Description
ON	Internal termination resistor ON
OFF	Internal termination resistor OFF (default setting)

◆ Terminal DM+ and DM- Output Signal Selection

Slide switch S6 selects N.C. or N.O. as the state of the DM+ and DM- terminals for EDM output.

Table i.26 EDM Switch Settings

S2 Position	Description
N.O.	Normally open
N.C.	Normally closed (default setting)

Note: *Refer to Safe Disable Input Function on page 122* for details on EDM.

◆ Enable the Internal EMC Filter

Drive models UU□E□□□□ and UU□W□□□□ have a built-in EMC filter. Change the placement of the EMC filter screw when switching between enabled (ON) or disabled (OFF). *Refer to Drive Model Number Definition on page 16* for model number definition.

DANGER! *Electrical Shock Hazard. Do not touch SW screw while power is applied to the drive. Failure to comply will result in death or serious injury.*

WARNING! *Electrical Shock Hazard. Connect the ground cable correctly. Failure to comply may result in death or serious injury.*

NOTICE: *When disabling the internal EMC filter, move the screws from ON to OFF and then tighten to the specified torque. Completely removing the screws or tightening the screws to an incorrect torque may cause drive failure.*

NOTICE: *Prevent Drive Damage: Install the two EMC filter screws in the same position (ON and ON, or OFF and OFF). Failure to comply may result in serious damage to the drive.*

NOTICE: *Prevent Drive Damage: Install the EMC filter screw in the OFF position. Installing the EMC filter screw disables the internal EMC filter in the network is grounded as follows. Failure to comply may result in serious damage to the drive.*

- Floating network
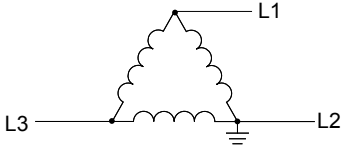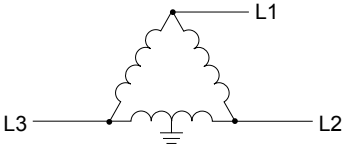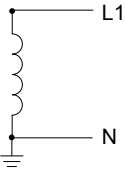- High impedance grounded network
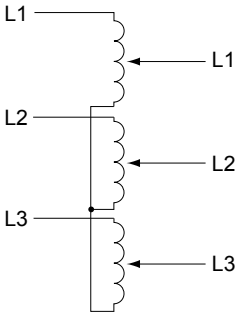- Asymmetrically grounded network

Note: 1. Models CIMR-U□4□0477 to 4□0930 are not available. Be sure to use a stand-alone EMC filter for models CIMR-U□4□0477 to 4□0930.
2. Models CIMR-U□2E0248, 2W0248, 4E0216, 4E0240 have two EMC filter screws.
3. For floating, impedance grounded, or asymmetrically grounded networks, disconnect the internal EMC filter by moving the SW screw to the OFF position.

Use size M4 internal EMC filter screws with 1.0 to 1.3 N·m tightening torque.

■ Asymmetrical Grounded Network

Table i.27 shows asymmetrical grounded networks. Asymmetrical networks require first moving the SW screw to disconnect the internal ground connection. (Drives are shipped with the SW screw installed at the OFF position.)

Table i.27 Asymmetrical Grounded Network

Characteristics	Diagram
Grounded at the corner of the delta	
Grounded at the middle of the side	
Single-phase, grounded at the end point	
Three-phase variable transformer without solidly grounded neutral	

■ Symmetrical Grounded Network

When EMC is a concern for drives with internal EMC filters and the network is grounded symmetrically, install the EMC filter screw to the ON position and enable the internal EMC filter.

Drives ship from the factory with EMC filter screws installed in the OFF position.
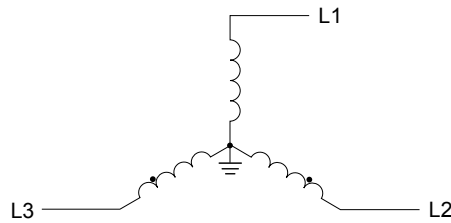
Figure i.35 Symmetrical Grounded Network

■ **EMC Filter Switch Location**
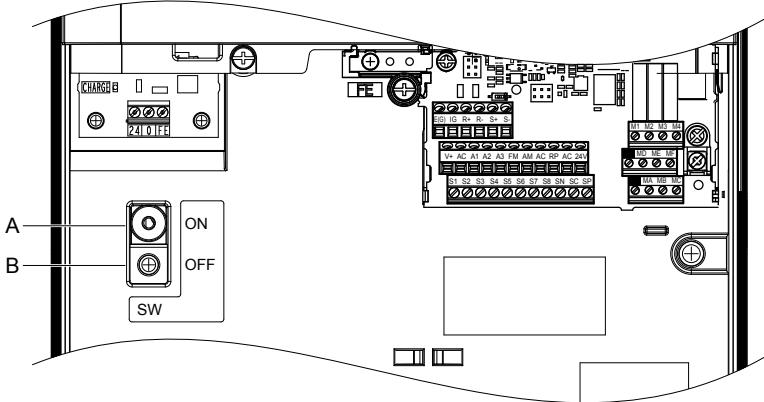
A – SW (ON)   **B – Screw (OFF)**

Figure i.36 EMC Filter Switch Location
(Drive Models 2E0028, 2W0028, 4E0011 to 4E0034, and 4W0011 to 4W0034)
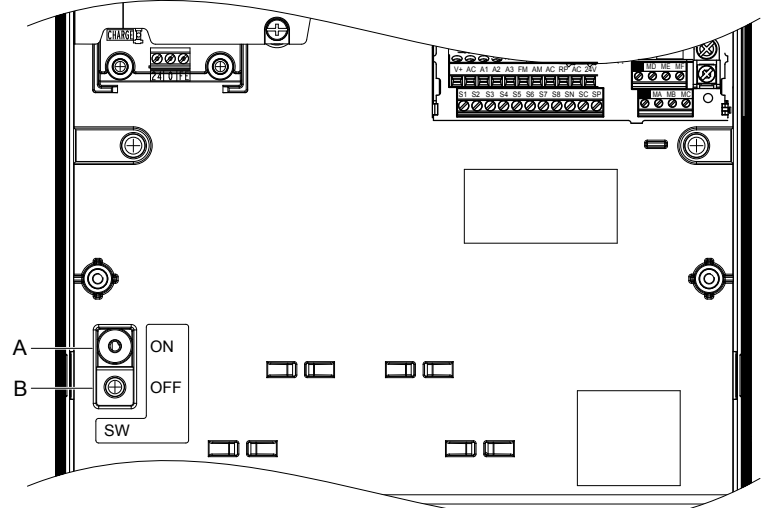
A – SW (ON)   **B – Screw (OFF)**

Figure i.37 EMC Filter Switch Location
(Drive Models 2E0042, 2W0042, 2E0054, 2W0054, 4E0040 to 4E0077, and 4W0040 to 4W0077)
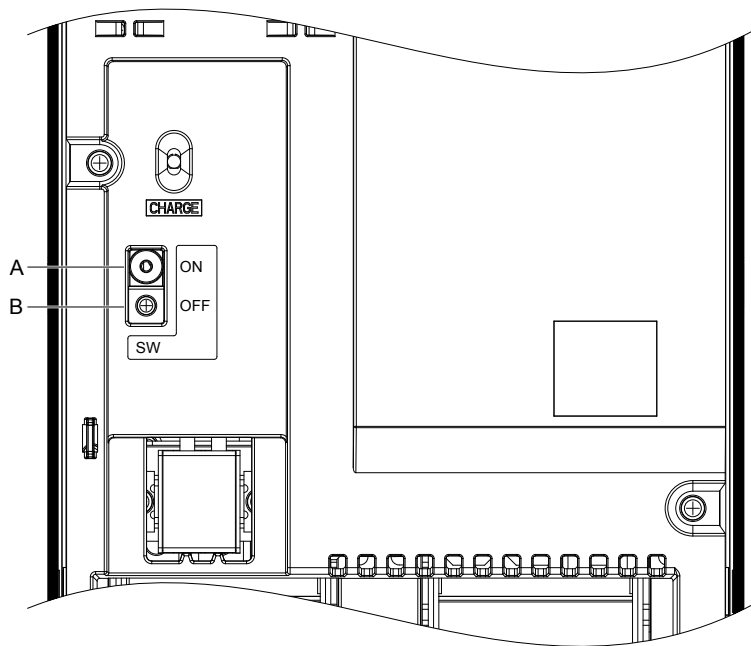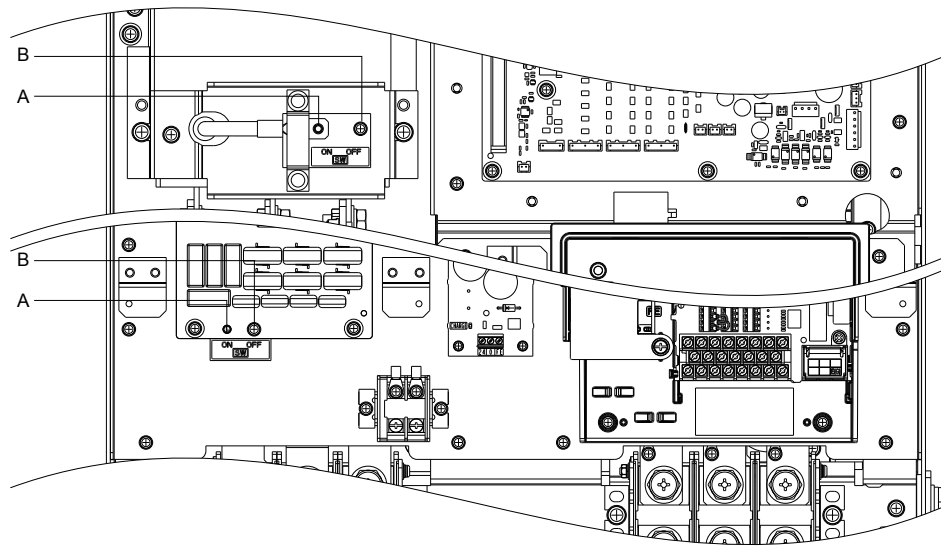
A – SW (ON)   **B – Screw (OFF)**

Figure i.38 EMC Filter Switch Location
(Drive Models 2E0104, 2W0104, 2E0130, 2W0130, 4E0096, 4W0096, 4E0124, and 4W0124)
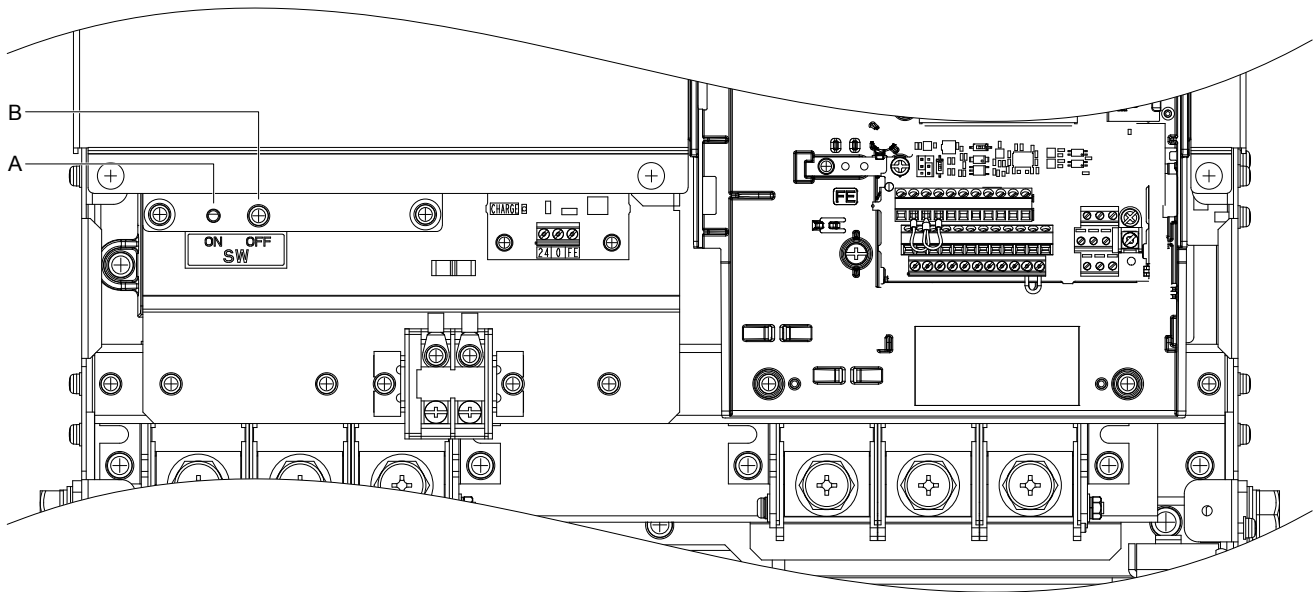
A – SW (ON)   **B – Screw (OFF)**

Figure i.39 EMC Filter Switch Location
(Drive Models 2E0154, 2W0154, 2E0192, 2W0192, 4E0156, 4W0156, 4E0180, and 4W0180)

A – SW (ON)   **B – Screw (OFF)**

**Figure i.40 EMC Filter Switch Location
(Drive Models 2E0248, 2W0248, 4EU0216, 4W0216, 4E0240, and 4W0240)**
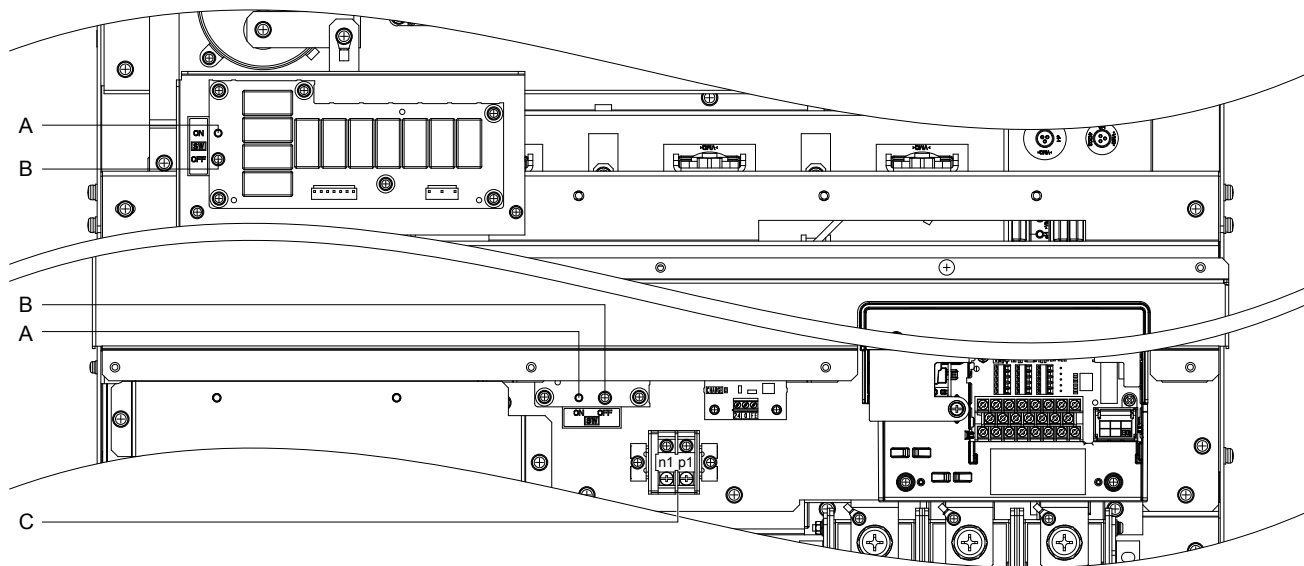
A – SW (ON)   **C – Terminals p1 and n1**
B – Screw (OFF)

**Figure i.41 EMC Filter Switch Location
(Drive Models 4E0302 to 4E0414 and 4W0302 to 4W0414)**

◆ 24 V Control Power Supply Unit Wiring

■ 24 V Control Power Supply Unit

The 24 V Control Power Supply Unit maintains drive control circuit power in the event of a main power outage. As long as the control circuit has power, network communications and I/O data remain operational. The unit provides external power to the control circuit only, and does not provide power to the main circuit of the drive.

It is possible to read fault and parameter data in the drive via the operator or network communications when the drive switches to the 24 V Control Power Supply Unit as a back-up power supply.
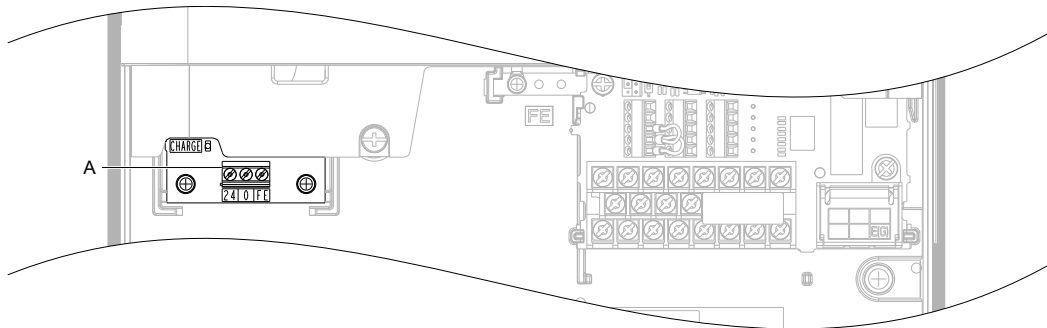
Note: Parameter settings cannot be changed without drive main circuit power regardless of whether the control circuit has enough power to operate.

■ 24 V Control Power Supply Unit Location
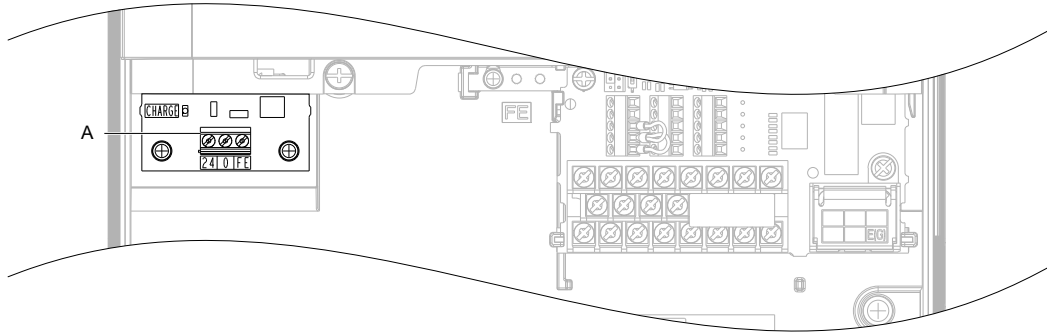
A –Power Supply Terminal Block TB1

Figure i.42 24 V Control Power Supply Unit Location
(Models 2P0028, 2W0028, 4P0011 to 4P0034, and 4W0011 to 4W0034)

A –Power Supply Terminal Block TB1

Figure i.43 24 V Control Power Supply Unit Location
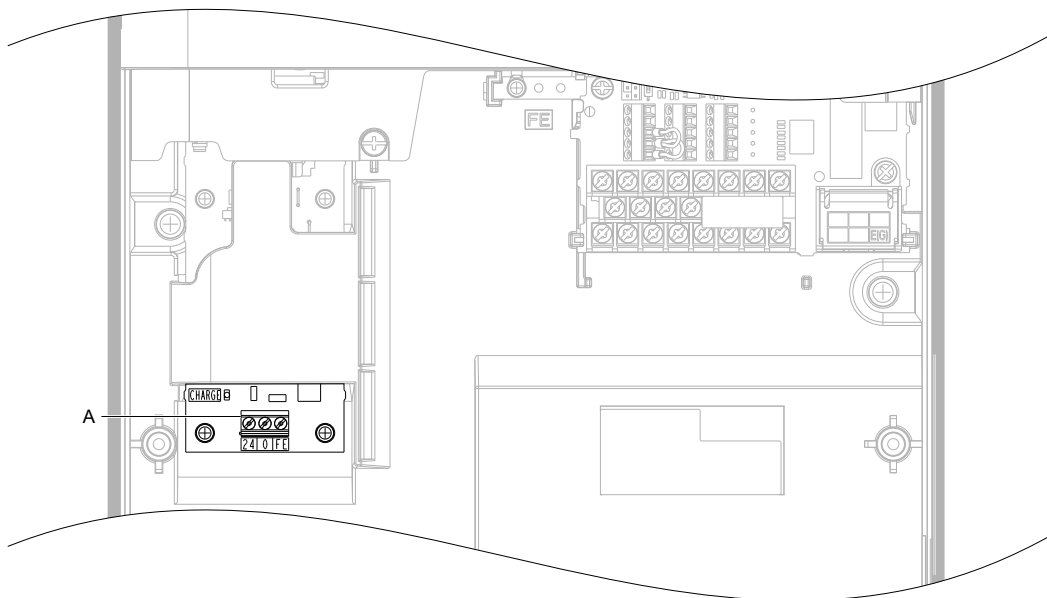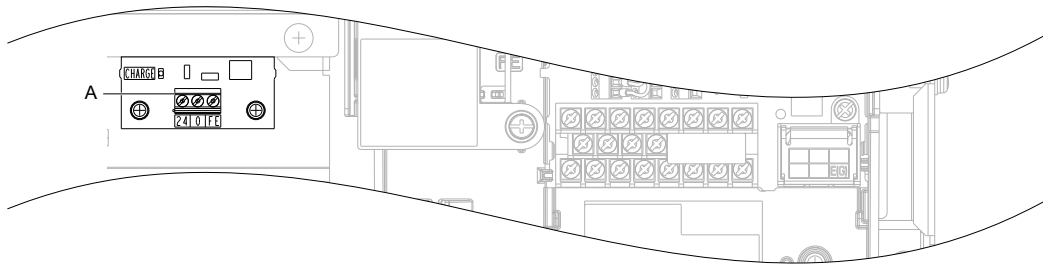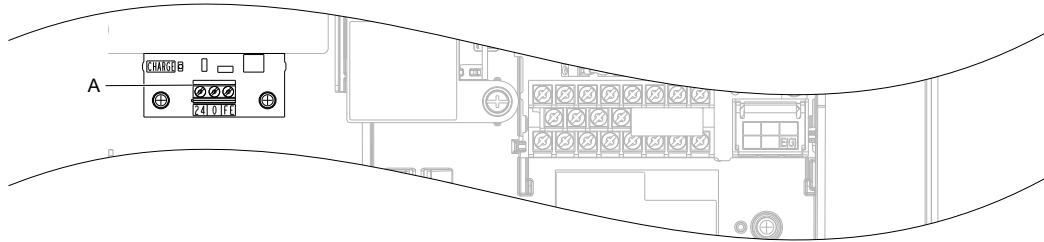**(Models 2P0042 to 2P0081, 2W0042 to 2W0081, 4P0040 to 4P0077, and 4W0040 to 4W0077)**

Figure i.44 24 V Control Power Supply Unit Location
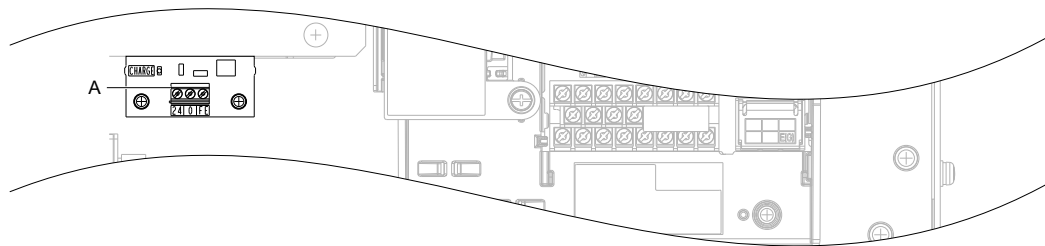**(Models 2P0104, 2W0104, 2P0130, 2W0130, 4P0096, 4W0096, 4P0124, and 4W0124)**

A –Power Supply Terminal Block TB1

Figure i.45 24 V Control Power Supply Unit Location
(Models 2P0154, 2W0154, 2P0192, 2W0192, 4P0156, 4W0156, 4P0180, and 4W0180)
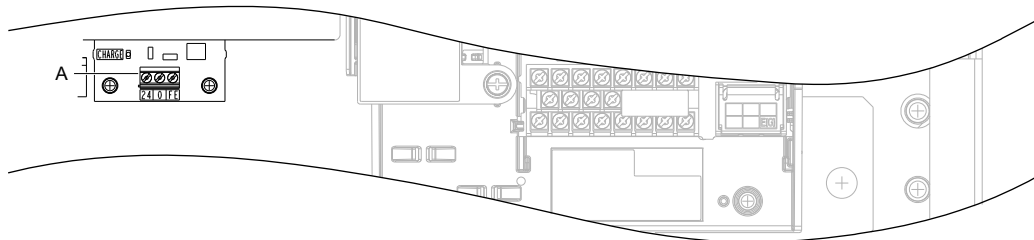

A –Power Supply Terminal Block TB1

Figure i.46 24 V Control Power Supply Unit Location
(Models 2P0248, 2W0248, 4P0216, 4W0216, 4P0240, and 4W0240)

A –Power Supply Terminal Block TB1

Figure i.47 24 V Control Power Supply Unit Location
(Models 4P0302 to 4P0414 and 4W0302 to 4W0414)

A –Power Supply Terminal Block TB1

Figure i.48 24 V Control Power Supply Unit Location (Models 4P0477 to 4P0930 and 4W0477 to 4W0930)

◼ Power Supply Terminal Block TB1 Wiring

Power Supply Terminal Block TB1 Wiring Procedure

1. Select an external power supply.

Two times the normal current will flow through the unit for approximately 0.5 seconds when the 24 V Control Power Supply Unit is first switched on. The unit requires at least 3 A to function properly.

WARNING! *Electrical Shock Hazard. Use a battery or a double-reinforced UL Class 2 power supply to provide power to the 24 V Control Power Supply Unit. Using a different type of power supply may result in death or serious injury by electrical shock or fire.*

NOTICE: *Do not install multiple 24 V Control Power Supply Units. Failure could cause erroneous operation or damage the drive.*

2. Use a flat-blade screwdriver to loosen the screws on the terminal block TB1, connect wiring to the 24, 0, and FE terminals as shown in *Figure i.49*, then tighten the terminal screws to hold wiring in place. Refer to *Table i.29* to confirm that the proper tightening torque is applied to each terminal. Take particular precaution to ensure that each wire is properly connected and wire insulation is not accidentally pinched into electrical terminals.

NOTICE: *Properly connect an external 24 Vdc power source to terminal block TB1. Refer to Table i.29 for details. Improper wiring practices could damage the 24 V Control Power Supply Unit due to incorrect terminal connections.*
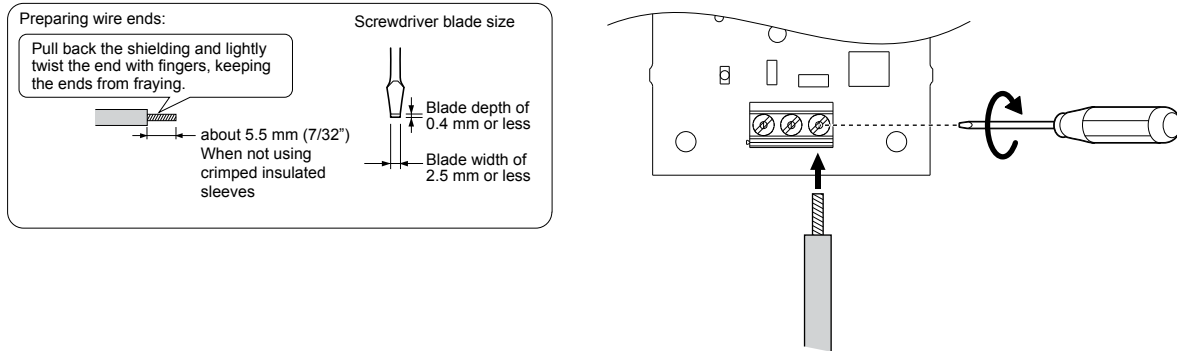
Figure i.49 Wire the Option Plug

WARNING! *Fire Hazard. Tighten terminal screws to the specified tightening torque. Loose electrical connections could result in death or serious injury by fire due to overheating. Tightening screws beyond the specified tightening torque may cause erroneous operation, damage the terminal block, or cause a fire.*

NOTICE: *Heat shrink tubing or electrical tape may be required to ensure that cable shielding does not contact other wiring. Insufficient insulation may cause a short circuit and damage the drive.*

Tools Required for Installation

A straight-edge screwdriver (blade depth: 0.4 mm, width: 2.5 mm) is required to install the unit and wire the option terminal block.

Note: Tools required to prepare option cables for wiring are not listed in this manual.

Power Supply Terminal Block TB1 Functions
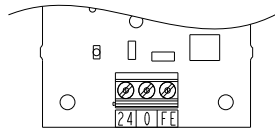
Figure i.50 Power Supply Terminal Block TB1

Table i.28 Power Supply Terminal Block TB1 Functions

| Terminal	Function
24	+24 Vdc Input
0	0 V
FE	Ground

Wire Gauges and Tightening Torques

Table i.29 Wire Gauges and Tightening Torques

Terminal	Screw Size	Tightening Torque N·m (in·lb)	Bare Cable		Crimp Terminals		Wire Type
			Recomm. Gauge mm² (AWG)	Applicable Gauges mm² (AWG)	Recomm. Gauge mm² (AWG)	Applicable Gauges mm² (AWG)	
24, 0, FE	M2	0.22 to 0.25 (1.95 to 2.21)	0.75 (18 AWG)	Stranded wire: 0.25 to 1.0 (24 to 17 AWG) Solid wire: 0.25 to 1.5 (24 to 16 AWG)	0.5 (20 AWG)	0.25 to 0.5 (24 to 20 AWG)	Shielded twisted pair, etc.

Ferrule-Type Wire Terminals

Yaskawa recommends using CRIMPFOX 6, a crimping tool manufactured by PHOENIX CONTACT, to prepare wire ends with insulated sleeves. See *Table i.30* for dimensions.
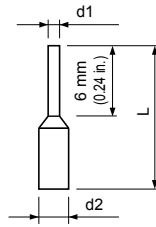
Figure i.51 Ferrule Dimensions

Table i.30 Ferrule Terminal Types and Sizes

Size mm² (AWG)	Type	L mm (in)	d1 mm (in)	d2 mm (in)	Manufacturer
0.25 (24)	AI 0.25-6YE AI 0.25-6BU	10.5 (0.41)	0.8 (0.03)	2.0 (0.08)	PHOENIX CONTACT
0.34 (22)	AI 0.34-6TQ	10.5 (0.41)	0.8 (0.03)	2.0 (0.08)	
0.5 (20)	AI 0.5-6WH	12 (0.47)	1.1 (0.04)	2.5 (0.10)	

Power Supply and the Control Circuit

Table i.31 outlines the various conditions under which the option provides power to the control circuit.

Table i.31 Power Supply and Control Circuit

Drive Main Circuit Input Power Supply	Power from 24 V Control Power Supply Unit	Control Circuit Operation in Drive	Drive Operation
ON	ON	Operating	Possible
ON	OFF		Possible
OFF	ON		Not possible
OFF	OFF	Stopping	Not possible

UL and CE Compliance

External Power Supply

Use a Class 2 power supply as defined by UL standards for the customer-supplied power supply connection to the 24 V Control Power Supply Unit.

■ **24 V Control Power Supply Unit Specifications**

Table i.32 24 V Control Power Supply Unit Specifications

Item	Specifications
Input Operating Voltage	24 Vdc ± 20% (19.2 V to 28.8 V)
Input Current	1.9 A
Consumption Power	38 W
Compliance	UL [1], CE

<1>   Use a Class 2 power supply with a capacity of 24 V to comply with UL standards.

◆ **Wiring Checklist**

☑	No.	Item	Page(s)
		Drive, Peripherals, Option Cards	
☐	1	Check drive model number to ensure receipt of correct model.	–
		Drive, Peripherals, Option Cards	
☐	2	Make sure you have the correct peripheral devices.	–
☐	3	Check the option card model number.	–
		Installation Area and Physical Setup	

☑	No.	Item	Page(s)
☐	4	Ensure that the area surrounding the drive complies with specifications.	*18*
Power Supply Voltage, Output Voltage			
☐	5	The voltage from the power supply should be within the input voltage specification range of the drive.	–
☐	6	The voltage rating for the motor should match the drive output specifications.	*13*
☐	7	Verify that the drive is properly sized to run the motor.	
☐	8	Power supply voltage of models 4□0477 to 4□0930 should not exceed 480 V when connecting with recommended EMC filters.	–
Main Circuit Wiring			
☐	9	Confirm proper branch circuit protection as specified by national and local codes.	–
☐	10	Properly wire the power supply to drive terminals R/L1, S/L2, and T/L3.	*30*
☐	11	Properly wire the drive and motor together. The motor lines and drive output terminals U/T1, V/T2, and W/T3 should match in order to produce the desired phase order. If the phase order is incorrect, the drive will rotate in the opposite direction.	*41*
☐	12	Use 600 Vac vinyl-sheathed wire for the power supply and motor lines. Wire gauge recommendations based on using 75 °C (167 °F), 600 Vac vinyl-sheathed wire.	*33*
☐	13	Use the correct wire gauges for the main circuit. • Consider the amount of voltage drop when selecting wire gauges. Increase the wire gauge when the voltage drop is greater than 2% of motor rated voltage. Ensure the wire gauge is suitable for the terminal block. Use the following formula to calculate the amount of voltage drop: Line drop voltage (V) = $\sqrt{3}$ × wire resistance (Ω/km) × wire length (m) × current (A) × 10^{-3} • If the cable between the drive and motor exceeds 50 m, adjust the carrier frequency set to C6-02 accordingly.	*33*
☐	14	Properly ground the drive.	*41*
☐	15	Tighten control circuit and grounding terminal screws.	*33*
☐	16	Set up overload protection circuits when running multiple motors from a single drive. **Note:** Close MC1 – MCn before operating the drive. MC1 – MCn cannot be switched off during run.	–
☐	17	Verify that ground wiring for models UU□E□□□□ and UU□W□□□□ is correct before turning on the EMC filter switch.	–
☐	18	Verify phase advancing capacitors, input noise filters, or GFCIs are NOT installed on the output side of the drive.	–
☐	19	Properly wire the power lines to terminals X, Y, and Z of drive models 4□0720 to 4□0930, and terminals X, Y, and Z of the filter module.	
☐	20	Properly wire the power lines to terminals X1, Y1, and Z1 of drive models 4□0720 to 4□0930, and terminals X1, Y1, and Z1 of the filter module.	*31*
☐	21	Properly wire the power lines to terminals p2 and n2 of mdrive models 4□0720 to 4□0930, and terminals p2 and n2 of the filter module.	
☐	22	The cable between drive models 4□0720 to 4□0930 and filter module should not exceed 5 m (16.4 ft.).	*31*
☐	23	The resistance value between the terminals R/L1, S/L2, and T/L3 of the filter module should exceed 1000 Ω when connected to drive models 4□0720 to 4□0930. If the resistance value does not exceed 1000 Ω, check for main circuit wiring mistakes between the filter module and drive models 4□0720 to 4□0930.	*31*
Control Circuit Wiring			
☐	24	Use twisted-pair line for all drive control circuit wiring.	*45*
☐	25	Ground the shields of shielded wiring to the GND ⏚ terminal.	*45*
☐	26	For 3-Wire sequence, set parameters for multi-function contact input terminals S1 – S8, and wire control circuits.	–
☐	27	Properly wire any option cards.	*45*
☐	28	Check for any other wiring mistakes. Only use a multimeter to check wiring.	–
☐	29	Properly fasten drive control circuit terminal screws.	*33*
☐	30	Pick up all wire clippings.	–

☑	No.	Item	Page(s)
☐	31	Ensure that no frayed wires on the terminal block are touching other terminals or connections.	–
☐	32	Properly separate control circuit wiring and main circuit wiring.	–
☐	33	Analog signal line wiring should not exceed 50 m (164 ft.).	–
☐	34	Safe Disable input wiring should not exceed 30 m (98.5 ft.).	*122*
☐	35	Verify the logic of Safety Monitor Output Signal (DM+, DM-).	–
☐	36	Disconnect the internal EMC filter by moving the SW screw to the OFF position for floating, impedance grounded, or asymmetrically grounded networks.	*51*
☐	37	Properly wire the control signal lines to Module Communications Connector port CN500 of drive models 4☐0720 to 4☐0930, and Module Communications Connector port CN500 of the filter module.	*46*
☐	38	The cable between drive models 4☐0720 to 4☐0930 and filter module should not exceed 5 m (16.4 ft.).	

i.5 Start-Up Programming and Operation
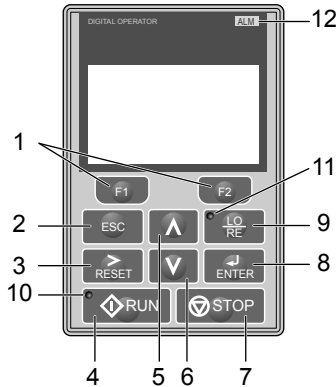
◆ Digital Operator Keys and Displays

Figure i.52 Keys and Displays on the Digital Operator

No.	Display	Name	Function
1	F1 / F2	Function Key (F1, F2)	The functions assigned to F1 and F2 vary depending on the currently displayed menu. The name of each function appears in the lower half of the display window.
2	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.
3	RESET	RESET Key	• Moves the cursor to the right. • Resets the drive to clear a fault situation.
4	RUN	RUN Key	Starts the drive in LOCAL mode.
5	∧	Up Arrow Key	Scrolls up to display the next item, selects parameter numbers, and increments setting values.
6	∨	Down Arrow Key	Scrolls down to display the previous item, selects parameter numbers, and decrements setting values.
7	STOP	STOP Key [1]	Stops drive operation.
8	ENTER	ENTER Key	• Enters parameter values and settings. • Selects a menu item to move between displays
9	LO/RE	LO/RE Selection Key [2]	Switches drive control and frequency setting between the operator (LOCAL) and an external source (REMOTE).
10	RUN	RUN Light	Lit while the drive is operating the motor.
11	LO/RE	LO/RE Light	Lit while the operator is selected to run the drive (LOCAL mode).
12	ALM	ALM LED Light	Lit when the drive detects an alarm or error.

[1] The STOP key has highest priority. Pressing the STOP key will always cause the drive to stop the motor, even if a Run command is active at any external Run command source. To disable the STOP key priority, set parameter o2-02 to 0.

[2] The LO/RE key can only switch between LOCAL and REMOTE when the drive is stopped. To disable the LO/RE key to prohibit switching between LOCAL and REMOTE, set parameter o2-01 to 0.
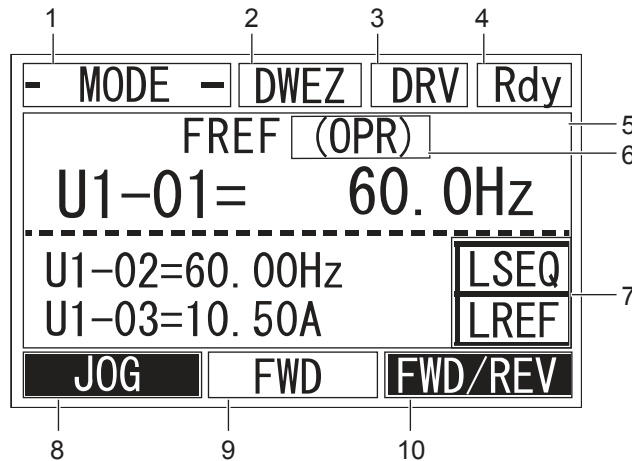
◆ LCD Display

Figure i.53 LCD Display

Table i.33 Display and Contents

No.	Name	Display	Content
1	Operation Mode Menus	MODE	Displayed when in Mode Selection.
		MONITR	Displayed when in Monitor Mode.
		VERIFY	Indicates the Verify Menu.
		PRMSET	Displayed when in Parameter Setting Mode.
		A.TUNE	Displayed during Auto-Tuning.
		SETUP	Displayed when in Setup Mode.
2	DriveWorksEZ Function Selection	DWEZ	Displayed when DriveWorksEZ is being used.
3	Mode Display Area	DRV	Displayed when in Drive Mode.
		PRG	Displayed when in Programming Mode.
4	Ready	Rdy	Indicates the drive is ready to run.
5	Data Display	—	Displays specific data and operation data.
6	Frequency Reference Assignment [1]	OPR	Displayed when the frequency reference is assigned to the LCD Operator.
		AI	Displayed when the frequency reference is assigned to the Analog Input of the drive.
		COM	Displayed when the frequency reference is assigned to the MEMOBUS/Modbus Communication Inputs of the drive.
		OP	Displayed when the frequency reference is assigned to an Option Unit of the drive.
		RP	Displayed when the frequency reference is assigned to the Pulse Train Input of the drive.
7	LO/RE Display [2]	RSEQ	Displayed when the run command is supplied from a remote source.
		LSEQ	Displayed when the run command is supplied from the operator keypad.
		RREF	Displayed when the frequency reference is supplied from a remote source.
		LREF	Displayed when the frequency reference is supplied from the operator keypad.
8	Function Key 1 (F1)	JOG	Pressing [F1] runs the motor at the Jog frequency.
		HELP	Pressing [F1] displays the Help menu.
		←	Pressing [F1] scrolls the cursor to the left.
		HOME	Pressing [F1] returns to the top menu (Frequency Reference).
		ESC	Pressing [F1] returns to the previous display.
9	FWD/REV	FWD	Indicates forward motor operation.
		REV	Indicates reverse motor operation.

No.	Name	Display	Content
10	Function Key 2 (F2)	FWD/REV	Pressing [F2] switches between forward and reverse.
		DATA	Pressing [F2] scrolls to the next display.
		→	Pressing [F2] scrolls the cursor to the right.
		RESET	Pressing [F2] resets the existing drive fault error.

<1> Displayed when in Frequency Reference Mode.

<2> Displayed when in Frequency Reference Mode and Monitor Mode.

◆ Menu Structure for Digital Operator
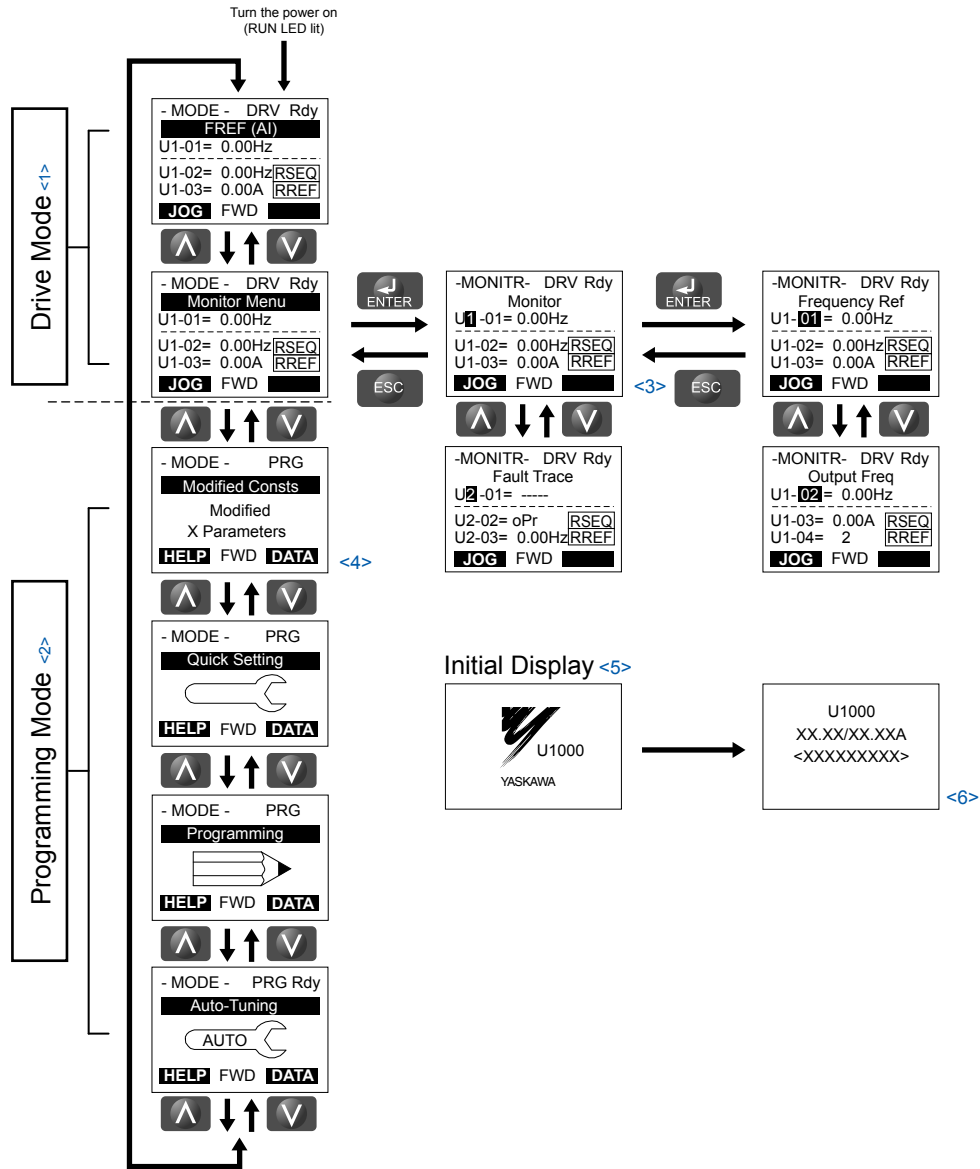
Figure i.54 Digital Operator Menu and Screen Structure

<1> Pressing [RUN] will start the motor.

<2> Drive cannot operate motor.

<3> Flashing characters are shown as █.

<4> "X" characters are used as examples in this manual. The LCD Operator will display the actual setting values.

<5> The Frequency Reference appears after the initial display that shows the product name.

<6> The information that appears on the display will vary depending on the drive.

◆ Basic Start-Up and Motor Tuning Flowchart

The flowchart shown in *Figure i.55* describes a basic start-up sequence that varies slightly depending on the application. Use the drive default parameter settings in simple applications that do not require high precision.

START

Properly install and wire the drive.

Apply main power to the drive while following safety guidelines.

Application Preset A1-06 used?

YES → Refer to Application Selection section

NO

Set the control mode in parameter A1-02.

Set the basic parameters
· **C6-01** for heavy/normal duty mode selection
· **b1-01/b1-02** for frequency reference selection and run command source selection
· **H1-□□,H2-□□,H3-□□,H4-□□,H6-□□** for I/O terminal setting
· **d1-□□** for using multi-speed references
· **C1-□□ and C2-□□** for accel/decel and S-curve time settings

Set the input power supply voltage in parameter E1-22

Fine tune parameters. Adjust application settings if necessary.

Check the machine operation and verify parameter settings.

Drive is ready to run the application.

Figure i.55 Basic Start-Up

■ Powering Up the Drive

Review the following checklist before turning the power on.

Item to Check	Description
Power supply voltage	200 V class: Three-phase 200 to 240 Vac 50/60 Hz 400 V class: Models 4A□□□□ and 4P□□□□: Three-phase 380 to 500 Vac 50/60 Hz 400 V class: Models 4E□□□□and 4W□□□□: Three-phase 380 to 480 Vac 50/60 Hz
	Properly wire the power supply input terminals (R/L1, S/L2, T/L3).
	Check for proper grounding of drive and motor. Use a power supply with a capacity that is equal to or greater than drive capacity.
Drive output terminals and motor terminals	Properly wire drive output terminals U/T1, V/T2, and W/T3 with motor terminals U, V, and W.
Control circuit terminals	Check control circuit terminal connections.
Drive control terminal status	Open all control circuit terminals (off).
Status of the load and connected machinery	Decouple the motor from the load.

◆ Basic Drive Setup Adjustments

■ A1-02: Control Method Selection

Selects the Control Method (also referred to as the control mode) that the drive uses to operate the motor. Parameter A1-02 determines the control mode for motor 1 when the drive is set up to run two motors.

Note: When changing control modes, all parameter settings depending upon the setting of A1-02 will be reset to the default.

No.	Parameter Name	Setting Range	Default
A1-02	Control Method Selection	0, 1, 2, 3, 5, 6, 7	0

Control Modes for Induction Motors (IM)

Setting 0: V/f Control for Induction Motors

Use this mode for simple speed control and for multiple motor applications with low demands to dynamic response or speed accuracy. This control mode is also used when the motor parameters are unknown and Auto-Tuning cannot be performed. The speed control range is 1:40.

Setting 1: V/f Control with PG Speed Feedback

Use this mode for general-purpose applications that require high speed accuracy but do not require high dynamic response. This control mode is also used when the motor parameters are unknown and Auto-Tuning cannot be performed. The speed control range is 1:40.

Setting 2: Open Loop Vector Control

Use this mode for general, variable-speed applications with a speed control range of 1:200 that require precise speed control, quick torque response, and high torque at low speed without using a speed feedback signal from the motor.

Setting 3: Closed Loop Vector Control

Use this mode for general, variable-speed applications that require precise speed control down to zero speed, quick torque response or precise torque control, and a speed feedback signal from the motor. The speed control range is up to 1:1500.

Control Modes for Permanent Magnet Motors (SPM or IPM)

Setting 5: Open Loop Vector Control for PM

Use this mode for general, variable-speed applications with low demands on dynamic response or speed accuracy. The drive can control an SPM or IPM motor with a speed range of 1:20 in this control mode.

Setting 6: Advanced Open Loop Vector Control for PM

Use this mode for general, variable speed applications that require precise speed control and torque limit. Set High Frequency Injection parameter n8-57 to 1 to achieve a speed control range as high as 1:100. In this case, perform High Frequency Injection Parameter Tuning after setting the motor parameters. High Frequency Injection cannot be used with an SPM motor.

Setting 7: Closed Loop Vector Control for PM

Use this mode for high-precision control of a PM motor in constant torque or variable torque applications. The speed control range reaches 1:1500. A speed feedback signal is required.

■ A1-03: Initialize Parameters

Resets parameters to default values. After initialization, the setting for A1-03 automatically returns to 0.

No.	Parameter Name	Setting Range	Default
A1-03	Initialize Parameters	0, 1110, 2220, 3330, 5550	0

Setting 0: No Initialize

Setting 1110: User Initialize

Resets parameters to the values selected by the user as User Settings. User Settings are stored when parameter o2-03 is set to "1: Set defaults".

Note: User Initialization resets all parameters to a user-defined set of default values previously saved to the drive. Set parameter o2-03 to 2 to clear the user-defined default values.

Setting 2220: 2-Wire Initialization

Resets parameters except parameters listed in *Table i.34* to default settings with digital inputs S1 and S2 configured as Forward run and Reverse run, respectively.

Setting 3330: 3-Wire Initialization

Resets parameters except parameters listed in *Table i.34* to default settings with digital inputs S1, S2, and S5 configured as Run, Stop, and Forward/Reverse respectively.

Setting 5550: oPE04 Reset

An oPE04 error appears on the digital operator when a terminal block with settings saved to its built-in memory is installed in a drive that has edited parameters. Set A1-03 to 5550 to use the parameter settings saved to the terminal block memory.

Notes on Parameter Initialization

The parameters shown in *Table i.34* will not be reset when the drive is initialized by setting A1-03 = 2220 or 3330. Although the control mode in A1-02 is not reset when A1-03 is set to 2220 or 3330, it may change when an application preset is selected.

Table i.34 Parameters Not Changed by Drive Initialization

No.	Parameter Name
A1-00	Language Selection
A1-02	Control Method Selection
E1-03	V/f Pattern Selection
E5-01	Motor Code Selection (for PM Motors)
E5-02	Motor Rated Power (for PM Motors)
E5-03	Motor Rated Current (for PM Motors)
E5-04	Number of Motor Poles (for PM Motors)
E5-05	Motor Stator Resistance (r1) (for PM Motors)
E5-06	Motor d-Axis Inductance (Ld) (for PM Motors)
E5-07	Motor d-Axis Inductance (Lq) (for PM Motors)
E5-09	Motor Induction Voltage Constant 1 (Ke) (for PM Motors)
E5-24	Motor Induction Voltage Constant 2 (Ke) (for PM Motors)
F6-□□/F7-□□	Communication Parameters (Initialized when F6-08 = 1)
L8-35	Installation Method Selection
o2-04	Drive Model Selection

■ b1-01: Frequency Reference Selection 1

Selects the frequency reference source 1 for the REMOTE mode.

Note: 1. If a Run command is input to the drive but the frequency reference entered is 0 or below the minimum frequency, the RUN indicator LED on the digital operator will light and the STOP indicator will flash. However, the RUN indicator LED will light in zero speed control when A1-02 is set to 3, 4, or 6.

   2. Press the LO/RE key to set the drive to LOCAL and use the operator keypad to enter the frequency reference.

No.	Parameter Name	Setting Range	Default
b1-01	Frequency Reference Selection 1	0 to 4	1

Setting 0: Operator keypad

Using this setting, the frequency reference can be input by using the operator keypad.

Setting 1: Terminals (analog input terminals)

Using this setting, an analog frequency reference can be entered as a voltage or current signal from terminals A1, A2, or A3.

Switching between Main/Auxiliary Frequency References

The frequency reference input can be switched between the analog terminals A1, A2, and A3 using multi-speed inputs. *Refer to Multi-Step Speed Selection on page 76* for details on using this function.

Setting 2: MEMOBUS/Modbus Communications

This setting requires entering the frequency reference via the RS-485/RS-422 serial communications port (control terminals R+, R-, S+, S-).

Setting 3: Option card

This setting requires entering the frequency reference via an option board plugged into connector CN5-A on the drive control board. Consult the option board manual for instructions on integrating the drive with the communication system.

Note: If the frequency reference source is set for Option PCB (b1-01 = 3), but an option board is not installed, an oPE05 operation error will be displayed on the digital operator and the drive will not run.

Setting 4: Pulse Train Input

This setting requires a pulse train signal to terminal RP to provide the frequency reference. Follow the directions below to verify that the pulse signal is working properly.

Verifying the Pulse Train is Working Properly

- Set b1-01 to 4 and set H6-01 to 0.
- Set the H6-02 to the pulse train frequency value that equals 100% of the frequency reference.
- Enter a pulse train signal to terminal RP and check for the correct frequency reference on the display.

■ b1-02: Run Command Selection 1

Determines the Run command source 1 in the REMOTE mode.

No.	Parameter Name	Setting Range	Default
b1-02	Run Command Selection 1	0 to 3	1

Setting 0: Operator

This setting will illuminate the LO/RE light to indicate that the Run command source is assigned to the digital operator. Use the digital operator RUN and STOP keys to start and stop operation.

Setting 1: Control Circuit Terminal

This setting requires entering the Run command via the digital input terminals using one of following sequences:

- 2-Wire sequence 1:

  Setting A1-03 to 2220 initializes the drive and presets terminals S1 and S2 to FWD/Stop and REV/Stop. These are the default settings of the drive.

- 2-Wire sequence 2:

  Two inputs (Start/Stop-FWD/REV).

- 3-Wire sequence:

  Setting A1-03 to 3330 initializes the drive and presets terminals S1, S2, and S5 to Start, Stop, and FWD/REV.

Setting 2: MEMOBUS/Modbus Communications

This setting requires entering the Run command via serial communications by connecting the RS-485/RS-422 serial communication cable to control terminals R+, R-, S+, and S- on the removable terminal block.

Setting 3: Option Card

This setting requires entering the Run command via the communication option board by plugging a communication option board into the CN5-A port on the control PCB. Refer to the option board manual for instructions on integrating the drive into the communication system.

Note: If b1-02 is set to 3, but an option board is not installed in CN5-A, an oPE05 operation error will be displayed on the digital operator and the drive will not run.

■ b1-03: Stopping Method Selection

Selects how the drive stops the motor when the Run command is removed or when a Stop command is entered.

No.	Parameter Name	Setting Range	Default
b1-03	Stopping Method Selection	0 to 3 [1]	0

<1> The setting range is 0, 1, or 3 in CLV, OLV/PM, AOLV/PM, and CLV/PM.

Setting 0: Ramp to Stop

When the Run command is removed, the drive will decelerate the motor to stop. The deceleration rate is determined by the active deceleration time. The default deceleration time is set to parameter C1-02.

When the output frequency falls below the level set in parameter b2-01, the drive will start DC injection or Zero Speed Control depending on the selected control mode.

V/f, V/f w/PG and OLV (A1-02 = 0, 1, 2)

For these control modes, parameter b2-01 sets the starting frequency for DC Injection Braking at Stop. When the output frequency falls below the setting of b2-01, DC Injection Braking is enabled for the time set in parameter b2-04.
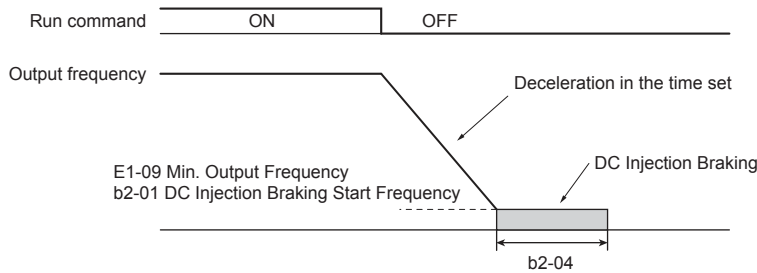
Figure i.56 DC Injection Braking at Stop for V/f, V/f w/PG, and OLV

Note: If b2-01 is set to a smaller value than E1-09 (Minimum Output Frequency), then DC Injection Braking will begin when the frequency falls to the E1-09 value.

OLV/PM and AOLV/PM (A1-02 = 5, 6)

When the output frequency falls below the setting of b2-01, drive output is shut down, and DC Injection Braking is performed for the time set in b2-04.
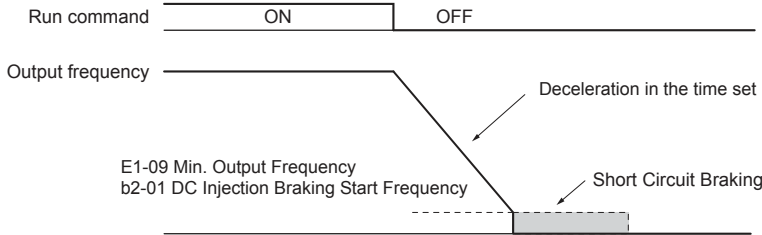
Figure i.57 Coast to Stop (OLV/PM and AOLV/PM)

Note: If b2-01 is set to a smaller value than E1-09 (Minimum Output Frequency), then DC Injection Braking will begin when the frequency falls to the E1-09 value.
The drive will not perform short-circuit braking when b2-01 = E1-09 = 0 Hz.

CLV and CLV/PM (A1-02 = 3, 7)

For these control modes, parameter b2-01 sets the starting frequency for Zero Speed Control (not position lock) at Stop. When the output frequency falls below the setting of b2-01, Zero Speed Control is enabled for the time set in parameter b2-04.
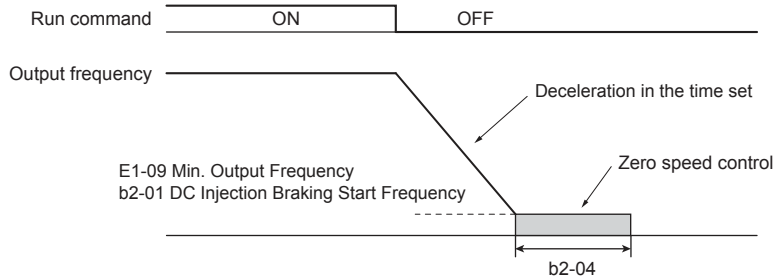
Figure i.58 Zero Speed Control at Stop in CLV and CLV/PM

Note: If b2-01 is set to lower than E1-09 (Minimum Output Frequency), then Zero Speed Control begins at the frequency set to E1-09.

Setting 1: Coast to Stop

When the Run command is removed, the drive will shut off its output and the motor will coast (uncontrolled deceleration) to stop. The stopping time is determined by the inertia and the friction in the driven system.
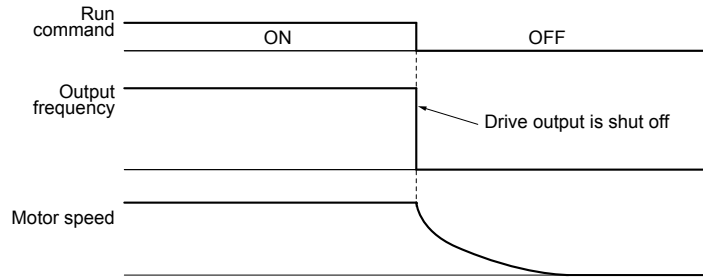
Figure i.59 Coast to Stop

Note: After a stop is initiated, any subsequent Run command entered will be ignored until the momentary power loss minimum baseblock time (L2-03) has expired. Do not enter Run command until it has come to a complete stop. Use DC Injection at Start or Speed Search to restart the motor before it has completely stopped.

Setting 2: DC Injection Braking to Stop

When the Run command is removed, the drive will enter baseblock (turn off its output) for the momentary power loss minimum baseblock time (L2-03). When the minimum baseblock time has expired, the drive will inject the amount DC Injection Braking is set in parameter b2-02 into the motor windings to brake the motor. The stopping time in DC Injection Braking to Stop is significantly faster compared to Coast to Stop.

Note: This function is not available in CLV (A1-02 = 3) or in control modes for PM motors (A1-02 = 5, 6, 7).
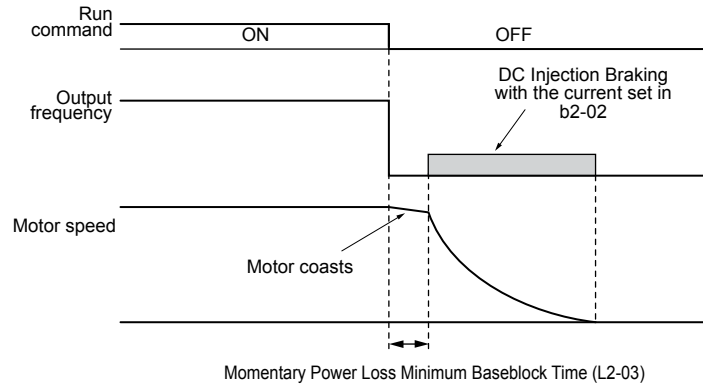
Figure i.60 DC Injection Braking to Stop

DC Injection Braking time is determined by the value set to b2-04 and the output frequency at the time the Run command is removed. It can be calculated by:

$$\text{DC Injection brake time} = \frac{(b2\text{-}04) \times 10 \times \text{Output frequency}}{\text{Maximum output frequency (E1-04)}}$$
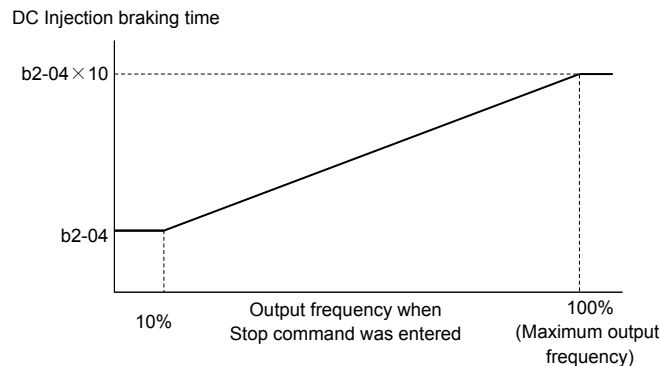
Figure i.61 DC Injection Braking Time Depending on Output Frequency

Note: If an overcurrent (oC) fault occurs during DC Injection Braking to Stop, lengthen the momentary power loss minimum baseblock time (L2-03) until the fault no longer occurs.

Setting 3: Coast to Stop with Timer

When the Run command is removed, the drive will turn off its output and the motor will coast to stop. The drive will not start if a Run command is input before the time t (C1-02) has expired. Cycle the Run command that was activated during time t after t has expired to start the drive.
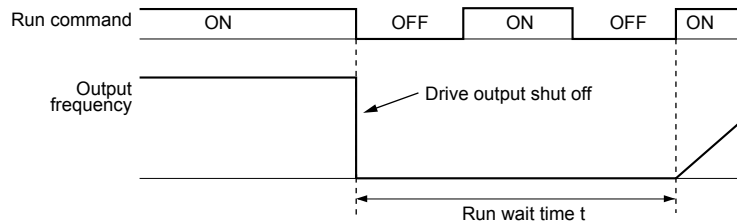
Figure i.62 Coast to Stop with Timer

The wait time t is determined by the output frequency when the Run command is removed and by the active deceleration time.
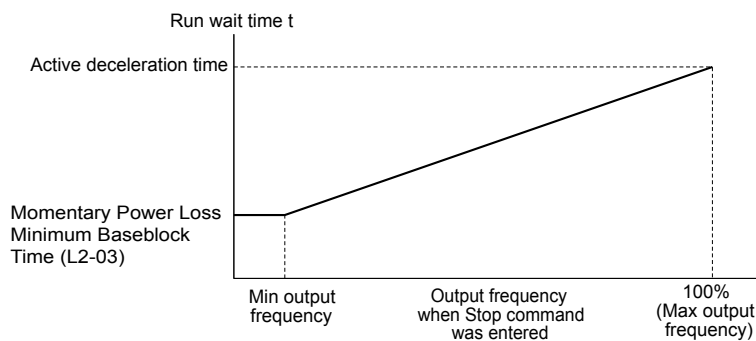
Figure i.63 Run Wait Time Depending on Output Frequency

■ b1-04: Reverse Operation Selection

Enables and disables Reverse operation. For some applications, reverse motor rotation is not appropriate and may cause problems (e.g., air handling units, pumps, etc.).

No.	Parameter Name	Setting Range	Default
b1-04	Reverse Operation Selection	0, 1	0

Setting 0: Reverse operation enabled

Possible to operate the motor in both forward and reverse directions.

Setting 1: Reverse operation disabled

Drive disregards a Reverse run command or a negative frequency reference.

■ b8-27: q-Axis Current Compensation Method when Output Voltage Is Limited

Sets a compensation method for the q-axis current when output voltage is limited.

There is normally no need to change this parameter from the default value.

No.	Name	Setting Range	Default
b8-27	q-Axis Current Compensation Method when Output Voltage Is Limited	0, 1	0

Setting 0: Output Voltage Limit Priority

Setting 1: q-Axis Current Priority

■ C1-01 to C1-08: Accel, Decel Times 1 to 4

Four different sets of acceleration and deceleration times can be set in the drive by digital inputs, motor selection, or switched automatically.

Acceleration time parameters always set the time to accelerate from 0 Hz to the maximum output frequency (E1-04). Deceleration time parameters always set the time to decelerate from maximum output frequency to 0 Hz. C1-01 and C1-02 are the default active accel/decel settings.

No.	Parameter Name	Setting Range	Default
C1-01	Acceleration Time 1	0.0 to 6000.0 s [1]	10.0 s
C1-02	Deceleration Time 1		
C1-03	Acceleration Time 2		
C1-04	Deceleration Time 2		
C1-05	Acceleration Time 3 (Motor 2 Accel Time 1)		
C1-06	Deceleration Time 3 (Motor 2 Decel Time 1)		
C1-07	Acceleration Time 4 (Motor 2 Accel Time 2)		
C1-08	Deceleration Time 4 (Motor 2 Decel Time 2)		

<1> The setting range for the acceleration and deceleration times is determined by the accel/decel time setting units in C1-10. For example, if the time is set in units of 0.01 s (C1-10 = 0), the setting range becomes 0.00 to 600.00 s.

Switching Acceleration Times by Digital Input

Accel/decel times 1 are active by default if no input is set. Activate accel/decel times 2, 3, and 4 by digital inputs (H1-□□ = 7 and 1A) as explained in *Table i.35*.

Table i.35 Accel/Decel Time Selection by Digital Input

Accel/Decel Time Sel. 1 H1-□□ = 7	Accel/Decel Time Sel. 2 H1-□□ = 1A	Active Times	
		Acceleration	Deceleration
0	0	C1-01	C1-02
1	0	C1-03	C1-04
0	1	C1-05	C1-06
1	1	C1-07	C1-08

Figure i.64 shows an operation example for changing accel/decel times. The example below requires that the stopping method be set for "Ramp to stop" (b1-03 = 0).
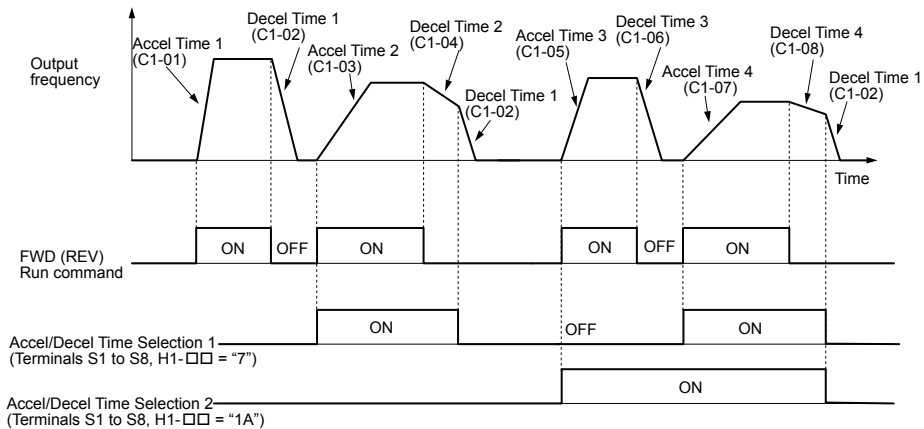
Figure i.64 Timing Diagram of Accel/Decel Time Change

Switching Acceleration and Deceleration Times by Motor Selection

When switching between motor 1 and 2 using a digital input (H1-□□ = 16), parameters C1-01 to C1-04 become accel/decel times 1 and 2 for motor 1, while C1-05 to C1-08 become accel/decel times 1 and 2 for motor 2. Accel/decel times 1 and 2 can be switched for each motor using a digital inputs set to H1-□□ = 7 like shown in *Table i.36*.

Note: 1.   The motor 2 selection function cannot be used with PM motors.

         2.   Attempting to use the digital input setting "Accel/Decel time 2 selection" (H1-□□ = 1A) together with motor 1/2 switching triggers an oPE03 error, indicating contradictory multifunction input settings.

Table i.36 Motor Switching and Accel/Decel Time Combinations

Accel/Decel Time 1 (H1-□□ = 7)	Motor 1 Selected (Terminal set to H1-□□ = 16 OFF)		Motor 2 Selected (Terminal set to H1-□□ = 16 ON)	
	Accel	Decel	Accel	Decel
Open	C1-01	C1-02	C1-05	C1-06
Closed	C1-03	C1-04	C1-07	C1-08

Switching Accel/Decel Times by a Frequency Level

The drive can switch between different acceleration and deceleration times automatically. The drive will switch from accel/decel time 4 in C1-07 and C1-08 to the default accel/decel time in C1-01 and C1-02 (C1-05 and C1-06 for motor 2) when the output frequency exceeds the frequency level set to parameter C1-11. When the frequency falls below this level, the accel/decel times are switched back. *Figure i.65* shows an operation example.

Note: Acceleration and deceleration times selected by digital inputs have priority over the automatic switching by the frequency level set to C1-11. For example, if accel/decel time 2 is selected, the drive will use only accel/decel time 2; it will not switch from accel/decel time 4 to the selected one.

$$C1\text{-}03 = \frac{(\text{accel time from 0 Hz to C1-11}) \times (E1\text{-}04)}{C1\text{-}11}$$

$$C1\text{-}01 = \frac{(\text{accel time between C1-11 and E1-04}) \times (E1\text{-}04)}{(E1\text{-}04 - C1\text{-}11)}$$

$$C1\text{-}02 = \frac{(\text{decel time between E1-04 and C1-11}) \times (E1\text{-}04)}{(E1\text{-}04 - C1\text{-}11)}$$

$$C1\text{-}04 = \frac{(\text{decel time from C1-11 to 0 Hz}) \times (E1\text{-}04)}{C1\text{-}11}$$

When the output frequency ≥ C1-11, drive uses Accel/Decel Time 1 (C1-01, -02)
When the output frequency < C1-11, drive uses Accel/Decel Time 2 (C1-03, -04)
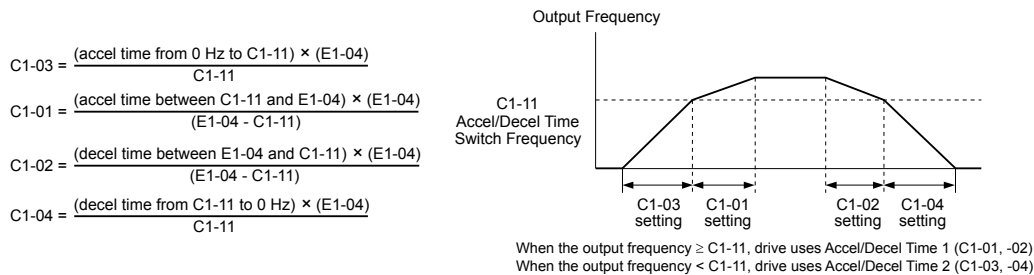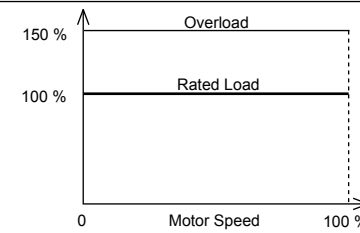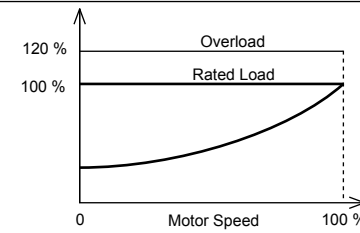
Figure i.65 Accel/Decel Time Switching Frequency

■ C6-01: Drive Duty Mode Selection

The drive has two different duty modes from which to select based on the load characteristics. The drive rated current, overload capacity, and maximum output frequency will change depending upon the duty mode selection. Use parameter C6-01 to select Heavy Duty (HD) or Normal Duty (ND) for the application. Refer to the U1000 Technical Manual for details.

No.	Parameter Name	Setting Range	Default
C6-01	Duty Mode Selection	0, 1	1 (ND)

Table i.37 Differences between Heavy Duty and Normal Duty

Characteristics	Heavy Duty Rating (HD)	Normal Duty Rating (ND)
C6-01	0	1
Performance	*150% / 100% Overload / Rated Load graph (Motor Speed 0–100%)*	*120% / 100% Overload / Rated Load graph (Motor Speed 0–100%)*
Application	Use Heavy Duty Rating for applications requiring a high overload tolerance with constant load torque, such as extruders and conveyors.	Use Normal Duty Rating for applications in which the torque requirements drop along with the speed, such as fans and pumps where a high overload tolerance is not required.
Overload capability (oL2)	150% of drive rated Heavy Duty current for 60 s	120% of drive rated Normal Duty current for 60 s
Stall Prevention during Acceleration (L3-02)	150%	120%
Stall Prevention during Run (L3-06)	150%	120%
Default Carrier Frequency	4 kHz [1]	4 kHz [1]

<1> Carrier frequency is 3 kHz for models 4□0477 to 4□0930.

Note: Changing the Duty Mode selection automatically sets the E2-□□ parameters to appropriate values (E4-□□ for motor 2) and recalculates parameter settings determined by motor capacity (e.g., b8-04, L2-03, n5-02, C5-17, and C5-37).

■ C7-60: Output Voltage Limit Mode Selection

Sets the mode to limit the output voltage.

Set this parameter to 0 (Harmonic suppression priority mode) to give priority to harmonic suppression. The maximum output voltage is automatically limited to suppress harmonics.

Set this parameter to 1 (High output voltage mode) to give priority to the output voltage over harmonic suppression. The effectiveness of harmonic suppression will be reduced because the maximum output voltage will be used.

Note: For drives with software versions PRG: 1021 or later, the default setting is 0 (Harmonic Suppression Priority Mode) when in Advanced Open Loop Vector Control for PM (A1-02 = 6).

No.	Parameter Name	Setting Range	Default
C7-60	Output Voltage Limit Mode Selection	0, 1	Determined by A1-02

Setting 0: Harmonic Suppression Priority Mode

Setting 1: High Output Voltage Mode

■ d1-01 to d1-17: Frequency Reference 1 to 16 and Jog Frequency Reference

The drive lets the user switch between up to 17 preset frequency references during run (including the Jog reference) through the digital input terminals. The drive uses the acceleration and deceleration times that have been selected when switching between each frequency reference.

The Jog frequency overrides all other frequency references and must be selected by a separate digital input.

The multi-speed references 1, 2, and 3 can be provided by analog inputs.

No.	Parameter Name	Setting Range	Default
d1-01 to d1-16	Frequency Reference 1 to 16	0.00 to 400.00 Hz [1] [2]	0.00 Hz [2]
d1-17	Jog Frequency Reference	0.00 to 400.00 Hz [1] [2]	6.00 Hz [2]

[1] The upper limit is determined by the maximum output frequency (E1-04) and upper limit for the frequency reference (d2-01).

[2] Setting units are determined by parameter o1-03. The default is "Hz" (o1-03 = 0) in V/f, V/f w/PG, OLV, CLV, and OLV/PM control modes. The default for AOLV/PM and CLV/PM control modes expresses the frequency reference as a percentage (o1-03 = 1).

Multi-Step Speed Selection

To use several speed references for a multi-step speed sequence, set the H1-□□ parameters to 3, 4, 5, and 32. To assign the Jog reference to a digital input, set H1-□□ to 6.

Notes on using analog inputs as Multi-Speed 1, 2, and 3:

- **Multi-Step Speed 1**

  Set b1-01 to 1 to set terminal A1 analog input to Multi-Step Speed 1.

  Set b1-01 to 0 when setting d1-01, Frequency Reference 1, to Multi-Step Speed 1.

- **Multi-Step Speed 2**

  Set H3-06, Terminal A3 Function Selection, to 2 (Auxiliary Frequency Reference 1) when setting terminal A3 analog input to Multi-Step Speed 2.

  Set H3-06 to F (Through mode) when setting d1-02, Frequency Reference 2, to Multi-Step Speed 2.

- **Multi-Step Speed 3**

  Set H3-10, Terminal A2 Function Selection, to 3 (Auxiliary Frequency Reference 2) when setting terminal A2 analog input to Multi-Step Speed 3.

  Set H3-10 to F (Through mode) when setting d1-03, Frequency Reference 3, to Multi-Step Speed 3.

  Set H3-09 to 0 and set DIP switch S1 on the control circuit terminal board to V (voltage) when inputting 0 to 10 V to terminal A2 analog input.

Select the different speed references as shown in *Table i.38*. *Figure i.66* illustrates the multi-step speed selection.

Table i.38 Multi-Step Speed Reference and Terminal Switch Combinations

Reference	Multi-Step Speed Reference H1-□□ = 3	Multi-Step Speed Reference 2 H1-□□ = 4	Multi-Step Speed Reference 3 H1-□□ = 5	Multi-Step Speed Reference 4 H1-□□ = 32	Jog Reference Selection H1-□□ = 6
Frequency Reference 1 (set in b1-01)	OFF	OFF	OFF	OFF	OFF
Frequency Reference 2 (d1-02 or input terminal A1, A2, A3)	ON	OFF	OFF	OFF	OFF
Frequency Reference 3 (d1-03 or input terminal A1, A2, A3)	OFF	ON	OFF	OFF	OFF
Frequency Reference 4 (d1-04)	ON	ON	OFF	OFF	OFF
Frequency Reference 5 (d1-05)	OFF	OFF	ON	OFF	OFF
Frequency Reference 6 (d1-06)	ON	OFF	ON	OFF	OFF
Frequency Reference 7 (d1-07)	OFF	ON	ON	OFF	OFF
Frequency Reference 8 (d1-08)	ON	ON	ON	OFF	OFF
Frequency Reference 9 (d1-09)	OFF	OFF	OFF	ON	OFF
Frequency Reference 10 (d1-10)	ON	OFF	OFF	ON	OFF
Frequency Reference 11 (d1-11)	OFF	ON	OFF	ON	OFF
Frequency Reference 12 (d1-12)	ON	ON	OFF	ON	OFF
Frequency Reference 13 (d1-13)	OFF	OFF	ON	ON	OFF
Frequency Reference 14 (d1-14)	ON	OFF	ON	ON	OFF
Frequency Reference 15 (d1-15)	OFF	ON	ON	ON	OFF
Frequency Reference 16 (d1-16)	ON	ON	ON	ON	OFF
Jog Frequency Reference (d1-17) [1]	–	–	–	–	ON

<1> The Jog frequency overrides all other frequency references.
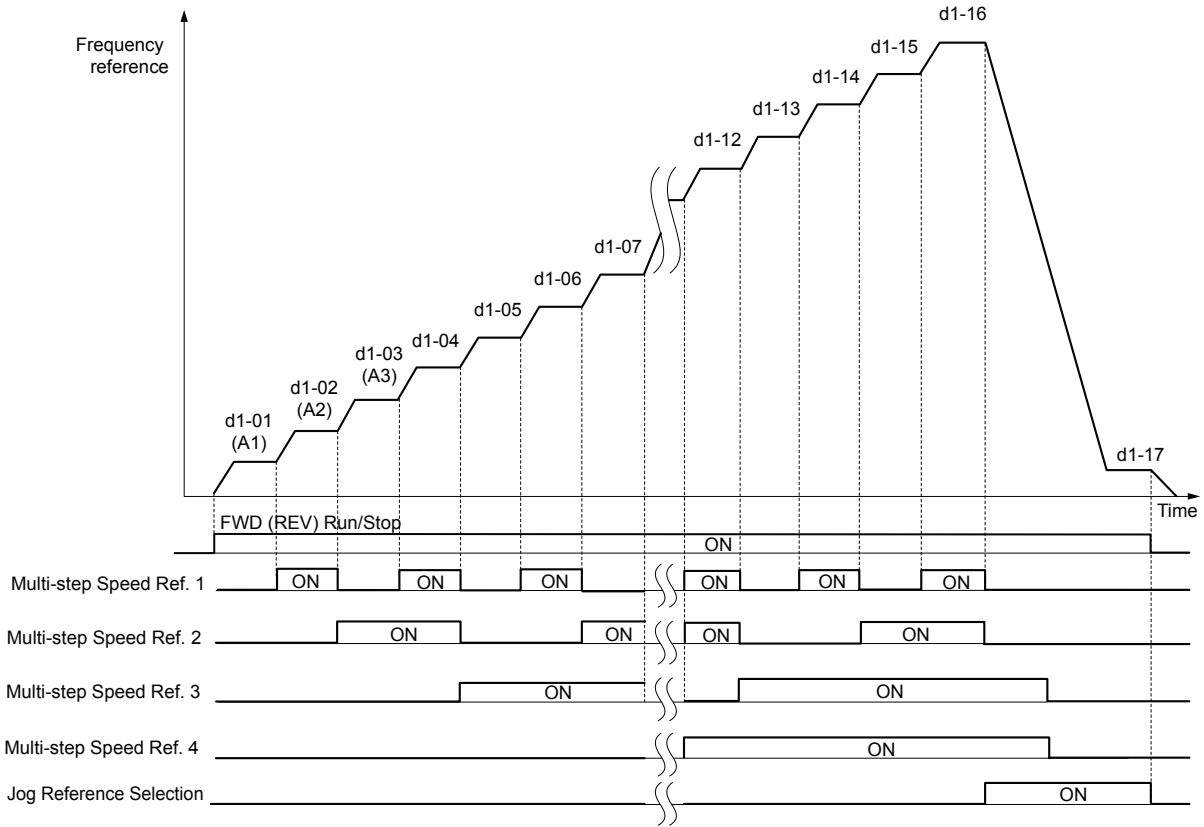
Figure i.66 Preset Reference Timing Diagram

■ d2-01: Frequency Reference Upper Limit

Sets the maximum frequency reference as a percentage of the maximum output frequency. This limit applies to all frequency references.

Even if the frequency reference is set to a higher value, the drive internal frequency reference will not exceed this value.

No.	Parameter Name	Setting Range	Default
d2-01	Frequency Reference Upper Limit	0.0 to 110.0%	100.0%

■ d2-02: Frequency Reference Lower Limit

Sets the minimum frequency reference as a percentage of the maximum output frequency. This limit applies to all frequency references.

If a lower reference than this value is entered, the drive will run at the limit set to d2-02. If the drive is started with a lower reference than d2-02, it will accelerate up to d2-02.

No.	Parameter Name	Setting Range	Default
d2-02	Frequency Reference Lower Limit	0.0 to 110.0%	0.0%
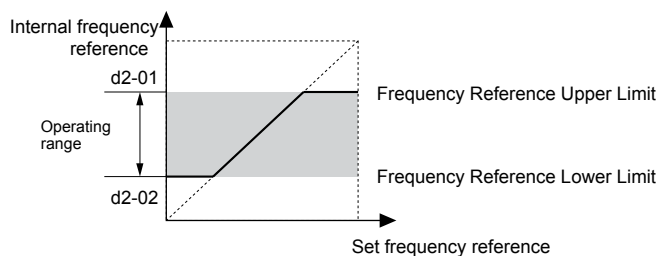
Figure i.67 Frequency Reference: Upper and Lower Limits

■ E1-22: Input Voltage Setting

Correctly set Input Voltage Setting (E1-22) to the input power supply voltage according to the voltage of the power supply that is input to the drive. This setting value serves as the baseline for the protective functions (Uv detection level). The input power supply voltage value can be checked in Drive Input Power Voltage Effective Value (U1-54).

NOTICE: *Make sure that you set E1-22 to the voltage of the power supply input to this product so that the protective functions work correctly.*

The detection levels of Control Circuit Undervoltage Fault (Uv1 and Uv) change according to the setting value of the input voltage as shown in the following table:

Product	E1-22 Setting	Uv1 Detection Level and Uv Detection Level
200 V Class	Setting value ≤ 220 Vrms	190 V
	Setting value > 220 Vrms	225 V
400 V Class	Setting value ≤ 440 Vrms	380 V
	Setting value > 440 Vrms	450 V

■ E2-01: Motor Rated Current

Provides motor control, protects the motor, and calculates torque limits. Set E2-01 to the full load amps (FLA) stamped on the motor nameplate. If Auto-Tuning completes successfully, the value entered to T1-04 will automatically be saved to E2-01.

No.	Parameter Name	Setting Range	Default
E2-01	Motor Rated Current	10% to 150% of the drive rated current [1]	Determined by C6-01 and o2-04

<1> Display is in the following units:
   2□0028, 2□0042, and 4□0011 to 4□0027: 0.01 A units
   2□0054 to 2□0248 and 4□0034 to 4□0930: 0.1 A units

Note: Setting E2-01 ≤ E2-03 will trigger an oPE02 error. Set E2-03 correctly to prevent this error.

■ H1-01 to H1-08: Functions for Terminals S1 to S8

No.	Parameter Name	Setting Range	Default
H1-01	Multi-Function Digital Input Terminal S1 Function Selection	1 to 9F	40 (F) [1] : Forward Run Command (2-Wire sequence)
H1-02	Multi-Function Digital Input Terminal S2 Function Selection	1 to 9F	41 (F) [1] : Reverse Run Command (2-Wire sequence)
H1-03	Multi-Function Digital Input Terminal S3 Function Selection	0 to 9F	24: External Fault (N.O., always detected, coast to stop)
H1-04	Multi-Function Digital Input Terminal S4 Function Selection	0 to 9F	14: Fault Reset
H1-05	Multi-Function Digital Input Terminal S5 Function Selection	0 to 9F	3 (0) [1] : Multi-Step Speed Reference 1
H1-06	Multi-Function Digital Input Terminal S6 Function Selection	0 to 9F	4 (3) [1] : Multi-Step Speed Reference 2
H1-07	Multi-Function Digital Input Terminal S7 Function Selection	0 to 9F	6 (4) [1] : Jog Reference Selection
H1-08	Multi-Function Digital Input Terminal S8 Function Selection	0 to 9F	8: External Baseblock Command

<1> Number appearing in parenthesis is the default value after performing a 3-Wire initialization (A1-03 = 3330).

■ H2-01 to H2-03: Terminal M1-M2, M3-M4, and M5-M6 Function Selection

No.	Parameter Name	Setting Range	Default
H2-01	Terminal M1-M2 Function Selection (relay)	0 to 192	0: During run
H2-02	Terminal M3-M4 Function Selection (relay)	0 to 192	1: Zero Speed
H2-03	Terminal M5-M6 Function Selection (relay)	0 to 192	2: Speed agree 1

■ L1-01: Motor Overload Protection Selection

The drive has an electronic overload protection function that estimates the motor overload level based on output current, output frequency, thermal motor characteristics, and time. When the drive detects a motor overload an oL1 fault is triggered and the drive output shuts off.

L1-01 sets the overload protection function characteristics according to the motor being used.

No.	Name	Setting Range	Default
L1-01	Motor Overload Protection Selection	0 to 6	Determined by A1-02

Note:

1. When the motor protection function is enabled (L1-01 ≠ 0), an oL1 alarm can be output through one of the multi-function outputs by setting H2-01 to 1F. The output closes when the motor overload level reaches 90% of the oL1 detection level.

2. Set L1-01 to a value between 1 and 6 when running a single motor from the drive to select a method to protect the motor from overheat. An external thermal relay is not necessary.

Setting 0: Disabled (Motor Overload Protection Is Not Provided)

Use this setting if no motor overheat protection is desired or if multiple motors are connected to a single drive. If multiple motors are connected to a single drive, install a thermal relay for each motor as shown in *Figure i.68*.
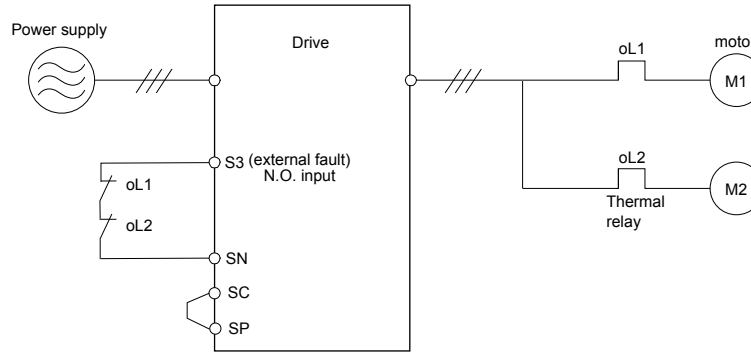
Figure i.68 Example of Protection Circuit Design for Multiple Motors

NOTICE: *Thermal protection cannot be provided when running multi-motors simultaneously with the same drive, or when using motors with a relatively high current rating compared to other standard motors (such as a submersible motor). Failure to comply could result in motor damage. Disable the electronic overload protection of the drive (L1-01 = "0: Disabled") and protect each motor with individual motor thermal overloads.*

Setting 1: General-purpose Motor (Standard Self-cooled)

Because the motor is self-cooled, the overload tolerance drops when the motor speed is lowered. The drive appropriately adjusts the electrothermal trigger point according to the motor overload characteristics, protecting the motor from overheat throughout the entire speed range.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor designed to operate from line power. Motor cooling is most effective when running at rated base frequency (check the motor nameplate or specifications).	Continuous operation at less than line power frequency with 100% load can trigger a motor overload fault (oL1). A fault is output and the motor will coast to stop.

Setting 2: Drive Dedicated Motor (Speed Range for Constant Torque: 1:10)

Use this setting when operating a drive duty motor that allows constant torque in a speed range of 1:10. The drive will allow the motor to run with 100% load from 10% up to 100% speed. Running the motor below 10% speed with 100% load will trigger an overload fault.

Overload Tolerance	Cooling Ability	Overload Characteristics
Rated Speed=100% Speed A: Max. speed for 200LJ and above B: Max. speed for 160MJ to 180 LJ C: Max. speed for 132MJ and below *(graph: Torque (%) vs Speed (%), 60 s, Continuous, points A, B, C; axis 150, 100, 55, 50, 0 / 1 10 100 120 167 200)*	Motor is designed to effectively cool itself even at low speeds.	Continuous operation with 100% load from 6 Hz to E1-06, Motor Base Frequency.

Setting 3: Vector Motor (Speed Range for Constant Torque: 1:100)

Use this setting when operating a drive-dedicated motor that allows constant torque in a speed range of 1:100. This motor type is allowed to run with 100% load from 1% up to 100% speed. Running the motor below 1% speed with 100% load will trigger an overload fault.

Overload Tolerance	Cooling Ability	Overload Characteristics
Rated Speed=100% Speed A: Max. speed for 200LJ and above B: Max. speed for 160MJ to 180 LJ C: Max. speed for 132MJ and below *(graph: Torque (%) vs Speed (%), 60 s, Continuous, points A, B, C; axis 150, 100, 90, 50, 0 / 1 100 120 167 200)*	Motor is designed to effectively cool itself at speeds near 0.6 Hz.	Continuous operation with 100% load from 0.6 Hz to E1-06, Motor Base Frequency. Continuous operation below 0.6 Hz may cause an oL1 or oL2 fault.

Setting 4: PM Derated Torque Motor
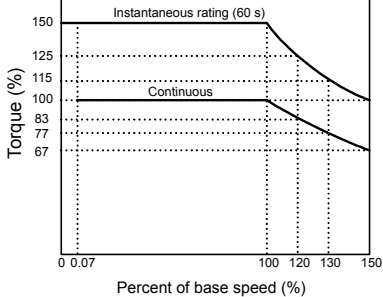
Use this setting when operating a PM motor. PM motors for derated torque have a self-cooling design and the overload tolerance drops as the motor slows. Electronic thermal overload is triggered in accordance with the motor overload characteristics, providing overheat protection across the entire speed range.

Overload Tolerance	Cooling Ability	Overload Characteristics
(graph: Torque (%) vs Motor Speed (%), 60 s, Continuous; axis 150, 130, 100, 85, 80, 67, 50, 0 / 0 10 33 100 150)	Motor is designed to produce 100% torque at base speed. Built with effective cooling capabilities.	Reaching 100% when operating at below the base frequency causes a motor overload fault (oL1). The drive fault output closes and the motor coasts to stop.

Setting 5: Constant Torque PM Motors (Constant Torque Range of 1:1500)

Sets necessary protection characteristics when driving a PM with constant torque. These motors allow for a speed control from 0.07% to 100% when operating with 100% load. Running the motor below 0.07% speed with 100% load will trigger an overload fault.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor is designed to effectively cool itself at speeds near 0.07% of base speed.	Continuous operation with 100% load from 0.07% to 100% of base speed.

Setting 6: General-purpose Motor

Note: General-purpose motors are designed with a base speed that operates at line frequency (50/60 Hz depending on geographic region).

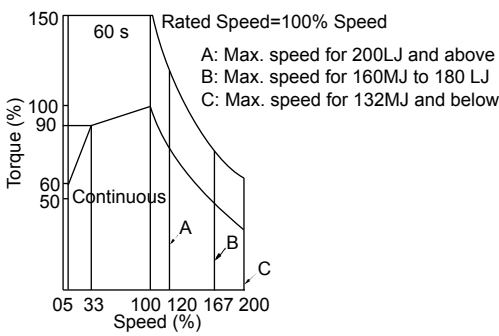Because the motor is self-cooled, the overload tolerance drops when the motor speed is lowered. The drive appropriately adjusts the electrothermal trigger point according to the motor overload characteristics and protects the motor from overheat throughout the entire speed range.

Overload Tolerance	Cooling Ability	Overload Characteristics
	Motor designed to operate from line power. Motor cooling is most effective when running at rated base frequency (check the motor nameplate or specifications)	Continuous operation at less than line power frequency with 100% load can trigger a motor overload fault (oL1). A fault is output and the motor will coast to stop.

■ L1-02: Motor Overload Protection Time

Sets the time for the drive to shut down on motor overload (oL1) when the motor is running with excessive current. Enter the time the motor can withstand operating at 150% current after previously running at 100% current (hot motor overload condition). There is normally no need to change this parameter from the default value.

No.	Name	Setting Range	Default
L1-02	Motor Overload Protection Time	0.1 to 5.0 minutes	1.0 minutes

Defaulted to operate with an allowance of 150% overload operation for one minute in a hot start after continuous operation at 100%.

Figure i.69 illustrates an example of the electrothermal protection operation time using a general-purpose motor operating at the value of E1-06, Motor Base Speed, with L1-02 set to one minute.

Motor overload protection operates in the area between a cold start and a hot start.

• Cold start: Characteristics of motor protection operation time in response to an overload situation that was suddenly reached when starting a stationary motor.

• Hot start: Characteristics of motor protection operation time in response to an overload situation that occurred while the motor was operating continuously at or below its rated current.
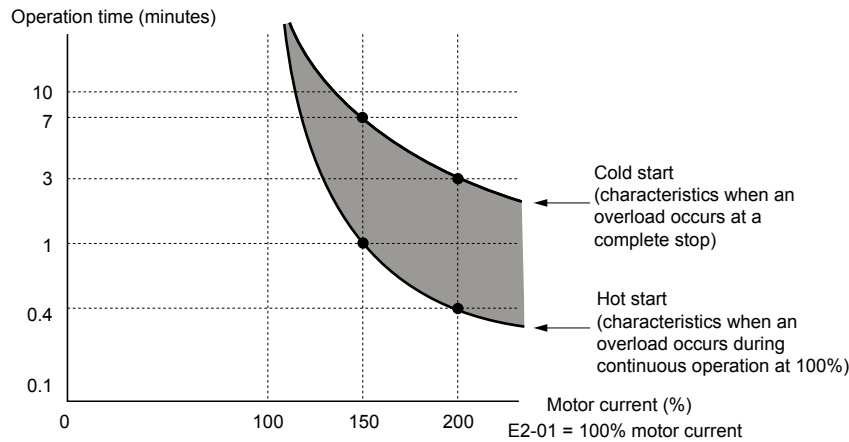
Figure i.69 Protection Operation Time for General Purpose Motors at the Rated Output Frequency

■ Motor Protection Using a Positive Temperature Coefficient (PTC) Thermistor

Connect a motor PTC can to an analog input of the drive for motor overheat protection.

The motor overheat alarm level triggers an oH3 alarm and the drive continues the operation selected in L1-03. The overheat fault level triggers an oH4 fault, outputs a fault signal, and the drive stops the motor using the stop method selected in L1-04.

Connect the PTC between terminals AC and A3 and set jumper S4 on the terminal board to "PTC" as shown in *Figure i.70*. Set H3-05 to 0 and H3-06 to E.
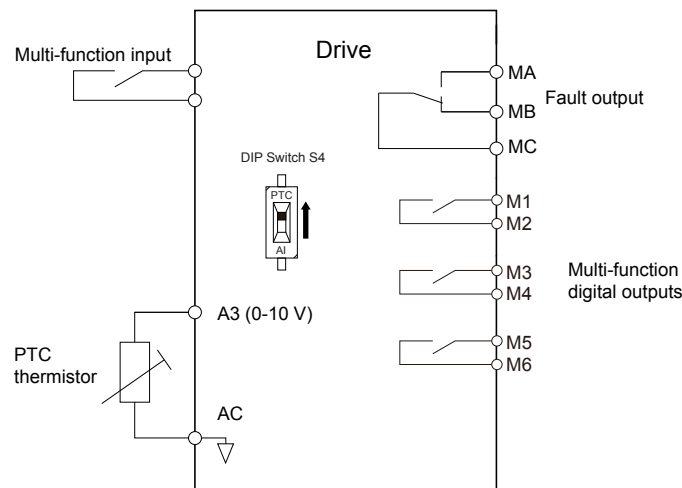
Figure i.70 Connection of a Motor PTC

The PTC must exhibit the characteristics shown in *Figure i.71* in one motor phase. The motor overload protection of the drive expects 3 of these PTCs to be connected in a series.

Figure i.71 Motor PTC Characteristics

Set up overheat detection using a PTC using parameters L1-03, L1-04, and L1-05 as explained in the following sections.

◆ Auto-Tuning

The drive offers different types of Auto-Tuning for induction motors and permanent magnet motors. The type of Auto-Tuning used differs further based on the control mode and other operating conditions. Refer to the tables below to select the type of Auto-Tuning that bests suits the application.

Note: The drive will only show Auto-Tuning parameters that are valid for the control mode that has been set in A1-02. If the control mode is for an induction motor, the Auto-Tuning parameters for PM motors will not be available. If the control mode is for a PM m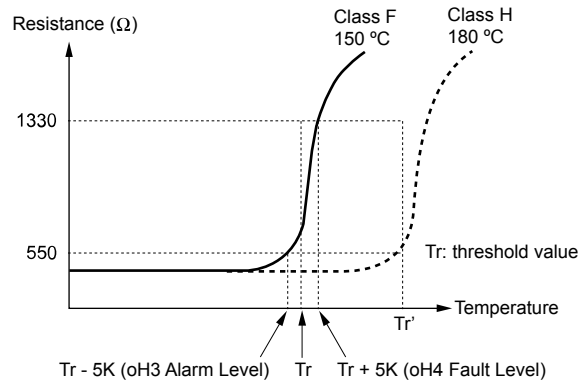otor, the Auto-Tuning parameters for induction motors will not be available. Inertia Tuning and ASR Gain Tuning parameters and setting options will be visible only when the drive is set for operation with CLV or CLV/PM.

Table i.39 Types of Auto-Tuning for Induction Motors

Type	Setting	Application Conditions and Benefits	Control Mode			
			V/f	V/f w/PG	OLV	CLV
Rotational Auto-Tuning	T1-01 = 0	• Motor can be decoupled from the load and rotate freely while Auto-Tuning is performed. • Motor and load cannot be decoupled but the motor load is below 30%. • Rotational Auto-Tuning gives the most accurate results, and is recommended if possible.	–	–	YES	YES
Stationary Auto-Tuning 2	T1-01 = 4	• Motor and load cannot be decoupled and the load is higher than 30%. • A motor test report is available. After entering the no-load current and the rated slip, the drive calculates and sets all other motor-related parameters.	–	–	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 are 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
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	–	–
Stationary Auto-Tuning 3	T1-01 = 5	• A motor test report listing motor data is not available. • Motor can be driven with a normal duty mode after Auto-Tuning. A trial run is performed after Auto-Tuning to automatically calculate motor parameters needed for vector control.	–	–	YES	YES

■ T1-01: Auto-Tuning Mode Selection

Sets the type of Auto-Tuning to be used.

No.	Name	Setting Range	Default
T1-01	Auto-Tuning Mode Selection	V/f: 2, 3 V/f w/PG: 2, 3 OLV: 0, 2, 4, 5 CLV: 0, 2, 4, 5, 8, 9	V/f, V/f w/PG: 2 OLV, CLV: 0

Setting 0: Rotational Auto-Tuning

Setting 2: Stationary Auto-Tuning for Line-to-Line Resistance

Setting 3: Rotational Auto-Tuning for V/f Control

Setting 4: Stationary Auto-Tuning 2

Setting 5: Stationary Auto-Tuning 3

Setting 8: Inertia Tuning

Setting 9: ASR Gain Auto-Tuning

Note: Inertia Tuning and ASR Gain Auto-Tuning may not be available when gears are between the machine and the motor shaft.

◆ No-Load Operation Test Run

This section explains how to operate the drive with the motor decoupled from the load during a test run.

■ Before Starting the Motor

Check the following items before operation:
• Ensure the area around the motor is safe.
• Ensure external emergency stop circuitry is working properly and other safety precautions have been taken.

■ During Operation

Check the following items during operation:
• The motor should rotate smoothly (i.e., no abnormal noise or oscillation).
• The motor should accelerate and decelerate smoothly.

◆ Test Run with the Load Connected

After performing a no-load test run, connect the motor and proceed to run the motor and load together.

■ Checklist Before Operation

• The motor should rotate in the proper direction.
• The motor should accelerate and decelerate smoothly.

■ Operating the Motor under Loaded Conditions

Test run the application similarly to the no-load test procedure when connecting the machinery to the motor.
• Monitor U1-03 for overcurrent during operation.
• If the application permits running the load in the reverse direction, change the motor direction and the frequency reference while watching for abnormal motor oscillation or vibration.
• Correct any problems that occur with hunting, oscillation, and other control-related issues.

◆ Test Run Checklist

Review the checklist before performing a test run. Check each item that applies.

☑	No.	Checklist	Page
☐	1	Thoroughly read the manual before performing a test run.	–
☐	2	Turn the power on.	–

Check the items that correspond to the control mode being used.

WARNING! *Sudden Movement Hazard. Ensure start/stop and safety circuits are wired properly and in the correct state before energizing the drive. Failure to comply could result in death or serious injury from moving equipment. When programmed for 3-Wire control, a momentary closure on terminal S1 may cause the drive to start.*

☑	No.	Checklist	Page
		V/f Control (A1-02 = 0) and V/f Control with PG (A1-02 = 1)	
☐	3	Select the best V/f pattern according to the application and motor characteristics.	–
☐	4	Perform Rotational Auto-Tuning for V/f Control if using Energy Saving functions.	–
		V/f Control with PG (A1-02 = 1)	
☐	5	Set up the PG feedback parameters correctly and make sure the encoder pulse counting direction is correct.	–
☐	6	Set the proportional gain for ASR speed control to C5-01 and the integral time to C5-02.	–
		Open Loop Vector Control (A1-02 = 2) or Closed Loop Vector Control (A1-02 = 3)	
☐	7	Decouple motor shafts and machines when performing Rotational Auto-Tuning.	–
☐	8	Set the Auto-Tuning mode to T1-01 (0 for Rotational Auto-Tuning).	–
☐	9	Enter the following data according to the information listed on the motor nameplate: • Motor rated power to T1-02 (kW) • Motor rated voltage to T1-03 (V) • Motor rated current to T1-04 (A) • Motor base frequency to T1-05 (Hz) • Number of motor poles to T1-06 • Motor base speed to T1-07 (r/min)	–
		Closed Loop Vector Control (A1-02 = 3)	
☐	10	Set F1-01 and F1-05.	–
☐	11	Set ASR proportional gain to C5-01 and ASR integral time to C5-02. Perform ASR Tuning if possible.	–
		Open Loop Vector Control for PM (A1-02 = 5)	
☐	12	Perform Auto-Tuning as described.	–
		Advanced Open Loop Vector Control for PM (A1-02 = 6)	
☐	13	Perform Auto-Tuning as described.	–
☐	14	Set the proportional gain for ASR speed control to C5-01 and the integral time to C5-02.	–
		Closed Loop Vector Control for PM (A1-02 = 7)	
☐	15	Set PM motor data using E5-☐☐ parameters.	–
☐	16	Set ASR proportional gain to C5-01 and ASR integral time to C5-02. Perform ASR Tuning if possible.	–
☐	17	Set F1-01 and F1-05.	–
☐	18	Set the offset between the rotor magnetic axis and the Z-pulse of the connected encoder to E5-11.	–
☑	19	The DRV should be displayed on the LCD operator after giving a Run command.	–
☐	20	To give Run command and frequency reference from the digital operator, press "LO/RE" key to set to LOCAL.	–
☐	21	If the motor rotates in the opposite direction during test run, switch two of U/T1, V/T2, W/T3, or change b1-14.	–
☐	22	In accordance with load condition, set Heavy Duty or Normal Duty mode using parameter C6-01. Normal Duty is the default setting.	–
☐	23	Set motor rated current (E2-01, E4-01, E5-03) and motor protection (L1-01) values for motor thermal protection.	–
☐	24	Set the drive for REMOTE when control circuit terminals provide the Run command and frequency reference.	–
☐	25	If the control circuit terminals should supply the frequency reference, select the correct voltage input signal level (0 to 10 V or -10 to +10 V) or the correct current input signal level (4 to 20 mA or 0 to 20 mA).	*68*
☐	26	Apply the proper signal level to terminals A1 and A3 (0 to 10 V or -10 to +10 V).	–
☐	27	Apply the proper signal level (-10 to +10 V, 4 to 20 mA or 0 to 20 mA) to terminal A2.	–
☐	28	When current input is used, switch the built-in DIP switch S1 from the V-side to I-side. Set the level for current signal used to H3-09 (set "2" for 4 to 20 mA, or "3" for 0 to 20 mA).	–
☐	29	Set DIP Switch S1 on the drive to "I" when using terminal A2 as current input. Set DIP Switch S1 on the drive to "V" when using terminal A2 as voltage input.	–

☑	No.	Checklist	Page
☐	30	If an analog input supplies the frequency reference, make sure it produces the desired frequency reference. Make the following adjustments if the drive does not operate as expected: Gain adjustment: Set the maximum voltage/current signal and adjust the analog input gain (H3-03 for A1, H3-11 for A2, H3-07 for A3) until the frequency reference value reaches the desired value. Bias adjustment: Set the minimum voltage/current signal and adjust the analog input bias (H3-04 for A1, H3-12 for A2, H3-08 for A3) until the frequency reference value reaches the desired minimum value.	–

i.6 Troubleshooting

NOTICE
Refer to the U1000 Industrial MATRIX Drive Technical Manual SIEP C710636 04 for information on *Troubleshooting* and complete product instructions necessary for proper installation, set-up, troubleshooting and maintenance. The U1000 Industrial MATRIX Drive Technical Manual is posted on the Yaskawa website, www.yaskawa.com.

◆ Fault Detection

■ Fault Displays

Digital Operator Display		Fault Name
Aou	Aov	Power Supply Overvoltage
		The input power supply voltage became equal to or higher than the Input Power Supply Overvoltage Detection Level. 200 V Class: Approximately 290 Vrms 400 V Class: Approximately 580 Vrms
AUu	AUv	Power Supply Undervoltage
		The input power supply voltage became equal to or lower than the Input Power Supply Undervoltage Detection Level (L2-21). 200 V Class: Approximately 150 Vrms 400 V Class: Approximately 300 Vrms
bUS	bUS	Option Communication Error
		• The connection was lost after establishing initial communication. • Only detected when the run command frequency reference is assigned to an option card.
CE	CE	MEMOBUS/Modbus Communication Error
		Control data was not received for the CE detection time set to H5-09.
CF	CF	Control Fault
		The torque limit was reached continuously for three seconds after the Stop command was input and deceleration was not possible in OLV Control.
CoF	CoF	Current Offset Fault
		Drive starts operation while the current-detection circuit failure, or the induced voltage remains in the motor (coasting and after rapid deceleration).
CPF00 to *CPF03*, *CPF07*, *CPF08*, *CPF11* to *CPF14*, *CPF16* to *CPF24*, *CPF26* to *CPF35*, *CPF40* to *CPF45* *<1> <2> <3>*	CPF00 to CPF03, CPF07, CPF08, CPF11 to CPF14, CPF16 to CPF24, CPF26 to CPF35, CPF40 to CPF45	Control Circuit Error
CPF06	CPF06	Control Circuit Error
		There is an error in the data saved to EEPROM.
CPF25	CPF25	Terminal Board Not Connected
dEu	dEv	Speed Deviation (for Control Mode with PG)
		The deviation between the speed detection value for the pulse input and the speed reference after speed agreement was reached exceeded the setting value of F1-10 for the time set in F1-11 or longer when the Operation Selection at Deviation was set to continue operation (F1-04 = 3).
doH	doH	Damping Resistor Overheat
		The temperature of the built-in damping resistor exceeded the set value.
du1	dv1	Z Pulse Fault (CLV/PM control mode only)
		The motor turned one full rotation without the Z Pulse being detected.
du2	dv2	Z Pulse Noise Fault Detection (CLV/PM control mode only)
		The Z Pulse is out of phase by more than 5 degrees for 10 consecutive revolutions.
du3	dv3	Inversion Detection (CLV/PM control mode only)
		The torque reference and acceleration are in opposite directions and the speed reference and actual motor speed differ by more than 30% for the number of times set to F1-18.

Digital Operator Display		Fault Name
du4	dv4	Inversion Prevention Detection (CLV/PM control mode only)
		Pulses indicate that the motor is rotating in the opposite direction of the speed reference. Set the number of pulses to trigger inverse detection to F1-19.
		Note: Set F1-19 to 0 to disable inverse detection in applications where the motor may rotate in the opposite direction of the speed reference.
du7	dv7	Initial Polarity Estimation Timeout
dWAL	dWAL	DriveWorksEZ Fault
dWFL	dWFL	
dWF1	dWF1	EEPROM Memory DriveWorksEZ Data Error
		There is an error in the DriveWorksEZ program saved to EEPROM.
E5	E5	MECHATROLINK Watchdog Timer Error
		The watchdog timed out.
EF0	EF0	Option Card External Fault
		An external fault condition is present.
EF1	EF1	External Fault (input terminal S1)
		External fault at multi-function input terminal S1.
EF2	EF2	External Fault (input terminal S2)
		External fault at multi-function input terminal S2.
EF3	EF3	External Fault (input terminal S3)
		External fault at multi-function input terminal S3.
EF4	EF4	External Fault (input terminal S4)
		External fault at multi-function input terminal S4.
EF5	EF5	External Fault (input terminal S5)
		External fault at multi-function input terminal S5.
EF6	EF6	External Fault (input terminal S6)
		External fault at multi-function input terminal S6.
EF7	EF7	External Fault (input terminal S7)
		External fault at multi-function input terminal S7.
EF8	EF8	External Fault (input terminal S8)
		External fault at multi-function input terminal S8.
Err	Err	EEPROM Write Error
		Data cannot be written to the EEPROM.
FAn	FAn	Fan fault
		Fan failure
FbH	FbH	Excessive PID Feedback
		PID feedback input is greater than the level set to b5-36 for longer than the time set to b5-37. Set b5-12 to 2 or 5 to enable fault detection.
FbL	FbL	PID Feedback Loss
		PID feedback loss detection is programmed to trigger a fault (b5-12 = 2 or 5) and the PID feedback level is below the detection level set to b5-13 for longer than the time set to b5-14.
Fdv	Fdv	Power Supply Frequency Fault
		The input power supply frequency exceeded the allowable frequency fluctuation.
GF	GF	Ground Fault
		• A current short to ground exceeded 50% of rated current on the output side of the drive.
		• Setting L8-09 to 1 enables ground fault detection.
LF	LF	Output Phase Loss
		• Phase loss on the output side of the drive.
		• Setting L8-07 to 1 or 2 enables Phase Loss Detection.

Digital Operator Display		Fault Name
LF2	LF2	Output Current Imbalance
		One or more of the phases in the output current are lost.
LSo <4>	LSo	LSo Fault
		Pull-out has been detected at low speed.
nSE	nSE	Node Setup Error
		A terminal assigned to the node setup function closed during run.
oC	oC	Overcurrent
		Drive sensors detected an output current greater than the specified overcurrent level.
oFA00	oFA00	Option Card Connection Error at Option Port CN5-A
		Option compatibility error
oFA01	oFA01	Option Card Fault at Option Port CN5-A
		Option not properly connected
oFA03 to *oFA06*	oFA03 to oFA06	Option Card Error Occurred at Option Port CN5-A
oFA10, oFA11	oFA10, oFA11	
oFA12 to *oFA17*	oFA12 to oFA17	Option Card Connection Error (CN5-A)
oFA30 to *oFA43*	oFA30 to oFA43	Communication Option Card Connection Error (CN5-A)
oFb00	oFb00	Option Card Fault at Option Port CN5-B
		Option compatibility error
oFb01	oFb01	Option Card Fault at Option Port CN5-B
		Option not properly connected
oFb02	oFb02	Option Card Fault at Option Port CN5-B
		Same type of option card is currently connected
oFb03 to *oFb11*	oFb03 to oFb11	Option card error occurred at Option Port CN5-B
oFb12 to *oFb17*	oFb12 to oFb17	
oFC00	oFC00	Option Card Connection Error at Option Port CN5-C
		Option compatibility error
oFC01	oFC01	Option Card Fault at Option Port CN5-C
		Option not properly connected
oFC02	oFC02	Option Card Fault at Option Port CN5-C
		Same type of option card is currently connected
oFC03 to *oFC11*	oFC03 to oFC11	Option Card Error Occurred at Option Port CN5-C
oFC12 to *oFC17*	oFC12 to oFC17	
oFC50 to *oFC55*	oFC50 to oFC55	Option Card Error Occurred at Option Port CN5-C
oH	oH	Heatsink Overheat
		The heatsink temperature exceeded the overheat pre-alarm level set to L8-02. The default value for L8-02 is determined by drive model selection (o2-04).
oH1	oH1	Overheat 1 (Heatsink Overheat)
		The heatsink temperature exceeded the drive overheat level. Overheat level is determined by drive capacity (o2-04).
oH3	oH3	Motor Overheat Alarm (PTC Input)
		• The motor overheat signal to analog input terminal A1, A2, or A3 exceeded the alarm detection level. • Detection requires setting multi-function analog inputs H3-02, H3-10, or H3-06 to E.
oH4	oH4	Motor Overheat Fault (PTC Input)
		• The motor overheat signal to analog input terminal A1, A2, or A3 exceeded the fault detection level. • Detection requires setting multi-function analog inputs H3-02, H3-10, or H3-06 to E.
oL1	oL1	Motor Overload
		The electronic motor overload protection tripped.
oL2	oL2	Drive Overload
		The thermal sensor of the drive triggered overload protection.

Digital Operator Display		Fault Name
oL3	oL3	Overtorque Detection 1
		The current has exceeded the value set for Torque Detection Level 1 (L6-02) for longer than the allowable time (L6-03).
oL4	oL4	Overtorque Detection 2
		The current has exceeded the value set for Torque Detection Level 2 (L6-05) for longer than the allowable time (L6-06).
oL5	oL5	Mechanical Weakening Detection 1
		Overtorque occurred, matching the conditions specified in L6-08.
oPr	oPr	External Digital Operator Connection Fault
		The external operator has been disconnected from the drive.
		Note: An oPr fault will occur when all of the following conditions are true:
		• Output is interrupted when the operator is disconnected (o2-06 = 1).
		• The Run command is assigned to the operator (b1-02 = 0 and LOCAL has been selected).
oS	oS	Overspeed
		The motor speed feedback exceeded the F1-08 setting.
ov	ov	Control Circuit Overvoltage
		Voltage in the control circuit has exceeded the overvoltage level.
		• For 200 V class drives: approximately 450 V
		• For 400 V class drives: approximately 900 V
PGo	PGo	PG Disconnect (for any control modes using a PG option card)
		No PG pulses are received for longer than the time set to F1-14.
PGoH	PGoH	PG Hardware Fault (detected when using a PG-X3 option card)
		PG cable is not connected properly.
SCF	SCF	Safety Circuit Fault
		Safety Circuit Fault is detected.
SEr	SEr	Too Many Speed Search Restarts
		The number of Speed Search restarts exceeded the value set to b3-19.
SoH	SoH	Snubber Discharge Resistor Overheat
SrC	SrC	Phase Order Detection Fault
		The phase rotation direction for the input power supply changed.
Srr	Srr	Internal Resistance Fault
		An operation failure occurred in the snubber discharge resistor circuit.
STo	STo	Pull-Out Detection
		Motor pull out or step out has occurred. Motor has exceeded its pull-out torque.
SvE	SvE	Zero Servo Fault
		Position deviation during zero servo.
UL3	UL3	Undertorque Detection 1
		The current has fallen below the minimum value set for Torque Detection Level 1 (L6-02) for longer than the allowable time (L6-03).
UL4	UL4	Undertorque Detection 2
		The current has fallen below the minimum value set for Torque Detection Level 2 (L6-05) for longer than the allowable time (L6-06).
UL5	UL5	Mechanical Weakening Detection 2
		The operation conditions matched the conditions set to L6-08.
Uv1	Uv1	Control Circuit Undervoltage Fault
		Voltage in the control circuit fell below the detection level:
		• 200 V class: When Input Voltage Setting (E1-22) ≤ 220 Vrms, approximately 190 V. When Input Voltage Setting (E1-22) > 220 Vrms, approximately 225 V.
		• 400 V class: When Input Voltage Setting (E1-22) ≤ 440 Vrms, approximately 380 V. When Input Voltage Setting (E1-22) > 440 Vrms, approximately 450 V.
Uv2	Uv2	Control Power Supply Voltage Fault
		Voltage is too low for the control drive input power.

Digital Operator Display		Fault Name
Uu3	Uv3	Undervoltage 3 (Soft-Charge Bypass Relay Fault)
		The soft-charge bypass relay failed.

<1> Displayed as CPF00 when occurring at drive power up. When one of the faults occurs after successfully starting the drive, the display will show CPF01.

<2> Displayed as CPF20 when occurring at drive power up. When one of the faults occurs after successfully starting the drive, the display will show CPF21.

<3> Fault trace (i.e., the fault history) is not kept when CPF00, CPF01, CPF06, CPF24, oFA00, oFb00, oFC00, Uv1, Uv2, Uv3, AUv, Fdv, or Src occur.

<4> This function prevents continuous operation in reverse when using high frequency injection (n8-57 = 1) in AOLV/PM (A1-02 = 6) with a motor for which no motor code has been entered (it does not only prevent reverse operation). Set L8-93, L8-94, and L8-95 to low values within range of erroneous detection to quickly detect undesirable reverse operation.

◆ Alarm Detection

■ Alarm Codes

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

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

Refer to the Technical Manual for a complete list of causes and possible solutions.

Digital Operator Display		Alarm Name
AEr	AEr	Station Address Setting Error (CC-Link, CANopen, MECHATROLINK)
		Option card node address is outside of the acceptable setting range.
AUu	AUv	Power Supply Undervoltage
		The input power supply voltage became equal to or lower than the Input Power Supply Undervoltage Detection Level (L2-21). 200 V Class: Approximately 150 Vrms 400 V Class: Approximately 300 Vrms
bb	bb	Baseblock
		Drive output interrupted as indicated by an external baseblock signal.
bUS	bUS	Option Communication Error
		• The connection was lost after establishing initial communication.
		• Only detected when the run command frequency reference is assigned to an option card.
bUSY	bUSy	Parameter Change
		The drive detected a different setting being changed while it was changing a setting.
CALL	CALL	Serial Communication Transmission Error
		Communication has not yet been established.
CE	CE	MEMOBUS/Modbus Communication Error
		Control data was not received for the CE detection time set to H5-09.
CrST	CrST	Cannot Reset
CYC	CyC	MECHATROLINK Comm. Cycle Setting Error
		Comm. Cycle Setting Error was detected.
dEu	dEv	Speed Deviation (for Control Mode with PG)
		The deviation between the speed detection value for the pulse input and the speed reference after speed agreement was reached exceeded the setting value of F1-10 for the time set in F1-11 or longer when the Operation Selection at Deviation was set to continue operation (F1-04 = 3).
dnE	dnE	Drive Disabled
doH	doH	Damping Resistor Overheat
		The temperature of the built-in damping resistor exceeded the set value.
EF	EF	Forward/Reverse Run Command Input Error
		Both forward run and reverse run closed simultaneously for longer than 0.5 s.
EF0	EF0	Option Card External Fault
		An external fault condition is present.

Digital Operator Display		Alarm Name
EF 1	EF1	External Fault (input terminal S1)
		External fault at multi-function input terminal S1.
EF2	EF2	External Fault (input terminal S2)
		External fault at multi-function input terminal S2.
EF3	EF3	External Fault (input terminal S3)
		External fault at multi-function input terminal S3.
EF4	EF4	External Fault (input terminal S4)
		External fault at multi-function input terminal S4.
EF5	EF5	External Fault (input terminal S5)
		External fault at multi-function input terminal S5.
EF6	EF6	External Fault (input terminal S6)
		External fault at multi-function input terminal S6.
EF7	EF7	External Fault (input terminal S7)
		External fault at multi-function input terminal S7.
EF8	EF8	External Fault (input terminal S8)
		External fault at multi-function input terminal S8.
FbH	FbH	Excessive PID Feedback
		PID feedback input is greater than the level set to b5-36 for longer than the time set to b5-37. Set b5-12 to 2 or 5 to enable fault detection.
FbL	FbL	PID Feedback Loss
		PID feedback loss detection is programmed to trigger a fault (b5-12 = 2 or 5) and the PID feedback level is below the detection level set to b5-13 for longer than the time set to b5-14.
Fdv	Fdv	Power Supply Frequency Fault
		The input power supply frequency exceeded the allowable frequency fluctuation.
Hbb	Hbb	Safe Disable Signal Input
		Both Safe Disable Input channels are open.
HbbF	HbbF	Safe Disable Signal Input
		One Safe Disable channel is open while the other channel is closed.
HCA	HCA	Current Alarm
		Drive current exceeded overcurrent warning level (150% of the rated current).
LT-1	LT-1	Cooling Fan Maintenance Time
		The cooling fan has reached its expected maintenance period and may need to be replaced. **Note:** An alarm output (H2-□□ = 10) will only be triggered if both (H2-□□ = 2F and H2-□□ = 10) are set.
LT-2	LT-2	Capacitor Maintenance Time
		The main circuit and control circuit capacitors are nearing the end of their expected performance life. **Note:** An alarm output (H2-□□ = 10) will only be triggered if H2-□□ = 2F.
LT-3	LT-3	Soft Charge Bypass Relay Maintenance Time
		The DC bus soft charge relay is nearing the end of its expected performance life. **Note:** An alarm output (H2-□□ = 10) will only be triggered if H2-□□ = 2F.
oH	oH	Heatsink Overheat
		The heatsink temperature exceeded the overheat pre-alarm level set to L8-02. The default value for L8-02 is determined by drive model selection (o2-04).
oH2	oH2	Heatsink Overheat Warning
		"Heatsink Overheat Warning" was input to a multi-function input terminal, S1 through S8 (H1-□□= B).
oH3	oH3	Motor Overheat Alarm (PTC Input)
		• The motor overheat signal to analog input terminal A1, A2, or A3 exceeded the alarm detection level. • Detection requires setting multi-function analog inputs H3-02, H3-10, or H3-06 to E.
oL3	oL3	Overtorque Detection 1
		The current has exceeded the value set for Torque Detection Level 1 (L6-02) for longer than the allowable time (L6-03).

Digital Operator Display		Alarm Name
oL4	oL4	Overtorque Detection 2
		The current has exceeded the value set for Torque Detection Level 2 (L6-05) for longer than the allowable time (L6-06).
oS	oS	Overspeed
		The motor speed feedback exceeded the F1-08 setting.
ov	ov	Control Circuit Overvoltage
		Voltage in the control circuit exceeded the trip point. • For 200 V class drives: approximately 450 V • For 400 V class drives: approximately 900 V
PASS	PASS	MEMOBUS/Modbus Comm. Test Mode Complete
PGo	PGo	PG Disconnect (for any control modes using a PG option card)
		No PG pulses are received for longer than the time set to F1-14.
PGoH	PGoH	PG Hardware Fault (detected when using a PG-X3 option card)
		PG cable is not connected properly.
rUn	rUn	Motor Switch during Run
		A command to switch motors was entered during run.
SE	SE	MEMOBUS/Modbus Communication Test Mode Error
		Note: This alarm will not trigger a multi-function output terminal that is set for alarm output (H2-□□ = 10).
SrC	SrC	Phase Order Detection Fault
		The phase rotation direction for the input power supply changed.
UL3	UL3	Undertorque Detection 1
		The current has fallen below the minimum value set for Torque Detection Level 1 (L6-02) for longer than the allowable time (L6-03).
UL4	UL4	Undertorque Detection 2
		The current has fallen below the minimum value set for Torque Detection Level 2 (L6-05) for longer than the allowable time (L6-06).
Uv	Uv	Control Circuit Undervoltage
		One of the following conditions occurred: • Contactor to suppress inrush current in the drive was opened. • Low voltage in the control drive input power. This alarm outputs only if L2-01 is not 0.

◆ Operator Programming Errors

■ oPE Codes

An Operator Programming Error (oPE) occurs when a contradictory parameter is set or an individual parameter is set to an inappropriate value.

The drive will not operate until the parameter or parameters causing the problem are set correctly. An oPE, however, does not trigger an alarm or fault output. When an oPE appears on the operator display, press the ENTER button to view U1-18 and see which parameter is causing the oPE.

Digital Operator Display		Error Name
oPE01	oPE01	Unit Capacity Setting Fault
		Unit capacity and the value set to o2-04 do not match.
oPE02	oPE02	Parameter Range Setting Error
		Use U1-18 to find parameters set outside the range.
oPE03	oPE03	Multi-Function Input Selection Error
		A contradictory setting is assigned to multi-function contact inputs H1-01 to H1-08.
oPE04	oPE04	Initialization Required
oPE05	oPE05	Run Command/Frequency Reference Source Selection Error
oPE06	oPE06	Control Method Selection Error
		Correct the setting for the control method.

Digital Operator Display		Error Name
oPE07	oPE07	Multi-Function Analog Input Selection Error
		A contradictory setting is assigned to multi-function analog inputs H3-02, H3-10, or H3-06 and PID functions conflict.
oPE08	oPE08	Parameter Selection Error
		A function has been set that cannot be used in the motor control method selected.
oPE09	oPE09	PID Control Selection Fault
		PID control function selection is incorrect. Requires that PID control is enabled (b5-01 = 1 to 4).
oPE10	oPE10	V/f Data Setting Error
		One or more of the parameters listed below are not set according to the formula: • E1-09 ≤ E1-07 < E1-06 ≤ E1-11 ≤ E1-04 • E3-09 ≤ E3-07 < E3-06 ≤ E3-11 ≤ E3-04
oPE11	oPE11	Carrier Frequency Setting Error
		Correct the setting for the carrier frequency.
oPE13	oPE13	Pulse Monitor Selection Error
		Incorrect setting of monitor selection for pulse train (H6-06).
oPE15	oPE15	Torque Control Setting Error
		Parameter settings that are not allowed in combination with Torque Control have been set.
oPE16	oPE16	Energy Savings Constants Error
oPE18	oPE18	Online Tuning Parameter Setting Error
		Parameters controlling online tuning are not set correctly.
oPE20	oPE20	PG-F3 Setting Error
		The encoder signal frequency is too high.
oPE30	oPE30	Incorrect Input Voltage Adjustment
		The input voltage offset adjustment has not been performed.

◆ Auto-Tuning Errors

■ Auto-Tuning Codes

Auto-Tuning faults in this section are displayed on the digital operator and will cause the motor to coast to a stop. Auto-Tuning faults do not trigger a multi-function digital output set for fault or alarm output.

An End□ error on the digital operator display indicates Auto-Tuning has successfully completed with discrepancies in the calculations. Restart Auto-Tuning after fixing the cause of the End□ error.

The drive may be used in the application if no cause can be identified despite the existence of an End□ error.
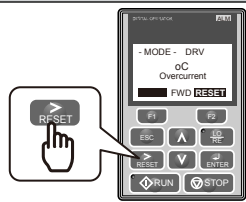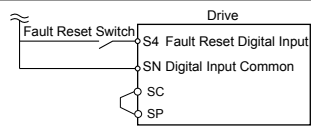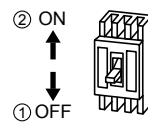
An Er□ error indicates that Auto-Tuning has not completed successfully. Check for the cause of the error using the tables in this section, and perform Auto-Tuning again after fixing the cause.

Digital Operator Display		Error Name
End1	End1	Excessive V/f Setting (detected only during Rotational Auto-Tuning and displayed after Auto-Tuning is complete)
End2	End2	Motor Iron-Core Saturation Coefficient (detected only during Rotational Auto-Tuning and displayed after Auto-Tuning is complete)
End3	End3	Rated Current Setting Alarm (displayed after Auto-Tuning is complete)
End4	End4	Adjusted Slip Calculation Error
End5	End5	Resistance Tuning Error
End6	End6	Leakage Inductance Alarm
End7	End7	No-Load Current Alarm
Er-01	Er-01	Motor Data Error
Er-02	Er-02	Minor Fault
Er-03	Er-03	STOP Button Input
Er-04	Er-04	Line-to-Line Resistance Error
Er-05	Er-05	No-Load Current Error

Digital Operator Display		Error Name
Er-08	Er-08	Rated Slip Error
Er-09	Er-09	Acceleration Error
Er-10	Er-10	Motor Direction Error
Er-11	Er-11	Motor Speed Error
Er-12	Er-12	Current Detection Error
Er-13	Er-13	Leakage Inductance Error
Er-14	Er-14	Motor Speed Error 2
Er-15	Er-15	Torque Saturation Error
Er-16	Er-16	Inertia ID Error
Er-17	Er-17	Reverse Prohibited Error
Er-18	Er-18	Induction Voltage Error
Er-19	Er-19	PM Inductance Error
Er-20	Er-20	Stator Resistance Error
Er-21	Er-21	Z Pulse Correction Error
Er-25	Er-25	High Frequency Injection Parameter Tuning Error

◆ Fault Reset Methods

When a fault occurs, the cause of the fault must be removed and the drive must be restarted. The table below lists the different ways to restart the drive.

After the Fault Occurs	Procedure	
Fix the cause of the fault, restart the drive, and reset the fault.	Press [RESET] on the digital operator when the error code is displayed.	
Resetting via Fault Reset Digital Input S4	Close then open the fault signal digital input via terminal S4. S4 is set for "Fault Reset" as default (H1-04 = 14).	
Turn off the main power supply if the above methods do not reset the fault. Reapply power after the digital operator display has turned off.		

Note: If the Run command is present, the drive will disregard any attempts to reset the fault. Remove the Run command before attempting to clear a fault situation.

i.7   Drive Specifications

Note: **1.** Perform rotational Auto-Tuning to obtain the performance specifications given below.

2. For optimum performance life of the drive, install the drive in an environment that meets the required specifications.

Item		Specification
Control Character-istics	**Control Method**	The following control methods can be set using drive parameters: • V/f Control (V/f) • V/f Control with PG (V/f w/PG) • Open Loop Vector Control (OLV) • Closed Loop Vector Control (CLV) • Open Loop Vector Control for PM (OLV/PM) • Advanced Open Loop Vector Control for PM (AOLV/PM) • Closed Loop Vector Control for PM (CLV/PM)
	Frequency Control Range	0.01 to 400 Hz
	Frequency Accuracy (Temperature Fluctuation)	Digital input: within ±0.01% of the max output frequency (-10 to +40 °C) Analog input: within ±0.1% of the max output frequency (25 °C ±10 °C)
	Frequency Setting Resolution	Digital inputs: 0.01 Hz Analog inputs: 1/2048 of the maximum output frequency setting (11 bit plus sign)
	Output Frequency Resolution	0.001 Hz
	Frequency Setting Signal	Main speed frequency reference: -10 to +10 Vdc (20 kΩ), 0 to +10 Vdc (20 kΩ), 4 to 20 mA (250 Ω), 0 to 20 mA (250 Ω) Main speed reference: Pulse train input (max. 32 kHz)
	Starting Torque	V/f, V/f w/PG: 150% at 3 Hz OLV: 200% at 0.3 Hz [1] CLV: 200% at 0.0 r/min [1] OLV/PM: 100 % at 5 % speed. AOLV/PM, CLV/PM: 200% at 0.0 min-1 [2] [3]
	Speed Control Range	V/f, V/f w/PG: 1:40 OLV: 1:200 CLV, CLV/PM: 1:1500 OLV/PM: 1:20 AOLV/PM: 1:100 [2] [3] [4]
	Speed Control Accuracy [5]	OLV: ±0.2% (25 °C ±10 °C (77 °F ±50 °F)) [5] CLV: ±0.02% (25 °C ±10 °C (77 °F ±50 °F)) [5]
	Speed Response	OLV: 10 Hz (25 °C ±10 °C (77 °F ±50 °F)) CLV: 250 Hz (25 °C ±10 °C (77 °F ±50 °F))
	Torque Limit	Parameters setting allow separate limits in four quadrants (available in OLV, CLV, AOLV/PM, CLV/PM)
	Accel/Decel Time	0.0 to 6000.0 s (4 selectable combinations of independent acceleration and deceleration settings)
	Braking Torque [6]	Same value as overload tolerance in motoring or regeneration.
	V/f Characteristics	User-selected programs and V/f preset patterns possible
	Main Control Functions	Torque Control, Droop Control, Speed/torque Control Switching, Feed Forward Control, Zero Servo Function, Momentary Power Loss Ride-Thru, Speed Search, Synchronous Transfer with Commercial Power Supply, Overtorque/Undertorque Detection, Torque Limit, 17 Step Speed (max), Accel/decel Switch, S-curve Accel/decel, 3-wire Sequence, Auto-tuning (rotational, stationary tuning), Dwell, Cooling Fan on/off Switch, Slip Compensation, Torque Compensation, Frequency Jump, Upper/lower Limits for Frequency Reference, DC Injection Braking at Start and Stop, PID Control (with sleep function), Energy Saving Control, MEMOBUS/Modbus Comm. (RS-422/RS-485 max, 115.2 kbps), Fault Restart, Application Presets, DriveWorksEZ (customized function), Removable Terminal Block with Parameter Backup Function, Online Tuning, Overexcitation Deceleration, Inertia (ASR) Tuning, High Frequency Injection.

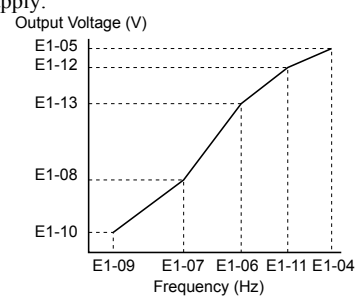| Item		Specification
Protection Functions	**Power Supply Regeneration**	Available
	Motor Protection	Electronic thermal overload relay
	Momentary Overcurrent Protection	Drive stops when output current reaches about 200% of the rated Heavy Duty current.
	Overload Protection	Drive stops after 60 s at 150% of rated Heavy Duty output current [7]
	Overvoltage Protection	200 V class: Stops when input voltage exceeds approx. 315 V 400 V class: Stops when input voltage exceeds approx. 630 V
	Undervoltage Protection	200 V class: Stops when input voltage falls below approx. 150 V 400 V class: Stops when input voltage falls below approx. 300 V
	Momentary Power Loss Ride-Thru	Immediately stop after 2 ms or longer power loss [8] Continuous operation during power loss shorter than 2 s (standard) [9]
	Heatsink Overheat Protection	Thermistor
	Stall Prevention	Stall Prevention is available during acceleration, deceleration, and during run.
	Ground Protection	Electronic circuit protection [10]
	Charge LED of Capacitor for Control Power Supply	Remains lit until control power supply voltage falls below 50 V
Environment	**Area of Use**	Indoors
	Ambient Temperature	IP20/UL Type 1 enclosure: -10 °C to +40 °C (14 °F to 104 °F) IP00 enclosure: -10 °C to +50 °C (14 °F to 122 °F)
	Humidity	95 RH% or less (no condensation)
	Storage Temperature	-20 °C to +60 °C (short-term temperature during transportation)
	Altitude	Up to 1000 meters without derating, up to 3000 m with output current and voltage derating.
	Vibration/Shock	10 to 20 Hz: 9.8 m/s^2 (2□0028 to 2□0248 and 4□0011 to 4□0414) 10 to 20 Hz: 5.9 m/s^2 (4□0477 to 4□0930) 20 to 55 Hz: 5.9 m/s^2 (2□0028 to 2□0081 and 4□0011 to 4□0077) 20 to 55 Hz: 2.0 m/s^2 (2□0104 to 2□0248 and 4□0096 to 4□0930)
Standards		• UL 61800-5-1 • IEC/EN 61800-3, IEC/EN 61800-5-1 • EN ISO 13849-1 Cat.3 PLe, IEC/EN 61508 SIL3
Protection Design		IP00/Open Type enclosure [11], IP20/UL Type 1 enclosure

<1> Current derating is required. Select control modes in accordance with drive capacity.

<2> High-frequency current superposition (n8-57 = 1) can be set. In this case, perform High Frequency Injection Parameter Tuning. High Frequency Injection cannot be used with an SPM motor.

<3> Rotational Auto Tuning must be performed.

<4> Contact Yaskawa or a Yaskawa representative if using a PM motor other than Super Energy-saving Motors manufactured by Yaskawa Motor Co., Ltd. (SSR1 series and SST4 series with standard specifications).

<5> The accuracy of these values depends on motor characteristics, ambient conditions, and drive settings. Specifications may vary with different motors and with changing motor temperature. Contact Yaskawa or a Yaskawa representative for consultation.

<6> Actual specifications may vary depending on motor characteristics.

<7> Overload protection may be triggered when operating with 150% of the rated output current if the output frequency is less than 6 Hz.

<8> Momentary power loss ride-thru during utility power loss designates the time the drive is able to maintain control over a motor operating at full load after utility power is lost. Actual specifications may vary depending on motor characteristics.

<9> Continuous operation time varies depending on the drive capacity. An auxiliary Momentary Power Loss Ride-Thru Unit is required if the application needs to maintain control power long after a 2 second momentary power loss. When L2-01 (Momentary Power Loss Operation Selection) is enabled, operation will stop about 2 ms after momentary power loss occurs. For applications where momentary power loss and power supply interruptions are likely to occur, such as power supply for crane trolleys, contact Yaskawa or a Yaskawa representative.

<10> Ground protection is triggered when a ground short circuit occurs while the drive is running. The ground protection cannot be provided when the impedance of the ground fault path is too low, or when the drive is powered up while a ground fault is present at the output.

<11> An IP20/UL Type 1 enclosure drive requires an IP20/UL Type 1 kit. Models 4□0720 to 4□0930 are not compatible with IP/20UL Type 1 enclosures.

i.8 Parameter Table

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

No.	Name	Description
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
A1-06	Application Preset	**0: General-purpose** 1: Water supply pump 2: Conveyor 3: Exhaust fan 4: HVAC fan 5: Air compressor
b1-01	Frequency Reference Selection 1	0: Digital operator **1: Analog input terminals** 2: MEMOBUS/Modbus communications 3: Option PCB 4: Pulse train 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
b1-04	Reverse Operation Selection	**0: Reverse enabled.** 1: Reverse disabled.
b8-27	q-Axis Current Compensation Method when Output Voltage is Limited	**0: Output Voltage Limit Priority** 1: q-Axis Current Priority
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.
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.
C6-01	Drive Duty Selection	0: Heavy Duty (HD) Overload capability: 150% of drive rated Heavy Duty current for 60 s **1: Normal Duty (ND)** Overload capability: 120% of drive rated Normal Duty current for 60 s

No.	Name	Description
C6-02	Carrier Frequency Selection	0: 3.0 kHz 1: 4.0 kHz 2: 6.0 kHz 3: 8.0 kHz 4: 10.0 kHz F: User-defined (determined by C6-03 to C6-05) Default setting value is determined by A1-02, Control Method Selection, C6-01, Drive Duty Selection, and o2-04, Drive Model Selection.
C7-60	Output Voltage Limit Mode Selection	0: Harmonic suppression priority mode **1: High output voltage mode** **Note:** For drives with software versions PRG: 1021 or later, the default setting is 0 (Harmonic Suppression Priority Mode) when in Advanced Open Loop Vector Control for PM (A1-02 = 6).
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.
d1-17	Jog Frequency Reference	Sets the Jog frequency reference. Setting units are determined by parameter o1-03.
d2-01	Frequency Reference Upper Limit	Sets the frequency reference upper limit as a percentage of the maximum output frequency.
d2-02	Frequency Reference Lower Limit	Sets the frequency reference lower limit as a percentage of the maximum output frequency.
E1-03	V/f Pattern Selection	0: 50 Hz, Constant torque 1 1: 60 Hz, Constant torque 2 2: 60 Hz, Constant torque 3 (50 Hz base) 3: 72 Hz, Constant torque 4 (60 Hz base) 4: 50 Hz, Variable torque 1 5: 50 Hz, Variable torque 2 6: 60 Hz, Variable torque 1 7: 60 Hz, Variable torque 2 8: 50 Hz, High starting torque 1 9: 50 Hz, High starting torque 2 A: 60 Hz, High starting torque 3 B: 60 Hz, High starting torque 4 C: 90 Hz (60 Hz base) D: 120 Hz (60 Hz base) E: 180 Hz (60 Hz base) **F: Custom V/f, E1-04 through E1-13 settings define the V/f pattern**

No.	Name	Description
E1-04	Maximum Output Frequency	Parameters E1-04 and E1-06 to E1-13 can only be changed 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 five frequencies are set according to the following rules to prevent triggering an oPE10 fault: E1-09 ≤ E1-07 < E1-06 ≤ E1-11 ≤ E1-04 Setting E1-11 to 0 disables both E1-11 and E1-12 and the above conditions do not apply.
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	
E1-11	Middle Output Frequency 2	
E1-12	Middle Output Frequency Voltage 2	
E1-13	Base Voltage	
E1-22	Input Voltage Setting	Sets the input power supply voltage (rms voltage value Vrms). This setting value serves as the baseline for the Uv1 and Uv detection levels.
E2-01	Motor Rated Current	Sets the motor nameplate full load current in amps. Automatically set during Auto-Tuning.
H1-01 to H1-08	Multi-Function Digital Input Terminal S1 to S8 Function Selection	Selects the function of terminals S1 to S8.
H2-01	Multi-Function Contact Output (terminal M1-M2)	Sets the function for the relay output M1-M2.
H2-02	Multi-Function Contact Output 2 (terminal M3-M4)	Sets the function for the relay output M3-M4.
H2-03	Terminal M5-M6 function selection (relay)	Sets the function for the relay output M5-M6
H2-06	Power Consumption Output Unit Selection	0: 0.1 kWh units [1] **1: 1 kWh units** 2: 10 kWh units 3: 100 kWh units 4: 1000 kWh units
H2-07	MEMOBUS Register 1 Address Select	Sets the addresses of the MEMOBUS/Modbus registers from which data will be sent to contact outputs 62 and 162.
H2-08	MEMOBUS Register 1 Bit Select	Sets the bits for the MEMOBUS/Modbus registers from which data will be sent to contact outputs 62 and 162.
H2-09	MEMOBUS Register 2 Address Select	Sets the addresses of the MEMOBUS/Modbus registers from which data will be sent to contact outputs 63 and 163.
H2-10	MEMOBUS Register 2 Bit Select	Sets the bits for the MEMOBUS/Modbus registers from which data will be sent to contact outputs 63 and 163.
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.

No.	Name	Description
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.
H3-14	Analog Input Terminal Enable Selection	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**
H3-16	Terminal A1 Offset	Adds an offset when the analog signal to terminal A1 is at 0 V.
H3-17	Terminal A2 Offset	Adds an offset when the analog signal to terminal A2 is at 0 V.
H3-18	Terminal A3 Offset	Adds an offset when the analog signal to terminal A3 is at 0 V.
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 100% of the selected monitor value.
H4-06	Multi-Function Analog Output Terminal AM Bias	Sets the signal level at terminal AM that is equal to 0% of the selected monitor value.
H4-07	Multi-Function Analog Output Terminal FM Signal Level Selection	**0: 0 to 10 V** 1: -10 to 10 V 2: 4 to 20mA
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

No.	Name	Description
H5-01	Drive Node Address	Selects drive station node number (address) for MEMOBUS/Modbus terminals R+, R-, S+, S-. **Note:** Cycle power for the setting to take effect.
H5-02	Communication Speed Selection	0: 1200 bps 1: 2400 bps 2: 4800 bps **3: 9600 bps** 4: 19200 bps 5: 38400 bps 6: 57600 bps 7: 76800 bps 8: 115200 bps **Note:** Cycle power for the setting to take effect.
H5-03	Communication Parity Selection	**0: No parity** 1: Even parity 2: Odd parity **Note:** Cycle power for the setting to take effect.
H5-04	Stopping Method After Communication Error (CE)	0: Ramp to stop 1: Coast to stop 2: Fast Stop **3: Alarm only**
H5-05	Communication Fault Detection Selection	0: Disabled **1: Enabled. If communication is lost for more than two seconds, a CE fault will occur.**
H5-06	Drive Transmit Wait Time	Set the wait time between receiving and sending data. **Note:** Cycle power for the setting to take effect.
H5-07	RTS Control Selection	0: Disabled. RTS is always on. **1: Enabled. RTS turns on only when sending.** **Note:** Cycle power for the setting to take effect.
H5-09	Communication Fault Detection Time	Sets the time required to detect a communications error.
H5-10	Unit Selection for MEMOBUS/Modbus Register 0025H	**0: 0.1 V units** 1: 1 V units
H5-11	Communications ENTER Function Selection	**0: Drive requires an Enter command before accepting any changes to parameter settings.** 1: Parameter changes are activated immediately without the Enter command.
H5-12	Run Command Method Selection	**0: FWD/Stop, REV/Stop** 1: Run/Stop, FWD/REV
H6-01	Pulse Train Input Terminal RP Function Selection	**0: Frequency reference** 1: PID feedback value 2: PID setpoint value 3: V/f Control with Simple PG feedback (possible only when using motor 1 in V/f Control)
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.
H6-05	Pulse Train Input Filter Time	Sets the pulse train input filter time constant.

No.	Name	Description
H6-06	Pulse Train Monitor Selection	Select the pulse train monitor output function (value of the □-□□ part of U□-□□). For example, enter "501" for U5-01.
H6-07	Pulse Train Monitor Scaling	Sets the terminal MP output signal frequency when the monitor value is 100%. For example, to have the pulse train monitor output equal the output frequency, set H6-06 to 102 and H6-07 to 0.
H6-08	Pulse Train Input Minimum Frequency	Sets the minimum frequency for the pulse train input to be detected. Enabled when H6-01 = 0, 1, or 2.
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) Default setting is determined by parameter A1-02, Control Method Selection.
L1-02	Motor Overload Protection Time	Sets the motor thermal overload protection (oL1) time.
L2-01	Momentary Power Loss Operation Selection	**0: Disabled. Drive trips on Uv1 fault when power is lost.** 1: Recover within the time set in L2-02. Uv1 is detected if power loss > L2-02. 2: Recover as long as CPU has power. Uv1 is not detected.
L3-04	Stall Prevention Selection during Deceleration	0: Disabled. Deceleration at the active deceleration rate. An oC fault may occur. **1: General purpose. Deceleration is paused when the output current exceeds the Stall Prevention level.** 4: Overexcitation Deceleration. Decelerates while increasing motor flux. 6: Enable (Current Limit). The deceleration rate is automatically adjusted while limiting the regeneration current at the setting value of the stall prevention level (L3-14).
L5-01	Number of Auto Restart Attempts	Sets the number of times the drive may attempt to restart after the following faults occur: GF, LF, oC, oH1, oL1, oL3, oL4, ov, Sto, Uv1.
L6-01	Torque Detection Selection 1	**0: Disabled** 1: oL3 detection only active during speed agree, operation continues after detection 2: oL3 detection always active during run, operation continues after detection 3: oL3 detection only active during speed agree, output shuts down on an oL3 fault 4: oL3 detection always active during run, output shuts down on an oL3 fault 5: UL3 detection only active during speed agree, operation continues after detection 6: UL3 detection always active during run, operation continues after detection 7: UL3 detection only active during speed agree, output shuts down on a UL3 fault 8: UL3 detection always active during run, output shuts down on a UL3 fault
L6-02	Torque Detection Level 1	Sets the overtorque and undertorque detection level.
L6-03	Torque Detection Time 1	Sets the time an overtorque or undertorque condition must exist to trigger torque detection 1.

No.	Name	Description	No.	Name	Description
o1-03	Digital Operator Display Selection	0: 0.01 Hz 1: 0.01% (100% = E1-04) 2: r/min (calculated using the number of motor poles setting in E2-04, E4-04, or E5-04) 3: User-selected units (set by o1-10, o1-11) Default setting is determined by parameter A1-02, Control Method Selection.	T1-01	Auto-Tuning Mode Selection	**0: Rotational Auto-Tuning** 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 5: Stationary Auto-Tuning 3 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)
o2-19	Selection of Parameter Write during Uv	Selects whether parameter settings can be changed during a control circuit undervoltage condition. To be used with 24 V Power Supply Unit Built-in model. 0: Disabled 1: Enabled			

<1>   Available in drive software versions PRG: 1015 and later.

i.9　Standards Compliance

◆ European Standards

$$\epsilon$$

Figure i.72　CE Mark

The CE mark indicates that a product is in compliance with applicable European Directives for safety and environmental regulations. It is required for engaging in business and commerce in Europe.

The applicable European Directives for this product are as follows. We declared the CE marking based on the harmonized standards in *Table i.40*.

Table i.40　European Directives

Applicable European Directive	Applicable Harmonized Standards
Low Voltage Directive (2014/35/EU)	IEC/EN 61800-5-1
EMC Guidelines (2014/30/EU)	EN 61800-3: 2004/A1: 2012
Machinery Directive (2006/42/EC)	• EN ISO 13849-1/AC:2008 (PL e (Cat.3)) • IEC 62061/A1:2012 (SIL CL 3) • EN 62061/A1:2013 (SIL CL 3) • IEC/EN 61800-5-2: 2007 (SIL3)
RoHS (2011/65/EU)	EN IEC 63000:2018

The user(s) is solely responsible for ensuring that the end products used with this drive comply with all applicable European directives and with other national regulations (if required).

◆ EU Declaration of Conformity

Go to www.yaskawa.com and search for "Declaration of Conformity" to get an original copy of the EU Declaration of Conformity.

Yaskawa declares that this product complies with the following directives and standards at our sole responsibility.

◆ CE Low Voltage Directive Compliance

This drive has been tested according to IEC/EN 61800-5-1, and it fully complies with the Low Voltage Directive.

To comply with the Low Voltage Directive, be sure to meet the following conditions when combining this drive with other devices:

■ Area of Use

Do not use drives in areas with pollution higher than degree 2 and overvoltage category 3 in accordance with IEC/EN 60664.

■ Grounding

The drive is designed to be used in T-N (grounded neutral point) networks. If installing the drive in other types of grounded systems, contact your Yaskawa representative for instructions. *Refer to Enable the Internal EMC Filter on page 51* for details.

■ Guarding Against Harmful Materials

When installing IP00/Open Type enclosure drives, use an enclosure that prevents foreign material from entering the drive from above or below.

■ Wiring Diagram

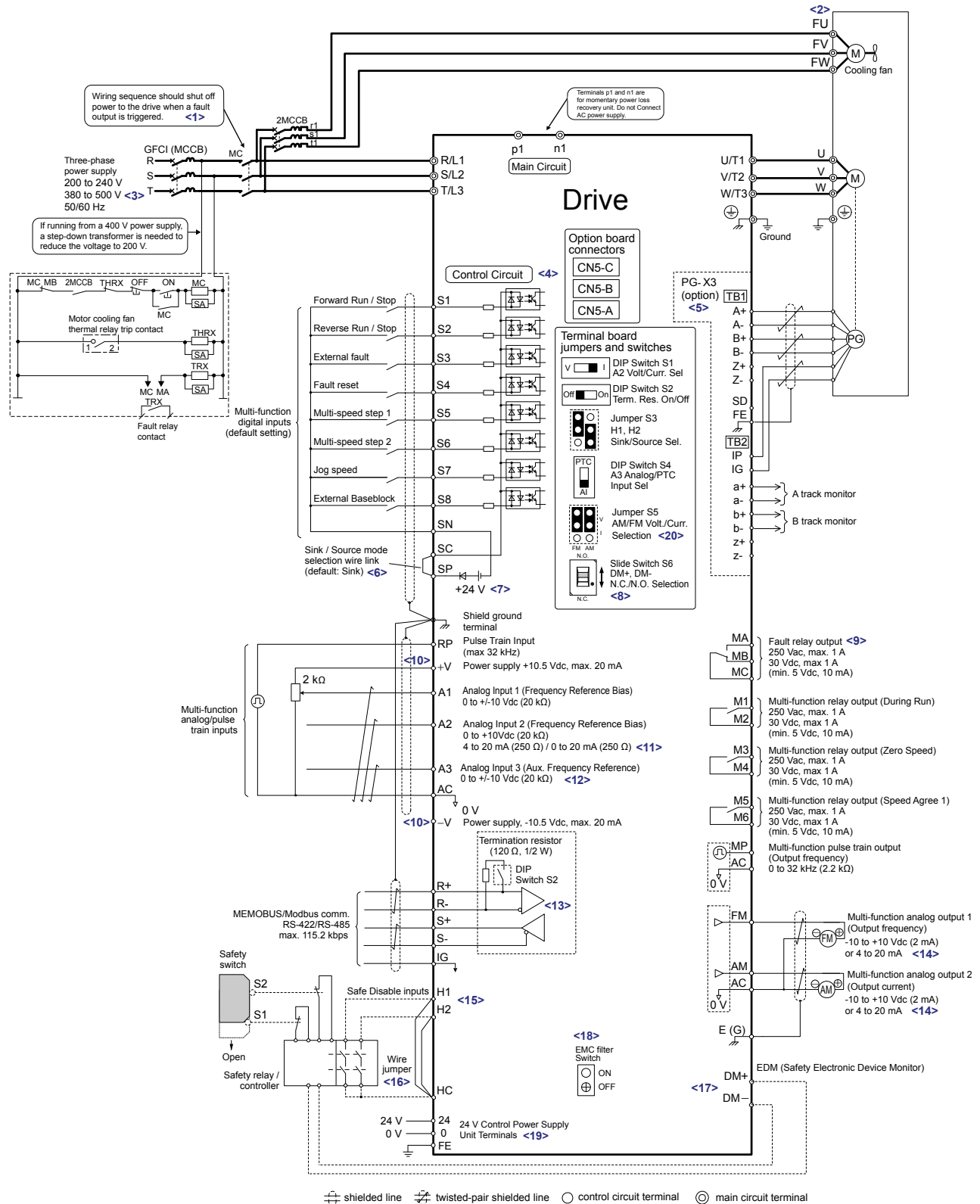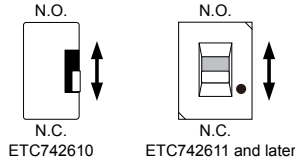Refer to *Figure i.73* for an example of this product wired to comply with the CE Low Voltage Directive.

Figure i.73 Wiring Diagram for CE Low Voltage Directive Compliance (example: 200 V Class)

<1> When setting L5-02 to 1 to trigger a fault output whenever the fault restart function is activated, a sequence to interrupt power when a fault occurs will turn off power to the drive as the drive attempts to restart. The default setting for L5-02 is 0 (Fault output not active during restart attempt).

<2> Self-cooling motors do not require wiring that is necessary for motors using a cooling fan.

<3> Use a three-phase power supply with a voltage of 380 to 480 V for drive models 4☐0011 to 4☐0414 (built-in EMC filter) and 4☐0477 to 4☐0590 (with stand-alone EMC filter).

<4> Supplying power to the control circuit separately from the main circuit requires 24 V power supply (option).

<5> PG option card wiring is not necessary for control modes that do not use a motor speed feedback signal.

<6> This figure illustrates an example of a sequence input to S1 through S8 using a non-powered relay or an NPN transistor. Install the wire link between terminals SC-SP for Sink mode, between SC-SN for Source mode, or leave the link out for external power supply. Never short terminals SP and SN, as it will damage the drive. *Refer to Sinking/Sourcing Mode for Digital Inputs on page 48* for details.

<7> This voltage source supplies a maximum current of 150 mA when not using a digital input card DI-A3.

<8> Slide switch S6 design differs based on PCB model number.

<9> Wire the fault relay output separately from the main circuit power supply and other power lines.

<10> The maximum output current capacity for the +V and -V terminals on the control circuit is 20 mA. Never short terminals +V, -V, and AC, as it can cause erroneous operation or damage the drive.

<11> Set DIP switch S1 to select between a voltage or current input signal to terminal A2. The default setting is for current input.

<12> Set DIP switch S4 to select between analog or PTC input for terminal A3.

<13> Set DIP switch S2 to the ON position to enable the termination resistor in the last drive in a MEMOBUS/Modbus network.

<14> Monitor outputs work with devices such as analog frequency meters, ammeters, voltmeters, and wattmeters. They are not intended for use as a feedback-type signal.

<15> Use jumper S3 to select between Sink mode, Source mode, and external power supply for the Safe Disable inputs.

<16> Disconnect the wire jumper between H1 - HC and H2 - HC when utilizing the Safe Disable input.

<17> Slide switch S6 to select N.C. or N.O. as the state of the DM+ and DM- terminals for EDM output.

<18> Models UU☐E☐☐☐☐ and UU☐W☐☐☐☐ have a built-in EMC filter switch. Use a stand-alone EMC filter for models 4☐0477 to 4☐0590, which do not have an EMC filter switch.

<19> Models UU☐P☐☐☐☐ and UU☐W☐☐☐☐ have terminals 24, 0, and FE to provide board-level component voltages for the drive from an external, customer-supplied 24 Vdc source. These terminals also maintain drive control power and network communications when the main three-phase input power is removed.

<20> Use jumper S5 to select between voltage or current output signals at terminals AM and FM. Set parameters H4-07 and H4-08 accordingly.

◆ EMC Guidelines Compliance for Models U☐☐☐E☐☐☐☐ and U☐☐☐W☐☐☐☐

Drives with internal EMC filters (CIMR-U☐☐☐E☐☐☐☐/U☐☐☐W☐☐☐☐) are tested according to IEC/EN 61800-3:2004+A1:2012 and complies with EMC guidelines. Use a model with an internal EMC filter or install a stand-alone EMC filter on the input side of the drive to comply with the EMC guidelines.

Refer to Stand-Alone EMC Filter Installation on page 106 for EMC filter installation.

Note: Drives with customized specifications A and P are not compatible.

■ Internal EMC Filter Installation

Installation Method

Verify the following installation conditions to ensure that other devices and machinery used in combination with drive models U☐☐☐E☐☐☐☐ and U☐☐☐W☐☐☐☐ also comply with EMC guidelines.

1. Place the drive in the enclosure.

2. Use braided shield cable for the drive and motor wiring, or run the wiring through a metal conduit.

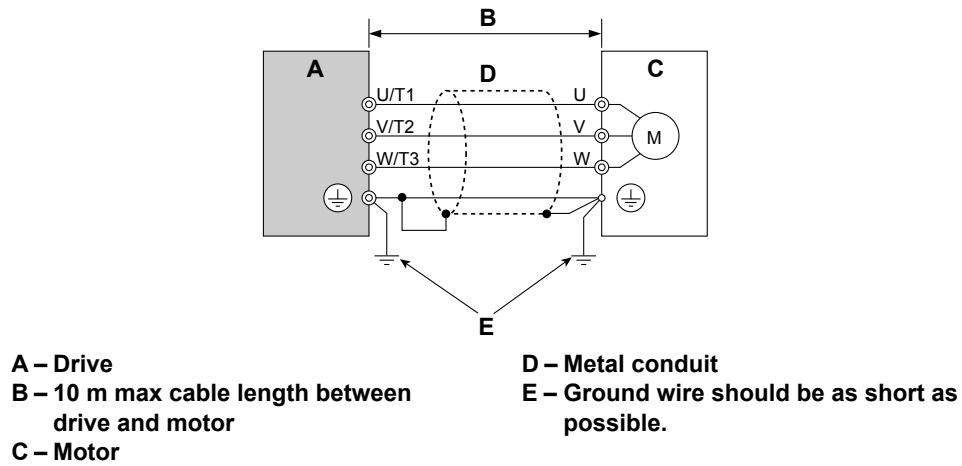**3.** Keep wiring as short as possible. Ground the shield on both the drive side and the motor side.

A – Drive
B – 10 m max cable length between
    drive and motor
C – Motor

D – Metal conduit
E – Ground wire should be as short as
    possible.

Figure i.74 Installation Method

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

WARNING! *Electrical Shock Hazard. Because the leakage current exceeds 3.5 mA in models 4□0302 and larger, IEC/EN 61800-5-1 states that either the power supply must be automatically disconnected in case of discontinuity of the protective earthing conductor, or a protective earthing conductor with a cross-section of at least 10 mm^2 (Cu) or 16 mm^2 (Al) must be used. Failure to comply may result in death or serious injury.*
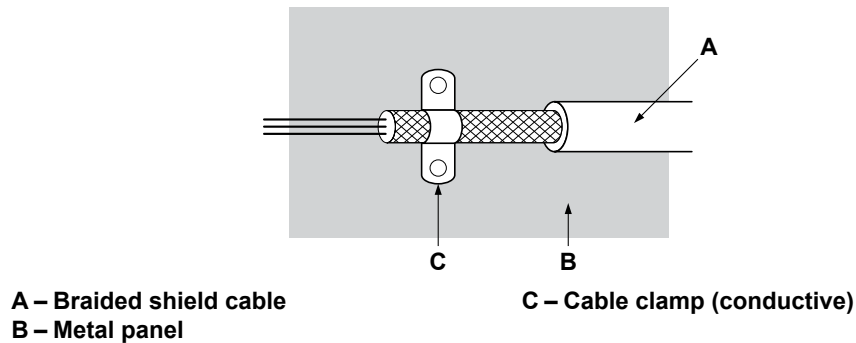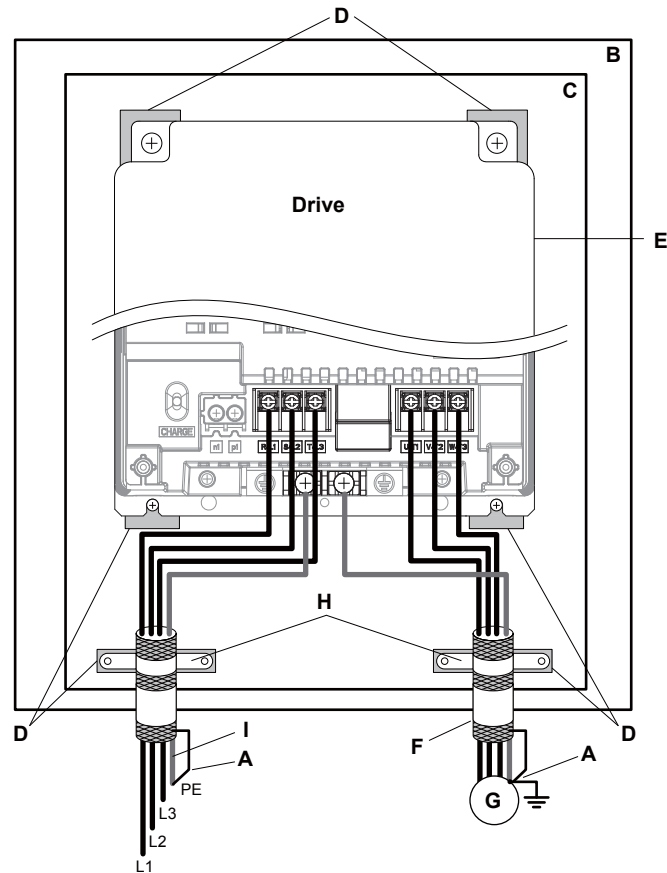

A – Braided shield cable
B – Metal panel

C – Cable clamp (conductive)

Figure i.75 Ground Area

Three-Phase 200 V / 400 V Class

A – Ground the cable shield
B – Enclosure panel
C – Metal plate
D – Grounding surface (remove any paint or sealant)
E – Drive

F – Motor cable (braided shield cable, max. 10 m)
G – Motor
H – Cable clamp
I – Ground plate (scrape off any visible paint)

Figure i.76 Internal EMC Filter and Drive Installation for CE Compliance (Three-Phase 200 V / 400 V Class)

◆ Stand-Alone EMC Filter Installation

The following conditions must be met to ensure continued compliance with European standards EN 61800-3:2004+A1:2012.

Install an EMC noise filter to the input side specified by Yaskawa for compliance with European standards. *Refer to EMC Filters on page 108* for EMC filter selection.

Installation Method

Verify the following installation conditions to ensure that other devices and machinery used in combination with drive models U□□E□□□□ and U□□W□□□□ also comply with EMC guidelines.

1. Place the drive in the enclosure.
2. Use braided shield cable for the drive and motor wiring, or run the wiring through a metal conduit.
3. Keep wiring as short as possible. Ground the shield on both the drive side and the motor side.
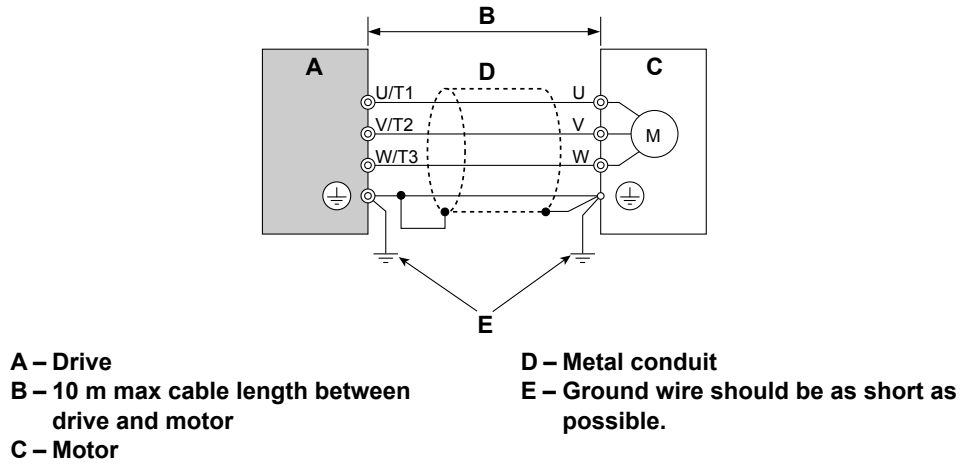
A – Drive
B – 10 m max cable length between drive and motor
C – Motor
D – Metal conduit
E – Ground wire should be as short as possible.

Figure i.77 Installation Method

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

A – Braided shield cable
B – Metal panel
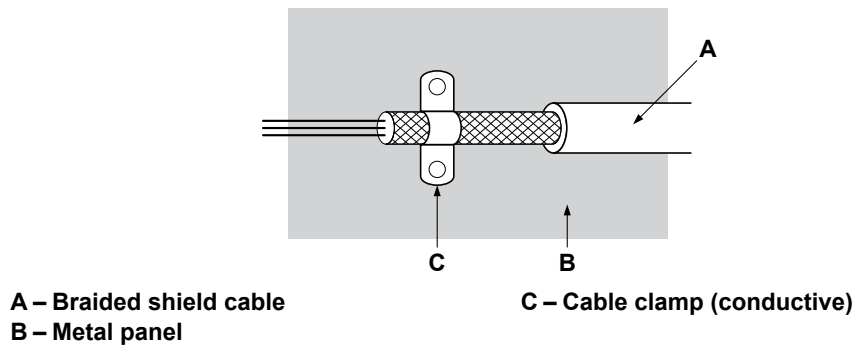C – Cable clamp (conductive)

Figure i.78 Ground Area

◆ Wiring Diagram

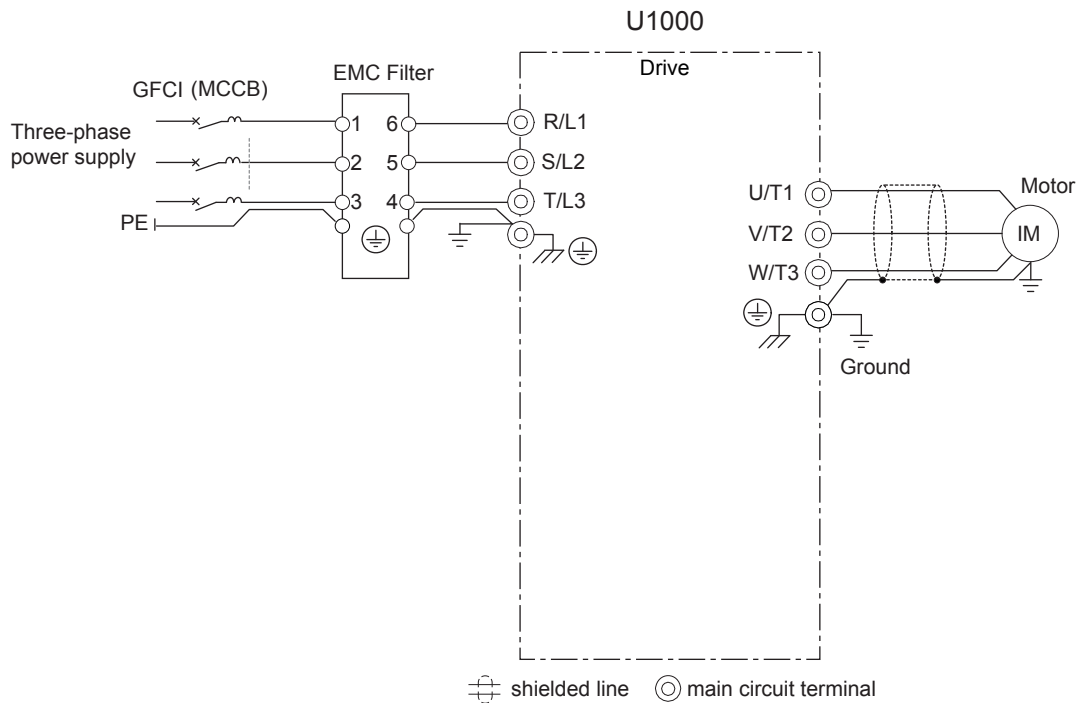**Figure i.79 Wiring Diagram for EMC (CIMR-U□2A0028 to 2A0248, 4A0011 to 4A0240, CIMR-U□2P0028 to 2P0248, 4P0011 to 4P0240)**
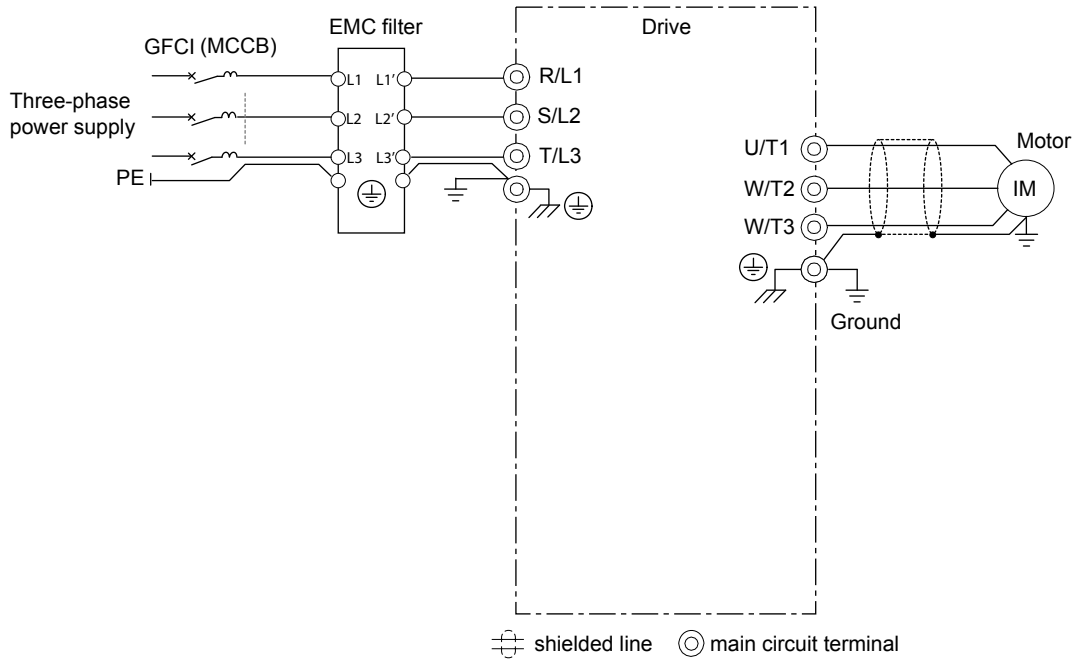
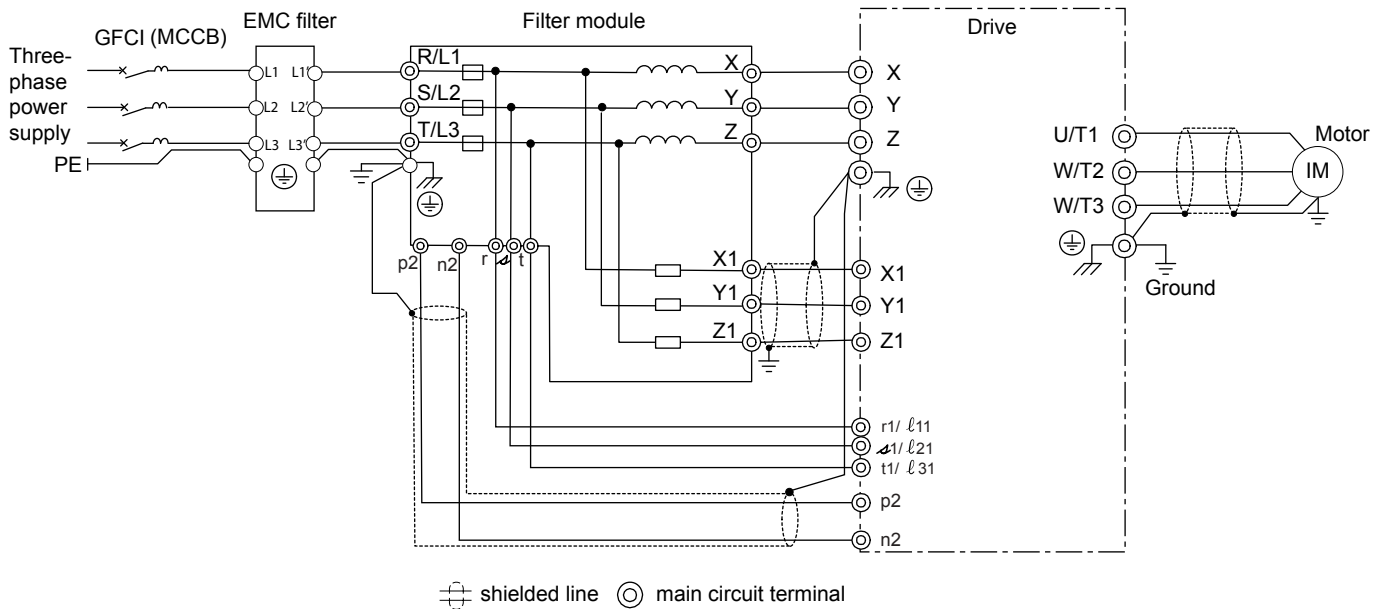**Figure i.80 Wiring Diagram for EMC (Models 4□0477 and 4□0590)**

Figure i.81 Wiring Diagram for EMC (Models 4□0720 to 4□0930)

■ EMC Filters

The drive should be installed with the EMC filters listed in *Table i.41* in order to comply with the EN 61800-3:2004+A1:2012 requirements.

Table i.41 EMC Filters

Model	Type	Manufacturer	Rated Current (A)	Weight (kg)	Dimensions [W × H × D] (mm)	Y × X (mm)	Figure	Qty.
2A0028 2P0028	RTEN-5030	TDK-Lambda	30	0.56	140 x 42 x 70	60 x 130	*Figure i.87*	1
2A0042 2P0042	RTEN-5100		100	4.2	267 x 85 x 161	135 x 247	*Figure i.88*	1
2A0054 2P0054	RTEN-5100		100	4.2	267 x 85 x 161	135 x 247		1
2A0068 2P0068	RTEN-5100		100	4.2	267 x 85 x 161	135 x 247		1
2A0081 2P0081	RTEN-5100		100	4.2	267 x 85 x 161	135 x 247		1
2A0104 2P0104	RTEN-5150		150	6.5	290 x 88 x 190	164 x 270	*Figure i.85*	1
2A0130 2P0130	RTEN-5150		150	6.5	290 x 88 x 190	164 x 270		1
2A0154 2P0154	RTEN-5200		200	9.2	390 x 103 x 195	169 x 370	*Figure i.86*	1
2A0192 2P0192	RTEN-5200		200	9.2	390 x 103 x 195	169 x 370		1
2A0248 2P0248	RTEN-5300		300	8.3	390 x 103 x 195	169 x 370		1
400 V Class								
4A0011 4P0011	RTEN-5040	TDK-Lambda	40	1.1	170 x 54 x 90	80 x 160	*Figure i.83*	1
4A0014 4P0014	RTEN-5040		40	1.1	170 x 54 x 90	80 x 160		1
4A0021 4P0021	RTEN-5040		40	1.1	170 x 54 x 90	80 x 160		1
4A0027 4P0027	RTEN-5040		40	1.1	170 x 54 x 90	80 x 160		1
4A0034 4P0034	RTEN-5040		40	1.1	170 x 54 x 90	80 x 160		1
4A0040 4P0040	RTEN-5080		80	3.9	267 x 85 x 161	135 x 247	*Figure i.84*	1
4A0052 4P0052	RTEN-5080		80	3.9	267 x 85 x 161	135 x 247		1
4A0065 4P0065	RTEN-5080		80	3.9	267 x 85 x 161	135 x 247		1
4A0077 4P0077	RTEN-5080		80	3.9	267 x 85 x 161	135 x 247		1
4A0096 4P0096	RTEN-5150		150	6.5	290 x 88 x 190	164 x 270	*Figure i.85*	1
4A0124 4P0124	RTEN-5150		150	6.5	290 x 88 x 190	164 x 270		1
4A0156 4P0156	RTEN-5200		200	9.2	390 x 103 x 195	169 x 370	*Figure i.86*	1
4A0180 4P0180	RTEN-5200		200	9.2	390 x 103 x 195	169 x 370		1
4A0216 4P0216	RTEN-5250		250	8.7	390 x 103 x 195	169 x 370		1
4A0240 4P0240	RTEN-5250		250	8.7	390 x 103 x 195	169 x 370		1

| Model	Type	Manufacturer	Rated Current (A)	Weight (kg)	Dimensions [W × H × D] (mm)	Y × X (mm)	Figure	Qty.
4A0302 4P0302	B84143B0400S080	EPCOS	400	7.5	320 x 120 x 190	165 x 170		1
4A0361 4P0361	B84143B0400S080		400	7.5	320 x 120 x 190	165 x 170	*Figure i.87*	1
4A0414 4P0414	B84143B0400S080		400	7.5	320 x 120 x 190	165 x 170		1
4A0477 4P0477	B84143B1000S080		1000	18.5	410 x 140 x 260	235 x 240	*Figure i.87*	1
4A0590 4P0590	B84143B1000S080		1000	18.5	410 x 140 x 260	235 x 240		1
4A0720 4P0720	B84143B1600S080		1600	24.5	490 x 140 x 260	235 x 240		1
4A0900 4P0900	B84143B1600S080		1600	24.5	490 x 140 x 260	235 x 240	*Figure i.88*	1
4A0930 4P0930	B84143B1600S080		1600	24.5	490 x 140 x 260	235 x 240		1
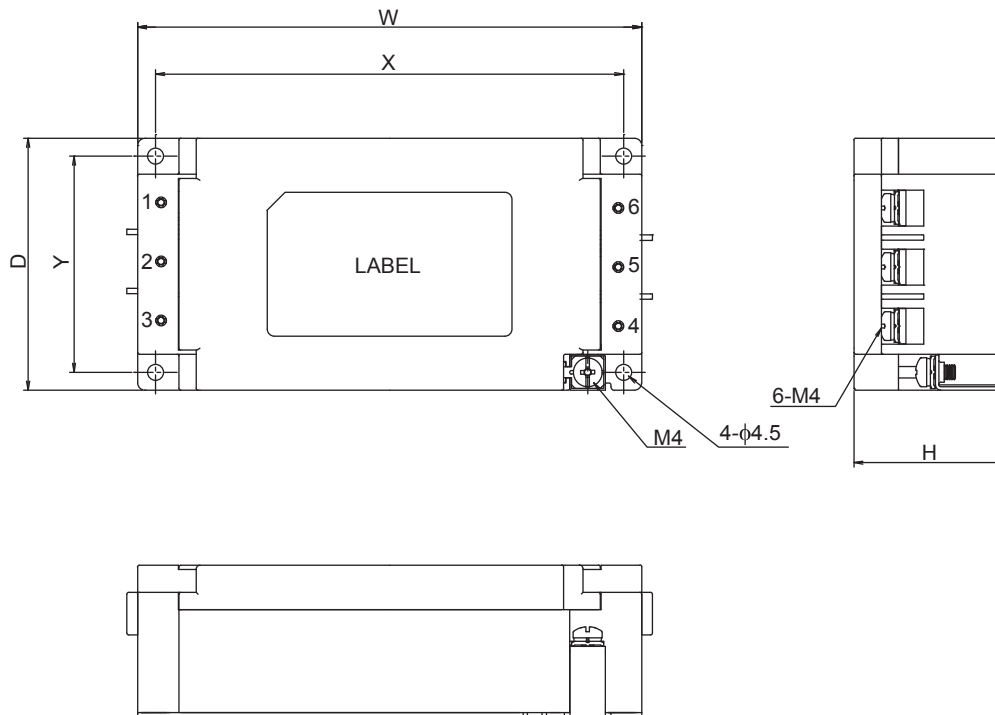
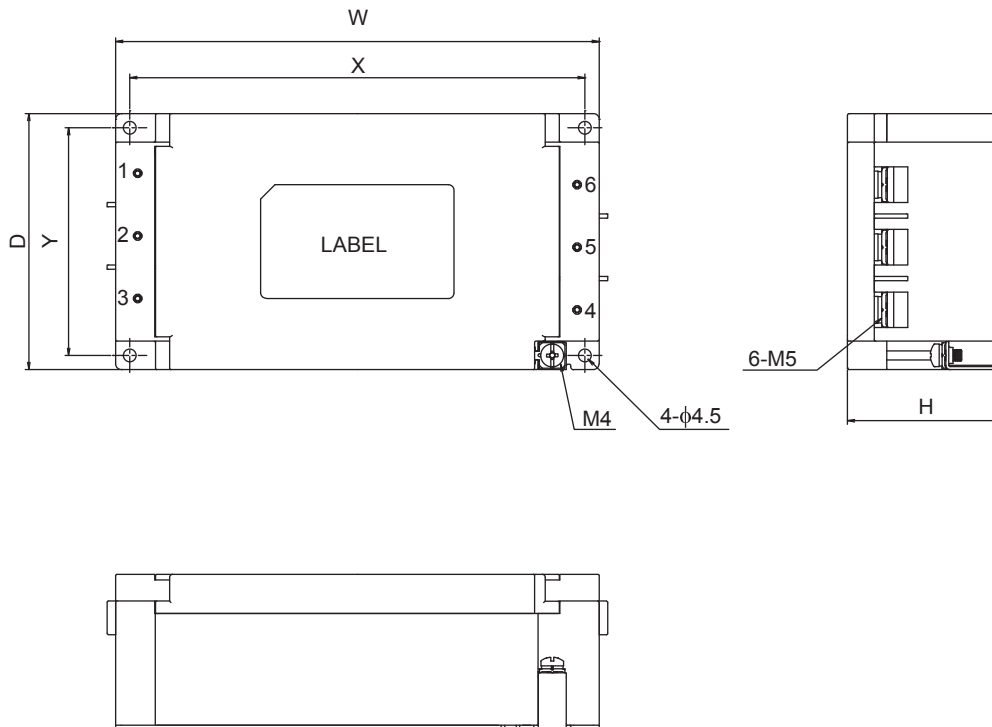**Figure i.82 EMC Filter Dimensions (RTEN-5030)**

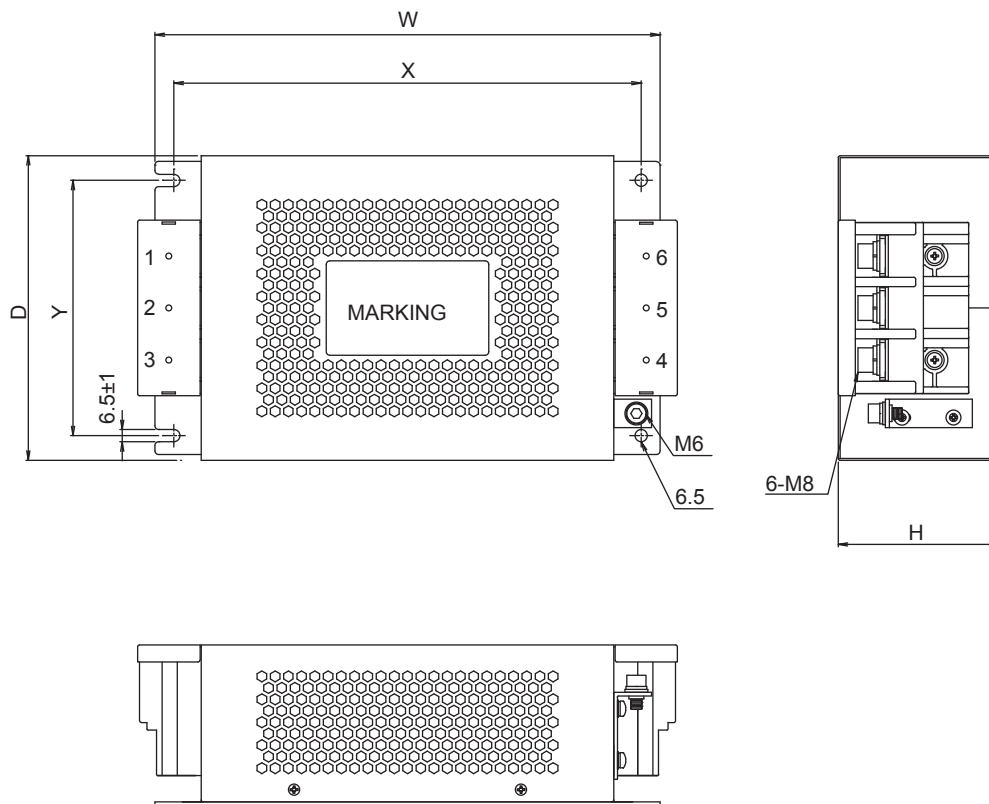**Figure i.83 EMC Filter Dimensions (RTEN-5040)**

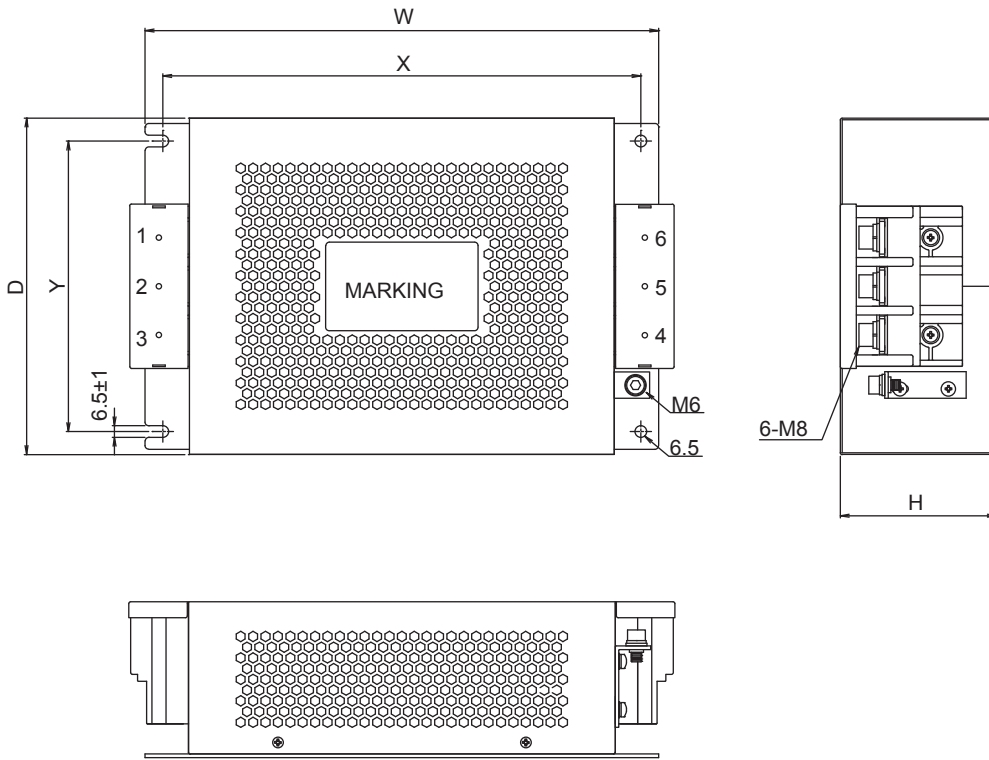**Figure i.84 EMC Filter Dimensions (RTEN-5080, RTEN-5100)**

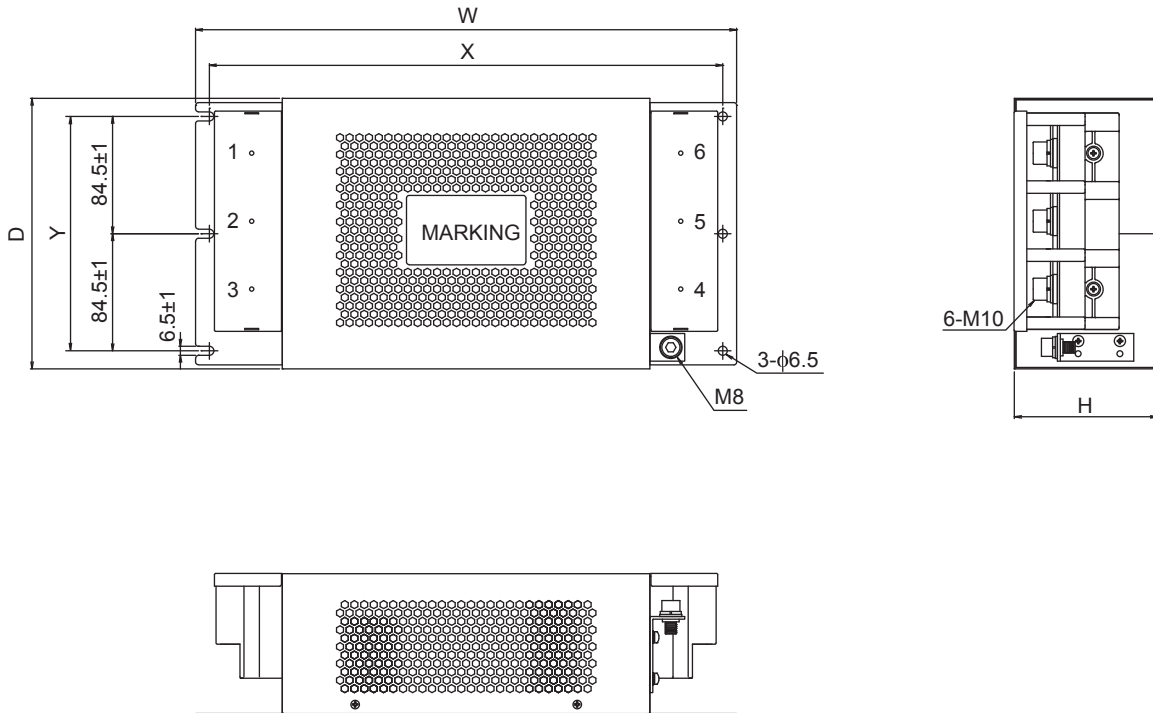**Figure i.85 EMC Filter Dimensions (RTEN-5150)**

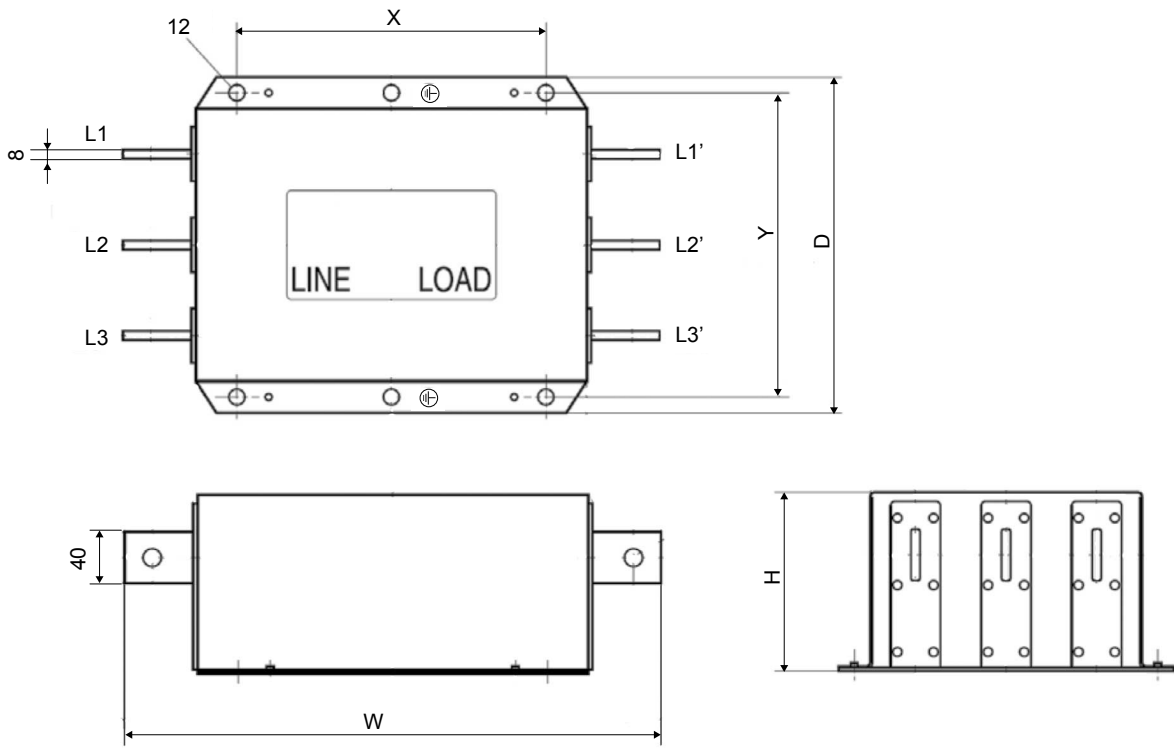**Figure i.86 EMC Filter Dimensions (RTEN-5200, RTEN-5250, RTEN-5300)**
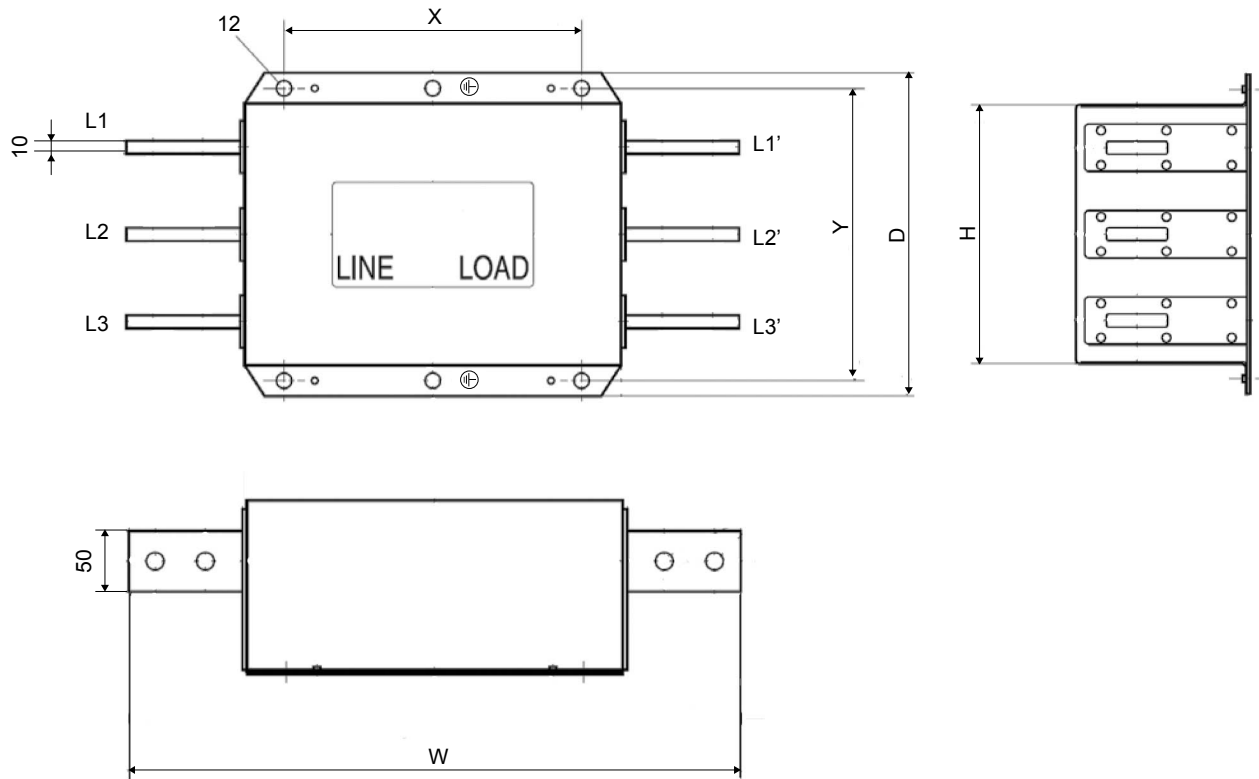
Figure i.87 EMC Filter Dimensions (B84143B1000S080)

Figure i.88 EMC Filter Dimensions (B84143B1600S080)

◆ UL Standards Compliance

Figure i.89 UL/cUL Mark

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.

This drive is tested in accordance with UL standard UL 61800-5-1 and complies with UL requirements. The conditions described below must be met to maintain compliance when using this drive in combination with other equipment:

■ Conditions of Acceptability

• Install the Three-Phase Filter Module on the input side of drive models 4□0720 to 4□0930. Refer to *Table i.42* for details.

Table i.42 Correspondence of Filter Module and Drive Models 4□0720 to 4□0930

Drive Model	Filter Module
4□0720	EUJ71180□.□
4□0900	EUJ71181□.□
4□0930	EUJ71182□.□

• Install the drive and peripherals in a suitable enclosure for end use.

■ Installation Area

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

■ Ambient Temperature

IP00/Open Type Enclosure: -10 °C to +50 °C (14 °F to 122 °F)

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

Finless Type: IP20/IP00 Enclosure: -10 to +45 °C (14 °F to 113 °F)

■ Main Circuit Terminal Wiring

Yaskawa recommends using closed-loop crimp terminals on all drive models. Use only the tools recommended by the terminal manufacturer for crimping. *Refer to Closed-Loop Crimp Terminal Recommendations on page 114* for closed-loop crimp terminal recommendations.

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

Note: The ⏚ mark indicates the terminals for protective ground connection.
Grounding impedance:
200 V: 100 Ω or less
400 V: 10 Ω or less

Wire Gauges and Tightening Torques
Refer to Main Circuit Wire Gauges and Tightening Torque on page 33.

■ Closed-Loop Crimp Terminal Recommendations

To maintain UL/cUL approval, UL Listed closed-loop crimp terminals are specifically required when wiring the drive main circuit terminals on models 2□0068 to 2□0248 and 4□0052 to 4□0930. Use only the tools recommended by the terminal manufacturer for crimping. Yaskawa recommends UL Listed crimp terminals made by JST and Tokyo DIP (or equivalent) for the insulation cap. *Table i.43* to *Table i.45* match 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.

Drive Models 2☐0028 to 2☐0248 and 4☐0011 to 4☐0590

Table i.43 Closed-Loop Crimp Terminal Size

Drive Model	Wire Gauge (AWG, kcmil) R/L1, S/L2, T/L3 U/T1, V/T2, W/T3	Screw Size	Crimp Terminal Model Number	Tool Machine No.	Die Jaw	Insulation Cap Model No.	Code [1]
200 V Class							
2☐0028	10	M5	R5.5-5	YA-4	AD-900	TP-005	100-054-030
	8 [2]		R8-5		AD-901	TP-008	100-054-032
2☐0042	8	M6	R8-6	YA-4	AD-901	TP-008	100-065-184
	6 [2]		R14-6		AD-902	TP-014	100-051-261
	4		R22-6	YA-5	AD-953	TP-022	100-051-262
	3		R22-6				
2☐0054	6	M6	R14-6	YA-5	AD-952	TP-014	100-051-261
	4 [2]		R22-6		AD-953	TP-022	100-051-262
	3						
2☐0068	4 [2]	M6	R22-6	YA-5	AD-953	TP-022	100-051-262
	3						
2☐0081	6 [2]	M6	R14-6	YA-5	AD-952	TP-014	100-051-261
	4		R22-6		AD-953	TP-022	100-051-262
	3						
2☐0104	6	M8	R14-8	YA-4	AD-902	TP-014	100-054-035
	4		R22-8	YA-5	AD-953	TP-022	100-051-263
	3						
	2		R38-8		AD-954	TP-038	100-051-264
	1 [2]						
	1/0		R60-8		AD-955	TP-060	100-051-265
2☐0130	6	M8	R14-8	YA-5	AD-952	TP-014	100-054-035
	4 [2]		R22-8		AD-953	TP-022	100-051-263
	3						
	2		R38-8		AD-954	TP-038	100-051-264
	1						
	1/0		R60-8		AD-955	TP-060	100-0051-265
2☐0154	4	M10	R22-10	YA-5	AD-953	TP-022	100-061-113
	3 [2]						
	2		R38-10		AD-954	TP-038	100-061-114
	1						
	1/0		R60-10		AD-955	TP-060	100-051-266
	2/0		70-10	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10	YF-1	TD-324	TP-100	100-051-269
2☐0192	3	M10	R22-10	YA-5	AD-953	TP-022	100-061-113
	2		R38-10		AD-954	TP-038	100-061-114
	1 [2]						
	1/0		R60-10		AD-955	TP-060	100-051-266
	2/0		70-10	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269

Drive Model	Wire Gauge (AWG, kcmil) R/L1, S/L2, T/L3 U/T1, V/T2, W/T3	Screw Size	Crimp Terminal Model Number	Tool Machine No.	Die Jaw	Insulation Cap Model No.	Code [1]
2☐0248	1	M10	R38-10	YA-5	AD-954	TP-038	100-061-114
	1/0		R60-10	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-051-266
	2/0 [2]		70-10		TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269
400 V Class							
4☐0011	14 [2]	M5	R2-5	YA-4	AD-900	TP-003	100-123-030
	12		R5.5-5			TP-005	100-054-030
	10						
	8		R8-5		AD-901	TP-008	100-054-032
4☐0014	14	M5	R2-5	YA-4	AD-900	TP-003	100-123-030
	12 [2]		R5.5-5			TP-005	100-054-030
	10						
	8		R8-5		AD-901	TP-008	100-054-032
4☐0021	12	M5	R5.5-5	YA-4	AD-900	TP-005	100-054-030
	10 [2]						
	8		R8-5		AD-901	TP-008	100-054-032
4☐0027	10	M5	R5.5-5	YA-4	AD-900	TP-005	100-054-030
	8 [2]		R8-5		AD-901	TP-008	100-054-032
4☐0034	8 [2]	M5	R8-5	YA-4	AD-901	TP-008	100-054-032
4☐0040	8 [2]	M6	R8-6	YA-4	AD-901	TP-008	100-065-184
	6		R14-6		AD-902	TP-014	100-051-261
	4		R22-6	YA-5	AD-953	TP-022	100-051-262
	3						
4☐0052	8	M6	R8-6	YA-4	AD-901	TP-008	100-065-184
	6 [2]		R14-6		AD-902	TP-014	100-051-261
	4		R22-6	YA-5	AD-953	TP-022	100-051-262
	3						
4☐0065	6	M6	R14-6	YA-5	AD-952	TP-014	100-051-261
	4 [2]		R22-6		AD-953	TP-022	100-051-262
	3						
4☐0077	4	M6	R22-6	YA-5	AD-953	TP-022	100-051-262
	3 [2]						
4☐0096	8	M8	R8-8	YA-4	AD-901	TP-008	100-601-111
	6		R14-8		AD-902	TP-014	100-054-035
	4		R22-8	YA-5	AD-953	TP-022	100-051-263
	3						
	2		R38-8	YA-5	AD-954	TP-038	100-051-264
	1 [2]						
	1/0		R60-8		AD-955	TP-060	100-051-265

Drive Model	Wire Gauge (AWG, kcmil) R/L1, S/L2, T/L3 U/T1, V/T2, W/T3	Screw Size	Crimp Terminal Model Number	Tool		Insulation Cap Model No.	Code [1]
				Machine No.	Die Jaw		
4☐0124	6	M8	R14-8	YA-5	AD-952	TP-014	100-054-035
	4 [2]		R22-8		AD-953	TP-022	100-051-263
	3						
	2		R38-8		AD-954	TP-038	100-051-264
	1						
	1/0		R60-8		AD-955	TP-060	100-051-265
4☐0156	4	M10	R22-10	YA-5	AD-953	TP-022	100-061-113
	3 [2]						
	2		R38-10		AD-954	TP-038	100-061-114
	1						
	1/0		R60-10		AD-955	TP-060	100-051-266
	2/0		70-10	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269
4☐0180	3	M10	R22-10	YA-5	AD-953	TP-022	100-061-113
	2 [2]		R38-10		AD-954	TP-038	100-061-114
	1						
	1/0		R60-10		AD-955	TP-060	100-051-266
	2/0		70-10	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269
4☐0216	2	M10	R38-10	YA-5	AD-954	TP-038	100-061-114
	1						
	1/0 [2]		R60-10	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-051-266
	2/0		70-10		TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269
4☐0240	1/0 [2]	M10	R60-10	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-051-266
	2/0		70-10		TD-322 TD-311	TP-080	100-064-251
	3/0		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269
4☐0302	1/0	M10	R60-10	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-051-266
	2/0		70-10		TD-322 TD-311	TP-080	100-064-251
	3/0 [2]		80-10		TD-323 TD-312		100-051-267
	4/0		R100-10		TD-324 TD-312	TP-100	100-051-269

Drive Model	Wire Gauge (AWG, kcmil) R/L1, S/L2, T/L3 U/T1, V/T2, W/T3	Screw Size	Crimp Terminal Model Number	Tool Machine No.	Tool Die Jaw	Insulation Cap Model No.	Code [1]
4□0361	3/0	M10	80-10	YF-1 YET-300-1	TD-323 TD-312	TP-080	100-051-267
4□0361	4/0 [2]	M10	R100-10	YF-1 YET-300-1	TD-324 TD-312	TP-100	100-051-269
4□0414	4/0	M12	R100-12	YF-1 YET-300-1	TD-324 TD-312	TP-100	100-051-270
4□0414	250	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0414	300 [2]	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0477	2/0	M12	70-12	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-054-036
4□0477	3/0 [2]	M12	80-12	YF-1 YET-300-1	TD-323 TD-312	TP-080	100-051-268
4□0477	4/0	M12	R100-12	YF-1 YET-300-1	TD-324 TD-312	TP-100	100-051-270
4□0477	250	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0477	300	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0590	3/0	M12	80-12	YF-1 YET-300-1	TD-323 TD-312	TP-080	100-051-268
4□0590	4/0	M12	R100-12	YF-1 YET-300-1	TD-324 TD-312	TP-100	100-051-270
4□0590	250 [2]	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0590	300	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273

<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.

<2> Recommended wire gauges. Refer to local codes for proper selections.

Note: Use crimp insulated terminals or insulated shrink tubing for wiring connections. Wires should have a continuous maximum allowable temperature of 75 °C (167 °F) 600 Vac UL-approved vinyl-sheathed insulation.

Drive Models 4□0720 to 4□0930

Table i.44 Closed-Loop Crimp Terminal Size

Drive Model	Wire Gauge (AWG, kcmil) X, Y, Z U/T1, V/T2, W/T3	Screw Size	Crimp Terminal Model Number	Tool Machine No.	Tool Die Jaw	Insulation Cap Model No.	Code [1]
4□0720	1/0	M12	R60-12	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-066-160
4□0720	2/0	M12	70-12	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-054-036
4□0720	4/0	M12	R100-12	YF-1 YET-300-1	TD-324 TD-312	TP-100	100-051-270
4□0720	250	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0720	300 [2]	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0900	1/0	M12	R60-12	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-066-160
4□0900	2/0	M12	70-12	YF-1 YET-300-1	TD-322 TD-311	TP-080	100-054-036
4□0900	3/0	M12	80-12	YF-1 YET-300-1	TD-323 TD-312	TP-080	100-051-268
4□0900	4/0 [2]	M12	R100-12	YF-1 YET-300-1	TD-324 TD-312	TP-100	100-051-270
4□0900	250	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273
4□0900	300	M12	R150-12	YF-1 YET-300-1	TD-325 TD-313	TP-150	100-051-273

Drive Model	Wire Gauge (AWG, kcmil) X, Y, Z U/T1, V/T2, W/T3	Screw Size	Crimp Terminal Model Number	Tool		Insulation Cap Model No.	Code [1]
				Machine No.	Die Jaw		
4☐0930	1/0	M12	R60-12	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-066-160
	2/0		70-12		TD-322 TD-311	TP-080	100-054-036
	4/0 [2]		R100-12		TD-324 TD-312	TP-100	100-051-270
	250		R150-12		TD-325 TD-313	TP-150	100-051-273
	300		R150-12			TP-150	100-051-273

<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.

<2> Recommended wire gauges. Refer to local codes for proper selections.

Note: Use crimp insulated terminals or insulated shrink tubing for wiring connections. Wires should have a continuous maximum allowable temperature of 75 °C (167 °F) 600 Vac UL-approved vinyl-sheathed insulation.

Filter Modules

Table i.45 Filter Module Closed-Loop Crimp Terminal Size

Drive Model	Wire Gauge (AWG, kcmil) R/L1, S/L2, T/L3 X, Y, Z	Screw Size	Crimp Terminal Model Number	Tool		Insulation Cap Model No.	Code [1]
				Machine No.	Die Jaw		
EUJ71180☐.☐	1/0	M12	R60-12	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-066-160
	2/0		70-12		TD-322 TD-311	TP-080	100-054-036
	4/0		R100-12		TD-324 TD-312	TP-100	100-051-270
	250		R150-12		TD-325 TD-313	TP-150	100-051-273
	300 [2]		R150-12			TP-150	100-051-273
EUJ71181☐.☐	1/0	M12	R60-12	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-066-160
	2/0		70-12		TD-322 TD-311	TP-080	100-054-036
	3/0		80-12		TD-323 TD-312	TP-080	100-051-268
	4/0 [2]		R100-12		TD-324 TD-312	TP-100	100-051-270
	250		R150-12		TD-325 TD-313	TP-150	100-051-273
	300		R150-12			TP-150	100-051-273
EUJ71182☐.☐	1/0	M12	R60-12	YF-1 YET-300-1	TD-321 TD-311	TP-060	100-066-160
	2/0		70-12		TD-322 TD-311	TP-080	100-054-036
	4/0 [2]		R100-12		TD-324 TD-312	TP-100	100-051-270
	250		R150-12		TD-325 TD-313	TP-150	100-051-273
	30		R150-12			TP-150	100-051-273

<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.

<2> Recommended wire gauges. Refer to local codes for proper selections.

Note: Use crimp insulated terminals or insulated shrink tubing for wiring connections. Wires should have a continuous maximum allowable temperature of 75 °C (167 °F) 600 Vac UL-approved vinyl-sheathed insulation.

■ 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. The external power supply shall be a UL Listed Class 2 power supply source or equivalent only.

Table i.46 Control Circuit Terminal Power Supply

Input / Output	Terminal Signal	Power Supply Specifications
Open Collector Outputs	DM+, DM-	Requires class 2 power supply
Digital Inputs / Outputs	S1 to 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, RP, MP	

■ Drive Short Circuit Rating

The drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 240 Vac maximum (200 V Class) and 480 Vac maximum (400 V class: 4E□□□□ and 4W□□□□), and 500 Vac maximum (400 V class: 4A□□□□ and 4P□□□□) with built-in fuses manufactured by Hinode Electric Co., Ltd. and Mersen (or equivalent).

■ Branch Circuit Protection

For installation in the United States, provide branch circuit protection in accordance with the National Electrical Code (NEC) and any applicable local codes.

For installation in Canada, provide branch circuit protection in accordance with the Canadian Electrical Code and any applicable provincial codes.

◆ 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: 10% to 150% of the drive rated current

Default Setting: Model-dependent

Parameter E2-01 protects the motor when parameter L1-01 is not set to 0. The default for L1-01 is 1, which enables protection for standard induction motors.

If Auto-Tuning has been performed successfully, the motor data entered to T1-04 and T2-06 are automatically written to 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 that 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.

Table i.47 Overload Protection Settings

Setting		Description
0	Disabled	Disabled the internal motor overload protection of the drive.
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 reduced 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 reduced 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 reduced 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 motor overload protection (L1-01 = 1 to 6) 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 while 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 a hot motor at 60 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.
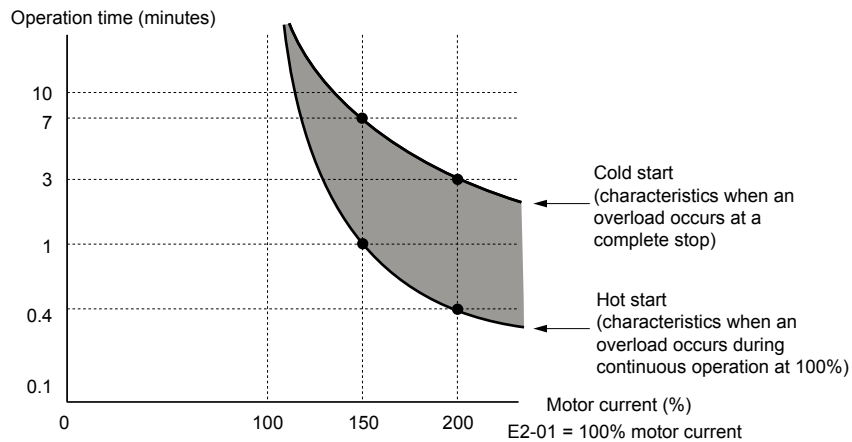
Figure i.90 Motor Overload Protection Time

■ L1-03: Motor Overheat Alarm Operation Selection (PTC input)

Sets the drive operation when the PTC input signal reaches the motor overheat alarm level (oH3).

No.	Name	Setting Range	Default
L1-03	Motor Overheat Alarm Operation Selection (PTC input)	0 to 3	3

Setting 0: Ramp to Stop
The drive stops the motor using the deceleration time 1 set in parameter C1-02.

Setting 1: Coast to Stop
The drive output is switched off and the motor coasts to stop.

Setting 2: Fast Stop
The drive stops the motor using the Fast Stop time set in parameter C1-09.

Setting 3: Alarm Only
The operation is continued and an oH3 alarm is displayed on the digital operator.

■ L1-04: Motor Overheat Fault Operation Selection (PTC input)

Sets the drive operation when the PTC input signal reaches the motor overheat fault level (oH4).

No.	Name	Setting Range	Default
L1-04	Motor Overheat Fault Operation Selection (PTC input)	0 to 2	1

Setting 0: Ramp to Stop
The drive stops the motor using the deceleration time 1 set in parameter C1-02.

Setting 1: Coast to Stop
The drive output is switched off and the motor coasts to stop.

Setting 2: Fast Stop

The drive stops the motor using the Fast Stop time set in parameter C1-09.

◆ CSA Standards Compliance

■ Conditions of Acceptability

Refer to Conditions of Acceptability on page 114 for details.

■ Branch Circuit Protection

For installation in Canada, branch circuit protection must be provided in accordance with the Canadian Electrical Code and any applicable provincial codes.

■ Main Circuit Terminal Wiring

Yaskawa recommends using closed-loop crimp terminals on all drive models. To maintain CSA approval, CSA Certified closed-loop crimp terminals are specifically required when wiring the drive main circuit terminals on models 2□0028 to 2□0248 and 4□0011 to 4□0930. Use only the tools recommended by the terminal manufacturer for crimping.

Refer to Closed-Loop Crimp Terminal Recommendations on page 114 for closed-loop crimp terminal recommendations. The wire gauges listed in the following tables are Yaskawa recommendations. Refer to local codes for proper wire gauge selections.

The external power supply shall be a CSA certified or cUL Listed Class 2 power source only or equivalent. Refer to *Table i. 46* for details.

■ CSA for Industrial Control Equipment

The drive is CSA certified as Industrial Control Equipment Class 3211.

Specifically, the drive is certified to: CAN/CSA C22.2 No.0-10 and CAN/CSA C22.2 No.14-13.

Figure i.91 CSA Mark

◆ Safe Disable Input Function

This section explains the Safe Disable function. Contact Yaskawa or a Yaskawa representative if more information is required.

■ Safety Standards

The TUV mark indicates compliance with safety standards.

Figure i.92 TUV Mark

Table i.48 Safety Standards and Applicable Harmonized Standards

Safety Standards	Applicable Harmonized Standards
Functional Safety	IEC/EN 61508 series: 2010 (SIL3)
	IEC 62061/A1: 2012 (SIL CL 3)
	EN 62061/A1: 2013 (SIL CL 3)
	IEC 61800-5-2: 2007 (SIL3)
	EN 61800-5-2: 2007 (SIL3)
Safety of Machinery	EN ISO 13849-1/AC: 2008 (PL e (Cat.3))
EMC	IEC/EN 61326-3-1: 2008 (EMC-related)

The Safe Disable function is in compliance with these standards.

■ Specifications

The Safe Disable inputs provide a stop function in compliance with "Safe Torque Off" as defined in the IEC/EN 61800-5-2. Safe Disable inputs have been designed to meet the requirements of the EN ISO 13849-1 and IEC/EN 61508.

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

Table i.49 Specifications for Safe Disable Function

Inputs/Outputs		• Input signal specifications Signal ON level: 18 to 28 Vdc Signal OFF level: -4 to 4 Vdc • Inputs: 2 Safe Disable inputs H1, H2 • Outputs: 1 Safe Disable Monitor output EDM (DM+, DM-)
Response Time from Input Open to Drive Output Stop		Shorter than 3 ms
Response Time from Input Open of H1 and H2 Terminals to EDM		Shorter than 4 ms
Failure Probability	**Demand Rate Low**	PFD = 11.04E^{-6}
	Demand Rate High/ Continuous	PFH = 2.67E^{-9}
Performance Level		The Safe Disable inputs satisfy the following requirements (DC from EDM considered) Performance Level (PL) e according to EN ISO 13849-1
HFT (Hardware Fault Tolerance)		N = 1
Classification of Subsystem		Type B

◆ Precautions

DANGER! *Sudden Movement Hazard. Improper use of the Safe Disable function can result in serious injury or even death. 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.*

DANGER! *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 rotor 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.*

DANGER! *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.*

DANGER! *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 may result in serious injury or death.*

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

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. Failing to do so will keep the Safe Disable circuit from operating properly and can cause injury or even death.*

NOTICE: *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.*

NOTICE: *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 2 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 2 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, an EMC filter must be used.*

◆ Using the Safe Disable Function

The Safe Disable inputs provide a stop function in compliance with "Safe Torque Off" as defined in the IEC/EN 61800-5-2. Safe Disable inputs have been designed to meet the requirements of the EN ISO 13849-1, Category 3 PLe, and IEC/EN 61508, SIL3.

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 (terminals H1 and H2). The input can use either 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 photocoupler output is available to monitor the status of Safe Disable terminals DM+ and DM-. *Refer to Output Terminals on page 43* for signal specifications when using this output.
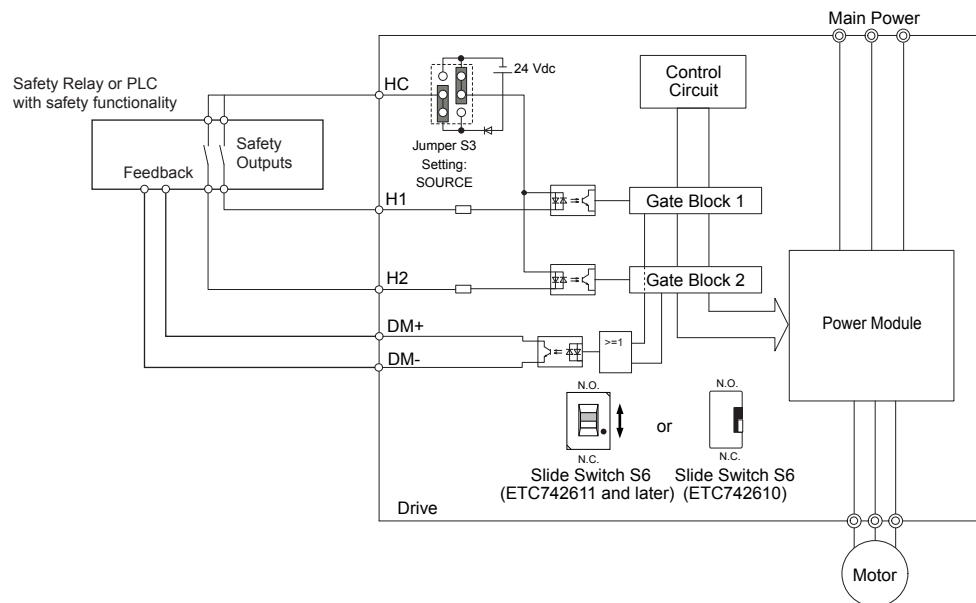
Figure i.93 Safe Disable Function Wiring Example (Source Mode)

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

Figure i.94 illustrates the Safe Disable input operation.
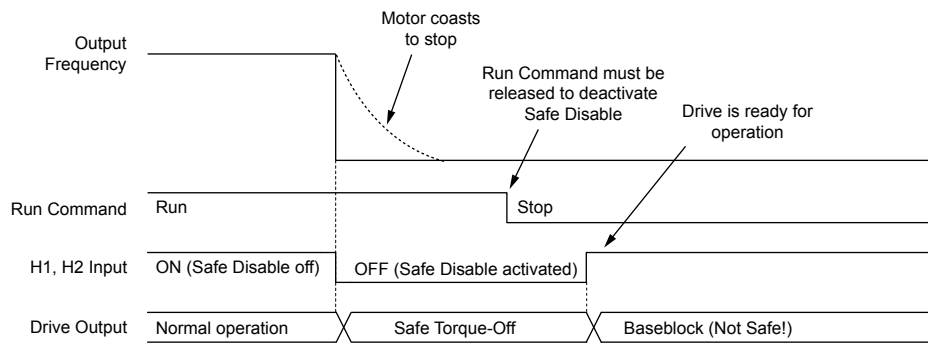
Figure i.94 Safe Disable Operation

Entering the "Safe Torque Off" State

When one or both Safe Disable inputs are 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.

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.

If Safe Disable was activated during stop, turn on both Safe Disable inputs by deactivating "Safe Torque Off" to resume normal operation.

If Safe Disable was activated during run, remove the Run command then turn on the Safe Disable inputs before restarting the drive.

■ Safe Disable Monitor Output Function and Digital Operator Display

Table i.50 explains the drive output and Safe Disable monitor state depending on the Safe Disable inputs.

Table i.50 Safety Input and EDM Terminal Status

Safe Disable Input Status		Safe Disable Status Monitor, (DM+, DM-)		Drive Output Status	Digital Operator Display
Input 1, H1-HC	Input 2, H2-HC	S6 Switch = "N.O."	S6 Switch = "N.C."		
OFF	OFF	OFF	ON	Safely disabled, "Safe Torque Off"	Hbb (flashes)
ON	OFF	ON	OFF	Safely disabled, "Safe Torque Off"	HbbF (flashes)
OFF	ON	ON	OFF	Safely disabled, "Safe Torque Off"	HbbF (flashes)
ON	ON	ON	OFF	Baseblock, ready for operation	Normal display

Safe Disable Status Monitor

Slide Switch S6 controls the polarity of this signal. Refer to *Table i.50* for functionality.

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.

If one Safe Disable channel is 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.

If a fault in the safety circuit of the drive is detected, "SCF" will be displayed in the LCD operator. This indicates damage to the drive.

■ Validating Safe Disable Function

Always perform the following validation test on the safe disable inputs after completing the wiring after start-up, when replacing parts, or when conducting maintenance. Maintain check results as a record of tests performed.

• When the H1 and H2 signals turn OFF, confirm that "Hbb" is displayed on the LCD operator, and that the motor is not in operation.

• Monitor the ON/OFF status of the H1 and H2 signals and confirm the EDM signal according to *Table i.50*.

If the ON/OFF status of the signals do not match the display, it is possible that there is an error in the external device, the external wiring is disconnected, there is a short circuit in the external wiring, or a failure in the drive. Find the cause and correct the problem.

• In normal operation, confirm the EDM signal according to *Table i.50*.

This Page Intentionally Blank

Revision History

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

MANUAL NO. TOEP C710636 04B <u><1></u> - <u>0</u>

                                       └── Web Revision number

Published in Japan <u>October 2014</u>   └── Revision number

                          └── Date of publication

Date of Publication	Revision Number	Web Revision Number	Section		Revised Content
June 2023	<4>	0	All	Revision:	Reviewed and corrected entire documentation.
			Back Cover	Revision:	Address
April 2016	<3>	0	Front Cover	Revision:	Format
			All	Revision:	Upgraded the software version to PRG: 1016 to 1017 Reviewed and corrected documentation
				Addition:	Larger drive capacities added along with corresponding data Three-phase 400 V: 4☐0477 to 4☐0930 Filter Module: EUJ71180☐.☐, EUJ71181.☐.☐, EUJ71182☐.☐
			i.9	Addition:	EMC Guidelines Compliance for Models 4☐0477 to 4☐0930 CSA Standards Compliance
			Back Cover	Revision:	Address, Format
January 2015	<2>	0	Front Cover	Revision:	Models
			i.2	Revision:	Reference Motor Capacity kW (HP) values
			Back Cover	Revision:	Address
October 2014	<1>	0	All	Revision:	Upgraded the software version to PRG: 1015
			Front Cover Back Cover	Revision:	Title
			Preface	Revision:	Applicable Documentation
			i.4	Revision:	EMC filter switch for models 2E0248, 2W0248, 4EU0216, 4W0216, 4E0240, and 4W0240
			i.8	Addition:	H2-06 = 0 (0.1 kWh units)
August 2014	–	–	–	First Edition.	This manual supports drive software version PRG: 1014.

Low Harmonic Regenerative Drive for Industrial Applications
U1000 Industrial MATRIX Drive
Quick Start Guide

YASKAWA

YASKAWA ELECTRIC CORPORATION

TOEPC71063604