YASKAWA

YASKAWA AC Drive Z1000

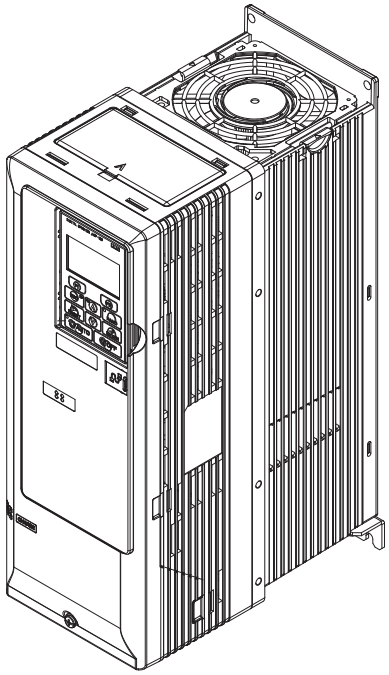
AC Drive for HVAC Fan and Pump

Quick Start Guide

Type: CIMR-ZU□A□□□□

Models: 200 V Class: 2.2 to 110 kW (3 to 150 HP)
400 V Class: 2.2 to 370 kW (3 to 500 HP)

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



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Z1000 HVAC Fan and Pump Quick Start Guide

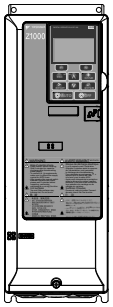
i.1 Preface

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. 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 Z1000-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 Z1000-series drives:

	Z1000-Series AC Drive Quick Start Guide (TOEPC71061654)
	Read this guide first. This guide is packaged together with the product and contains basic information required to install and wire the drive. It also 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.
	Z1000-Series AC Drive User Manual (TOEPC71061645)
	This manual contains detailed information on fault diagnostics, parameter settings, and BACnet specifications. The purpose of this manual is to prepare the drive for a trial run with an application and for basic operation. The most recent version of this manual is available for download on our documentation website, www.yaskawa.com.
	Z1000-Series AC Drive Programming Manual (SIEPC71061645)
	This manual provides detailed information on parameter settings, drive functions, maintenance, and MEMOBUS/ Modbus specifications. Use this manual to expand drive functionality and to take advantage of higher performance features. The most recent version of this manual is available for download on our documentation website, www.yaskawa.com.

◆ 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

Do not connect or disconnect wiring while the power is on.

Failure to comply will result in death or serious injury.

Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. After shutting off the power, wait for at least the amount of time specified on the drive before touching any components.

⚠ 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.

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.

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

⚠ WARNING

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

Failure to comply could 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

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 (200 V class) and 480 Vac (400 V class), when protected by branch circuit protection devices specified in this manual.
Branch circuit protection shall be provided by any of the following: Non-time delay Class J, T, or CC fuses sized at 300% of the drive input rating, or Time delay Class J, T, or CC fuses sized at 175% of the drive input rating, or MCCB sized at 200% maximum of the drive input rating.

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.

⚠ 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.

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 perform a withstand voltage test on any part of 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.

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.

Do not use screws of different sizes in SW1 and SW2.

Failure to comply may cause overheating and electrical damage.

■ General Application Precautions

Selection

Installing a Reactor

Use an AC reactor in the following situations:

- to suppress harmonic current.
- when the drive is running from a power supply system with thyristor converters.

Drive Capacity

For specialized motors, make sure that the motor rated current is less than the rated output current for the drive.

When running more than one motor in parallel from a single drive, the capacity of the drive should be larger than [total motor rated current × 1.1].

Starting Torque

The startup and acceleration characteristics of the motor are restricted to the drive overload current rating.

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.

Options

NOTICE: *The -M, +M, -, +1, and +3 terminals are used to connect optional Z1000-compatible devices only. Connecting non-Yaskawa-approved devices to these terminals may damage the drive.*

Installation

Enclosure Panels

Keep the drive in a clean environment by installing the drive in an enclosure panel. 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 your Yaskawa agent 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

Upper Limits

NOTICE: *The drive is capable of running the motor up to 240 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: *Do not connect power supply lines to output terminals U/T1, V/T2, or W/T3. Failure to comply will destroy the drive. 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, Sudden Movement Hazard. Shut off the drive with a magnetic contactor (MC) when a fault occurs in external equipment. Failure to comply may cause serious injury or death due to fire or inadvertent equipment movement.*

NOTICE: *To get the full performance life out of the electrolytic capacitors 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

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.

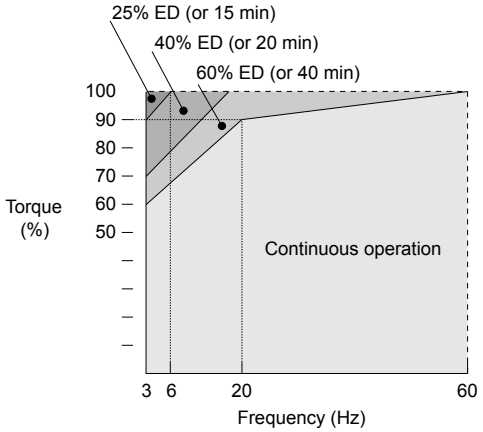


Figure i.1 Allowable Load Characteristics for a Yaskawa Motor

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 and low carrier PWM. Selecting high carrier PWM 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 selection to prevent continuous operation in the resonant frequency range.

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.

Specialized Motors

Synchronous Motor

- Contact Yaskawa or a Yaskawa agent 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 agent when planning to use a motor that does not fall within these specifications:
- In Open Loop Vector Control for PM motors, braking torque is less than 125% when running between 20% and 100% speed. Braking torque drops to less than 50% when running at less than 20% speed.
- In Open Loop Vector Control for PM motors, the allowable load moment of inertia is approximately 50 times higher than the motor moment of inertia.

  Contact Yaskawa or a Yaskawa agent for questions concerning applications with a larger moment of inertia.
- To restart a coasting motor rotating below 100 Hz, use the Speed Search function if the motor cable is not too long. If the motor cable is relatively long, stop the motor using Short Circuit Braking.

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.

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.

◆ Drive Label Warning Example

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

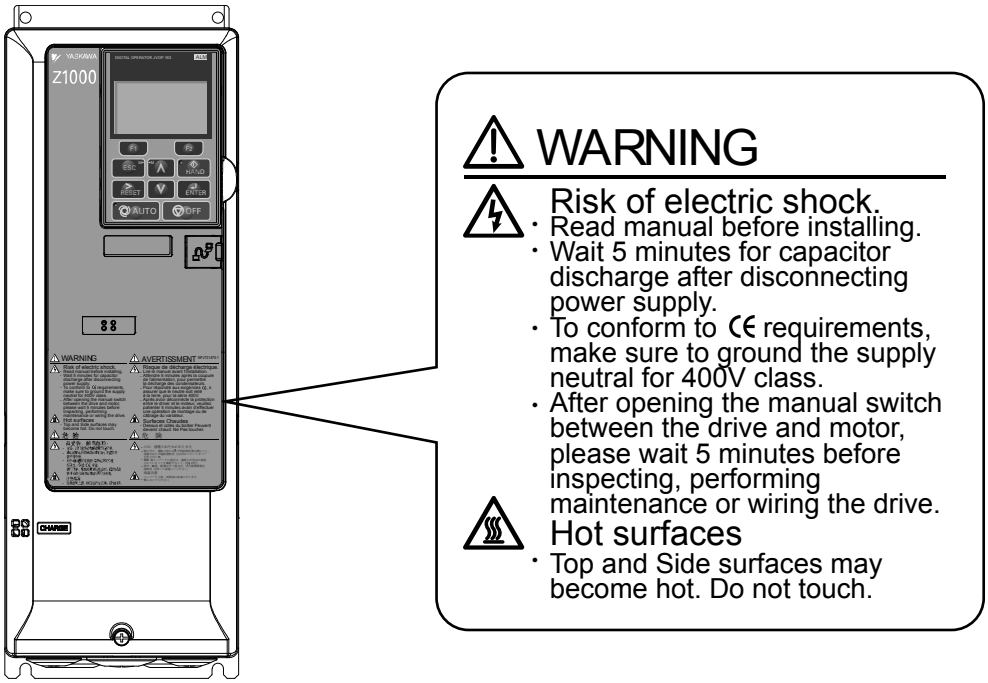


Figure i.2 Warning Information Example and Position

i.2 Receiving

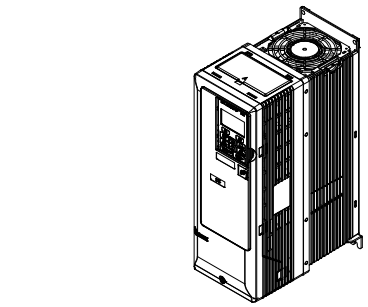
◆ Model Number and Nameplate Check

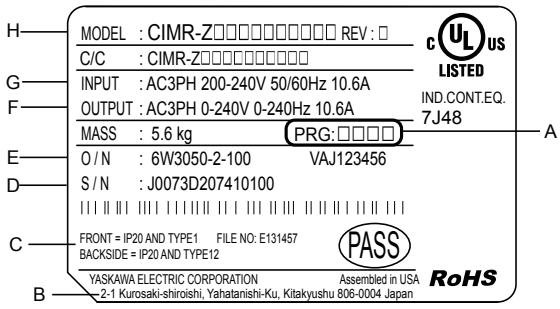
Please perform the following tasks after receiving the drive:

- 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 your supplier.

◆ Drive Nameplate





A – Software version
B – Address <1>
C – Enclosure type
D – Serial number
E – Lot number
F – Output specifications
G – Input specifications
H – AC drive model

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 Model Number Definition

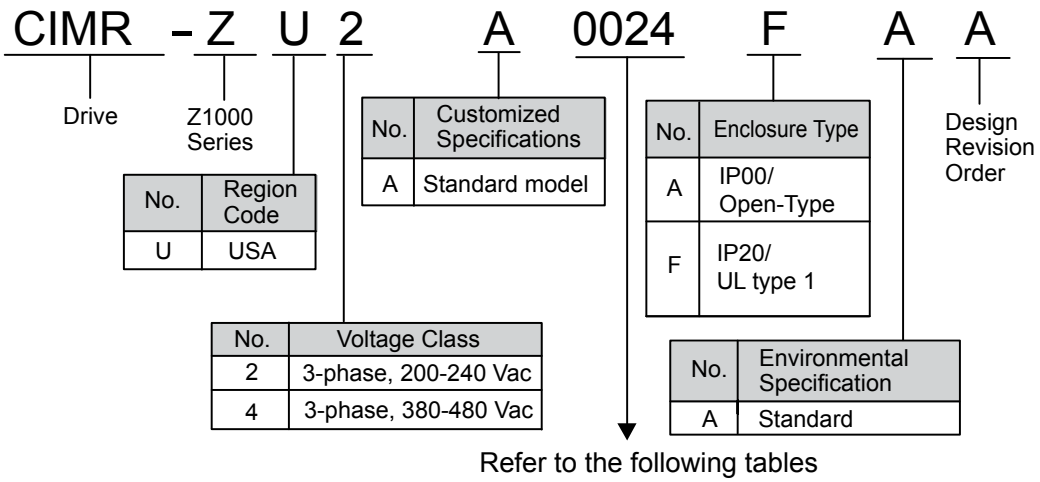


Figure i.4 Drive Model Number Definition

■ Three-Phase 200 V Class

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

Drive Model	Max Motor Capacity kW (HP)	Rated Output Current A
2A0011	2.2 (3)	10.6
2A0017	3.7 (5)	16.7
2A0024	5.5 (7.5)	24.2
2A0031	7.5 (10)	30.8
2A0046	11 (15)	46.2
2A0059	15 (20)	59.4
2A0075	18.5 (25)	74.8
2A0088	22 (30)	88
2A0114	30 (40)	114
2A0143	37 (50)	143
2A0169	45 (60)	169
2A0211	55 (75)	211
2A0273	75 (100)	273
2A0343	90 (125)	343
2A0396	110 (150)	396

■ Three-Phase 400 V Class

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

Drive Model	Max Motor Capacity kW (HP)		Rated Output Current A
	Input Voltage < 460 V	Input Voltage ≥ 460 V	
4A0005	1.5 (2)	2.2 (3)	4.8
4A0008	3.0 (4)	3.7 (5)	7.6
4A0011	4.0 (5)	5.5 (7.5)	11
4A0014	5.5 (7.5)	7.5 (10)	14
4A0021	7.5 (10)	11 (15)	21
4A0027	11 (15)	15 (20)	27
4A0034	15 (20)	18.5 (25)	34
4A0040	18.5 (25)	22 (30)	40
4A0052	22 (30)	30 (40)	52
4A0065	30 (40)	37 (50)	65
4A0077	37 (50)	45 (60)	77
4A0096	45 (60)	55 (75)	96
4A0124	55 (75)	75 (100)	124
4A0156	75 (100)	90 (125)	156
4A0180	90 (125)	110 (150)	180
4A0240	110 (150)	150 (200)	240
4A0302	160 (220)	185 (250)	302
4A0361	185 (250)	220 (300)	361
4A0414	220 (300)	260 (350)	414
4A0480	250 (340)	300 (400)	480
4A0590	300 (400)	370 (500)	590

i.3 Mechanical Installation

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

◆ Installation Environment

Install the drive in an environment matching the conditions below to prolong the optimum performance life of the drive.

Table i.3 Drive Installation Environment

Environment	Conditions
Installation Area	Indoors
Ambient Temperature	-10 °C to +40 °C (14 °F to 104 °F) IP20/UL Type 1 Enclosure, External Heatsink (2A0011 to 2A0273 and 4A0005 to 4A0302) -10 °C to +50 °C (14 °F to 122 °F) IP00/Open Type Enclosure (2A0343 and 2A0396, and 4A0361 to 4A0590) **Note:** 1. To install a heatsink on the outside of a panel, design the panel to keep the air temperature inside the panel within 10 °C (18 °F) [5 °C (9 °F) for 2A0273 and 4A0124] of the outside air temperature. 2. Ambient temperature range for continuous operations is -10 °C to +40 °C (14 °F to 104 °F) when external heatsink installation method is applied for models 2A0343 and 2A0396 and 4A0361 to 4A0590.
Humidity	95% RH or less and free of condensation
Storage Temperature	-20 °C to +70 °C (-4 °F to +158 °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	Up to 1000 m (3281 ft.) without derating. Up to 3000 m (9843 ft.) with output current and voltage derating
Vibration	10 to 20 Hz at 9.8 m/s^2 20 to 55 Hz at 5.9 m/s^2 (2A0011 to 2A0031 and 4A0005 to 4A0027) or 2.0 m/s^2 (2A0046 to 2A00396 and 4A0034 to 4A0590)
Orientation	Install the drive vertically to maintain maximum cooling effects.

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

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 drive start-up, as the cover will reduce ventilation and cause the drive to overheat.*

◆ Transporting the Drive

CAUTION! *Do not lift drive models 2A0011 to 2A0114 and 4A0005 to 4A0096 by the front cover. Failure to comply might result in minor or moderate injury if the main body of the drive falls.*

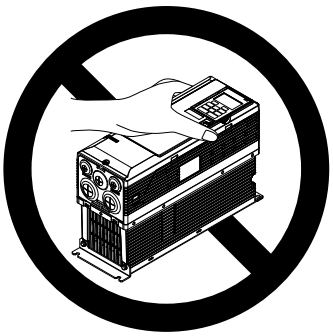


Figure i.5 Incorrect Way to Transport the Drive

◆ Installation Orientation and Spacing

Install the drive upright as illustrated in *Figure i.6* to maintain proper cooling.

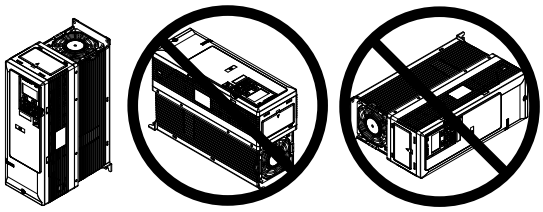
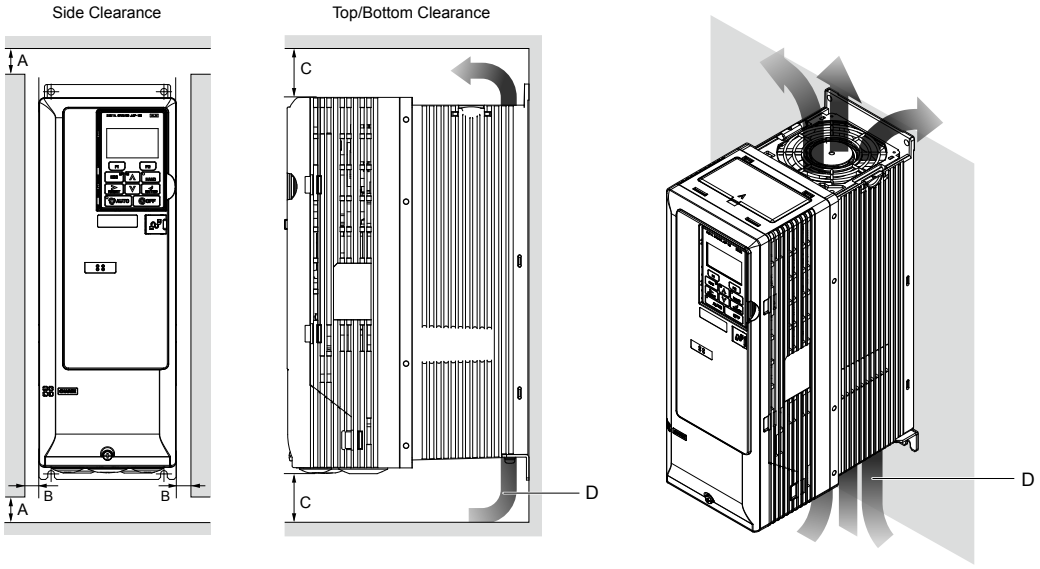


Figure i.6 Correct Installation Orientation

■ Single Drive Installation

Figure i.7 shows the installation distance required to maintain sufficient space for airflow and wiring. Install the heatsink against a closed surface to avoid diverting cooling air around the heatsink.



A – 50 mm minimum
B – 30 mm minimum
C – 120 mm minimum
D – Airflow direction

Figure i.7 Correct 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.

◆ Instructions on Installation Using the Eye Bolts

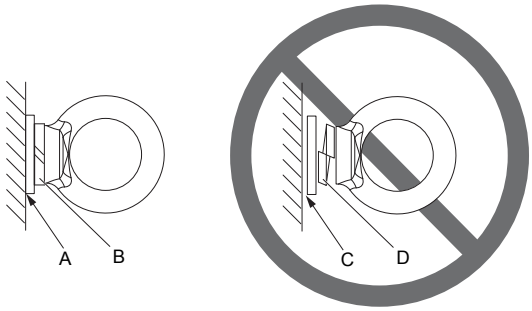
Eye bolts are used to install the drive or to temporarily lift the drive when replacing it. Using the eye bolts, the drive can be installed in an enclosure panel or on a wall. Do not leave the drive suspended by the wires in a horizontal or vertical position for long periods of time. Do not transport 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.
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.

■ Horizontal Suspension of Drive Models 2A0343A, 2A0396A, and 4A0361A to 4A0590A

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 holes of the four eye bolts.

NOTICE: *Damage to Equipment. When lifting the drive, confirm that the spring washer is fully closed. Failure to comply may deform or damage the drive when lifted.*



A – No space between drive and washer
B – Spring washer fully closed
C – Space between drive and washer
D – Spring washer open

Figure i.8 Spring Washer

■ Vertical Suspension of Drive Models 2A0343A, 2A0396A, and 4A0361A to 4A0590A

When vertical suspension of the drive is required in an enclosure panel, change the orientation of the eye bolts for these models by turning the eye bolts counterclockwise 90 degrees.

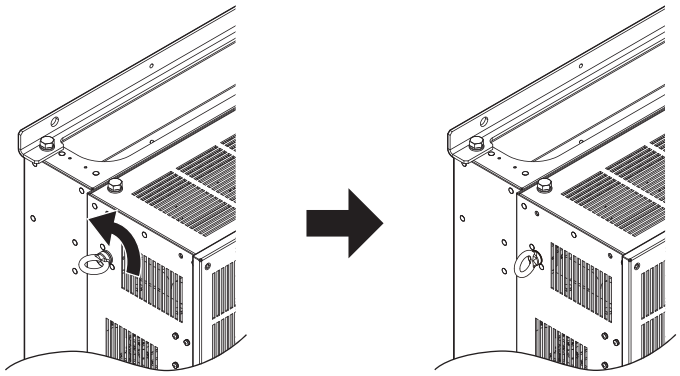


Figure i.9 Adjusting Angle of Eye Bolts

◆ Drive Dimensions

NOTICE

Refer to the Z1000 AC Drive User Manual TOEP C710616 45 for IP20/UL Type 1 and IP00/Open-Type dimensions. The Z1000 AC Drive User 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.10***. It is possible to set and run the drive via the HOA keypad without connecting digital I/O wiring. This section does not discuss drive operation; ***Refer to Start-Up Programming and Operation on page 41*** for instructions on operating the drive.

WARNING! *Fire Hazard. 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 (200 V class) and 480 Vac (400 V class), when protected by branch circuit protection devices specified in this manual.*
Branch circuit protection shall be provided by any of the following: Non-time delay Class J, T, or CC fuses sized at 300% of the drive input rating, or Time delay Class J, T, or CC fuses sized at 175% of the drive input rating, or MCCB sized at 200% maximum of the drive input rating.

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.*

NOTICE: *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: *When the input voltage is 440 V or higher or the wiring distance is greater than 100 meters, pay special attention to the motor insulation voltage or use a drive duty motor. Failure to comply could lead to motor insulation breakdown.*

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

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

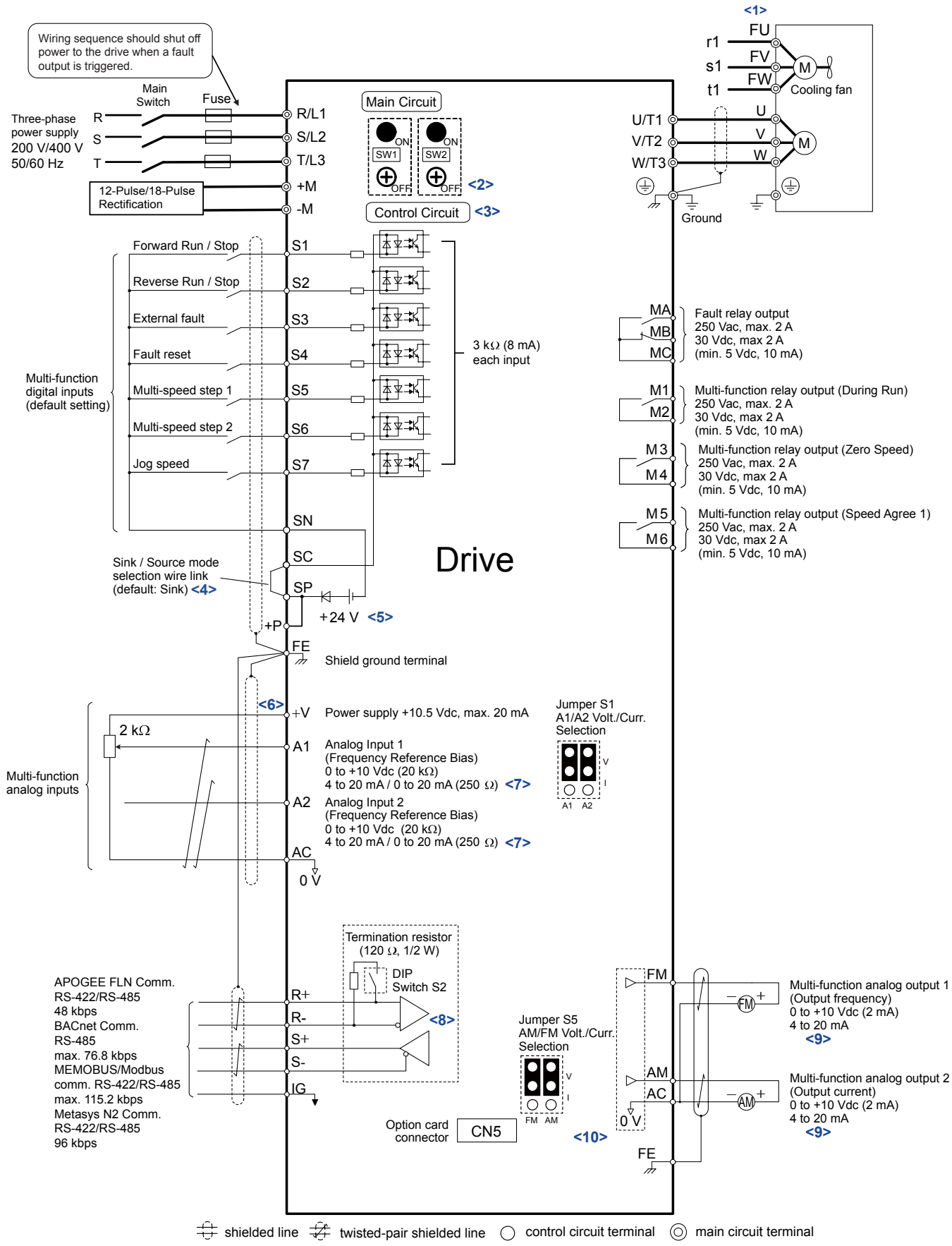


Figure i.10 Drive Standard Connection Diagram (example: 2A0011)

<1> Self-cooling motors do not require the same wiring necessary for motors with cooling fans.

<2> For floating, impedance grounded, or asymmetrically grounded networks, disconnect the internal EMC filter by moving the SW1 and SW2 screws to the OFF position.

<3> A 24 V power supply option is required to supply power to the control circuit separately from the main circuit.

<4> This figure illustrates an example of a sequence input to S1 through S7 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.

<5> This voltage source supplies a maximum current of 150 mA.

<6> The maximum output current capacity for the +V terminal on the control circuit is 20 mA. Never short terminals +V and AC, as it can cause erroneous operation or damage the drive.

<7> Use jumper S1 to select between a voltage or current input signal to terminals A1 and A2. The default setting is for voltage input.

<8> Set DIP switch S2 to the ON position to enable the termination resistor in the last drive in a MEMOBUS/Modbus network.

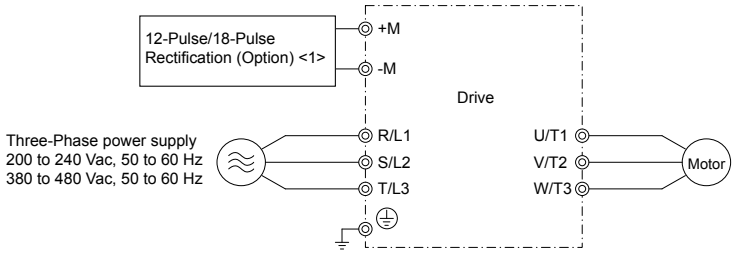
<9> Monitor outputs work with devices such as analog frequency meters, ammeters, voltmeters, and wattmeters. They are not intended for use as a feedback-type signal.

<10> Use jumper S5 to select between voltage or current output signals at terminals FM and AM. Set parameters H4-07 and H4-08 accordingly.

◆ Main Circuit Connection Diagrams

Refer to ***Figure i.11*** through ***Figure i.17*** when wiring the main circuit of the drive. Connections may vary based on drive capacity. The DC power supply for the main circuit also provides power to the control circuit.

■ Three-Phase 200 V Class (2A0011 to 2A0273) Three-Phase 400 V Class (4A0005 to 4A0302)



<1> +M and -M are for rectification options only. Do not use for dynamic braking or line-regeneration.

Figure i.11 Connecting Main Circuit Terminals

■ Three-Phase 200 V Class (2A0343 and 2A0396) Three-Phase 400 V Class (4A0361 to 4A0590)

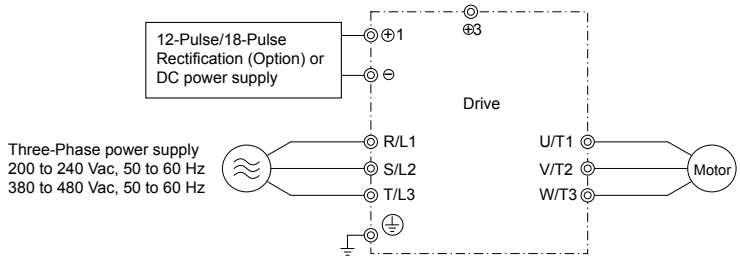


Figure i.12 Connecting Main Circuit Terminals

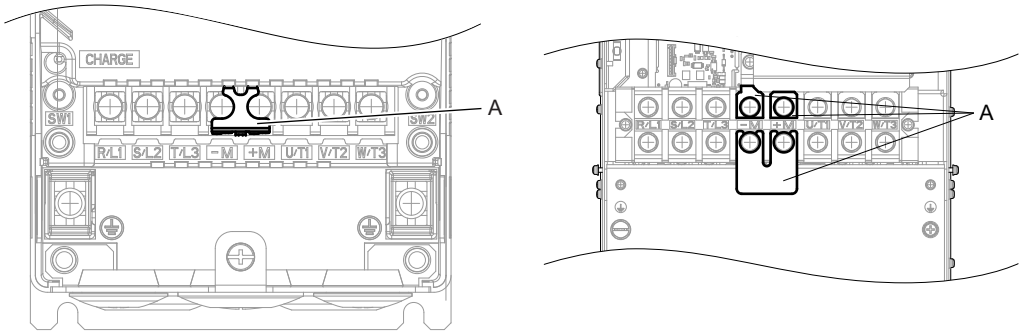
■ 12-Pulse/18-Pulse Rectification

Operation with 12-pulse/18-pulse rectification requires the user to separately prepare a 3-winding/4-winding transformer for the power supply. Contact Yaskawa or your nearest sales representative for the transformer specifications.

Wiring to –M/+M Terminals (2A0011 to 2A0273 and 4A0005 to 4A0302)

Access the –M/+M terminals by cutting off the protection cover on models 2A0011 to 2A0114 and 4A0005 to 4A0096 or by removing the protection sheet on –M/+M terminals on models 2A0143 to 2A0273 and 4A0124 to 4A0302.

–M/+M are for rectification options only. Do not use for dynamic braking or line-regeneration.



A –Protective covering over –M/+M terminals

Figure i.13 –M/+M Terminals

■ Wiring to –/+1 Terminals (2A0343 to 2A0396 and 4A0361 to 4A0590)

Wire directly to the –/+1 terminals.

Connection Diagrams

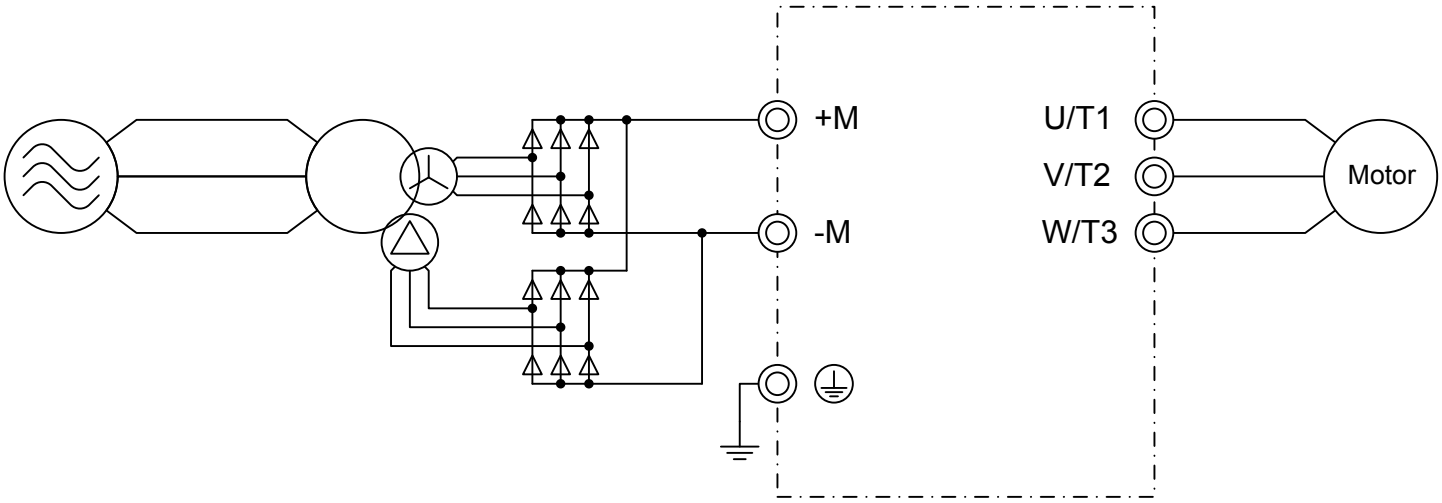


Figure i.14 12-Pulse Connection Diagram (2A0011 to 2A0273 and 4A0005 to 4A0302)

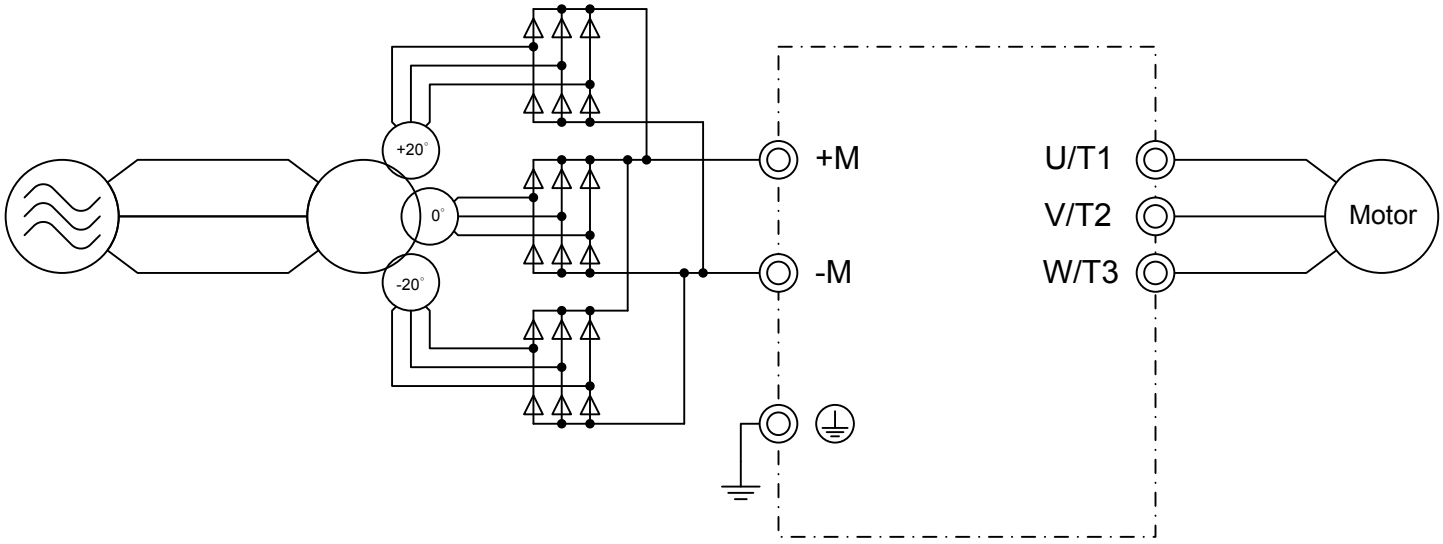


Figure i.15 18-Pulse Connection Diagram (2A0011 to 2A0273 and 4A0005 to 4A0302)

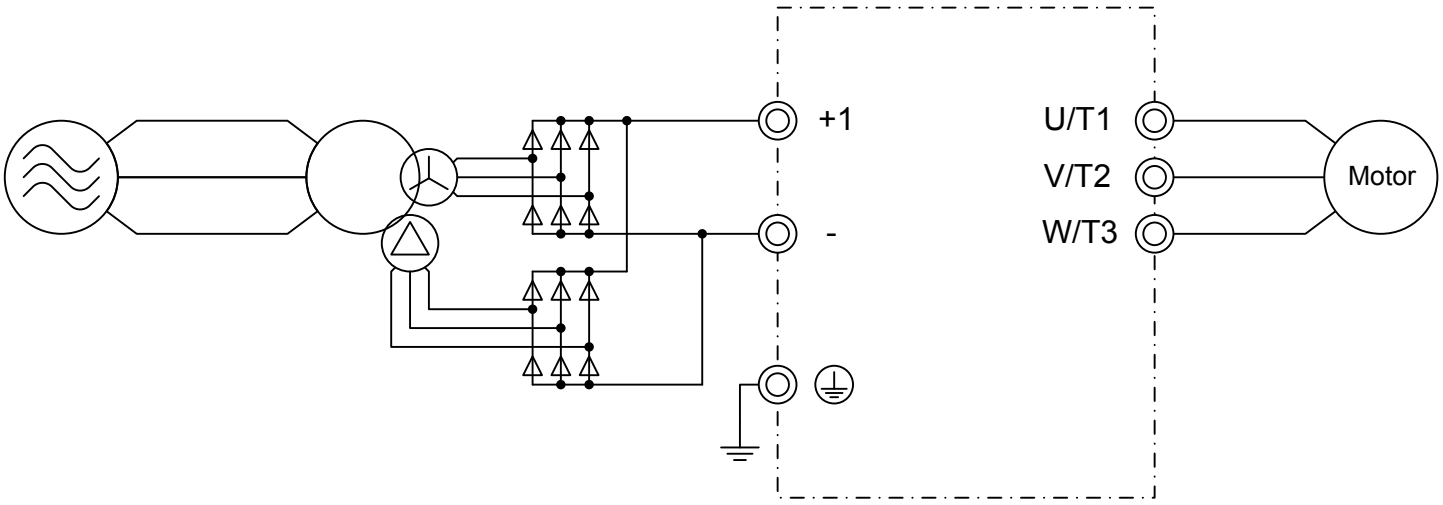


Figure i.16 12-Pulse Connection Diagram (2A0343, 2A0396, and 4A0361 to 4A0590)

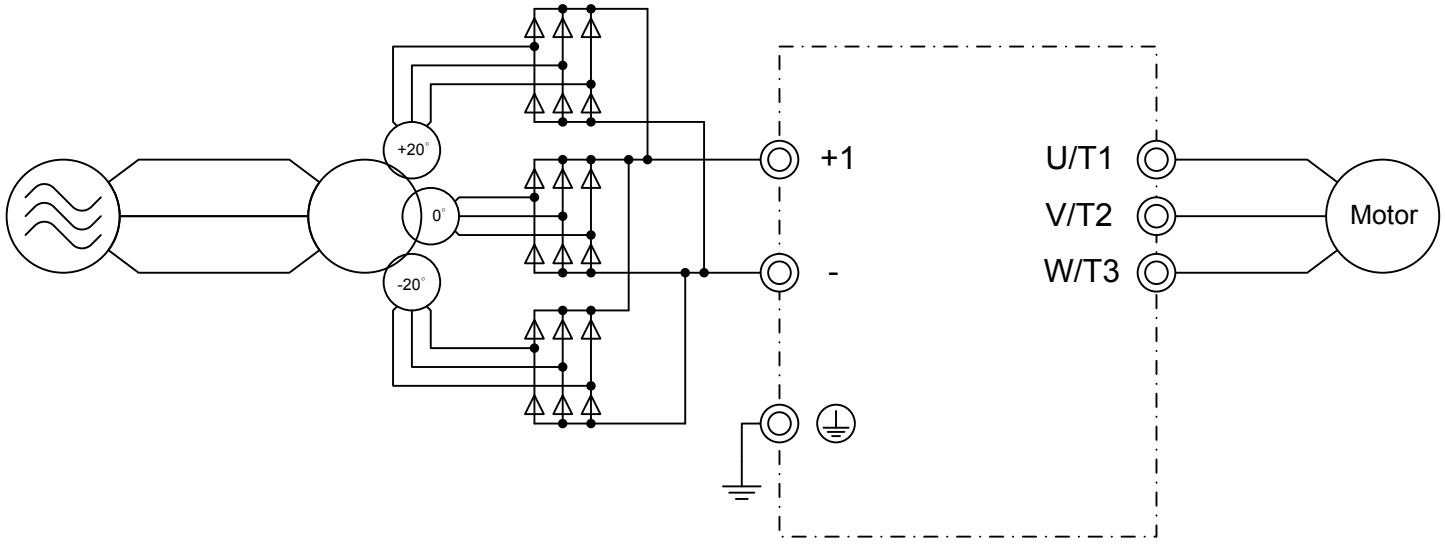


Figure i.17 18-Pulse Connection Diagram (2A0343, 2A0396, and 4A0361 to 4A0590)

◆ Main Circuit Terminal Functions

Table i.4 Main Circuit Terminal Functions

Terminal		Type		Function	Page
200 V Class / 400 V Class	Drive Model	2A0011 to 2A0273 / 4A0005 to 4A0302	2A0343 and 2A0396 / 4A0361 to 4A0590		
R/L1		Main circuit power supply input		Connects line power to the drive	*17*
S/L2					
T/L3					
U/T1		Drive output		Connects to the motor	*17*
V/T2					
W/T3					
+1		–	DC power supply input (+1 and –) or 12/18 pulse rectification	For connecting peripheral devices	–
–					
+3 <1>		–	–	–	–

Terminal		Type		Function	Page
200 V Class	Drive Model	2A0011 to 2A0273	2A0343 and 2A0396		
400 V Class		4A0005 to 4A0302	4A0361 to 4A0590		
+M		12/18 pulse rectification <2>	–	Input for 12/18 pulse rectification	–
-M					
⏚		For 200 V class: 100 Ω or less For 400 V class: 10 Ω or less		Grounding terminal	*27*

<1> Not used.

<2> +M and –M are for rectification purposes only. Do not use for dynamic braking or line-regeneration.

◆ 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 4A0361 through 4A0590 to provide added protection between terminals. Yaskawa recommends using the provided insulation barriers to ensure proper wiring. Refer to ***Figure i.18*** for instructions on placement of the insulation barriers.

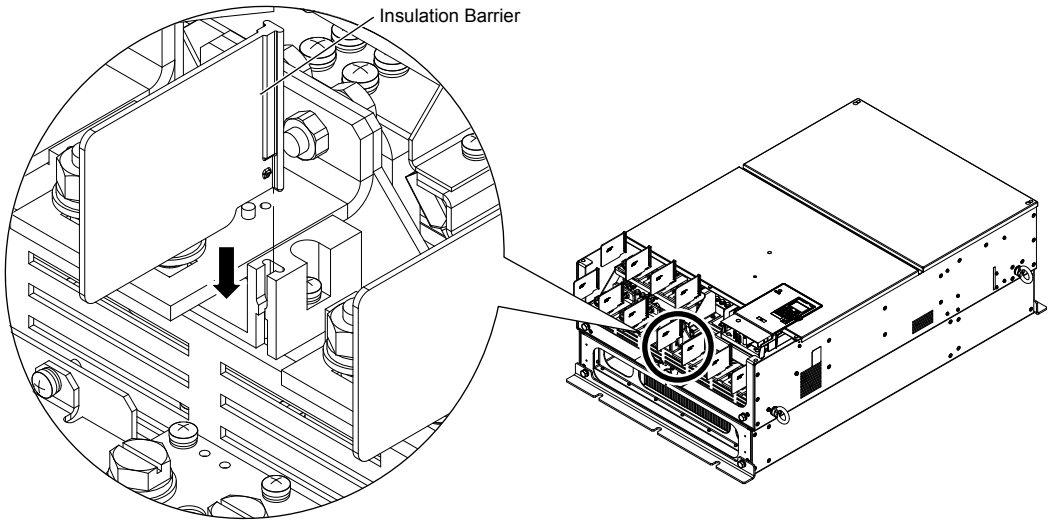
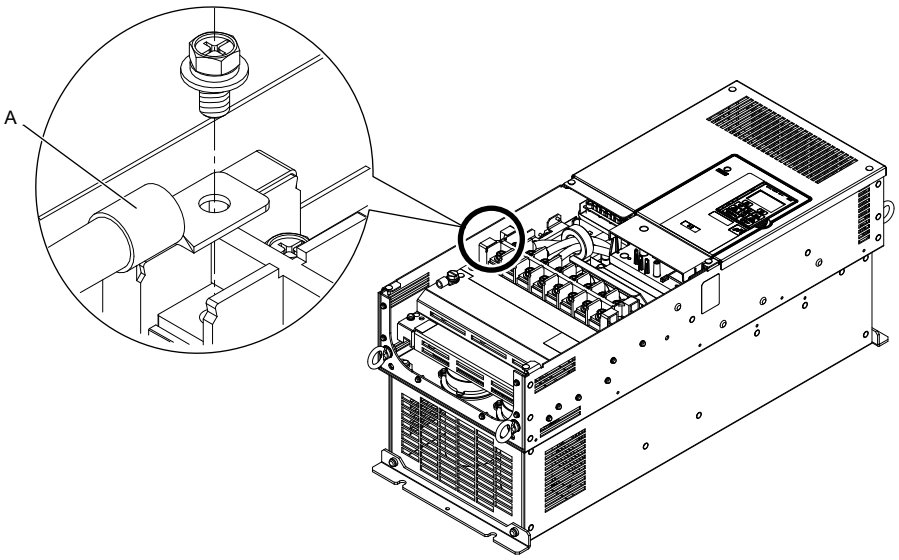


Figure i.18 Installing Insulation Barriers

When wiring 4A0124, make sure the crimp terminals on the main circuit are connected so that they are facing in the correct direction as shown in ***Figure i.19***.



A –Crimp terminals in correct position

Figure i.19 Crimp Terminals

◆ 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:
1. Wire gauge recommendations based on drive continuous current ratings using 75 °C 600 Vac vinyl-sheathed wire assuming ambient temperature within 40 °C and wiring distance less than 100 m.
2. Terminal +3 is not used. Do not connect devices or wiring to this terminal.

- 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 78*** for information on UL compliance.

Yaskawa recommends using closed-loop crimp terminals on all drive models. To maintain UL/cUL approval, UL Listed closed-loop crimp terminals are specifically required when wiring the drive main circuit terminals on models 2A0031 to 2A0396 and 4A0034 to 4A0590. Use only the tools recommended by the terminal manufacturer for crimping. ***Refer to Closed-Loop Crimp Terminal Size on page 79*** for closed-loop crimp terminal recommendations.

The wire gauges listed in the following tables are Yaskawa recommendations. Refer to NEC table 310-16 for proper wire gauge selection for terminals -M, +M, -1, +3, and ground.

■ Three-Phase 200 V Class

Table i.5 Wire Gauge and Torque Specifications (Three-Phase 200 V Class)

Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb. in.)
2A0011	R/L1, S/L2, T/L3	14	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	14			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
2A0017	R/L1, S/L2, T/L3	10	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	10			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)

Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb. in.)
2A0024	R/L1, S/L2, T/L3	8	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	8			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
2A0031 <I>	R/L1, S/L2, T/L3	8	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	8			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
2A0046 <I>	R/L1, S/L2, T/L3	6	10 to 4	M5	2.7 to 3.0 (24 to 27)
	U/T1, V/T2, W/T3	6			
	-M, +M	–			
	⏚	–			
2A0059 <I>	R/L1, S/L2, T/L3	4	10 to 4	M5	2.7 to 3.0 (24 to 27)
	U/T1, V/T2, W/T3	4			
	-M, +M	–			
	⏚	–			
2A0075 <I>	R/L1, S/L2, T/L3	3	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	3			
	-M, +M	–			
	⏚	–			
2A0088 <I>	R/L1, S/L2, T/L3	2	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	2			
	-M, +M	–			
	⏚	–			
2A0114 <I>	R/L1, S/L2, T/L3	1/0	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	1/0			
	-M, +M	–			
	⏚	–			
2A0143 <I>	R/L1, S/L2, T/L3	3 × 2	1/0 to 3/0	M8	13.5 to 15.0 (120 to 133)
	U/T1, V/T2, W/T3	3 × 2			
	-M, +M	–			
	⏚	–			
2A0169 <I>	R/L1, S/L2, T/L3	2 × 2	1/0 to 3/0	M8	13.5 to 15.0 (120 to 133)
	U/T1, V/T2, W/T3	2 × 2			
	-M, +M	–			
	⏚	–			
2A0211 <I>	R/L1, S/L2, T/L3	1/0 × 2	1/0 to 3/0	M8	13.5 to 15.0 (120 to 133)
	U/T1, V/T2, W/T3	1/0 × 2			
	-M, +M	–			
	⏚	–			
2A0273 <I>	R/L1, S/L2, T/L3	2/0 × 2	1/0 to 4/0	M10	27.0 to 30.0 (239 to 266)
	U/T1, V/T2, W/T3	2/0 × 2			
	-M, +M	–			
	⏚	–		M8	13.5 to 15.0 (120 to 133)

Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb. in.)
2A0343 <1>	R/L1, S/L2, T/L3	4/0 × 2	3/0 to 350	M12	32.0 to 40.0 (283 to 354)
	U/T1, V/T2, W/T3	4/0 × 2			
	–, +1	–			
	+3	–		M10	18.0 to 23.0 (159 to 204)
	⏚	–		M12	32.0 to 40.0 (283 to 354)
2A0396 <1>	R/L1, S/L2, T/L3	250 × 2	3/0 to 350	M12	32.0 to 40.0 (283 to 354)
	U/T1, V/T2, W/T3	250 × 2			
	–, +1	–			
	+3	–		M10	18.0 to 23.0 (159 to 204)
	⏚	–		M12	32.0 to 40.0 (283 to 354)

<1> Drive models 2A0046 to 2A0396 require the use of closed-loop crimp terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

■ Three-Phase 400 V Class

Table i.6 Wire Gauge and Torque Specifications (Three-Phase 400 V Class)

Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
4A0005 4A0008 4A0011	R/L1, S/L2, T/L3	14	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	14			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
4A0014	R/L1, S/L2, T/L3	12	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	12			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
4A0021	R/L1, S/L2, T/L3	10	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	10			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
4A0027	R/L1, S/L2, T/L3	8	14 to 8	M4	1.6 to 1.8 (14 to 16)
	U/T1, V/T2, W/T3	8			
	-M, +M	–			
	⏚	–		M5	2.7 to 3.0 (24 to 27)
4A0034 <1>	R/L1, S/L2, T/L3	8	10 to 4	M5	2.7 to 3.0 (24 to 27)
	U/T1, V/T2, W/T3	8			
	-M, +M	–			
	⏚	–			
4A0040 4A0052□□B <1>	R/L1, S/L2, T/L3	8	10 to 4	M5	2.7 to 3.0 (24 to 27)
	U/T1, V/T2, W/T3	8			
	-M, +M	–			
	⏚	–			
4A0052□□A <1>	R/L1, S/L2, T/L3	6	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	6			
	-M, +M	–			
	⏚	–			

Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
4A0065 <I>	R/L1, S/L2, T/L3	4	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	4			
	-M, +M	–			
	⏚	–			
4A0077 <I>	R/L1, S/L2, T/L3	3	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	3			
	-M, +M	–			
	⏚	–			
4A0096 <I>	R/L1, S/L2, T/L3	1	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	1			
	-M, +M	–			
	⏚	–			
4A0124 <I>	R/L1, S/L2, T/L3	2/0	8 to 2/0	M8	5.4 to 6.0 (48 to 53)
	U/T1, V/T2, W/T3	2/0			
	-M, +M	–			
	⏚	–			
4A0156 <I>	R/L1, S/L2, T/L3	3 × 2	1/0 to 3/0	M8	13.5 to 15.0 (120 to 133)
	U/T1, V/T2, W/T3	3 × 2			
	-M, +M	–			
	⏚	–			
4A0180 <I>	R/L1, S/L2, T/L3	2 × 2	1/0 to 3/0	M8	13.5 to 15.0 (120 to 133)
	U/T1, V/T2, W/T3	2 × 2			
	-M, +M	–			
	⏚	–			
4A0240 <I>	R/L1, S/L2, T/L3	1/0 × 2	1/0 to 3/0	M8	13.5 to 15.0 (120 to 133)
	U/T1, V/T2, W/T3	1/0 × 2			
	-M, +M	–			
	⏚	–			
4A0302 <I>	R/L1, S/L2, T/L3	3/0 × 2	1/0 to 4/0	M10	27.0 to 30.0 (239 to 266)
	U/T1, V/T2, W/T3	3/0 × 2			
	-M, +M	–			
	⏚	–			
4A0361 <I>	R/L1, S/L2, T/L3	4/0 × 2	3/0 to 600	M12	32.0 to 40.0 (283 to 354)
	U/T1, V/T2, W/T3	4/0 × 2	3/0 to 600		
	–, +1	–	4/0 to 600		
	+3	–	3/0 to 600	M10	18 to 23 (159 to 204)
	⏚	1	1 to 350	M12	32 to 40 (283 to 354)
4A0414 <I>	R/L1, S/L2, T/L3	300 × 2	4/0 to 300	M12	32.0 to 40.0 (283 to 354)
	U/T1, V/T2, W/T3	300 × 2	4/0 to 300		
	–, +1	–	3/0 to 300		
	+3	–	3/0 to 300		
	⏚	1	1 to 3/0		
4A0480 <I>	R/L1, S/L2, T/L3	1/0 × 4	3/0 to 300	M12	32.0 to 40.0 (283 to 354)
	U/T1, V/T2, W/T3	1/0 × 4			
	–, +1	–			
	+3	–			
	⏚	–			

Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N·m (lb.in.)
4A0590 <1>	R/L1, S/L2, T/L3	3/0 × 4	3/0 to 300	M12	32.0 to 40.0 (283 to 354)
	U/T1, V/T2, W/T3	3/0 × 4			
	–, +1	–			
	+3	–			
	⏚	–			

<1> Drive models 4A0034 to 4A0590 require the use of closed-loop crimp terminals for UL/cUL compliance. Use only the tools recommended by the terminal manufacturer for crimping.

◆ Main Circuit Terminal and Motor Wiring

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

WARNING! *Electrical Shock Hazard. Do not connect the AC power line to the output terminals of the drive. Failure to comply could result in death or serious injury by fire as a result of drive damage from line voltage application to output terminals.*

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.*

NOTICE: *Do not connect phase-advancing capacitors or LC/RC noise filters to the output circuits. Failure to comply could result in damage to the drive, phase-advancing capacitors, LC/RC noise filters or ground fault circuit interrupters.*

■ Ground Wiring

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

DANGER! *Electrical Shock Hazard. Do not touch SW1 or SW2 screws while power is applied to the drive. Failure to comply will result in death or serious injury.*

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 and 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.20*** when using multiple drives. Do not loop the ground wire.

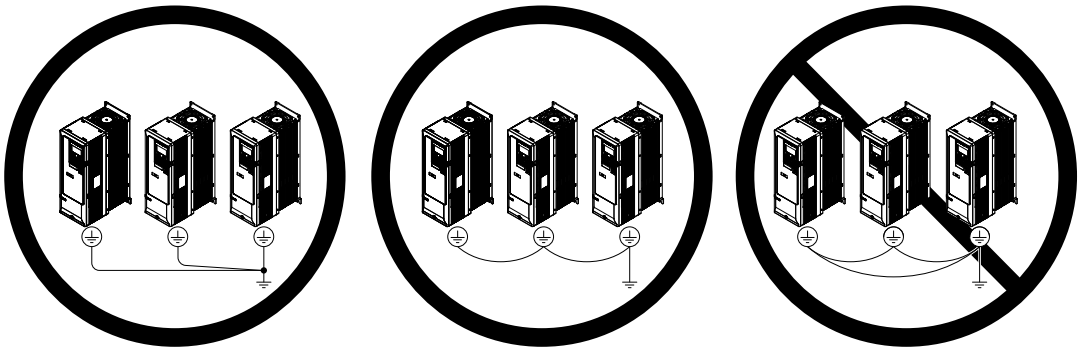


Figure i.20 Ground Wiring for Multiple Drives

◆ Control Circuit Terminal Block Functions

Drive parameters determine which functions apply to the multi-function digital inputs (S1 to S7), multi-function digital outputs (M1 to M6), multi-function analog inputs (A1 and A2), and multi-function analog monitor output (FM, AM). The default setting is listed next to each terminal in ***Figure i.10*** on page *17*.

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 default setting. Failure to comply may result in death or serious injury.*

■ Input Terminals

Table i.7 lists the input terminals on the drive. Text in parenthesis indicates the default setting for each multi-function input.

Table i.7 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 • Set the wire jumper to select between sinking, sourcing mode, and the power supply. *Refer to Sinking/Sourcing Mode Switch for Digital Inputs on page 35*.
	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)	
	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 **NOTICE:** *Do not jumper or short terminals SP and SN. Failure to comply will damage the drive.*
	SN	Digital input power supply 0 V	
Frequency Reference Inputs	+V	Power supply for analog inputs	10.5 Vdc (max allowable current 20 mA)
	A1	Multi-function analog input 1 (Frequency reference bias)	• 0 to 10 Vdc/100% (input impedance: 20 kΩ) • 4 to 20 mA/100%, 0 to 20 mA/100% (input impedance: 250 Ω) • Voltage or current input must be selected by Jumper S1 and H3-01.
	A2	Multi-function analog input 2 (Frequency reference bias)	• 0 to 10 Vdc/100% (input impedance: 20 kΩ) • 4 to 20 mA/100%, 0 to 20 mA/100% (input impedance: 250 Ω) • Voltage or current input must be selected by Jumper S1 and H3-09.
	AC	Frequency reference common	0 V
	FE	Ground for shielded lines and option cards	–

■ Output Terminals

Table i.8 lists the output terminals on the drive. Text in parenthesis indicates the default setting for each multi-function output.

Table i.8 Control Circuit Output Terminals

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Fault Relay Output	MA	N.O.	30 Vdc, 10 mA to 2 A; 250 Vac, 10 mA to 2 A Minimum load: 5 Vdc, 10 mA
	MB	N.C. output	
	MC	Fault output common	
Multi-Function Digital Output <1>	M1	Multi-function digital output (During run)	30 Vdc, 10 mA to 2 A; 250 Vac, 10 mA to 2 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	FM	Analog monitor output 1 (Output frequency)	0 to 10 V / 0 to 100% 4 to 20 mA / 0 to 100% Voltage or current output must be selected by Jumper S5 and H4-07 for FM and H4-08 for AM.
	AM	Analog monitor output 2 (Output current)	
	AC	Monitor common	0 V
External Power Supply	+P	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 100,000 times (assumes 2 A, resistive load).

■ Serial Communication Terminals

Table i.9 Control Circuit Terminals: Serial Communications

Type	No.	Signal Name	Function (Signal Level)	
Serial Communication (APOGEE FLN, BACnet, MEMOBUS/ Modbus, or Metasys N2) <1>	R+	Communications input (+)	APOGEE FLN, BACnet, MEMOBUS/ Modbus, or Metasys N2 communication: Use an RS-422 or RS-485 cable to connect the drive.	• APOGEE FLN Comm. RS-422/ RS-485, 4.8 kbps • BACnet Comm. RS-485, max. 76.8 kbps • MEMOBUS/ Modbus Comm. RS-422/RS-485, max. 115.2 kbps • Metasys N2 Comm. RS-422/RS-485, 9.6 kbps
	R-	Communications input (-)		
	S+	Communications output (+)		
	S-	Communications output (-)		
	IG	Communications ground	0 V	
	FE	Option card ground	–	

<1> Enable the termination resistor in the last drive in an APOGEE FLN, BACnet, MEMOBUS/Modbus, or Metasys N2 network by setting DIP switch S2 to the ON position. Refer to the Z1000 AC Drive User Manual TOEP C710616 45 for detailed information on ***Control I/O Connections***.

◆ Terminal Configuration

The control circuit terminals are arranged as shown in ***Figure i.21***.

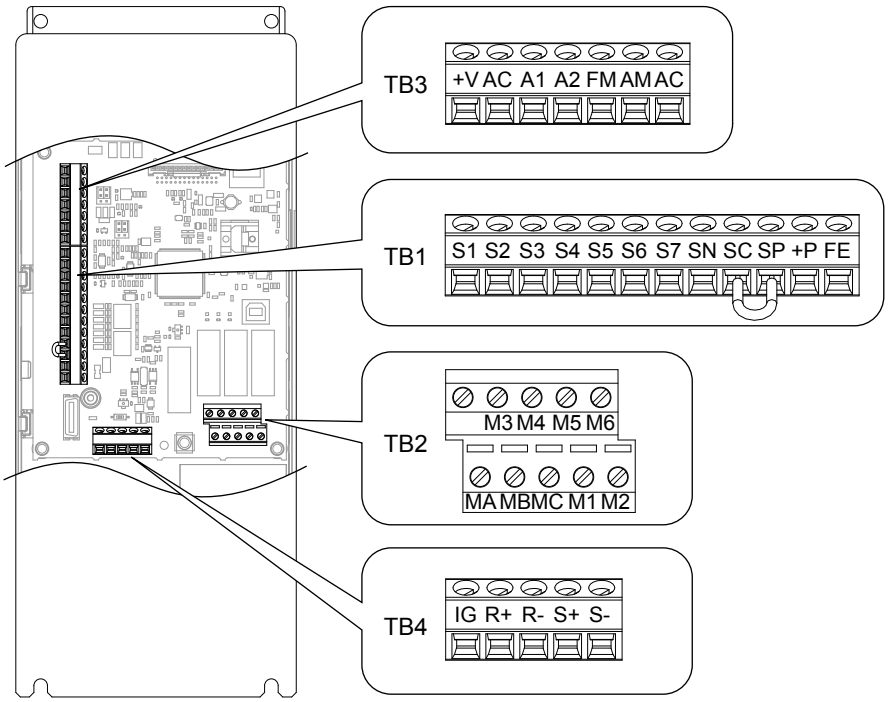


Figure i.21 Control Circuit Terminal Arrangement

■ Wire Size and Torque Specifications

Select appropriate wire type and gauges from ***Table i.10***. For simpler and more reliable wiring, use crimp ferrules on the wire ends. Refer to ***Table i.11*** for ferrule terminal types and sizes.

Table i.10 Wire Gauges

Terminal Block	Terminal	Screw Size	Tightening Torque N•m (lb. in)	Bare Wire Terminal		Ferrule-Type Terminal		Wire Type
				Recomm. wire size mm² (AWG)	Applicable wire size mm² (AWG)	Recomm. wire size mm² (AWG)	Applicable wire size mm² (AWG)	
TB1, TB2, TB3, TB4	S1-S7, SN, SC, SP, MA, MB, MC, M1-M6, V+, AC, A1, A2, FM, AM, IG, R+, R-, S+, S-	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.11*** for dimensions.

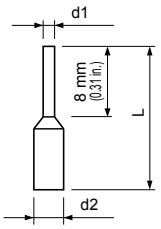


Figure i.22 Ferrule Dimensions

Table i.11 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)	PHOENIX CONTACT
0.34 (22)	AI 0.34-8TQ	12.5 (0.49)	0.8 (0.03)	2.0 (0.08)	
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 (terminals R/L1, S/L2, T/L3, -M, +M, -, +1, +3, U/T1, V/T2, W/T3) and other high-power lines. Improper wiring practices could result in drive malfunction due to electrical interference.*

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.*

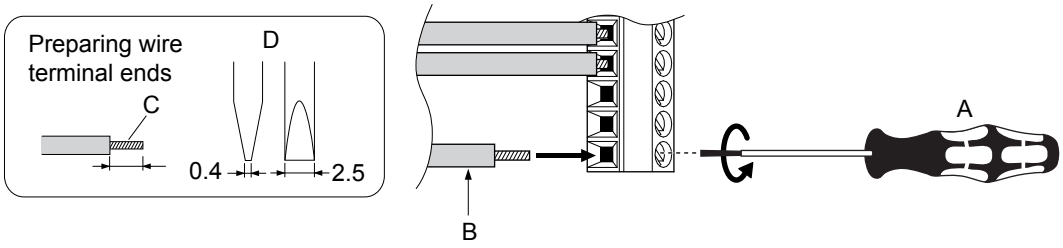
Wire the control circuit only after terminals have been properly grounded and main circuit wiring is complete. ***Refer to Terminal Wiring Guide on page 32*** for details. Prepare the ends of the control circuit wiring as shown in ***Figure i.29***. ***Refer to Wire Gauges on page 30***.

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.*

Connect control wires as shown in ***Figure i.23*** and ***Figure i.24***.

Yaskawa recommends Phoenix Contact screwdriver model SZF 0-0.4 x 2.5 or equivalent to wire the terminal block.

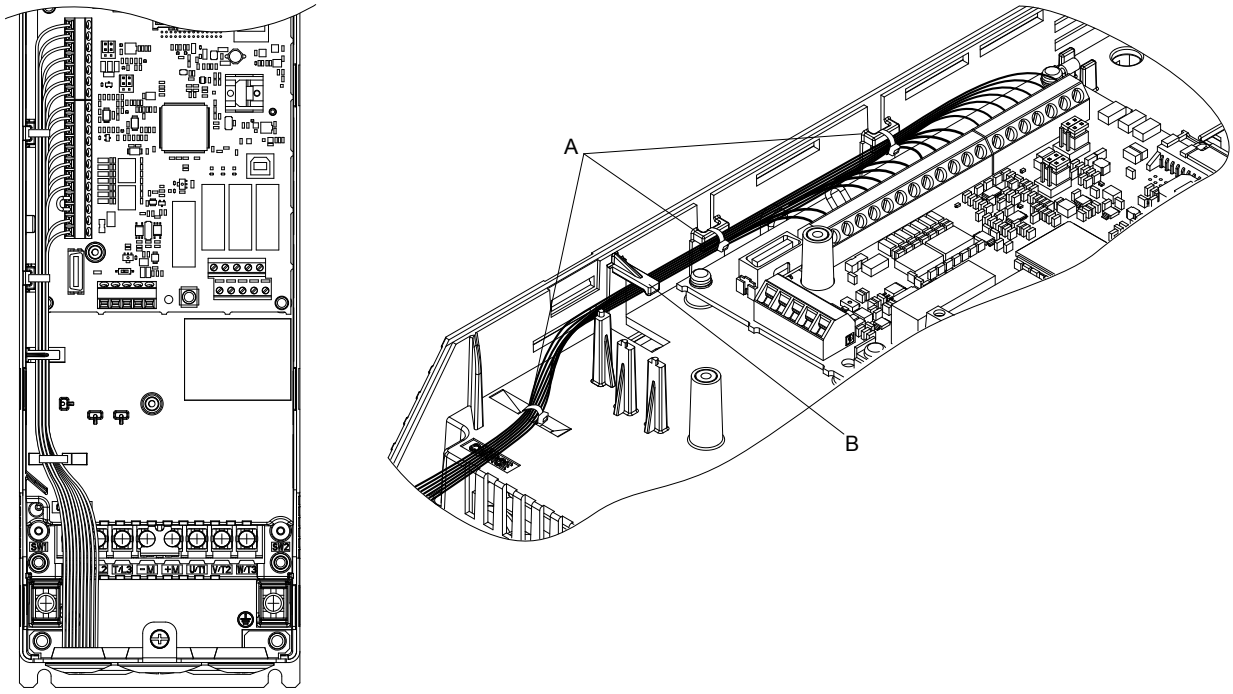


A – Loosen screw to insert wire.
B – Single wire or stranded wire
C – Avoid fraying wire strands when stripping insulation from wire. Strip length 5.5 mm.
D – Blade depth of 0.4 mm or less Blade width of 2.5 mm or less

Figure i.23 Terminal Wiring Guide

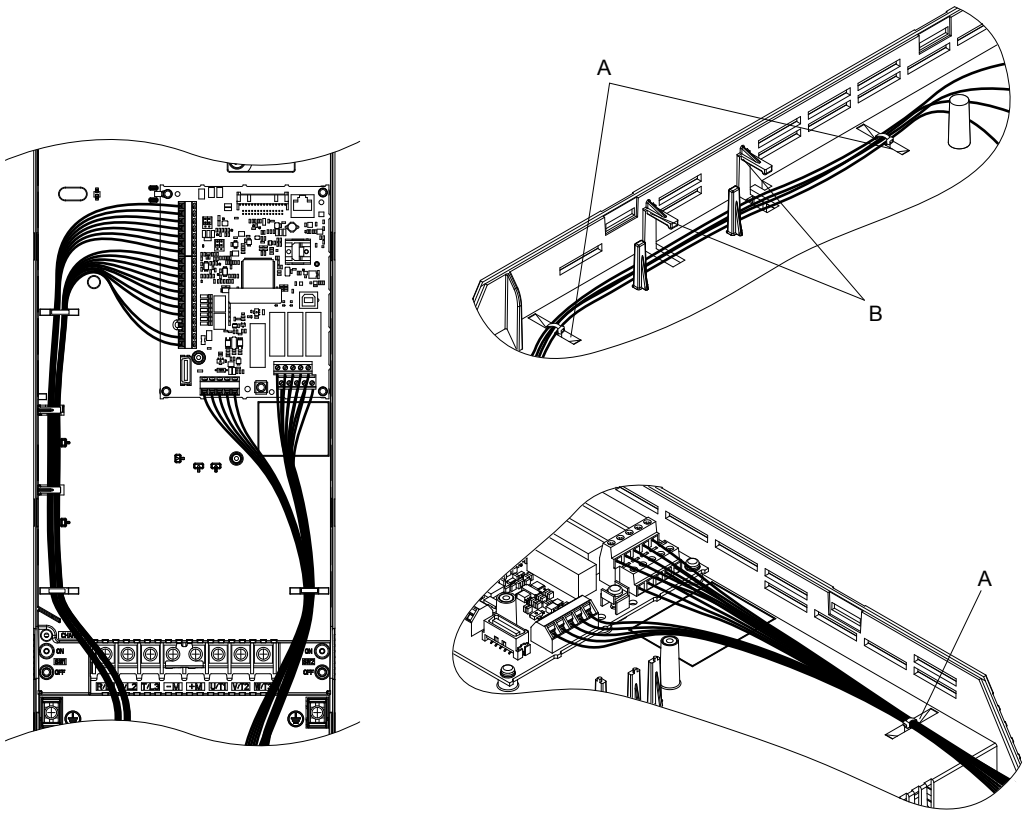
Use the cable tie holes and cable hooks when wiring control terminals.

Note: Take proper precautions when wiring the cables so that the front covers will easily fit back onto the drive. Make sure cables are not pinched between the front covers and the drive when replacing the covers.



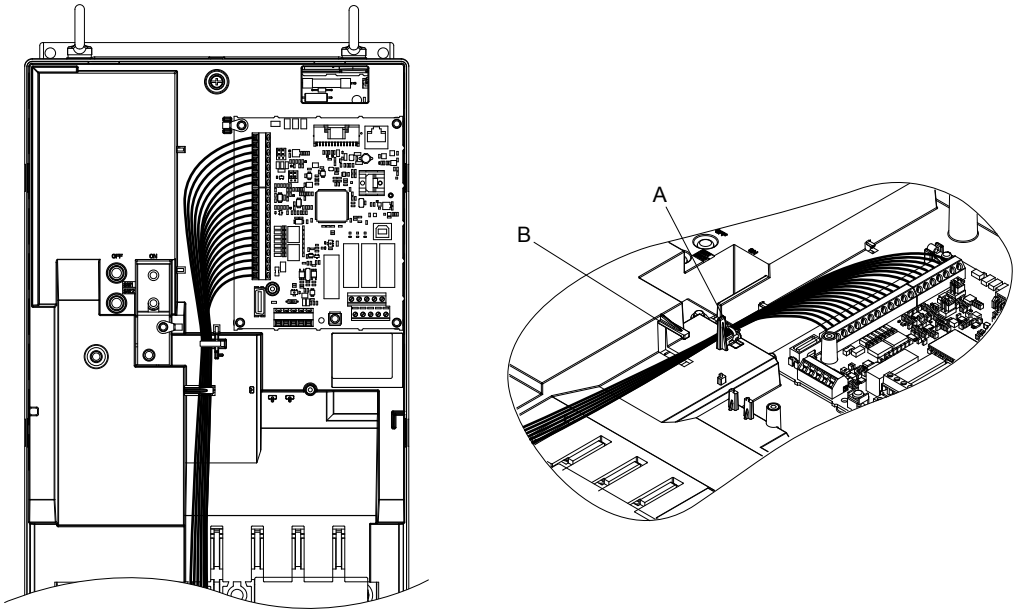
A – Cable tie hole **B – Cable hook**

Figure i.24 Control Terminal Wiring (2A0011 to 2A0031 and 4A0005 to 4A0027)



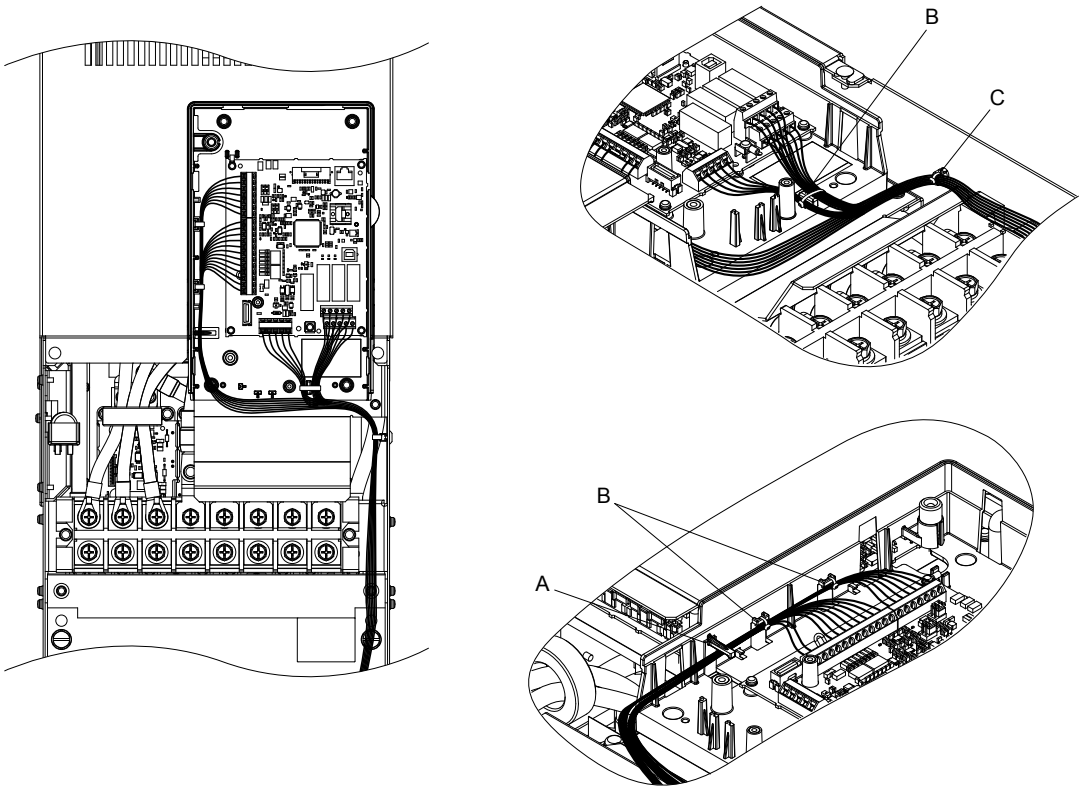
A – Cable tie hole **B – Cable hook**

Figure i.25 Control Terminal Wiring (2A0046, 2A0059, 4A0034, 4A0040, and 4A0052□□B)



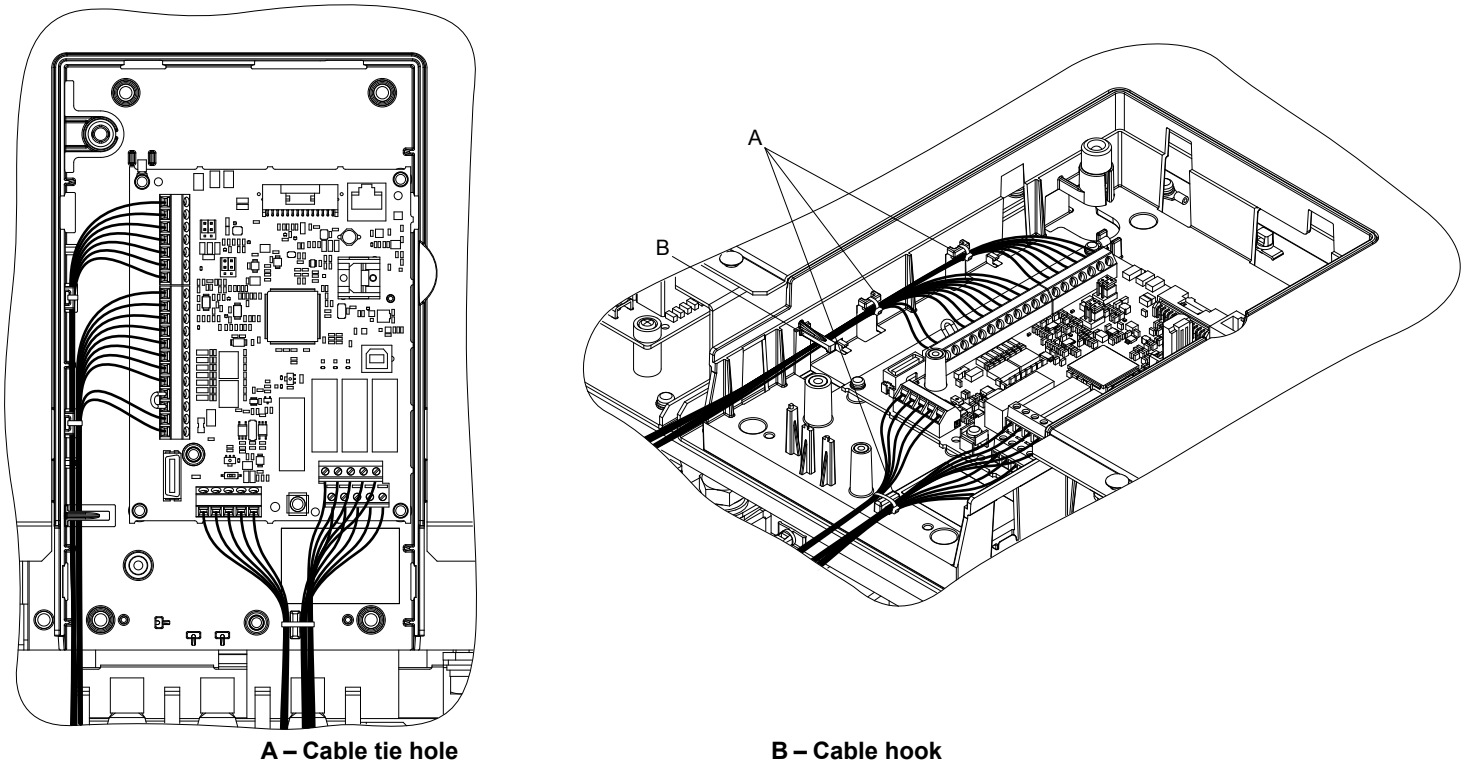
A – Cable tie hole **B – Cable hook**

Figure i.26 Control Terminal Wiring (2A0075 to 2A0114, 4A0052□□A, and 4A0065 to 4A0096)



A – Cable hook
B – Cable tie hole
C – Cable anchor

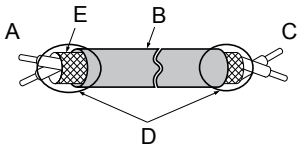
Figure i.27 Control Terminal Wiring (4A0124)



A – Cable tie hole
B – Cable hook

Figure i.28 Control Terminal Wiring (2A0143 to 2A0396 and 4A0156 to 4A0590)

When setting the frequency by analog reference from an external potentiometer, use shielded twisted-pair wires (preparing wire ends as shown in ***Figure i.29***) 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.29 Preparing the Ends of Shielded Cables

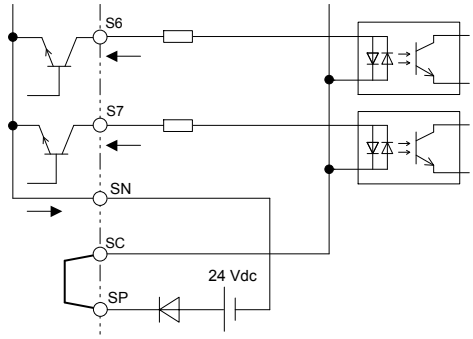
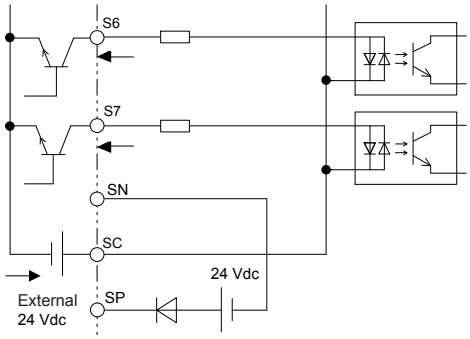
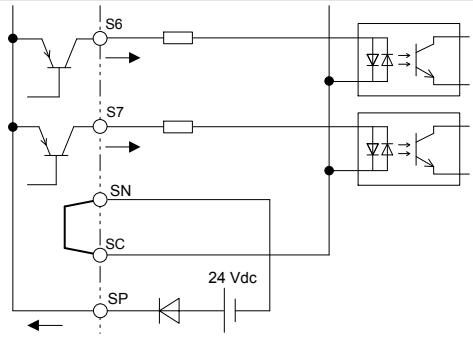
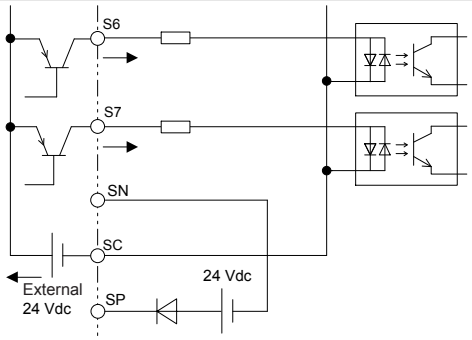
NOTICE: *The analog signal wiring between the drive and the operator station or peripheral equipment should not exceed 50 meters when using an analog signal from a remote source to supply the frequency reference. Failure to comply could result in poor system performance.*

◆ Sinking/Sourcing Mode Switch 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 S7 as shown in ***Table i.12*** (Default: Sink mode, internal power supply).

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

Table i.12 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)		

◆ Input Signal Selection for Terminals A1 and A2

Terminals A1 and A2 can be used to input either a voltage or a current signal. Select the signal type using jumper S1 as explained in ***Table i.13***. Set parameters H3-01 and H3-09 accordingly as shown in ***Table i.14***.

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.13 Jumper S1 Settings

Terminal	Voltage Output	Current Output
Terminal A1		
Terminal A2		

Table i.14 Parameters H3-01 and H3-09 Details

No.	Parameter Name	Description	Setting Range	Default Setting
H3-01	Terminal A1 signal level selection	Selects the signal level for terminal A1. 0: 0 to 10 V with Zero Limit 1: 0 to 10 V without Zero Limit 2: 4 to 20 mA Current Input 3: 0 to 20 mA Current Input	0 to 3	0
H3-09	Terminal A2 signal level selection	Selects the signal level for terminal A2. 0: 0 to 10 V with Zero Limit 1: 0 to 10 V without Zero Limit 2: 4 to 20 mA Current Input 3: 0 to 20 mA Current Input	0 to 3	0

◆ Terminal FM/AM Signal Selection

The signal type for terminals FM and AM can be set to either voltage or current output using jumper S5 on the terminal board as explained in ***Table i.15***. 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.15 Jumper S5 Settings

Terminal	Voltage Output	Current Output
Terminal FM		
Terminal AM		

Table i.16 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 2: 4 to 20 mA	0, 2	0
H4-08	Terminal AM signal level selection			

◆ MEMOBUS/Modbus Termination

This drive is equipped with a built-in termination resistor for the RS-422/RS-485 communication connector. DIP switch S2 enables or disabled the termination resistor as shown in ***Table i.17***. 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.17 MEMOBUS/Modbus Termination Switch S2 Settings

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

■ Enable the Internal EMC Filter

DANGER! *Electrical Shock Hazard. Do not touch SW1 or SW2 screws 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.*

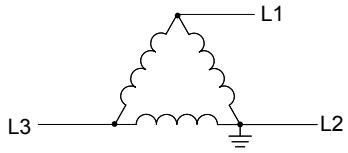
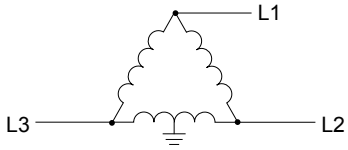
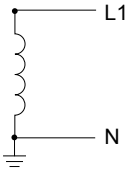
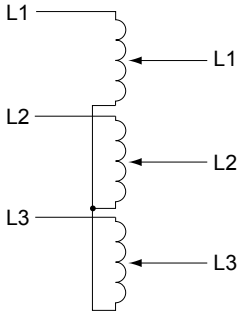
NOTICE: *Keep SW1/SW2 screws positioned together (ON/ON or OFF/OFF). Screws at different positions may cause drive failure.*

Note: For floating, impedance grounded, or asymmetrically grounded networks, disconnect the internal EMC filter by moving the SW1/SW2 screws to the OFF position.

■ Asymmetrical Grounded Network

Table i.18 shows asymmetrical grounded networks. Asymmetrical networks require screws SW1 and SW2 to be in the OFF position. The internal ground connection for the filter is removed when the screws are in the OFF position. (Drives are shipped with SW1 and SW2 screws installed at the OFF position.)

Table i.18 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	

If EMC is a concern and the network is grounded symmetrically, install the SW1 and SW2 screws to the ON position. Installing the SW1 and SW2 screws enables the internal EMC filter (Drives are shipped with SW1/SW2 screws installed at the OFF position).

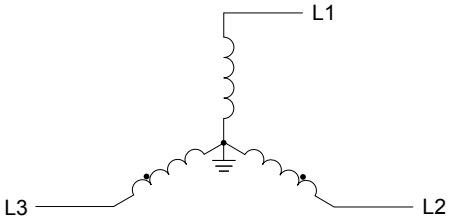
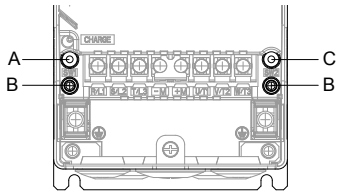


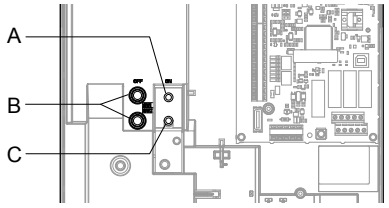
Figure i.30 Symmetrical Grounded Network

■ EMC Filter Switch Location



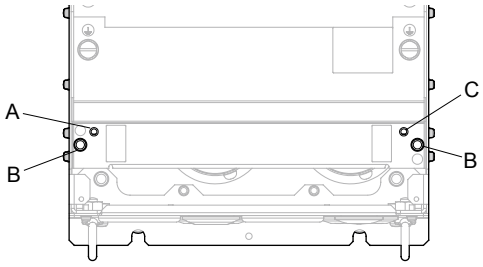
A – SW1 (ON) **C – SW2 (ON)**
B – Screw (OFF)

Figure i.31 EMC Filter Switch Location (2A0011 to 2A0059, 4A0005 to 4A0040, and 4A0052□□B)



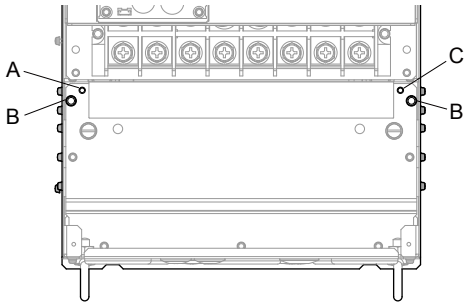
A – SW1 (ON) **C – SW2 (ON)**
B – Screw (OFF)

Figure i.32 EMC Filter Switch Location (2A0075 to 2A0114, 4A0052□□A, and 4A0065 to 4A0096)



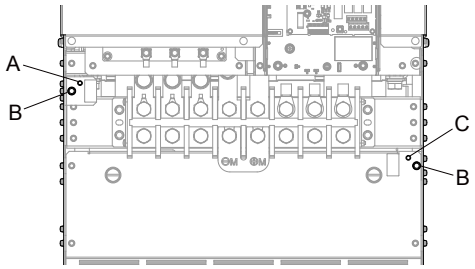
A – SW1 (ON) **C – SW2 (ON)**
B – Screw (OFF)

Figure i.33 EMC Filter Switch Location (4A0124)



A – SW1 (ON) **C – SW2 (ON)**
B – Screw (OFF)

Figure i.34 EMC Filter Switch Location (2A0143 to 2A0273 and 4A0156 to 4A0240)



A – SW1 (ON)
B – Screw (OFF)
C – SW2 (ON)

Figure i.35 EMC Filter Switch Location (4A0302)

If the SW1/SW2 screws are missing, install proper size screws with the proper tightening torque as shown in ***Table i.19***.

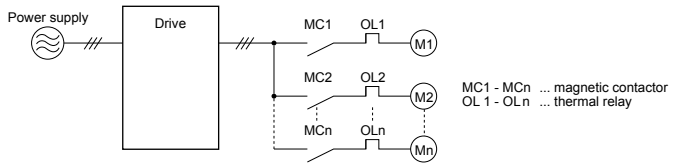
NOTICE: *Do not use screws of different sizes in SW1 and SW2. Failure to comply may cause overheating.*

Table i.19 SW1/SW2 Screw Sizes and Tightening Torques

Drive Model		SW1/SW2 Screw Size	Tightening Torque
2A0011 **2A0017**	**4A0005** **4A0008** **4A0011**	M3 × 16	0.5 to 0.6 N•m
2A0024 **2A0031**	**4A0014** **4A0021** **4A0027**	M3 × 16	0.5 to 0.6 N•m
2A0046 **2A0059**	**4A0034** **4A0040** **4A0052□□B**	M3 × 16	0.5 to 0.6 N•m
2A0075 **2A0088** **2A0114**	**4A0052□□A** **4A0065** **4A0077** **4A0096**	M5 × 30	2 to 2.5 N•m
–	**4A0124**	M5 × 25	2 to 2.5 N•m
2A0143 **2A0169** **2A0211** **2A0273**	**4A0156** **4A0180** **4A0240**	M5 × 25	2 to 2.5 N•m
–	**4A0302**	M5 × 25	2 to 2.5 N•m

◆ Wiring Checklist

☑	No.	Item	Page
		Drive, Peripherals, Option Cards	
☐	1	Check drive model number to ensure receipt of correct model.	*11*
☐	2	Make sure you have the correct noise filters and other peripheral devices.	–
☐	3	Check the option card model number.	–
		Installation Area and Physical Setup	
☐	4	Ensure that the area surrounding the drive complies with specifications.	*13*
		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.	*11*
☐	7	Verify that the drive is properly sized to run the motor.	
		Main Circuit Wiring	
☐	8	Confirm proper branch circuit protection as specified by national and local codes.	–
☐	9	Properly wire the power supply to drive terminals R/L1, S/L2, and T/L3.	*19*

☑	No.	Item	Page
☐	10	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.	*27*
☐	11	Confirm that the crimp terminals are in the correct position.	*22*
☐	12	Use 600 Vac vinyl-sheathed wire for the power supply and motor lines.	*23*
☐	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.	*23*
☐	14	For floating, impedance grounded, or asymmetrically grounded networks, disconnect the internal EMC filter by moving the SW screw to the OFF position.	*37*
☐	15	Properly ground the drive.	–
☐	16	Tighten control circuit and grounding terminal screws.	*23*
☐	17	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.	–
☐	18	Verify phase advancing capacitors, input noise filters, or GFCIs are NOT installed on the output side of the drive.	–
		Control Circuit Wiring	
☐	19	Use twisted-pair line for all drive control circuit wiring.	*31*
☐	20	Ground the shields of shielded wiring to the GND ⏚ terminal.	*31*
☐	21	For 3-Wire sequence, set parameters for multi-function contact input terminals S1 to S7, and wire control circuits.	–
☐	22	Properly wire the option card.	*31*
☐	23	Check for any other wiring mistakes. Only use a multimeter to check wiring.	–
☐	24	Properly fasten drive control circuit terminal screws.	*23*
☐	25	Pick up all wire clippings.	–
☐	26	Ensure that no frayed wires on the terminal block are touching other terminals or connections.	–
☐	27	Properly separate control circuit wiring and main circuit wiring.	–
☐	28	Analog signal line wiring should not exceed 50 m.	–

i.5 Start-Up Programming and Operation

Use the HOA keypad to enter OFF commands, switch to AUTO or HAND Mode, change parameters, and display data including fault and alarm information.

◆ HOA Keypad Keys and Displays

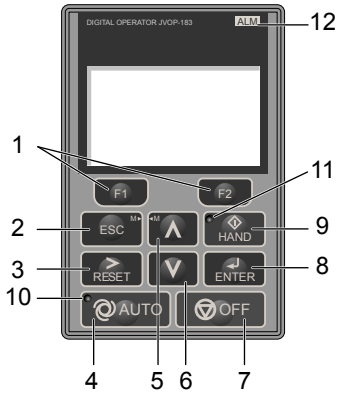


Figure i.36 Keys and Displays on the HOA Keypad

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	AUTO	AUTO Key	Selects the source of Run command and frequency reference. • Set the drive to AUTO mode. • Run command input source depends on b1-02. • Frequency reference input source depends on b1-01.
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	OFF	OFF Key	Follows the stopping method set in b1-03 to stop drive operation. **Note:** The OFF key is DISABLED during Emergency Override.
8	ENTER	ENTER Key	• Enters parameter values and settings. • Selects a menu item to move between displays.
9	HAND	HAND Key	The drive runs at a selectable frequency reference source by S5–01. • Set the drive to HAND mode. • When S5–02 is set to 1, HAND and AUTO mode can be switched while the drive is running.
10	AUTO	AUTO Light	Lit while the drive is in AUTO mode. Refer to page *43* for details.
11	HAND	HAND Light	Lit while the drive is in HAND mode. Refer to page *43* for details.
12	ALM	ALM LED Light	*Refer to ALARM (ALM) LED Displays on page 43*.

◆ LCD Display

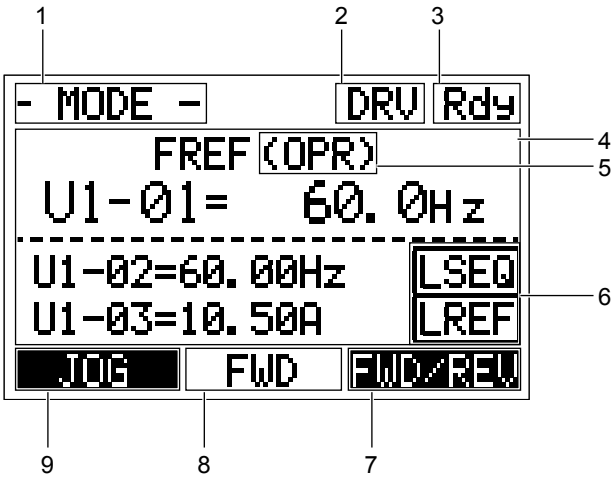


Figure i.37 LCD Display

Table i.20 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	Mode Display Area	DRV	Displayed when in Drive Mode.
		PRG	Displayed when in Programming Mode.
3	Ready	Rdy	Indicates the drive is ready to run.
4	Data Display	—	Displays specific data and operation data.
5	Frequency Reference Assignment <1>	OPR	Displayed when the frequency reference is assigned to the HOA keypad.
		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 option card connected to the drive.
		AI	Displayed when the function reference is assigned to an analog input.
		OFF	Displayed when HAND mode is OFF.
6	LOCAL/REMOTE 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 run command is supplied from a remote source.
		LREF	Displayed when the run command is supplied from the operator keypad.
7	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.
		Monitor	Pressing F2 switches Monitor mode.
		DRV/BYP	The multi-function relay selected Drive/Bypass contact will be toggled.
		RUNBYP	The multi-function relay selected to RUN Bypass will be toggled.
		RLY	The multi-function relay selected to Relay operator control will be toggled.

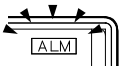
No.	Name	Display	Content
8	FWD/REV	FWD	Indicates forward motor operation.
		REV	Indicates reverse motor operation.
9	Function Key 1 (F1)	JOG	Pressing F1 executes the Jog function.
		HELP	Pressing F1 displays the Help menu.
		←	Pressing F1 scrolls the cursor to the left.
		HOME	Pressing F1 returns to the top menu (Frequency Reference).
		ESC	Pressing F1 returns to the previous display.
		Monitor	Pressing F1 switches Monitor mode.
		DRV/BYP	The multi-function relay selected Drive/Bypass contact will be toggled.
		RUNBYP	The multi-function relay selected to RUN Bypass will be toggled.
		RLY	The multi-function relay selected to Relay operator control will be toggled.

<1> Displayed when in Frequency Reference Mode.

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

◆ ALARM (ALM) LED Displays

Table i.21 ALARM (ALM) LED Status and Contents

State	Content	Display
Illuminated	When the drive detects an alarm or error.	
Flashing	• When an alarm occurs. • When an oPE is detected. • When a fault or error occurs during Auto-Tuning.	
Off	Normal operation (no fault or alarm).	

◆ AUTO LED and HAND LED Indications

Table i.22 AUTO LED and HAND LED Indications

AUTO LED	HAND LED	State
 Off	 Off	OFF mode
 Off	 On solid	HAND mode (Also during DC injection braking)
 Off	 Long blink (50% duty)	HAND mode when the Frequency Reference is 0 and/or decelerating in HAND mode, or during PI Sleep or Snooze.
 On solid	 Off	Running in AUTO mode (Also during DC injection braking)
 Off	 Double blink	HAND mode, cycle the Run command.
 Long blink (50% duty)	 Off	Running in AUTO mode when the Frequency Reference is 0 and/or decelerating in AUTO mode, or during PI Sleep or Snooze. AUTO mode, Ready, No Run command input.
 Double blink	 Off	AUTO mode, stopped by a Fast- Stop from a Multi-Function Digital Input.

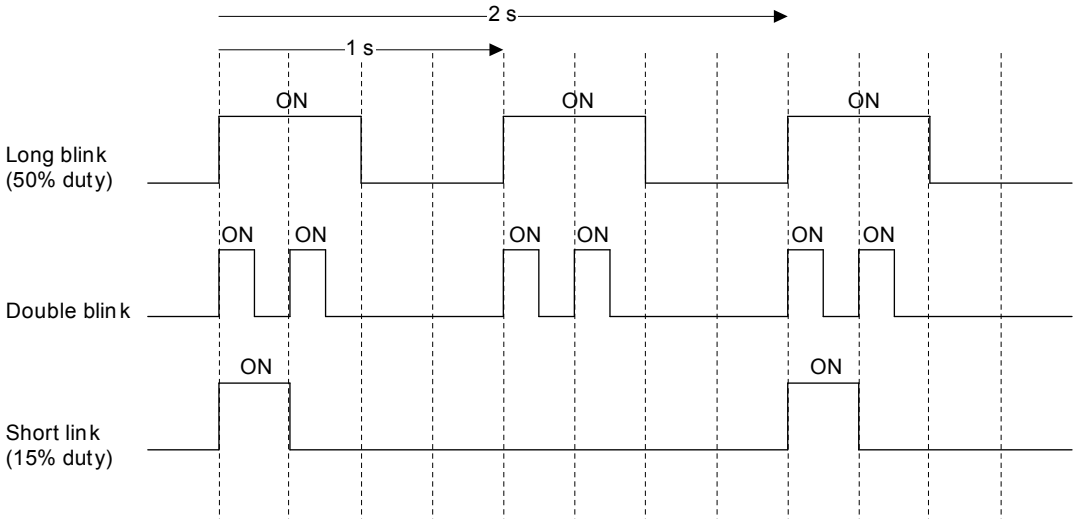


Figure i.38 AUTO LED and HAND LED Timing Status

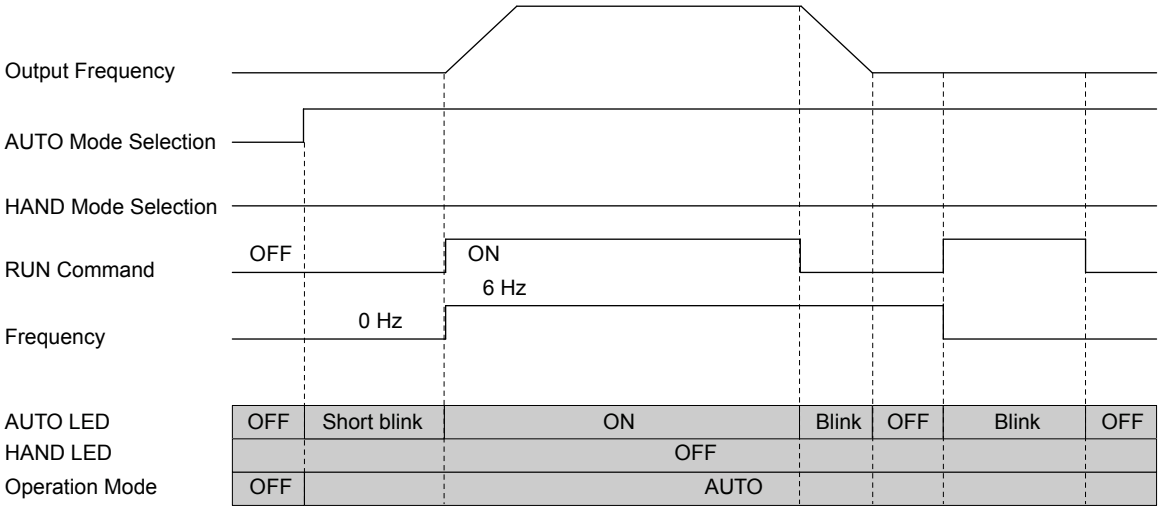


Figure i.39 LEDs and Drive Operation in AUTO and HAND Modes

◆ Menu Structure for HOA Keypad

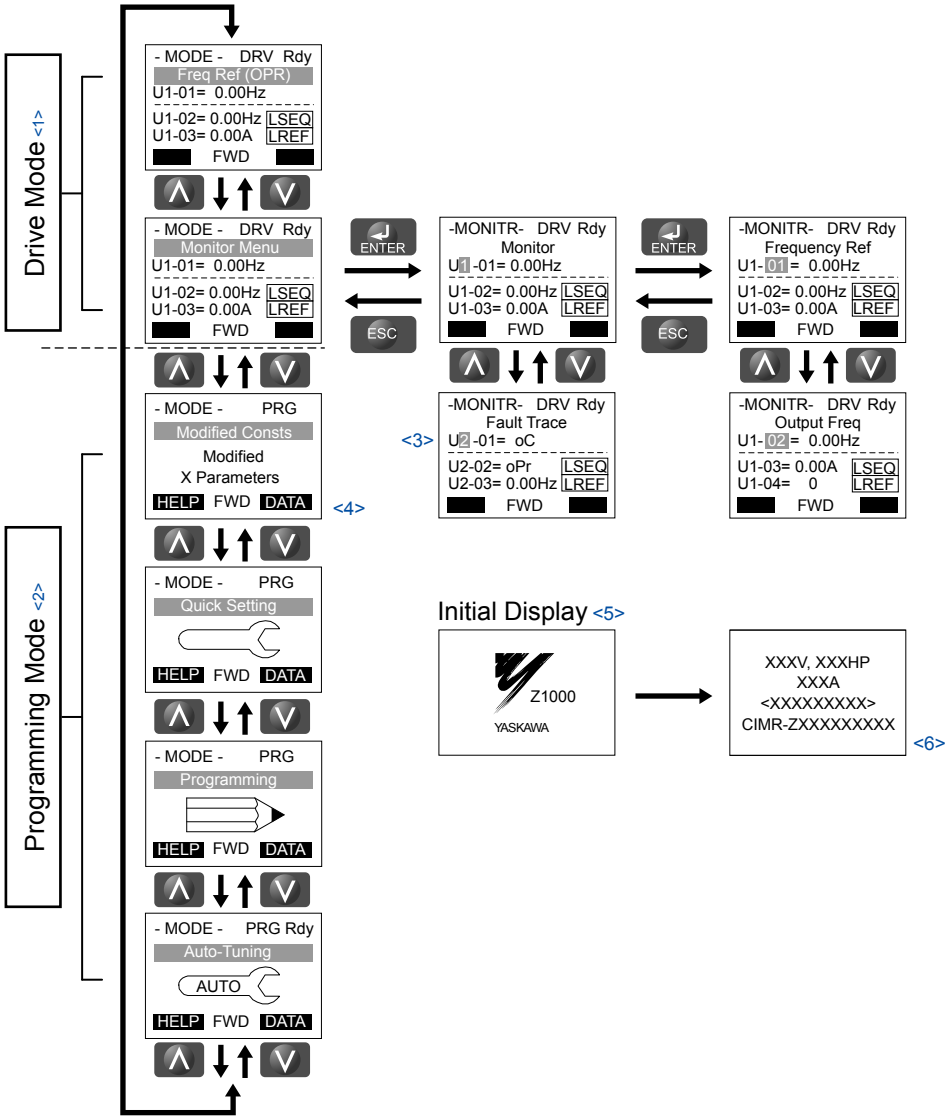


Figure i.40 HOA Keypad Menu and Screen Structure

<1> Pressing AUTO or HAND will start the motor.

<2> Drive cannot operate motor.

<3> Flashing characters are shown with white letters on gray background. (Example: 0)

<4> "X" characters are used as examples in this manual. The HOA keypad 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.

◆ Start-Up Flowcharts

■ Flowchart A: Basic Start-Up and Motor Tuning

Flowchart A in ***Figure i.41*** 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.

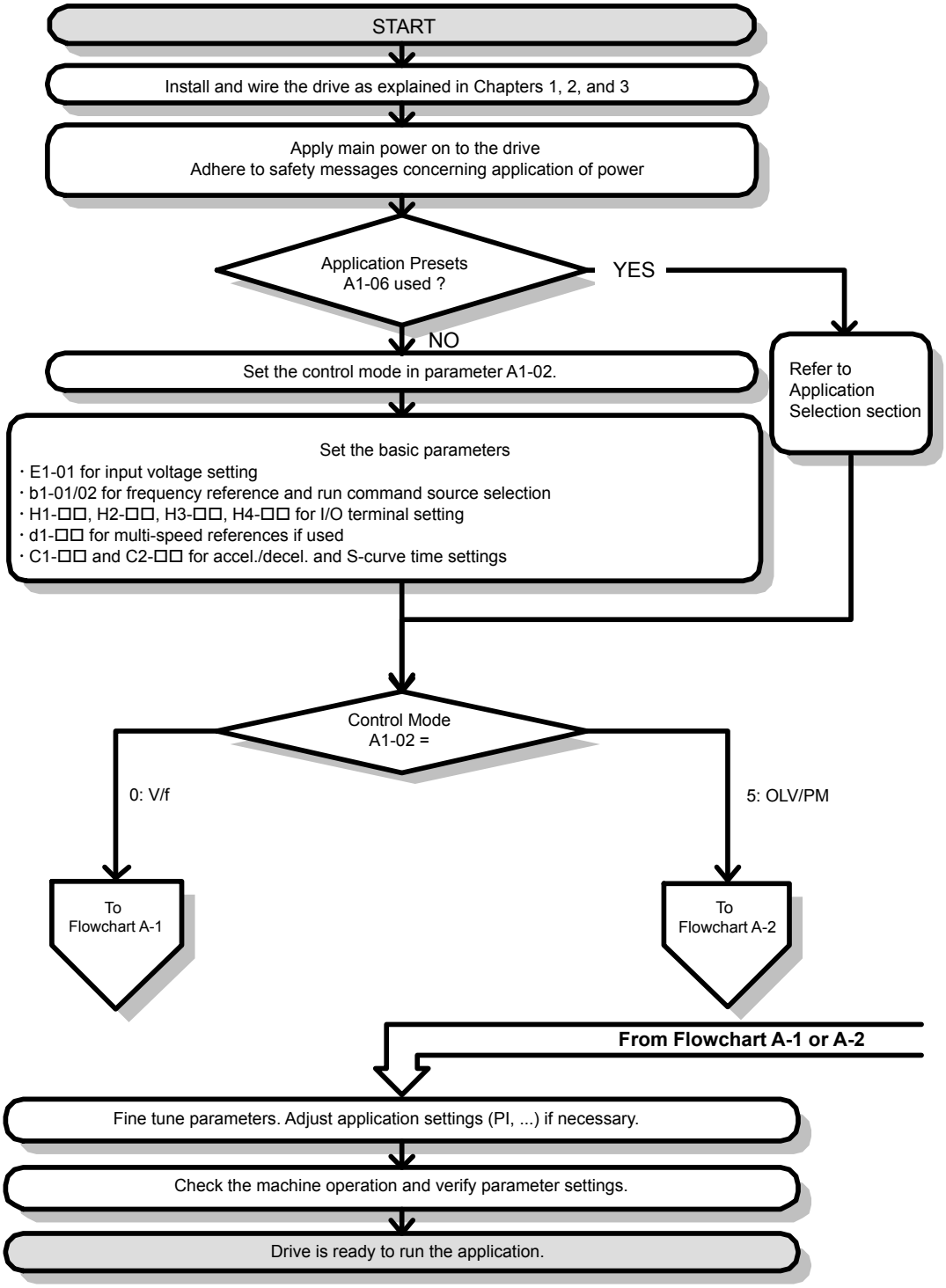


Figure i.41 Basic Start-Up

Note:
1. Execute Stationary Auto-Tuning for Line-to-Line Resistance if the drive has been Auto-Tuned and then moved to a different location where the motor cable length exceeds 50 m.
2. Perform Auto-Tuning again after installing an AC reactor or other such components to the output side of the drive.

■ Subchart A-1: Simple Motor Setup Using V/f Control

Flowchart A-1 in ***Figure i.42*** describes simple motor setup for V/f Control. V/f Control is suited for more basic applications such as fans and pumps. This procedure illustrates Energy Savings and Speed Estimation Speed Search.

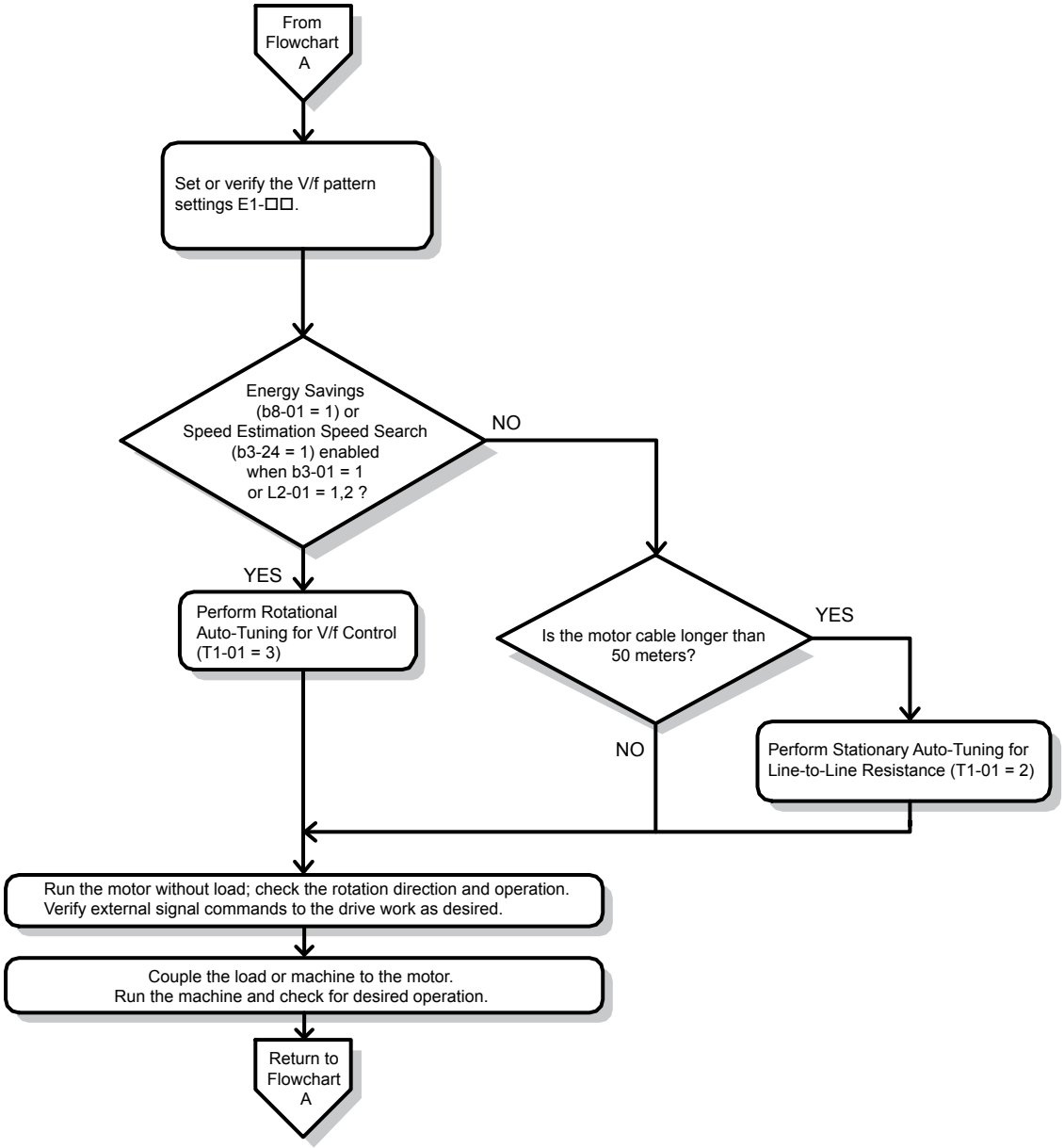


Figure i.42 Simple Motor Setup with Energy Savings or Speed Search

■ Subchart A-2: Operation with Permanent Magnet Motors

Flowchart A-2 in *Figure i.43* describes the setup procedure for running a PM motor in Open Loop Vector Control. PM motors can be used for more energy-efficient operation in reduced or variable torque applications.

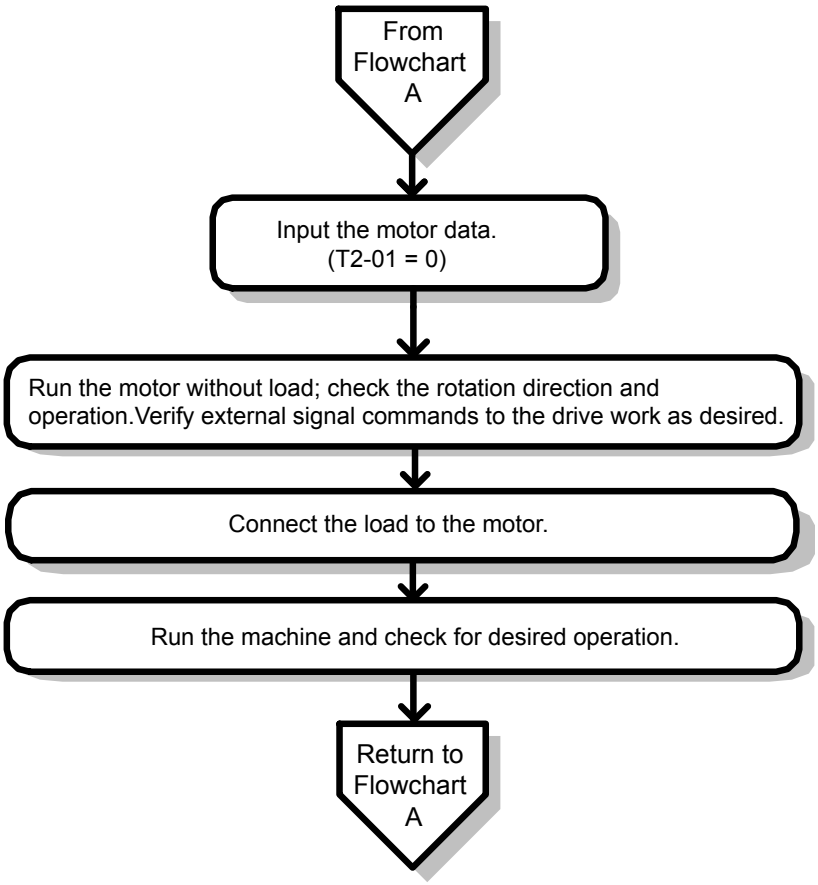


Figure i.43 Operation with Permanent Magnet Motors

■ 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: 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.
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 the motor.

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, 5	0

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. The speed control range is 1:40.

Setting 5: Open Loop Vector Control for PM

Use this mode when running a PM motor in variable torque applications that benefit from energy efficiency. The drive can control an SPM or IPM motor with a speed range of 1:20 in this control mode.

■ b1-01: Frequency Reference Selection for AUTO Mode

Selects the frequency reference source 1.

Note: If a Run command is input to the drive, but the frequency reference entered is 0 or below the minimum frequency, the AUTO or HAND indicator LED on the HOA keypad will light and the OFF indicator will flash.

No.	Parameter Name	Setting Range	Default
b1-01	Frequency Reference Selection for AUTO Mode	0 to 3	1

Setting 0: HOA Keypad

Using this setting, the frequency reference can be input by:

- switching between the multi-speed references from d1-01 to d1-04.
- entering the frequency reference on 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 or A2.

Voltage Input

Voltage input can be used at any of the two analog input terminals. Make the settings as described in ***Table i.23*** for the input used.

Table i.23 Analog Input Settings for Frequency Reference Using Voltage Signals

Terminal	Signal Level	Parameter Settings				Notes
		Signal Level Selection	Function Selection	Gain	Bias	
A1	0 to 10 V with Zero Limit	H3-01 = 0	H3-02 = 0 (Frequency Reference Bias)	H3-03	H3-04	Set Jumper S1 on the terminal board to "V" for voltage input.
	0 to 10 V without Zero Limit	H3-01 = 1				
A2	0 to 10 V with Zero Limit	H3-09 = 0	H3-10 = 0 (Frequency Reference Bias)	H3-11	H3-12	
	0 to 10 V without Zero Limit	H3-09 = 1				

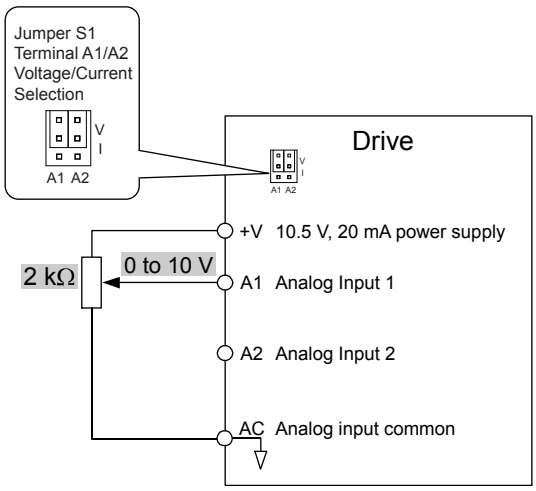


Figure i.44 Setting the Frequency Reference as a Voltage Signal at Terminal A1

Use the wiring example shown in ***Figure i.44*** for any other analog input terminals. When using input terminals A1 and A2, make sure Jumper S1 is set for voltage input.

Current Input

Input terminals A1 and A2 can accept a current input signal. Refer to ***Table i.24*** to set terminals A1 and A2 for current input.

Table i.24 Analog Input Settings for Frequency Reference Using a Current Signal

Terminal	Signal Level	Parameter Settings				Notes
		Signal Level Selection	Function Selection	Gain	Bias	
A1	4 to 20 mA	H3-01 = 2	H3-02 = 0 (Frequency Reference Bias)	H3-03	H3-04	Make sure to set Jumper S1 on the terminal board to "I" for current input.
	0 to 20 mA	H3-01 = 3				
A2	4 to 20 mA	H3-09 = 2	H3-10 = 0 (Frequency Bias)	H3-11	H3-12	
	0 to 20 mA	H3-09 = 3				

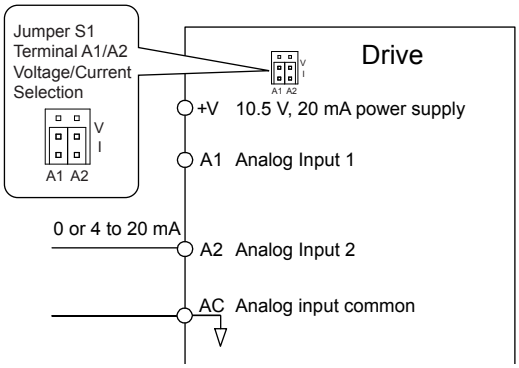


Figure i.45 Setting the Frequency Reference as a Current Signal to Terminal A2

Switching between Main/Auxiliary Frequency References

The frequency reference input can be switched between the analog terminals A1 and A2 using multi-speed inputs. ***Refer to Multi-Step Speed Selection on page 55*** for details on using this function.

Setting 2: Serial Communication (APOGEE FLN, BACnet, MEMOBUS/Modbus, Metasys N2)

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

Setting 3: Option Card

This setting requires entering the frequency reference via an option board plugged into connector CN5 on the drive control board. Consult the option card 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 Programming Error will be displayed on the HOA keypad and the drive will not run.

■ b1-02: Run Command Selection for AUTO Mode

Determines the Run command selection for AUTO mode.

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

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:

  Two inputs (FWD/Stop-REV/Stop). Set A1-03 to 2220 to initialize the drive and preset terminals S1 and S2 to these functions. This is the default setting of the drive.
- 2-Wire sequence 2:

  Two inputs (Start/Stop-FWD/REV).
- 3-Wire sequence:

  Three inputs (Start-Stop-FWD/REV). Set A1-03 to 3330 to initialize the drive and preset terminals S1, S2, and S5 to these functions.

Setting 2: Serial Communication (APOGEE FLN, BACnet, MEMOBUS/Modbus, Metasys N2)

This setting requires entering the Run command via serial communications by connecting the RS-422/RS-485 serial communication cable to control terminals R+, R-, S+, and S- on the 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 port on the control PCB. Refer to the option card manual for instructions on integrating the drive into the communication system.

Note: If b1-02 is set to 3, but an option card is not installed in CN5, an oPE05 operation error will be displayed on the HOA keypad 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

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.

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.

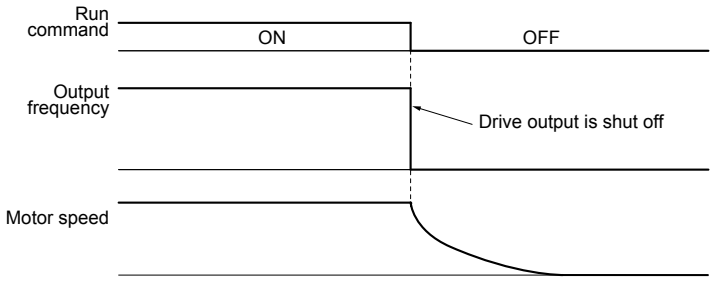


Figure i.46 Coast to Stop

Note: After a stop is initiated, any subsequent Run command entered will be ignored until the 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 minimum baseblock time (L2-03). When the minimum baseblock time has expired, the drive will inject the amount DC current 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 OLV/PM control mode (A1-02 = 5).

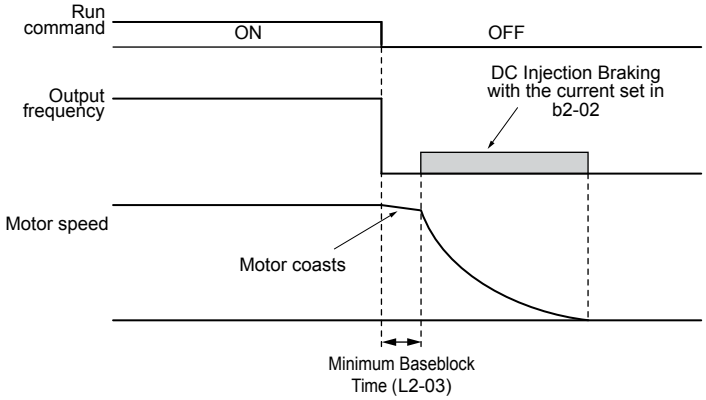


Figure i.47 DC Injection Braking to Stop

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:

$$\text{DC Injection brake time} = \frac{\text{(b2-04) x 10 x Output frequency}}{\text{Maximum output frequency (E1-04)}}$$

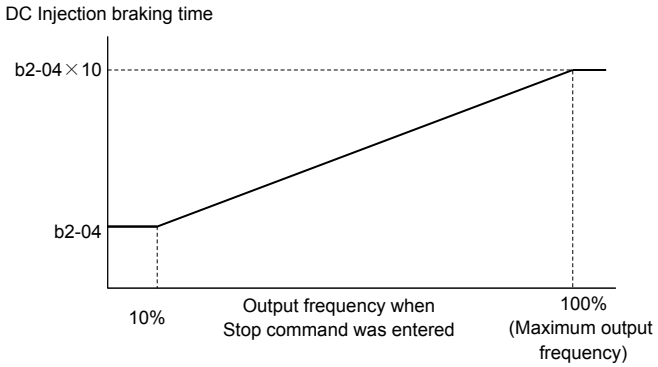


Figure i.48 DC Injection Braking Time Depending on Output Frequency

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

Setting 3: Coast 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.

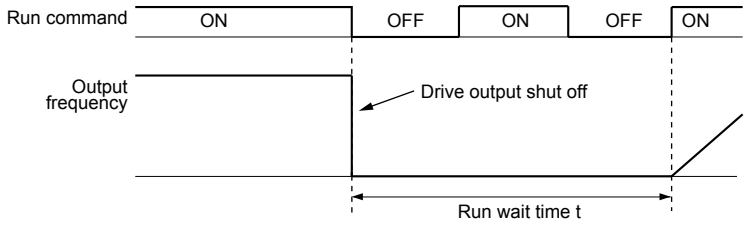


Figure i.49 Coast with Timer

The wait time *t* is determined by the output frequency when the Run command is removed and by the active deceleration time.

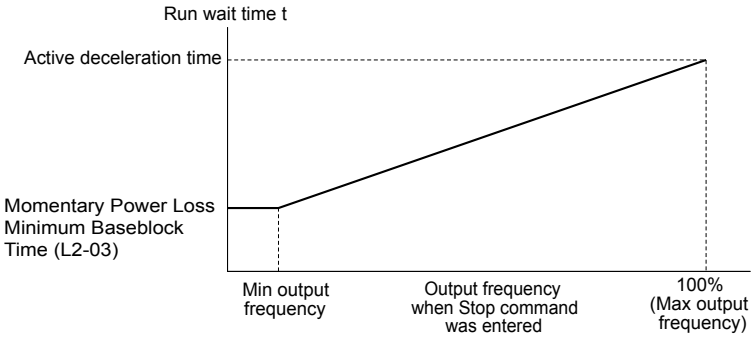


Figure i.50 Run Wait Time Depending on Output Frequency

■ 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	1

Setting 0: Reverse Enabled

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

Setting 1: Reverse Disabled

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

■ C1-01 to C1-04: Accel, Decel Times 1 and 2

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	0.1 to 6000.0 s	30.0 s
C1-02	Deceleration Time 1		
C1-03	Acceleration Time 2		
C1-04	Deceleration Time 2		

Switching Acceleration Times by Digital Input

Accel/decel time 1 is active by default if no input is set.

Table i.25 Accel/Decel Time Selection by Digital Input

Accel/Decel Time Sel. 1 H1-□□ = 7	Active Times	
	Acceleration	Deceleration
0	C1-01	C1-02
1	C1-03	C1-04

Figure i.51 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).

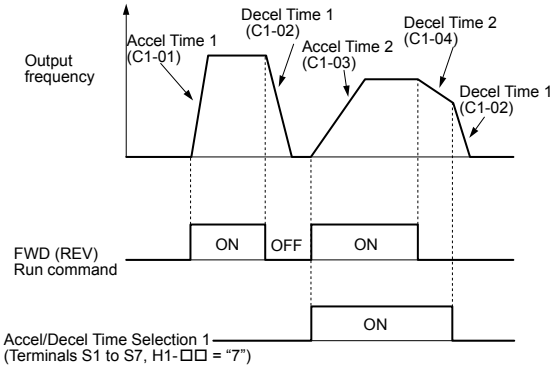


Figure i.51 Timing Diagram of Accel/Decel Time Change

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 2 in C1-03 and C1-04 to the default accel/decel time in C1-01 and C1-02 when the output frequency exceeds the frequency level set in parameter C1-11. When the frequency falls below this level, the accel/decel times are switched back. *Figure i.52* 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 2 to the selected time.

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

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

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

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

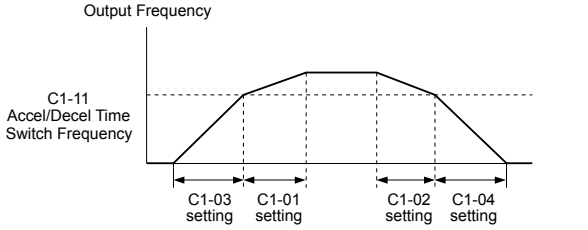


Figure i.52 Accel/Decel Time Switching Frequency

■ C6-02: Carrier Frequency Selection

Sets the switching frequency of the drive output transistors. Changes to the switching frequency lower audible noise and reduce leakage current.

Note: Increasing the carrier frequency above the default value automatically lowers the drive current rating.

No.	Parameter Name	Setting Range	Default
C6-02	Carrier Frequency Selection	1 to 5; 7 to 9; A to F	Determined by A1-02 and o2-04

Settings:

C6-02	Carrier Frequency
1	2.0 kHz

C6-02	Carrier Frequency
2	5.0 kHz

C6-02	Carrier Frequency
3	8.0 kHz
4	10.0 kHz
5	12.5 kHz
7	Swing PWM 1
8	Swing PWM 2

C6-02	Carrier Frequency
9	Swing PWM 3
A	Swing PWM 4
B to E	No setting possible
F	User defined

Note: Swing PWM uses a carrier frequency of 2.0 kHz as a base, then applies a special PWM pattern to reduce the audible noise.

Guidelines for Carrier Frequency Parameter Setup

Symptom	Remedy
Speed and torque are unstable at low speeds	Lower the carrier frequency.
Noise from the drive affects peripheral devices	
Excessive leakage current from the drive	
Wiring between the drive and motor is too long <1>	
Audible motor noise is too loud	Increase the carrier frequency or use Swing PWM.

<1> The carrier frequency may need to be lowered if the motor cable is too long. Refer to the following table.

Wiring Distance	Up to 50 m	Up to 100 m	Greater than 100 m
Recommended setting value for C6-02	1 to F (up to 12.5 kHz)	1 to 2 (up to 5 kHz), 7 (Swing PWM)	1 (up to 2 kHz), 7 (Swing PWM)

Note: The maximum cable length is 100 m when using OLV/PM (A1-02 = 5).

■ d1-01 to d1-04, d1-16, and d1-17: Frequency References 1 to 4, HAND Frequency Reference 1, and Jog Frequency Reference

The drive lets the user switch between up to 5 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 and 2 can be provided by analog inputs.

No.	Parameter Name	Setting Range	Default
d1-01 to d1-04	Frequency Reference 1 to 4	0.00 to 240.00 Hz <1> <2>	0.00 Hz <2>
d1-16	HAND Frequency Reference 1	0.00 to 240.00 Hz <1> <2>	0.00 Hz <2>
d1-17	Jog Frequency Reference	0.00 to 240.00 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).

Multi-Step Speed Selection

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

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

- The first frequency reference (Multi-Speed 1) comes from the source specified in b1-01. When using an analog input terminal to supply the frequency reference, assign the frequency reference source to the control terminals (b1-01 = 1).
- When an analog input is set to "Auxiliary frequency 1" (H3-02 or H2-06 = 2), the value set to this input will be used as the Multi-Step Speed 2 instead of the value set to parameter d1-02. If no analog inputs are set for "Auxiliary frequency 1", then d1-02 becomes the reference for Multi-Step Speed 2.

Select the different speed references as shown in ***Table i.26***. ***Figure i.53*** illustrates the multi-step speed selection.

Table i.26 Multi-Step Speed Reference and Terminal Switch Combinations

Reference	Multi-Step Speed H1-□□ = 3	Multi-Step Speed 2 H1-□□ = 4	Jog Reference H1-□□ = 6
Frequency Reference 1 (set in b1-01)	OFF	OFF	OFF
Frequency Reference 2 (d1-02 or input terminal A1, A2)	ON	OFF	OFF

Reference	Multi-Step Speed H1-□□ = 3	Multi-Step Speed 2 H1-□□ = 4	Jog Reference H1-□□ = 6
Frequency Reference 3 (d1-03 or input terminal A1, A2)	OFF	ON	OFF
Frequency Reference 4 (d1-04)	ON	ON	OFF
Jog Frequency Reference (d1-17) <1>	–	–	ON

<1> The Jog frequency overrides all other frequency references.

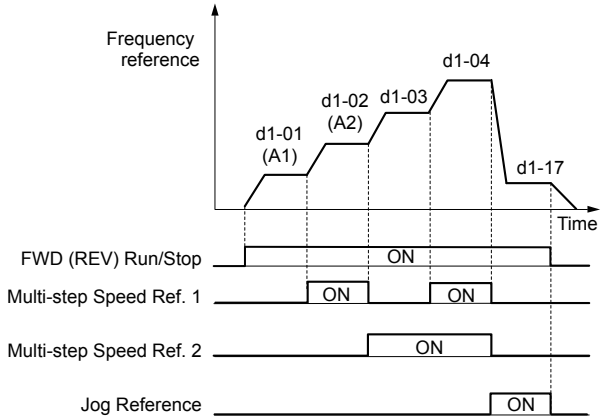


Figure i.53 Preset Reference Timing Diagram

■ 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%

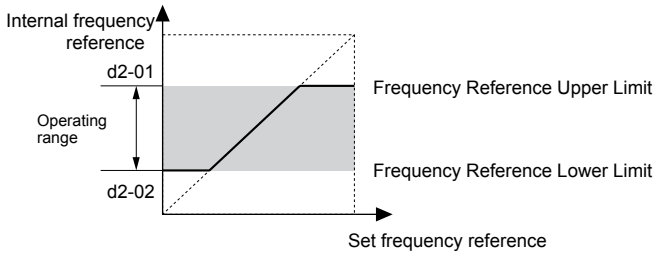


Figure i.54 Frequency Reference: Upper and Lower Limits

■ 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.

No.	Parameter Name	Setting Range	Default
E2-01	Motor Rated Current	10% to 200% of the drive rated current	Determined by o2-04

Note:
1. The number of decimal places in the parameter value depends on the drive model. This value has two decimal places (0.01 A) if the drive is set for a maximum applicable motor capacity up to and including 11 kW, 2A0031, 4A0021 (input voltage of 460 V or higher) or 4A0027 (input voltage of lower than 460 V) and one decimal place (0.1 A) if the maximum applicable motor capacity is higher than 11 kW, 2A0046, 4A0027 (input voltage 460 V or higher) or 4A0034 (input voltage lower than 460 V).
2. An oPE02 error will occur if the motor rated current in E2-01 is set lower than the motor no-load current in E2-03. Set E2-03 correctly to prevent this error.

■ H1-01 to H1-07: Functions for Terminals S1 to S7

No.	Parameter Name	Setting Range	Default
H1-01	Multi-Function Digital Input Terminal S1 Function Selection	1 to B2	40 (F) <1> : Forward Run Command (2-Wire sequence)
H1-02	Multi-Function Digital Input Terminal S2 Function Selection	1 to B2	41 (F) <1> : Reverse Run Command (2-Wire sequence)
H1-03	Multi-Function Digital Input Terminal S3 Function Selection	0 to B2	24: External Fault
H1-04	Multi-Function Digital Input Terminal S4 Function Selection	0 to B2	14: Fault Reset
H1-05	Multi-Function Digital Input Terminal S5 Function Selection	0 to B2	3 (0) <1> : Multi-Step Speed Reference 1
H1-06	Multi-Function Digital Input Terminal S6 Function Selection	0 to B2	4 (3) <1> : Multi-Step Speed Reference 2
H1-07	Multi-Function Digital Input Terminal S7 Function Selection	0 to B2	6 (4) <1> : Jog Reference Selection

<1> Number appearing in parenthesis is the default value after performing a 3-Wire initialization.

■ 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 1B2	0: During Run
H2-02	Terminal M3-M4 Function Selection (relay)	0 to 1B2	1: Zero Speed
H2-03	Terminal M5-M6 Function Selection (relay)	0 to 1B2	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, 1, 4	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 5 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.55***.

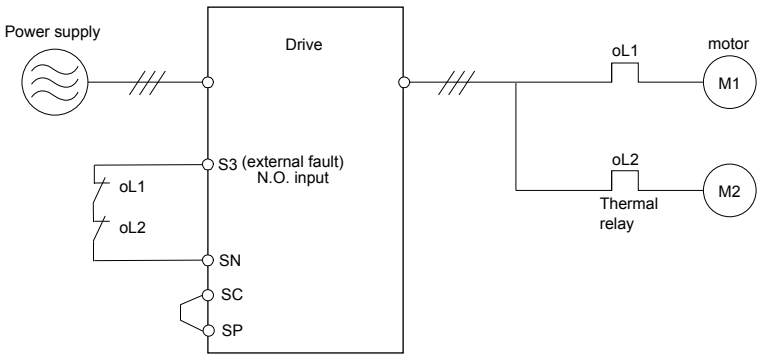
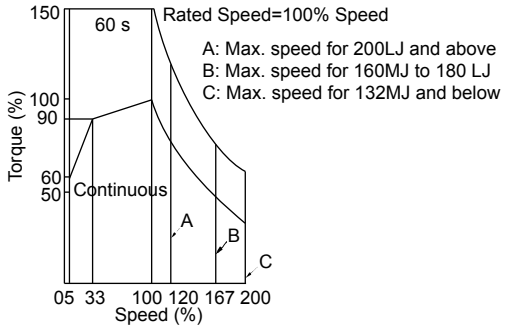


Figure i.55 Example of Protection Circuit Design for Multiple Motors

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.*

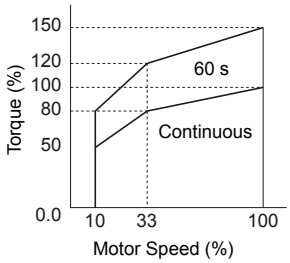
Setting 1: General-Purpose Motor (Standard Self-Cooled)

Because the motor is self-cooled, the maximum load current 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.

Maximum Load Current	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 motor overload protection (oL1). A fault is output and the motor will coast to stop.

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 maximum load current 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.

Maximum Load Current	Cooling Ability	Overload Characteristics
	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.

■ L1-02: Motor Overload Protection Time

Sets the detection time of motor overheat due to overload. This setting rarely requires adjustment, but should correlate with the motor maximum load current protection time for performing a hot start.

No.	Name	Setting Range	Default
L1-02	Motor Overload Protection Time	0.1 to 50.0 minutes	1.0 minute

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

Figure i.56 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.

During normal operation, motor overload protection operates in the area between a cold start and a hot start.

- Cold start: Motor protection operation time in response to an overload situation that was suddenly reached when starting a stationary motor.
- Hot start: Motor protection operation time in response to an overload situation that occurred during sustained operation at rated current.

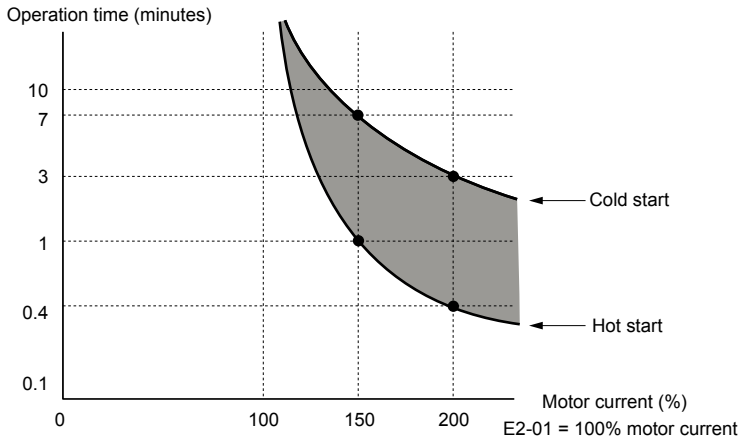


Figure i.56 Motor Protection Operation Time

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

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

When the PTC input signal reaches the motor overheat alarm level, an oH3 alarm will be triggered and the drive will continue operation as selected in L1-03. When the PTC input signal reaches the overheat fault level, an oH4 fault will be triggered, a fault signal will be output, and the drive will stop the motor using the stopping method determined in L1-04.

Figure i.57 shows a PTC connection example for analog input A2. When using analog input A2, be sure to set Jumper S1 on the control board for voltage input when using this function.

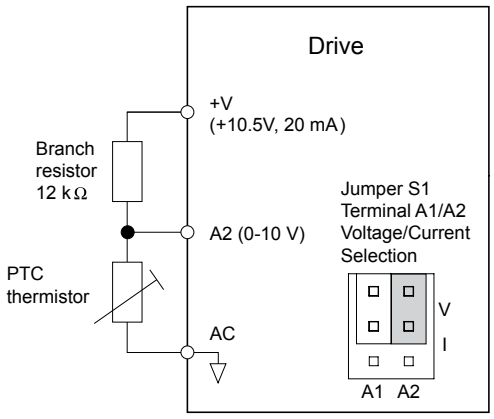


Figure i.57 Connection of a Motor PTC

The PTC must exhibit the characteristics shown in *Figure i.58* for one motor phase. The motor overload protection of the drive expects 3 of these PTCs to be connected in a series.

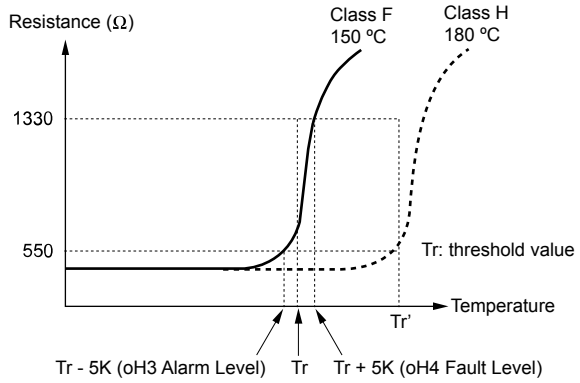


Figure i.58 Motor PTC Characteristics

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.

■ Auto-Tuning for Induction Motors

This feature automatically sets the V/f pattern and motor parameters E1-□□ and E2-□□ for an induction motor.

Table i.27 Types of Auto-Tuning for Induction Motors

Type	Setting	Application Conditions and Benefits	Control Mode
			V/f
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
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

■ 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	2, 3	2

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

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

◆ 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. Refer to the Z1000 AC Drive User Manual TOEP C710616 45 section on ***Test Run with Load Connected*** for details.

◆ Test Run Checklist

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

☑	No.	Checklist
☐	1	Thoroughly read the manual before performing a test run.
☐	2	Turn the power on.
☐	3	Set the voltage for the power supply to E1-01.

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
V/f Control (A1-02 = 0)		
☐	4	Select the best V/f pattern according to the application and motor characteristics.
☐	5	Perform Rotational Auto-Tuning for V/f Control if using Energy Saving functions.
Open Loop Vector Control for PM (A1-02 = 5)		
☐	6	Perform Auto-Tuning as described.

i.6 Troubleshooting

NOTICE

Refer to the Z1000 AC Drive User Manual TOEP C710616 45 for detailed information on ***Troubleshooting*** and complete product instructions necessary for proper installation, set-up, troubleshooting and maintenance.

The Z1000 AC Drive User Manual is posted on the Yaskawa website, www.yaskawa.com.

◆ Fault Detection

■ Fault Displays

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

To reset a fault, trace and remove the cause, and push the Reset key on the keypad or cycle the power supply.

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

Table i.28 Fault Displays

HOA Keypad Display	Name
bAT	HOA Keypad Battery Voltage Low
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	MEMOBUS/Modbus Communication Error Control data was not received for the CE detection time set to H5-09.
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, CPF01 <1>	Control Circuit Error
CPF02	A/D Conversion Error An A/D conversion error or control circuit error occurred.
CPF03	Control Board Connection Error Connection error between the control board and the drive.
CPF06	EEPROM Memory Data Error There is an error in the data saved to EEPROM.
CPF07, CPF08	Terminal Board Connection Error
CPF20, CPF21 <2>	Control Circuit Error
CPF22	Hybrid IC Failure
CPF23	Control Board Connection Error Connection error between the control board and the drive.
CPF24	Drive Unit Signal Fault The drive capacity cannot be detected correctly (Drive capacity is checked when the drive is powered up).
CPF46	Terminal Board Error A terminal board that is not supported has been installed in the drive.
EF0	Option Card External Fault An external fault condition is present.
EF1 to EF7	External Fault (input terminal S1 to S7) External fault at multi-function input terminal S1 to S7.
Err	EEPROM Write Error Data cannot be written to the EEPROM
FAn	Internal Fan fault Fan or magnetic contactor failure
Fn1	External Fan fault External fan failure
FbH	Excessive PI Feedback PI 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	PI Feedback Loss This fault occurs when PI feedback loss detection is programmed to trigger a fault (b5-12 = 2) and the PI feedback level is below the detection level set to b5-13 for longer than the time set to b5-14.
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 in models 2A0075 to 2A0396, 4A0052□□A, and 4A0065 to 4A0590.
LF	Output Phase Loss • Phase loss on the output side of the drive. • Setting L8-07 to 1 or 2 enables Phase Loss Detection.
LF2	Output Current Imbalance One or more of the phases in the output current are lost.
nSE	Node Setup Error A terminal assigned to the node setup function closed during run.
oC	Overcurrent Drive sensors detected an output current greater than the specified overcurrent level.

HOA Keypad Display	Name
oFA00	Option Card Connection Error (CN5)
	Option compatibility error
oFA01	Option Card Fault (CN5)
	Option not properly connected
oFA05, oFA06	Option Card Error (CN5)
oFA10, oFA11	
oFA12 to oFA17	Option Card Connection Error (CN5)
oFA30 to oFA43	Comm Option Card Connection Error (CN5)
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 capacity (o2-04).
oH1	Heatsink Overheat
	The heatsink temperature exceeded the drive overheat level. Overheat level is determined by drive capacity (o2-04).
oH3	Motor Overheat Alarm (PTC input)
	• The motor overheat signal to analog input terminals A1 or A2 exceeded the fault detection level. • Detection requires setting multi-function analog inputs H3-02 or H3-10 to E.
oH4	Motor Overheat Fault (PTC input)
	• The motor overheat signal to analog input terminals A1 or A2 exceeded the fault detection level. • Detection requires setting multi-function analog inputs H3-02 or H3-10 to E.
oL1	Motor Overload
	The electronic motor overload protection tripped
oL2	Drive Overload
	The thermal sensor of the drive triggered overload protection.
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).
oL7	High Slip Braking oL
	The output frequency stayed constant for longer than the time set to n3-04 during High Slip Braking.
oPr	HOA Keypad Connection Fault
	The HOA keypad has been disconnected from the drive. An oPr fault will occur when all of the following conditions are true: • Output is interrupted when the keypad is disconnected (o2-06 = 1). • The Run command is assigned to the keypad (b1-02 = 0 and OFF mode has been selected). • Drive software versions PRG: 1014 and later detect an oPr fault when the HOA keypad is removed from the drive while the sequence timer is active, even when oPr error detection is disabled (o2-06 = 0).

HOA Keypad Display	Name
ov	Overvoltage
	Voltage in the DC Bus has exceeded the overvoltage detection level. • For 200 V class drives: approximately 410 V • For 400 V class drives: approximately 820 V (740 V when E1-01 is less than 400)
ov2	Overvoltage 2
	Bus voltage is boosted because the motor cable is too long.
PF	Input Phase Loss
	Drive input power has an open phase or has a large imbalance of voltage between phases. Detected when L8-05 is set 1 (enabled).
SEr	Too Many Speed Search Restarts
	The number of Speed Search restarts exceeded the value set to b3-19.
STo	Motor Pull Out or Step Out Detection
	Motor pull out or step out has occurred. Motor has exceeded its pull-out torque.
TdE	Time Data Error
TIM	Time Not Set
UL3	Undertorque Detection 1
	The current has fallen below the minimum value set for torque detection (L6-02) for longer than the allowable time (L6-03).
UL6	Motor Underload
	The weight of the load has fallen below the underload curve defined in L6-14.
Uv1	DC Bus Undervoltage
	Voltage in the DC bus fell below the undervoltage detection level (L2-05). • For 200 V class drives: approximately 190 V • For 400 V class drives: approximately 440 when using input voltages 460 V or higher (350 V when E1-01 is less than 400, and 380 V when 400V ≤ E1-01 < 460 V) The fault is output only if L2-01 is set to 0 or 1 and the DC bus voltage has fallen below the level set to L2-05 for longer than the time set to L2-02.
Uv2	Control Power Supply Undervoltage
	Voltage is too low for the control drive input power.
Uv3	Soft Charge Circuit Fault
	The soft-charge bypass circuit failed.
voF	Output Voltage Detection Fault
	Problem detected with the voltage on the output side of the drive.

<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.

◆ 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 keypad or cycle the power supply.

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

Table i.29 Minor Fault and Alarm Displays

HOA Keypad Display	Alarm Name
bb	Drive Baseblock
	Drive output interrupted as indicated by an external baseblock signal.
bUS	Option Card Communications Error
	• The connection was lost after initial communication was established. • Assign a Run command frequency reference to the option.
CALL	Serial Communication Transmission Error
	Communication has not yet been established.
CE	MEMOBUS/Modbus Communication Error
	Control data was not received correctly for two seconds.
CrST	Cannot Reset
dnE	Drive Disabled
EF	Run Command Input Error
	Both forward run and reverse run closed simultaneously for longer than 0.5 s.
EF0	Option Card External Fault
	An external fault condition is present.
EF1 to EF7	External Fault (input terminal S1 to S7)
	External fault at multi-function input terminal S1 to S7.
FbH	Excessive PI Feedback
	The PI feedback input is higher than the level set to b5-36 for longer than the time set to b5-37, and b5-12 is set to 1 or 4.
FbL	PI Feedback Loss
	The PI feedback input is lower than the level set to b5-13 for longer than the time set to b5-14, and b5-12 is set to 1 or 4.
HCA	Current Alarm
	Drive current exceeded overcurrent warning level (150% of the rated current).
inTLK <1>	Interlock Open
	ALM LED will not blink.
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	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	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.
LT-4	IGBT Maintenance Time (50%)
	IGBTs have reached 50% of their expected performance life. **Note:** An alarm output (H2-☐☐ = 10) will only be triggered if H2-☐☐ = 2F.
oH	Heatsink Overheat
	The temperature of the heatsink exceeded the overheat pre-alarm level set to L8-02 (90-100 °C). Default value for L8-02 is determined by drive capacity (o2-04).
oH2	Drive Overheat Warning
	"Drive Overheat Warning" was input to a multi-function input terminal, S1 through S7 (H1-☐☐ = B)
oH3	Motor Overheat
	The motor overheat signal entered to a multi-function analog input terminal exceeded the alarm level (H3-02 or H3-10 = E).
oL3	Overtorque 1
	Drive output current was greater than L6-02 for longer than the time set to L6-03.
ov	DC Bus Overvoltage
	The DC bus voltage exceeded the trip point. • For 200 V class drives: approximately 410 V • For 400 V class drives: approximately 820 V (740 V when E1-01 is less than 400)
PASS	MEMOBUS/Modbus Test Mode Complete
SAFE	Customer Safety
	Customer Safeties mult-function input is open. This alarm has display priority over the Interlock Open (inTLK).
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).
TrPC	IGBT Maintenance Time (90%)
	IGBTs have reached 90% of their expected performance life.

HOA Keypad Display	Alarm Name
UL3	Undertorque Detection 1
	Drive output current less than L6-02 for longer than L6-03 time.
UL6	Undertorque Detection 6
Uv	Undervoltage
	One of the following conditions was true when the drive was stopped and a Run command was entered: • DC bus voltage dropped below the level specified in L2-05. • 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 and DC bus voltage is under L2-05.

HOA Keypad Display	Alarm Name
voF	Output Voltage Detection Fault
	There is a problem with the output voltage.
WrUn	Waiting for Run
	A Run command has been issued and the drive is waiting to begin running the motor.

<1> ALM LED will not blink.

◆ Programming Errors

■ oPE Codes

A 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 keypad display, press the ENTER button to view U1-18 and see which parameter is causing the oPE.

Table i.30 Operation Error Displays

HOA Keypad Display	Name
oPE01	Drive Capacity Setting Fault
	Drive capacity and the value set to o2-04 do not match.
oPE02	Parameter Range Setting Error
	Use U1-18 to find parameters set outside the range.
oPE03	Multi-Function Input Selection Error
	A contradictory setting is assigned to multi-function contact inputs H1-01 to H1-07.
oPE05	Run Command/Frequency Reference Source Selection Error
oPE07	Multi-Function Analog Input Selection Error
	A contradictory setting is assigned to multi-function analog inputs H3-02 or H3-10 and PI functions conflict.
oPE08	Parameter Selection Error
	A function has been set that cannot be used in the motor control method selected.
oPE09	PI Control Selection Error
	PI control function selection is incorrect. Requires that PI control is enabled (b5-01 = 1 or 3).

HOA Keypad Display	Name
oPE10	V/f Data Setting Error
	One of the following setting errors has occurred: E1-04 ≥ E1-06 E1-06 ≥ E1-07 E1-07 ≥ E1-09 or E1-09 ≥ E1-11
oPE11	Carrier Frequency Setting Error
	Correct the setting for the carrier frequency.
oPE16	Energy Saving Constants Error
oPE27	BP Program Error
	Bypass mode is not correctly configured.
oPE28	Sequence Timer Error
	One or more of the sequence timers is not set in the correct order.
oPE29	Baud Rate Setting Error
	The baud rate setting (H5-02) is not compatible with the currently selected protocol (H5-08).

◆ Auto-Tuning Errors

■ Auto-Tuning Codes

Auto-Tuning faults in this section are displayed on the HOA keypad 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 HOA keypad 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.

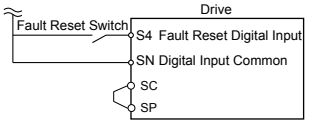
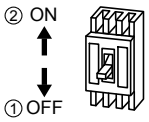
Table i.31 Auto-Tuning Error Displays

HOA Keypad Display	Name
End3	Rated Current Setting Alarm (displayed after Auto-Tuning is complete)
End4	Adjusted Slip Calculation Error
End5	Resistance Tuning Error
End7	No-Load Current Alarm
Er-01	Motor Data Error
Er-02	Minor Fault

HOA Keypad Display	Name
Er-03	OFF Button Input
Er-04	Line-to-Line Resistance Error
Er-05	No-Load Current Error
Er-08	Rated Slip Error
Er-09	Acceleration Error
Er-12	Current Detection 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 HOA keypad 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 HOA keypad display has turned off. When an “SC” error occurs, contact Yaskawa or a Yaskawa agent before cycling the power to the drive.		

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 Characteristics	Control Method	The following control methods can be set using drive parameters: • V/f Control (V/f) • Open Loop Vector Control for PM (OLV/PM)
	Frequency Control Range	0.01 to 240 Hz
	Frequency Accuracy (Temperature Fluctuation)	Digital input: within ±0.01% of the max output frequency (-10 °C to +50 °C [14 °F to 122 °F]) Analog input: within ±0.1% of the max output frequency (25 °C ±10 °C [77 °F ±50 °F])
	Frequency Setting Resolution	Digital inputs: 0.01 Hz Analog inputs: 1/1000 of the maximum output frequency setting (10 bit unsigned)
	Output Frequency Resolution	0.001 Hz
	Frequency Setting Signal	0 to 10 V, 0 to 20 mA, 4 to 20 mA
	Starting Torque <1>	V/f: 140% at 3 Hz OLV/PM: 50% at 6 Hz
	Speed Control Range <1>	V/f: 1:40 OLV/PM: 1:20
	Speed Response <1>	OLV/PM: 10 Hz
	Accel/Decel Time	0.0 to 6000.0 s (4 selectable combinations of independent acceleration and deceleration settings)
	Braking Torque	Approximately 20%
	V/f Characteristics	User-selected programs and V/f preset patterns possible
	Main Control Functions	Momentary Power Loss Ride-Thru, Speed Search, Overtorque/Undertorque Detection, 4 Step Speed (max), Accel/Decel Switch, S-curve Accel/decel, 3-Wire Sequence, Auto-Tuning (Stationary for Line-to-Line Resistance, Rotational for V/f Control), Cooling Fan on/off Switch, Slip Compensation, Torque Compensation, Frequency Jump, Upper/lower Limits for Frequency Reference, DC Injection Braking at Start and Stop, Overexcitation Braking, High Slip Braking, PI Control (with sleep function), Energy Saving Control, APOGEE FLN Comm. (RS-422/RS-485 4.8 kbps), BACnet Comm. (RS-485 max. 76.8 kbps), MEMOBUS/Modbus Comm. (RS-422/RS-485 max, 115.2 kbps), Metasys N2 Comm. (RS-422/RS-485 9.6 kbps), Fault Restart, Application Presets, KEB, Overexcitation Deceleration, Overvoltage Suppression, Sequence Timer Operation, Secondary PI Control, Bypass Operation, HOA Keypad, Dynamic Noise Control
Protection Functions	Motor Protection	Electronic thermal overload relay
	Momentary Overcurrent Protection	Drive stops when rated output current exceeds 175%
	Overload Protection	Drive stops after 60 s at 110% of rated output current <2> Drive stops after 0.5 s at 140% of rated output current <2>
	Overvoltage Protection	200 V class: Stops when DC bus voltage exceeds approx. 410 V 400 V class: Stops when DC bus voltage exceeds approx. 820 V

Item		Specification
Protection Functions	Undervoltage Protection	200 V class: Stops when DC bus voltage falls below approx. 190 V 400 V class: Stops when DC bus voltage falls below approximately 350 V when using an input voltage lower than 400V Stops when DC bus voltage falls below approximately 380 V when using an input voltage lower than 460 V Stops when DC bus voltage falls below approximately 440 V when using an input voltage of 460 V or higher
	Momentary Power Loss Ride-Thru	Immediately stop after 15 ms or longer power loss <3> Continuous operation during power loss shorter than 2 s by speed search function <4>
	Heatsink Overheat Protection	Thermistor
	Stall Prevention	Stall Prevention is available during acceleration, deceleration, and during run.
	Ground Protection	Electronic circuit protection <5> <6>
	DC Bus Charge LED	Remains lit until DC bus voltage falls below 50 V
Environment	Area of Use	Indoors
	Ambient Temperature	-10 °C to +40 °C (14 °F to 104 °F) IP20/UL Type 1 Enclosure, External Heatsink (2A0011 to 2A0273 and 4A0005 to 4A0302) -10 °C to +50 °C (14 °F to 122 °F) IP00/Open Type Enclosure (2A0343 and 2A0396, and 4A0361 to 4A0590) **Note:** 1. To install a heatsink on the outside of a panel, design the panel to keep the air temperature inside the panel within 10 °C (18 °F) [5 °C (9 °F) for 2A0273 and 4A0124] of the outside air temperature. 2. Ambient temperature range for continuous operations is -10 °C to +40 °C (14 °F to 104 °F) when external heatsink installation method is applied for models 2A0343 and 2A0396 and 4A0361 to 4A0590.
	Humidity	95% RH or less (no condensation)
	Storage Temperature	-20 °C to +70 °C (-4 °F to +158 °F) (short-term temperature during transportation)
	Altitude	Up to 1000 meters without derating, up to 3000 m with output current and voltage derating. ***Refer to Altitude Derating on page 68*** for details.
	Vibration/Shock	10 to 20 Hz at 9.8 m/s^2 20 to 55 Hz at 5.9 m/s^2 (2A0011 to 2A0031 and 4A0005 to 4A0027) or 2.0 m/s^2 (2A0046 to 2A0396 and 4A0034 to 4A0590)
Protection Design		IP00/Open Type enclosure, IP20/UL Type 1 enclosure <7>

<1> 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 for consultation.

<2> Overload protection may be triggered when operating with 100% of the rated output current if the output frequency is less than 6 Hz.

<3> May be shorter due to load conditions and motor speed.

<4> A 24 V power supply Unit (Model Nos. PS-A10LB, PS-A10HB) is required for models 2A0011 to 2A0059 and 4A0005 to 4A0052 if the application must continue running for up to 2 seconds during a momentary power loss.

<5> 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.

<6> Setting L8-09 to 1 enables ground fault detection in models 2A0075 to 2A0396, 4A0052□□A, and 4A0065 to 4A0590.

<7> Drive models 2A0011 to 2A0273 and 4A0011 to 4A0302 are designed to IP20/UL Type 1 specifications with a protective cover on the top. Removing this top protective cover voids the UL Type 1 protection while maintaining IP20 conformity; removing the bottom conduit bracket voids the UL Type 1 protection and IP20 conformity.

◆ Altitude Derating

The drive standard ratings are valid for installation altitudes up to 1000 m. For installations from 1000 m to 3000 m, the drive rated output current must be derated for 0.2% per 100 m.

i.8 Parameter Table

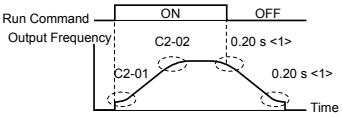
This parameter table shows the most important parameters. Default settings are in **bold type**. Refer to the Programming Manual for a complete list of parameters.

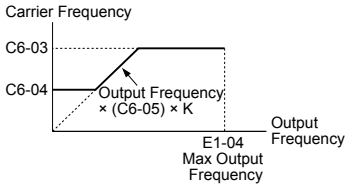
No.	Name	Description
A1-00	Language Selection	**0: English** 1: Japanese 3: French 5: Spanish 6: Portuguese
A1-01	Access Level Selection	0: View and set A1-01 and A1-04. U□-□□ parameters can also be viewed. 1: User Parameters (access to a set of parameters selected by the user, A2-01 to A2-32) **2: Advanced Access (access to view and set all parameters)**
A1-02	Control Method Selection	**0: V/f Control** 5: Open 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 3410: HVAC Initialization 3420: OEM Bypass Initialization
A1-04	Password	When the value set into A1-04 does not match the value set into A1-05, parameters A1-01 through A1-03, A1-06, and A2-01 through A2-32 cannot be changed.
A1-05	Password Setting	
A1-06	Application Preset	**0: Standard** 1: Fan 2: Fan with PI Control 3: Return Fan with PI Control 4: Cooling Tower Fan 5: Cooling Tower Fan with PI Control 6: Pump (Secondary) 7: Pump with PI Control
A2-01 to A2-32	User Parameters 1 to 32	Recently edited parameters are listed here. The user can also select parameters to appear here for quicker access. **Note:** Default setting value is dependent on parameter A1-06.
A2-33	User Parameter Automatic Selection	0: Parameters A2-01 to A2-32 are reserved for the user to create a list of User Parameters. 1: Save history of recently viewed parameters. **Note:** Default setting value is dependent on parameter A1-06. Default is 0 when A1-06 = 0, and 1 when A1-06 ≠ 0.
b1-01	Frequency Reference Selection for AUTO mode	0: HOA keypad **1: Terminals (Analog Input Terminals)** 2: Serial communications (APOGEE FLN, BACnet, MEMOBUS/Modbus, or Metasys N2) 3: Option card
b1-02	Run Command Selection for AUTO mode	**1: Control Circuit Terminal** 2: Serial communications (APOGEE FLN, BACnet, MEMOBUS/Modbus, or Metasys N2) 3: Option card
b1-03	Stopping Method Selection	0: Ramp to stop **1: Coast to stop** 2: DC Injection Braking to stop 3: Coast with timer

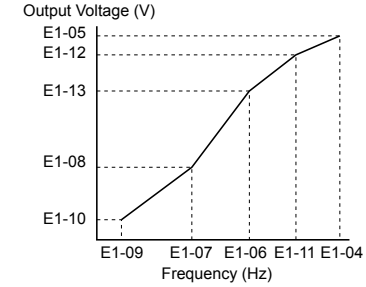
No.	Name	Description
b1-04	Reverse Operation Selection	0: Reverse enabled **1: Reverse disabled**
b1-14	Phase Order Selection	**0: Standard** 1: Switch phase order (reverses the direction of the motor)
b1-17	Run Command at Power Up	0: Disregarded A new Run command must be issued after power up. **1: Allowed** Motor will start immediately after power up if a Run command is already enabled.
b2-01	DC Injection Braking Start Frequency	Sets the frequency at which DC Injection Braking starts when "Ramp to stop" (b1-03 = 0) is selected.
b2-02	DC Injection Braking Current	Sets the DC Injection Braking current as a percentage of the drive rated current.
b2-03	DC Injection Braking Time at Start	Sets DC Injection Braking time at start. Disabled when set to 0.00 seconds.
b2-04	DC Injection Braking Time at Stop	Sets DC Injection Braking time at stop.
b2-09	Motor Pre-Heat Current 2	Determines the percentage of motor rated output current used for the motor pre-heat function.
b2-12	Short Circuit Brake Time at Start	Sets the time for Short Circuit Braking operation at start.
b2-13	Short Circuit Brake Time at Stop	Sets the Short Circuit Braking operation time at stop.
b2-18	Short Circuit Braking Current	Determines the current level for Short Circuit Braking. Set as a percentage of the motor rated current.
b3-01	Speed Search Selection at Start	0: Disabled 1: Enabled **Note:** Default setting is determined by parameter A1-02, Control Method Selection.
b3-02	Speed Search Deactivation Current	Sets the current level at which the speed is assumed to be detected and Speed Search is ended. Set as a percentage of the drive rated current.
b3-03	Speed Search Deceleration Time	Sets output frequency reduction time during Speed Search.
b3-04	V/f Gain during Speed Search	Determines how much to lower the V/f ratio during Speed Search. Output voltage during Speed Search equals the V/f setting multiplied by b3-04.
b3-05	Speed Search Delay Time	When using an external contactor on the output side, b3-05 delays executing Speed Search after a momentary power loss to allow time for the contactor to close.
b3-06	Output Current 1 during Speed Search	Sets the current injected to the motor at the beginning of Speed Estimation Speed Search. Set as a coefficient for the motor rated current.
b3-10	Speed Search Detection Compensation Gain	Sets the gain which is applied to the speed detected by Speed Estimation Speed Search before the motor is reaccelerated. Increase this setting if ov occurs when performing Speed Search after a relatively long period of baseblock.

No.	Name	Description
b3-14	Bi-Directional Speed Search Selection	0: Disabled (uses the direction of the frequency reference) 1: Enabled (drive detects which way the motor is rotating) **Note:** Default setting is determined by parameter A1-02, Control Method Selection.
b3-17	Speed Search Restart Current Level	Sets the Speed Search restart current level as a percentage of the drive rated current.
b3-18	Speed Search Restart Detection Time	Sets the time to detect Speed Search restart.
b3-19	Number of Speed Search Restarts	Sets the number of times the drive can attempt to restart when performing Speed Search.
b3-24	Speed Search Method Selection	**0: Current Detection** 1: Speed Estimation
b3-25	Speed Search Wait Time	Sets the time the drive must wait between each Speed Search restart attempt.
b3-27	Start Speed Search Select	Selects a condition to activate Speed Search Selection at Start (b3-01) or External Speed Search Command 1 or 2 from the multi-function input. **0: Triggered when a Run command is issued. (normal).** 1: Triggered when an external baseblock is released.
b5-01	PI Function Setting	**0: Disabled** 1: Enabled (PI output becomes output frequency reference) 3: Enabled (PI output added to frequency reference)
b5-02	Proportional Gain Setting (P)	Sets the proportional gain of the PI controller.
b5-03	Integral Time Setting (I)	Sets the integral time for the PI controller.
b5-04	Integral Limit Setting	Sets the maximum output possible from the integrator as a percentage of the maximum output frequency.
b5-06	PI Output Limit	Sets the maximum output possible from the entire PI controller as a percentage of the maximum output frequency.
b5-07	PI Offset Adjustment	Applies an offset to the PI controller output. Set as a percentage of the maximum output frequency.
b5-08	PI Primary Delay Time Constant	Sets a low pass filter time constant on the output of the PI controller.
b5-09	PI Output Level Selection	**0: Normal output (direct acting)** 1: Reverse output (reverse acting)
b5-10	PI Output Gain Setting	Sets the gain applied to the PI output.
b5-11	PI Output Reverse Selection	**0: Negative PI output triggers zero limit.** 1: Rotation direction reverses with negative PI output. **Note:** When using setting 1, make sure reverse operation is permitted by b1-04.

No.	Name	Description
b5-12	PI Feedback Loss Detection Selection	**0: Digital Output Only** (Remains active when PI is disabled by digital input) 1: Alarm output, drive continues operation (Remains active when PI is disabled by digital input) 2: Fault output, drive output is shut off (Remains active when PI is disabled by digital input) 3: Digital output only. No detection when PI is disabled by digital input. 4: Alarm detection. No detection when PI is disabled by digital input. 5: Fault detection. No detection when PI is disabled by digital input.
b5-13	PI Feedback Loss Detection Level	Sets the PI feedback loss detection level as a percentage of the maximum output frequency.
b5-14	PI Feedback Loss Detection Time	Sets a delay time for PI feedback loss.
b5-15	PI Sleep Function Start Level	Sets the frequency level that triggers the sleep/snooze function.
b5-16	PI Sleep Delay Time	Sets a delay time before the sleep/snooze function is triggered.
b5-17	PI Accel/Decel Time	Sets the acceleration and deceleration time to PI setpoint.
b5-18	PI Setpoint Selection	**0: Disabled** 1: Enabled
b5-19	PI Setpoint Value	Sets the PI target value when b5-18 = 1. Set as a percentage of the maximum output frequency.
b5-20	PI Setpoint Scaling	0: 0.01 Hz units **1: 0.01% units (100% = max output frequency)** 2: r/min (number of motor poles must entered) 3: User-set (set scaling to b5-38 and b5-39)
b5-21	PI Sleep Input Source	Input source selection for Sleep Function mode. 0: PI Setpoint **1: SFS Input** 2: Snooze
b5-22	PI Snooze Level	Sets the PI Snooze Function start level as a percentage of the maximum frequency.
b5-23	PI Snooze Delay Time	Sets the PI Snooze Function delay time in seconds.
b5-24	PI Snooze Deactivation Level	When the PI feedback level drops below this level, the drive returns to normal operation. Set as a percentage of the maximum frequency.
b5-25	PI Setpoint Boost Setting	Temporarily increases the PI setpoint to create an overshoot of the intended PI setpoint.
b5-26	PI Maximum Boost Time	Sets the maximum boost time when PI feedback does not reach boost level. The Snooze Function starts when the PI feedback exceeds the boost setting level or when the boost time expires.
b5-27	PI Snooze Feedback Level	Sets the PI feedback level above which Snooze mode is activated. Set as a percentage of the maximum frequency.
b5-28	PI Feedback Function Selection	**0: Disabled** 1: Square root
b5-29	PI Square Root Gain	A multiplier applied to the square root of the feedback.
b5-30	PI Feedback Offset	PI feedback offset set as a percentage of the maximum frequency.
b5-34	PI Output Lower Limit	Sets the minimum output possible from the PI controller as a percentage of the maximum output frequency.

No.	Name	Description
b5-35	PI Input Limit	Limits the PI control input (deviation signal) as a percentage of the maximum output frequency. Acts as a bipolar limit.
b5-36	PI Feedback High Detection Level	Sets the PI feedback high detection level as a percentage of the maximum output frequency.
b5-37	PI Feedback High Detection Time	Sets the PI feedback high level detection delay time.
b5-38	PI Setpoint User Display	Sets the display value of U5-01 and U5-04 when the maximum frequency is output.
b5-39	PI Setpoint Display Digits	0: No decimal places 1: One decimal place 2: Two decimal places 3: Three decimal places **Note:** Default setting is dependent on parameter b5-20, PI Setpoint Scaling.
b5-40	Frequency Reference Monitor Content during PI	**0: Display the frequency reference (U1-01) after PI compensation has been added.** 1: Display the frequency reference (U1-01) before PI compensation has been added.
b5-41	PI Unit Selection	**0: WC (Inch of water)** 1: PSI (Pounds per square inch) 2: GPM (Gallons per minute) 3: F (Degrees Fahrenheit) 4: CFM (Cubic feet per minute) 5: CMH (Cubic meters per hour) 6: LPH (Liters per hour) 7: LPS (Liters per second) 8: Bar (Bar) 9: Pa (Pascal) 10: C (Degrees Celsius) 11: Mtr (Meters) 12: Ft (Feet) 13: LPM (Liters per minute) 14: CMM (Cubic meters per minute)
b5-42	PI Output Monitor Calculation Method	**0: Linear - the monitor displays PI output** 1: Square root - the monitor displays square root PI output 2: Quadratic - the monitor displays 1/(PI output) 3: Cubic - the monitor displays 1/(PI output)
b5-43	PI Output 2 Monitor Max Upper 4 Digits	Sets the upper 4 digits of the maximum monitor value. Used with b5-44 to set maximum monitor value of U5-14 and U5-15 at maximum frequency. **Note:** Used for U5-14 and U5-15 only.
b5-44	PI Output 2 Monitor Max Lower 4 Digits	Sets the lower 4 digits of the maximum monitor value. Used with b5-43 to set maximum monitor value of U5-14 and U5-15 at maximum frequency. **Note:** Used for U5-14 and U5-15 only.
b5-45	PI Output 2 Monitor Minimum	Sets the minimum display value at zero speed. This function is effective when b5-42 is set to 0 (Linear output mode). **Note:** Used for U5-14 and U5-15 only.
b5-46	PI Setpoint Monitor Unit Selection	**0: WC (Inch of water)** 1: PSI (Pounds per square inch) 2: GPM (Gallons per minute) 3: F (Degrees Fahrenheit) 4: CFM (Cubic feet per minute) 5: CMH (Cubic meters per hour) 6: LPH (Liters per hour) 7: LPS (Liters per second) 8: Bar (Bar) 9: Pa (Pascal) 10: C (Degrees Celsius) 11: Mtr (Meters) 12: Ft (Feet) 13: LPM (Liters per minute) 14: CMM (Cubic meters per minute)
b5-47	Reverse Operation Selection 2 by PI Output	Reverse operation selection when b5-01 = 3 0: Reverse Disabled **1: Reverse Enabled**
b8-01	Energy Saving Control Selection	0: Disabled 1: Enabled **Note:** Default setting is determined by parameter A1-02, Control Method Selection.
b8-04	Energy Saving Coefficient Value	Determines the level of maximum motor efficiency. Setting range is 0.0 to 2000.0 for drives 3.7 kW and smaller.
b8-05	Power Detection Filter Time	Sets a time constant filter for output power detection.
b8-06	Search Operation Voltage Limit	Sets the limit for the voltage search operation as a percentage of the motor rated voltage.
C1-01	Acceleration Time 1	Sets the time to accelerate from 0 to maximum frequency.
C1-02	Deceleration Time 1	Sets the time to decelerate from maximum frequency to 0.
C1-03	Acceleration Time 2	Sets the time to accelerate from 0 to maximum frequency.
C1-04	Deceleration Time 2	Sets the time to decelerate from maximum frequency to 0.
C1-09	Fast Stop Time	Sets the time for the Fast Stop function.
C1-11	Accel/Decel Time Switching Frequency	Sets the frequency to switch between accel/decel time settings. Setting units are determined by parameter A1-02, Control Method Selection.
C2-01	S-Curve Characteristic at Accel Start	The S-curve can be controlled at the four points shown below.  <1> S-curve characteristics at decel start/end are fixed to 0.20 s. **Note:** Default setting is determined by parameter A1-02, Control Method Selection.
C2-02	S-Curve Characteristic at Accel End	

No.	Name	Description
C6-02	Carrier Frequency Selection	1: 2.0 kHz 2: 5.0 kHz 3: 8.0 kHz 4: 10.0 kHz 5: 12.5 kHz 7: Swing PWM1 (Audible sound 1) 8: Swing PWM2 (Audible sound 2) 9: Swing PWM3 (Audible sound 3) A: Swing PWM4 (Audible sound 4) B to E: No setting possible F: User-defined (determined by C6-03 through C6-05) **Note:** Default setting value is dependent on parameters A1-02, Control Method Selection and o2-04, Drive Model Selection.
C6-03	Carrier Frequency Upper Limit	Determines the upper and lower limits for the carrier frequency. 
C6-04	Carrier Frequency Lower Limit	
C6-05	Carrier Frequency Proportional Gain	
d1-01 to d1-04; d1-16	Frequency Reference 1 to 4; 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.
d2-03	Master Speed Reference Lower Limit	Sets the lower limit for frequency references from analog inputs as a percentage of the maximum output frequency.
d3-01	Jump Frequency 1	Eliminates problems with resonant vibration of the motor/machine by avoiding continuous operation in predefined frequency ranges. The drive accelerates and decelerates the motor through the prohibited frequency ranges. Setting 0.0 disables this function. Parameters must be set so that d3-01 ≥ d3-02 ≥ d3-03.
d3-02	Jump Frequency 2	
d3-03	Jump Frequency 3	
d3-04	Jump Frequency Width	Sets the dead-band width around each selected prohibited frequency reference point.
E1-01	Input Voltage Setting	This parameter must be set to the power supply voltage. **WARNING!** *Electrical Shock Hazard. Drive input voltage (not motor voltage) must be set in E1-01 for the protective features of the drive to function properly. Failure to do so may result in equipment damage and/or death or personal injury.*

No.	Name	Description
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 3 7: 60 Hz, Variable torque 4 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** **Note:** Parameter setting value is not reset to the default value when the drive is initialized.
E1-04	Maximum Output Frequency	These parameters are only applicable when E1-03 is set to F. To set linear V/f characteristics, set the same values for E1-07 and E1-09. In this case, the setting for E1-08 will be disregarded. Ensure that the four frequencies are set according to these rules: E1-09 ≤ E1-07 < E1-06 ≤ E1-11 ≤ E1-04  **Note:** E1-07, E1-08, and E1-10 to E1-13 are not available in OLV/PM control mode.
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	
E2-01	Motor Rated Current	Sets the motor nameplate full load current in amps. Automatically set during Auto-Tuning.
E2-11	Motor Rated Power	Sets the motor rated power in kilowatts (1 HP = 0.746 kW). Automatically set during Auto-Tuning.
E5-02	Motor Rated Power	Sets the rated capacity of the motor.
E5-03	Motor Rated Current	Sets the motor rated current.
E5-04	Number of Motor Poles	Sets the number of motor poles.
E5-05	Motor Stator Resistance	Set the resistance for each motor phase.
E5-06	Motor d-Axis Inductance	Sets the d-Axis inductance for the PM motor.
E5-07	Motor q-Axis Inductance	Sets the q-Axis inductance for the PM motor.
E5-09	Motor Induction Voltage Constant 1	Sets the induced peak voltage per phase in units of 0.1 mV/(rad/s) [electrical angle]. Set this parameter when using an IPM motor with variable torque. Set E5-24 to 0 when setting this parameter.
E5-24	Motor Induction Voltage Constant 2	Sets the induced phase-to-phase rms voltage in units of 0.1 mV/(r/min) [mechanical angle].

No.	Name	Description
F6-01	Communications Error Operation Selection	0: Ramp to stop. Decelerate to stop using the deceleration time in C1-02. **1: Coast to stop.** 2: Fast Stop. Decelerate to stop using the deceleration time in C1-09. 3: Alarm only. 4: Alarm only. Continue operation using the frequency reference set in d1-04. 5: Alarm only. Decelerate to stop using the deceleration time in C1-02. **Note:** 1. Setting 4 available in drive software versions PRG: 1017 and later. 2. Setting 5 available in drive software versions PRG: 1018 and later.
H1-01 to H1-07	Multi-Function Digital Input Terminal S1 to S7 Function Selection	Selects the functions of terminals S1 to S7. **Note:** Set unused terminals to F.
H2-01	Terminal M1-M2 function selection (relay)	Selects the functions of terminals M1-M2, M3-M4, and M5-M6.
H2-02	Terminal M3-M4 function selection (relay)	
H2-03	Terminal M5-M6 function selection (relay)	
H3-01	Terminal A1 Signal Level Selection	**0: 0 to 10 V with zero limit** 1: 0 to 10 V without zero limit 2: 4-20 mA 3: 0-20 mA **Note:** Use jumper switch S1 to set input terminal A1 for current or voltage.
H3-02 (0434)	Terminal A1 Function Selection	Sets the function of terminal A1.
H3-03	Terminal A1 Gain Setting	Sets the level of the input value selected in H3-02 when 10 V is input at terminal A1.
H3-04	Terminal A1 Bias Setting	Sets the level of the input value selected in H3-02 when 0 V is input at terminal A1.
H3-09	Terminal A2 Signal Level Selection	0: 0 to 10 V with zero limit 1: 0 to 10 V without zero limit **2: 4 to 20 mA** 3: 0 to 20 mA **Note:** Use jumper switch S1 to set input terminal A2 for current or 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 and A2. Used for noise filtering.
H3-14	Analog Input Terminal Enable Selection	Determines which analog input terminals will be enabled when a digital input programmed for "Analog input enable" (H1-□□ = C) is activated. 1: Terminal A1 only **2: Terminal A2 only** 3: Terminals A1 and A2

No.	Name	Description
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.
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** 2: 4 to 20 mA
H4-08	Multi-Function Analog Output Terminal AM Signal Level Selection	**0: 0 to 10 V** 2: 4 to 20 mA
H5-01	Drive Slave Address	Selects drive station slave number (address) for MEMOBUS/Modbus terminals R+, R-, S+, S-. Cycle power for the setting to take effect. **Note:** If this parameter is set to 0, the drive will be unable to respond to MEMOBUS/ Modbus commands.
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 Cycle power for the setting to take effect.
H5-03	Communication Parity Selection	**0: No parity** 1: Even parity 2: Odd parity 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** 4: Run at d1-04
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.
H5-07	RTS Control Selection	0: Disabled. RTS is always on. **1: Enabled. RTS turns on only when sending.**

No.	Name	Description
H5-08	Communication Protocol Selection	Selects the communication protocol. **0: MEMOBUS/Modbus** 1: N2 (Metasys) 2: P1 (APOGEE FLN) 3: BACnet
H5-09	CE Detection Time	Sets the time required to detect a communications error. Adjustment may be needed when networking several drives.
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
L1-01	Motor Overload Protection Selection	0: Disabled 1: General purpose motor (standard fan cooled) 4: PM motor with variable torque control The drive may not be able to provide protection when using multiple motors, even if overload is enabled in L1-01. Set L1-01 to 0 and install separate thermal relays to each motor. **Note:** 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.
L1-03	Motor Overheat Alarm Operation Selection (PTC input)	Sets operation when the motor temperature analog input (H3-02 or H3-10 = E) exceeds the alarm level. 0: Ramp to stop 1: Coast to stop 2: Fast Stop (decelerate to stop using the deceleration time in C1-09) **3: Alarm only ("oH3" will flash)**
L1-04	Motor Overheat Fault Operation Selection (PTC input)	Sets stopping method when the motor temperature analog input (H3-02, or H3-10 = E) exceeds the oH4 fault level. 0: Ramp to stop **1: Coast to stop** 2: Fast Stop (decelerate to stop using the deceleration time in C1-09)
L1-05	Motor Temperature Input Filter Time (PTC input)	Adjusts the filter for the motor temperature analog input (H3-02, or H3-10 = E).
L1-08	oL1 Current Level	Sets the reference current for motor thermal overload detection for the motor in amperes. **Note:** 1. Available in drive software versions PRG: 1016 and later. 2. Default setting is determined by parameters o2-04, Drive Model Selection, and C6-01, Drive Duty Selection.
L1-13	Continuous Electrothermal Operation Selection	0: Disabled **1: Enabled** 2: Enable using Real Time Clock

No.	Name	Description
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 will be detected if power loss is longer than L2-02. **2: Recover as long as CPU has power.** Uv1 is not detected.
L2-02	Momentary Power Loss Ride-Thru Time	Sets the Power Loss Ride-Thru time. Enabled only when L2-01 = 1 or 3.
L2-03	Momentary Power Loss Minimum Baseblock Time	Sets the minimum wait time for residual motor voltage decay before the drive output reenergizes after performing Power Loss Ride-Thru. Increasing the time set to L2-03 may help if overcurrent or overvoltage occur during Speed Search or during DC Injection Braking. **Note:** Default setting is dependent on parameter o2-04, Drive Model Selection.
L4-05	Frequency Reference Loss Detection Selection	0: Stop. Drive stops when the frequency reference is lost. **1: Run. Drive runs at a reduced speed when the frequency reference is lost.**
L4-06	Frequency Reference at Reference Loss	Sets the percentage of the frequency reference that the drive should run with when the frequency reference is lost.
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, ov, PF, oL1, oL2, oL3, STo, Uv1.
L5-02	Auto Restart Fault Output Operation Selection	**0: Fault output not active.** 1: Fault output active during restart attempt.
L5-03	Time to Continue Making Fault Restarts	Enabled only when L5-05 is set to 0. Causes a fault if a fault restart cannot occur after the set time passes.
L5-04	Fault Reset Interval Time	Sets the amount of time to wait between performing fault restarts.
L5-05	Fault Reset Operation Selection	0: Continuously attempt to restart while incrementing restart counter only at a successful restart. **1: Attempt to restart with the interval time set in L5-04 and increment the restart counter with each attempt.**
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 an oL3 fault 8: UL3 detection always active during run, output shuts down on an oL3 fault 9: UL6 at speed agree (alarm) 10: UL6 at run (alarm) 11: UL6 at speed agree (fault) 12: UL6 at run (fault)
L6-02	Torque Detection Level 1	Sets the overtorque and undertorque detection level.

No.	Name	Description
L6-03	Torque Detection Time 1	Sets the time an overtorque or undertorque condition must exist to trigger torque detection 1.
L6-13	Motor Underload Protection Selection	Sets the motor underload protection (UL6) based on motor load. **0: Enabled (Base frequency)** 1: Enabled (Max frequency)
L6-14	Motor Underload Protection Level at Minimum Frequency	Sets the UL6 detection level at minimum frequency by percentage of drive rated current.
L8-02	Overheat Alarm Level	An overheat alarm occurs when heatsink temperature exceeds the L8-02 level.
L8-03	Overheat Pre-Alarm Operation Selection	0: Ramp to stop. A fault is triggered. 1: Coast to stop. A fault is triggered. 2: Fast Stop. Decelerate to stop using the deceleration time in C1-09. A fault is triggered. 3: Continue operation. An alarm is triggered. **4: Continue operation at reduced speed as set in L8-19.**
L8-05	Input Phase Loss Protection Selection	Selects the detection of input current phase loss, power supply voltage imbalance, or main circuit electrolytic capacitor deterioration. 0: Disabled **1: Enabled**
L8-06	Input Phase Detection Level	When ripple is observed in the DC bus, expansion of the input bias is calculated. This value becomes the input phase if the difference between the maximum and minimum values of the ripple is greater than the value set to L8-06. Detection Level = 100% = Voltage class x $\sqrt{2}$
L8-07	Output Phase Loss Protection Selection	0: Disabled **1: Enabled (triggered by a single phase loss)** 2: Enabled (triggered when two phases are lost)
L8-09	Output Ground Fault Detection Selection	0: Disabled 1: Enabled **Note:** Default setting is dependent on parameter o2-04, Drive Model Selection.
L8-10	Heatsink Cooling Fan Operation Selection	**0: During run only. Fan operates only during run for L8-11 seconds after stop.** 1: Fan always on. Cooling fan operates whenever the drive is powered up.
L8-11	Heatsink Cooling Fan Off Delay Time	Sets a delay time to shut off the cooling fan after the Run command is removed when L8-10 = 0.
L8-12	Ambient Temperature Setting	Enter the ambient temperature. This value adjusts the oL2 detection level.
L8-15	oL2 Characteristics Selection at Low Speeds	0: No oL2 level reduction below 6 Hz. **1: oL2 level is reduced linearly below 6 Hz. It is halved at 0 Hz.**
L8-18	Software Current Limit Selection	**0: Disabled** 1: Enabled
L8-19	Frequency Reduction Rate during Overheat Pre-Alarm	Specifies the frequency reference reduction gain at overheat pre-alarm when L8-03 = 4.
L8-27	Overcurrent Detection Gain	Sets the gain for overcurrent detection as a percentage of the motor rated current. Overcurrent is detected using the lower value between the overcurrent level of the drive or the value set to L8-27.

No.	Name	Description
L8-29	Current Unbalance Detection (LF2)	0: Disabled **1: Enabled**
L8-32	Main Contactor and Cooling Fan Power Supply Failure Selection	Determines drive response when a fault occurs with the internal cooling fan. 0: Ramp to stop **1: Coast to stop** 2: Fast stop (Decelerate to stop using the deceleration time set to C1-09) 3: Alarm only ("FAn" will flash) 4: Continue operation at reduced speed as set to L8-19.
L8-35	Installation Method Selection	0: IP00/Open-Chassis enclosure 2: IP20/UL Type 1 enclosure 3: External Heatsink Installation **Note:** Default setting is determined by the drive model: Setting 2: Models 2A0011 to 2A0211 and 4A0005 to 4A0096 Setting 0: Models 2A0273 to 2A0396 and 4A0124 to 4A0590
L8-38	Carrier Frequency Reduction	0: Disabled 1: Enabled below 6 Hz 2: Enabled for the entire speed range **Note:** Default setting is dependent on parameters A1-02, Control Method Selection, and o2-04, Drive Model Selection.
L8-40	Carrier Frequency Reduction Off Delay Time	Sets the time that the drive continues running with reduced carrier frequency after the carrier reduction condition is gone. Setting 0.00 s disables the carrier frequency reduction time.
L8-41	High Current Alarm Selection	**0: Disabled** 1: Enabled. An alarm is triggered at output currents above 150% of drive rated current.
o1-01	Drive Mode Unit Monitor Selection	Selects the content of the last monitor that is shown when scrolling through Drive Mode display. Enter the last three digits of the monitor parameter number to be displayed: U□-□□.
o1-02	User Monitor Selection after Power Up	**1: Frequency reference (U1-01)** 2: Direction 3: Output frequency (U1-02) 4: Output current (U1-03) 5: User Monitor
o1-03	HOA Keypad Display Selection	Sets the units the drive should use to display the frequency reference and motor speed monitors. **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 and o1-11)
o1-06	User Monitor Selection Mode	**0: 3 Monitor Sequential** (Displays the next two sequential monitors) 1: 3 Monitor Selectable (o1-07 and o1-08 selected monitor are shown)
o1-07	Second Line Monitor Selection	Selects the monitor that is shown in the second line. Enter the last three digits of the monitor parameter number to be displayed: U□-□□. For example, set "403" to display monitor parameter U4-03.

No.	Name	Description
o1-08	Third Line Monitor Selection	Selects the monitor that is shown in the third line. Enter the last three digits of the monitor parameter number to be displayed: U☐-☐☐. For example, set "403" to display monitor parameter U4-03.
o1-09	Frequency Reference Display Units	Sets unit display for the frequency reference parameters and frequency related monitors when o1-03 = 3. 0: WC (Inch of water) 1: PSI (Pounds per square inch) 2: GPM (Gallons per minute) 3: F (Degrees Fahrenheit) 4: CFM (Cubic feet per minute) 5: CMH (Cubic meters per hour) 6: LPH (Liters per hour) 7: LPS (Liters per second) 8: Bar (Bar) 9: Pa (Pascal) 10: C (Degrees Celsius) 11: Mtr (Meters) 12: Ft (Feet) 13: LPM (Liters per minute) 14: CMM (Cubic meters per minute) 15: Custom units (Determined by o1-12) **16: None**
o1-10	User-Set Display Units Maximum Value	These settings define the display values when o1-03 is set to 3. o1-10 sets the display value that is equal to the maximum output frequency. o1-11 sets the position of the decimal position.
o1-11	User-Set Display Units Decimal Display	
o1-13	Frequency Reference and Frequency Related Monitor Custom Units 1	Sets the customer-specified unit display for the frequency reference parameters and frequency related monitors when o1-03 = 3 and o1-09 = 15 as custom units.
o1-14	Frequency Reference and Frequency Related Monitor Custom Units 2	Sets the customer-specified unit display for the frequency reference parameters and frequency related monitors when o1-03 = 3 and o1-09 = 15 as custom units
o1-15	Frequency Reference and Frequency Related Monitor Custom Units 3	Sets the customer-specified unit display for the frequency reference parameters and frequency related monitors when o1-03 = 3 and o1-09 = 15 as custom units
o1-16	F1 Key Function Selection	Selects the function of the F1 key and the LCD display text above the F1 key. **0: Standard** 1: Monitor 2: Drive/Bypass (DRV/BYP) 3: Bypass Run Command (RUN BYP) 4: Toggle Relay Output (RLY)
o1-17	F2 Key Function Selection	Selects the function of the F2 key and the LCD display text above the F2 key. **0: Standard** 1: Monitor 2: Drive/Bypass (DRV/BYP) 3: Bypass Run Command (RUN BYP) 4: Toggle Relay Output (RLY)
o1-18	User Defined Parameter Upper	Allows the user to set values that can be used as reference information.
o1-19	User Defined Parameter Lower	Allows the user to set values that can be used as reference information.
o2-02	OFF Key Function Selection	0: Disabled. OFF key is disabled in REMOTE operation. **1: Enabled. OFF key is always enabled.**
o2-03	User Parameter Default Value	**0: No change.** 1: Set defaults. Saves parameter settings as default values for a User Initialization. 2: Clear all. Clears the default settings that have been saved for a User Initialization.
o2-04	Drive Model Selection	Enter the drive model. Setting required only if installing a new control board.

No.	Name	Description
o2-05	Frequency Reference Setting Method Selection	**0: ENTER key must be pressed to enter a frequency reference.** 1: ENTER key is not required. The frequency reference can be adjusted using the up and down arrow keys only.
o2-06	Operation Selection when HOA Keypad is Disconnected	0: The drive continues operating if the HOA keypad is disconnected. **1: An oPr fault is triggered and the motor coasts to stop.**
o2-07	Motor Direction at Power Up when Using Operator	**0: Forward** 1: Reverse This parameter requires assigning drive operation to the HOA keypad.
o2-19	Selection of Parameter Write during Uv	Selects whether parameter settings can be changed during a DC bus undervoltage condition. Used with 24 V Power Supply (PS-A10L, PS-A10H). **0: Disabled** 1: Enabled
o3-01	Copy Function Selection	**0: No action** 1: Read parameters from the drive, saving them onto the HOA keypad. 2: Copy parameters from the digital operator, writing them to the drive. 3: Verify parameter settings on the drive to check if they match the data saved on the HOA keypad.
o3-02	Copy Allowed Selection	**0: Read operation prohibited** 1: Read operation allowed
o4-01	Cumulative Operation Time Setting	Sets the value for the cumulative operation time of the drive in units of 10 h.
o4-02	Cumulative Operation Time Selection	0: Logs power-on time **1: Logs operation time when the drive output is active (output operation time).**
o4-03	Cooling Fan Operation Time Setting	Sets the value of the fan operation time monitor U4-03 in units of 10 h.
o4-05	Capacitor Maintenance Setting	Sets the value of the Maintenance Monitor for the capacitors. See U4-05 to check when the capacitors may need to be replaced.
o4-07	DC Bus Pre-Charge Relay Maintenance Setting	Sets the value of the Maintenance Monitor for the soft charge bypass relay. See U4-06 to check when the bypass relay may need to be replaced.
o4-11	U2, U3 Initialization	**0: U2-☐☐ and U3-☐☐ monitor data is not reset when the drive is initialized (A1-03).** 1: U2-☐☐ and U3-☐☐ monitor data is reset when the drive is initialized (A1-03).
o4-12	kWh Monitor Initialization	**0: U4-10 and U4-11 monitor data is not reset when the drive is initialized (A1-03).** 1: U4-10 and U4-11 monitor data is reset when the drive is initialized (A1-03).
o4-13	Number of Run Commands Counter Initialization	**0: Number of Run commands counter is not reset when the drive is initialized (A1-03).** 1: Number of Run commands counter is reset when the drive is initialized (A1-03).
o4-17	Set/Reset Real Time Clock	Sets the current date and time for the Real Time Clock. **0: Disabled** 1: Enabled **Note:** Available in drive software versions PRG: 1012 and earlier.

No.	Name	Description
o4-17	Set/Reset Real Time Clock	Sets the current date and time for the Real Time Clock. **0: — — No Setting** 1: Real Time Clock Set 2: Real Time Clock Reset **Note:** Available in drive software versions PRG: 1013 and later.
T1-01	Auto-Tuning Mode Selection	**2: Stationary Auto-Tuning for Line-to-Line Resistance** 3: Rotational Auto-Tuning for V/f Control Energy Saving **Note:** The availability of certain Auto-Tuning methods depends on the control mode selected for the drive.
T1-02	Motor Rated Power	Sets the motor rated power as specified on the motor nameplate. **Note:** 1. Use the following formula to convert horsepower into kilowatts: 1HP = 0.746 kW. 2. Default setting is dependent on parameter o2-04, Drive Model Selection.
T1-03	Motor Rated Voltage	Sets the motor rated voltage as specified on the motor nameplate.
T1-04	Motor Rated Current	Sets the motor rated current as specified on the motor nameplate.
T1-05	Motor Base Frequency	Sets the rated frequency of the motor as specified on the motor nameplate.
T1-06 (0706)	Number of Motor Poles	Sets the number of motor poles as specified on the motor nameplate.
T1-07	Motor Base Speed	Sets the rated speed of the motor as specified on the motor nameplate.
T1-11	Motor Iron Loss	Sets the iron loss for determining the Energy Saving coefficient. The value is set to E2-10 (motor iron loss) set when the power is cycled. If T1-02 is changed, a default value appropriate for the motor capacity that was entered will appear.
T1-12	T1 Tuning Start	The drive starts tuning.
U1-01	Frequency Reference	Monitors the frequency reference. Display units are determined by o1-03.
U1-02	Output Frequency	Displays the output frequency. Display units are determined by o1-03.
U1-03	Output Current	Displays the output current.
U1-06	Output Voltage Reference	Displays the output voltage.
U1-10	Input Terminal Status	Displays the input terminal status. U1-10=00000000 1 Digital input 1 (terminal S1 enabled) 1 Digital input 2 (terminal S2 enabled) 1 Digital input 3 (terminal S3 enabled) 1 Digital input 4 (terminal S4 enabled) 1 Digital input 5 (terminal S5 enabled) 1 Digital input 6 (terminal S6 enabled) 1 Digital input 7 (terminal S7 enabled)

No.	Name	Description
U1-11	Output Terminal Status	Displays the output terminal status. U1-11=00000000 1 Multi-Function Digital Output (terminal MD-ME-MF) enabled 1 Multi-Function Digital Output (terminal M1-M2) enabled 1 Multi-Function Digital Output (terminal M3-M4) enabled 0 Not Used 1 Fault Relay (terminal MA-MC closed, MA open) enabled
U1-12	Drive Status	Verifies the drive operation status. U1-12=00000000 1 During run 1 During zero-speed 1 During REV 1 During fault reset signal input 1 During speed agree 1 Drive ready 1 During alarm detection 1 During fault detection
U1-13	Terminal A1 Input Level	Displays the signal level to analog input terminal A1.
U1-14	Terminal A2 Input Level	Displays the signal level to analog input terminal A2.
U1-16	Output Frequency after Soft Starter	Displays output frequency with ramp time and S-curves. Units determined by o1-03.
U1-18	oPE Fault Parameter	Displays the parameter number that caused the oPE□□ or Err (EEPROM write error) error.
U1-19	MEMOBUS/Modbus Error Code	Displays the contents of a MEMOBUS/Modbus error. U1-19=00000000 1 CRC Error 1 Data Length Error 0 Not Used 1 Parity Error 1 Overrun Error 1 Framing Error 1 Timed Out 0 Not Used
U1-25	Software Number (Flash)	FLASH ID
U1-26	Software No. (ROM)	ROM ID
U1-27	Message ID (OPR)	OPR ID
U1-28	Message ID (INV)	INV ID
U5-01	PI Feedback	Displays the PI feedback value.
U5-02	PI Input	Displays the amount of PI input (deviation between PI setpoint and feedback).
U5-03	PI Output	Displays PI control output.
U5-04	PI Setpoint	Displays the PI setpoint.

i.9 Standards Compliance

Figure i.59 UL/cUL Mark

◆ UL Standards Compliance

Figure i.60 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 UL508C and complies with UL requirements. The conditions described below must be met to maintain compliance when using this drive in combination with other equipment:

■ Installation Area

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

■ Ambient Temperature

IP20/UL Type 1 Enclosure, External Heatsink (2A0011 to 2A0073 and 4A0005 to 4A0302): -10 to +40 °C (14 to 104 °F)

IP00/Open Type Enclosure (2A0343 and 2A0396 and 4A0361 to 4A0590): -10 to +50 °C (14 to 122 °F)

■ Main Circuit Terminal Wiring

Yaskawa recommends using closed-loop crimp terminals on all drive models. To maintain UL/cUL approval, UL Listed closed-loop crimp terminals are specifically required when wiring the drive main circuit terminals on models 2A0031 to 2A0396 and 4A0034 to 4A0590. Use only the tools recommended by the terminal manufacturer for crimping. *Refer to Closed-Loop Crimp Terminal Size on page 79* for closed-loop crimp terminal recommendations.

The wire gauges listed in the following tables are Yaskawa recommendations. Refer to NEC table 310-16 for proper wire gauge selection for terminals -M, +M, -1, +3, and ground.

Wire Gauges and Tightening Torques

Refer to Wire Gauges and Tightening Torque on page 23 to select the appropriate wires and crimp terminals for use in the United States.

Closed-Loop Crimp Terminal Recommendations

Yaskawa recommends using closed-loop crimp terminals on all drive models. To maintain UL/cUL approval, UL Listed closed-loop crimp terminals are specifically required when wiring the drive main circuit terminals on models 2A0031 to 2A0396 and 4A0034 to 4A0590. Use only the tools recommended by the terminal manufacturer for crimping. Yaskawa recommends crimp terminals made by JST and Tokyo DIP (or equivalent) for the insulation cap.

Table i.32 matches the wire gauges and terminal screw sizes with Yaskawa-recommended crimp terminals, tools, and insulation caps. Refer to the appropriate Wire Gauge and Torque Specifications table for the wire gauge and screw size for your drive model. Place orders with a Yaskawa representative or the Yaskawa sales department. Refer to local codes for proper selections.

Table i.32 Closed-Loop Crimp Terminal Size

Wire Gauge	Terminal Screws	Crimp Terminal Model Number	Tool		Insulation Cap Model No.	Code <1>
			Machine No.	Die Jaw		
2 mm² 14 AWG	M4	R2-4	YA-4	AD-900	TP-003	100-054-028
3.5 / 5.5 mm² 12 / 10 AWG	M4	5.5-4NS	YA-4	AD-900	TP-005	100-064-248
8 mm² 8 AWG	M4	8-4NS	YA-4	AD-901	TP-008	100-064-249
	M5	R8-5	YA-4	AD-901	TP-008	100-054-032
14 mm² 6 AWG	M5	R14-5	YA-4	AD-902	TP-014	100-054-034
	M8	R14-8	YA-5	AD-952	TP-014	100-054-035
22 mm² 4 AWG	M5	22-5NS	YA-5	AD-953	TP-022	100-051-262
	M8	R22-8	YA-5	AD-953	TP-022	100-051-263
30 / 38 mm² 3 / 2 AWG	M8	R38-8	YA-5	AD-954	TP-038	100-051-264
50 / 60 mm² 1 AWG 1/0 AWG 1/0 AWG × 2P	M8	R60-8	YA-5	AD-955	TP-060	100-051-265
70 mm² 2/0 AWG 2/0 AWG × 2P	M8	CB70-S8	YF-1 YET-300-1	TD-322,TD-311	TP-080	100-064-417
		70-8				100-064-250
	M10	70-10	YF-1 YET-300-1	TD-322,TD-311	TP-080	100-064-251
80 mm² 3/0 AWG × 2P 3/0 AWG × 4P	M10	80-10	YF-1 YET-300-1	TD-323,TD-312	TP-080	100-051-267
	M12	80-L12	YF-1 YET-300-1	TD-323,TD-312	TP-080	100-051-558
100 mm² 4/0 AWG × 2P 4/0 AWG × 4P	M12	100-L12	YF-1 YET-300-1	TD-324,TD-312	TP-100	100-051-560
150 mm² 250 kcmil × 2P 300 kcmil × 2P	M12	150-L12	YF-1 YET-300-1	TD-325,TD-313	TP-150	100-051-562

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

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

■ Factory Recommended Branch Circuit Protection

WARNING! *Fire Hazard. 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 (200 V class) and 480 Vac (400 V class), when protected by branch circuit protection devices specified in this manual.*
Branch circuit protection shall be provided by any of the following: Non-time delay Class J, T, or CC fuses sized at 300% of the drive input rating, or Time delay Class J, T, or CC fuses sized at 175% of the drive input rating, or MCCB sized at 200% maximum of the drive input rating.

Yaskawa recommends installing one of the following types of branch circuit protection to maintain compliance with UL508C. Semiconductor protective type fuses are preferred. Alternate branch circuit protection devices are also listed in ***Table i.33***.

Table i.33 Factory Recommended Z1000 AC Drive Branch Circuit Protection

Model	Nominal Output Power (HP)	AC Drive Input (A)	MCCB Rating (A) <1>	Time Delay Fuse Rating (A) <2>	Non-time Delay Fuse Rating (A) <3>	Bussmann Semiconductor Fuse Model (Fuse Ampere) <4>
Three-Phase 200 V Class						
2A0011	3	10.6	20	17.5	30	FWH-40B (40)
2A0017	5	16.7	30	25	50	FWH-50B (50)
2A0024	7.5	24.2	40	40	70	FWH-80B (80)

Model	Nominal Output Power (HP)	AC Drive Input (A)	MCCB Rating (A) <1>	Time Delay Fuse Rating (A) <2>	Non-time Delay Fuse Rating (A) <3>	Bussmann Semiconductor Fuse Model (Fuse Ampere) <4>
2A0031	10	30.8	60	50	90	FWH-100B (100)
2A0046	15	46.2	90	80	125	FWH-150B (150)
2A0059	20	59.4	110	100	175	FWH-175B (175)
2A0075	25	74.8	150	125	200	FWH-225A (225)
2A0088	30	88	175	150	250	FWH-225A (225)
2A0114	40	114	225	175	300	FWH-250A (250)
2A0143	50	143	250	250	400	FWH-275A (275)
2A0169	60	169	300	275	500	FWH-350A (350)
2A0211	75	211	400	350	600	FWH-400A (400)
2A0273	10	273	500	450	<5>	FWH-450A (450)
2A0343	125	343	600	600		FWH-600A (600)
2A0396	150	396	700	<5>		FWH-600A (600)
Three-Phase 400 V Class						
4A0005	3	4.8	15	8	12	FWH-40B (40)
4A0008	5	7.6	15	12	20	FWH-40B (40)
4A0011	7.5	11	20	17.5	30	FWH-45B (45)
4A0014	10	14	25	20	40	FWH-45B (45)
4A0021	15	21	40	35	60	FWH-60B (60)
4A0027	20	27	50	45	80	FWH-80B (80)
4A0034	25	34	60	50	100	FWH-125B(125)
4A0040	30	40	75	70	110	FWH-150B (150)
4A0052	40	52	100	90	150	FWH-200B (200)
4A0065	50	65	125	110	175	FWH-225A (225)
4A0077	60	77	150	125	225	FWH-225A (225)
4A0096	75	96	175	150	275	FWH-225A (225)
4A0124	100	124	225	200	350	FWH-250A(250)
4A0156	125	156	300	250	450	FWH-300A (300)
4A0180	150	180	350	300	500	FWH-350A (350)
4A0240	200	240	450	400	<5>	FWH-400A (400)
4A0302	250	302	600	500		FWH-600A (600)
4A0361	300	346	600	600	1000 <6>	FWH-800A (800)
4A0414	350	410	800	700	1200 <6>	FWH-800A (800)
4A0480	400	480	900	<5>	<5>	FWH-700A (700)
4A0590	500	590	1100			FWH-1000A (1000)

<1> Maximum MCCB rating is 15 A, or 200% of drive input current rating, whichever value is larger. MCCB voltage rating must be 600 Vac or greater.

<2> Maximum Time delay fuse is 175% or drive input current rating. This covers any Class J, T, or CC fuse.

<3> Maximum Non-time delay fuse is 300% of drive input current rating. This covers any Class J, T, or CC fuse.

<4> When using semiconductor fuses, Bussmann FWH fuses are required for UL compliance.

<5> Consult factory.

<6> Class L fuse is also approved for this rating.

■ 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. Refer to NEC Article 725 Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power Limited Circuits for requirements concerning class 1 circuit conductors and class 2 power supplies.

Table i.34 Control Circuit Terminal Power Supply

Input / Output	Terminal Signal	Power Supply Specifications
Multi-function digital inputs	S1, S2, S3, S4, S5, S6, S7, SC, SP, SN	Use the internal control power supply of the drive or an external class 2 power supply.
Multi-function analog inputs	+V, A1, A2, AC, FM, AM	

■ 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), when protected by Bussmann Type FWH or FWP fuses as specified in *Factory Recommended Branch Circuit Protection* on page *79*.

◆ Drive Motor Overload Protection

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

■ E2-01: Motor Rated Current

Setting Range: Model-dependent

Default Setting: Model-dependent

Parameter E2-01 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 is 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.35 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.
4	Permanent Magnet motor with variable torque control	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.

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, 2, or 4) 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.

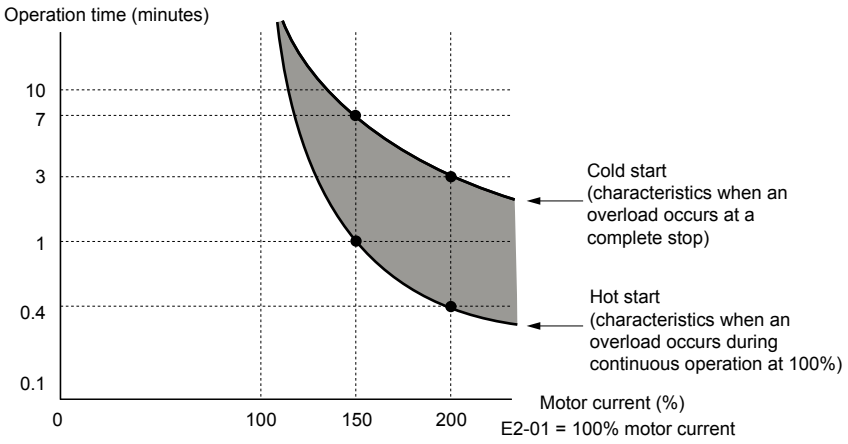


Figure i.61 Motor Overload Protection Time

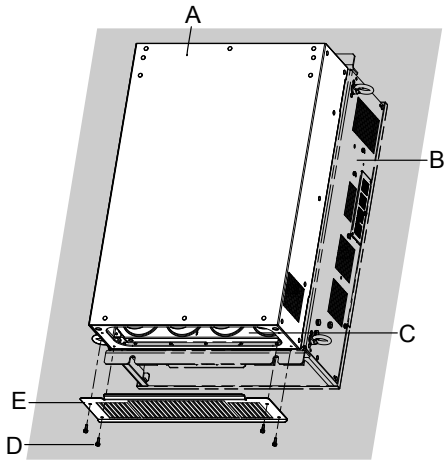
◆ Precautionary Notes on External Heatsink (IP00/Open-Type Enclosure)

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

The portion of the external heatsink that projects out can be protected with the enclosure or with the appropriate capacitor cover after completing drive installation. Use *Table i.36* to match drive models with available capacitor covers. Order capacitor covers from a Yaskawa representative or directly from the Yaskawa sales department.

Table i.36 Capacitor Cover

Model	Code Number	Model	Figure
2A0343	100-061-278	ECAT31698-11	*Figure i.62*
2A0396			
4A0361	100-061-278	ECAT31698-11	
4A0414	100-061-279	ECAT31740-11	
4A0480	100-061-280	ECAT31746-11	
4A0590			



A – Drive (outside panel)
B – Drive (inside panel)
C – Opening to capacitors
D – Installation screws
E – Capacitor cover

Figure i.62 Capacitor Cover

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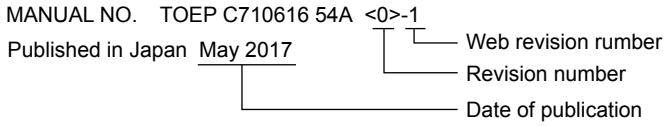
Revision History

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



Date of Publication	Revision Number	Web Revision Number	Section	Revised Content
May 2024	<2>	0	i.9	Revision: Model 4A0027 applicable fuse changed to FWH-80B.
June 2021	<1>	0	All	Revision: Reviewed and corrected entire document.
			i.1	Deletion: Safety messages about EMC Guidelines Compliance
			i.2	Revision: Drive Nameplate
			i.9	Deletion: European Standards, CE Low Voltage Directive Compliance, EMC Guidelines Compliance
			Back Cover	Revision: Address
May 2017	<0>	1	Preface	Revision: Removed restrictions
May 2016	–	—	–	First Edition. This manual supports drive software version PRG: 1018.

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YASKAWA AC Drive Z1000

AC Drive for HVAC Fan and Pump

Quick Start Guide

YASKAWA AMERICA, INC.
2121, Norman Drive South, Waukegan, IL 60085, U.S.A.
Phone: +1-800-YASKAWA (927-5292) or +1-847-887-7000 Fax: +1-847-887-7310
www.yaskawa.com

DRIVE CENTER (INVERTER PLANT)
2-13-1, Nishimiyaichi, Yukuhashi, Fukuoka, 824-8511, Japan
Phone: +81-930-25-2548 Fax: +81-930-25-3431
www.yaskawa.co.jp

YASKAWA ELECTRIC CORPORATION
New Pier Takeshiba South Tower, 1-16-1, Kaigan, Minatoku, Tokyo, 105-6891, Japan
Phone: +81-3-5402-4502 Fax: +81-3-5402-4580
www.yaskawa.co.jp

YASKAWA ELÉTRICO DO BRASIL LTDA.
777, Avenida Piraporinha, Diadema, São Paulo, 09950-000, Brasil
Phone: +55-11-3585-1100 Fax: +55-11-3585-1187
www.yaskawa.com.br

YASKAWA EUROPE GmbH
Hauptstraβe 185, 65760 Eschborn, Germany
Phone: +49-6196-569-300 Fax: +49-6196-569-398
www.yaskawa.eu.com E-mail: info@yaskawa.eu.com

YASKAWA ELECTRIC KOREA CORPORATION
35F, Three IFC, 10 Gukjegeumyung-ro, Yeongdeungpo-gu, Seoul, 07326, Korea
Phone: +82-2-784-7844 Fax: +82-2-784-8495
www.yaskawa.co.kr

YASKAWA ASIA PACIFIC PTE. LTD.
30A, Kallang Place, #06-01, 339213, Singapore
Phone: +65-6282-3003 Fax: +65-6289-3003
www.yaskawa.com.sg

YASKAWA ELECTRIC (THAILAND) CO., LTD.
59, 1F-5F, Flourish Building, Soi Ratchadapisek 18, Ratchadapisek Road, Huaykwang, Bangkok, 10310, Thailand
Phone: +66-2-017-0099 Fax: +66-2-017-0799
www.yaskawa.co.th

YASKAWA ELECTRIC (CHINA) CO., LTD.
22F, Link Square 1, No.222, Hubin Road, Shanghai, 200021, China
Phone: +86-21-5385-2200 Fax: +86-21-5385-3299
www.yaskawa.com.cn

YASKAWA ELECTRIC (CHINA) CO., LTD. BEIJING OFFICE
Room 1011, Tower W3 Oriental Plaza, No. 1, East Chang An Avenue,
Dong Cheng District, Beijing, 100738, China
Phone: +86-10-8518-4086 Fax: +86-10-8518-4082

YASKAWA ELECTRIC TAIWAN CORPORATION
12F, No. 207, Section 3, Beishin Road, Shindian District, New Taipei City 23143, Taiwan
Phone: +886-2-8913-1333 Fax: +886-2-8913-1513 or +886-2-8913-1519
www.yaskawa.com.tw

YASKAWA INDIA PRIVATE LIMITED
#17/A, Electronics City, Hosur Road, Bengaluru, 560 100 (Karnataka), India
Phone: +91-80-4244-1900 Fax: +91-80-4244-1901
www.yaskawaindia.in

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In the event that the end user of this product is to be the military and said product is to be employed in any weapons systems or the manufacture thereof, the export will fall under the relevant regulations as stipulated in the Foreign Exchange and Foreign Trade Regulations. Therefore, be sure to follow all procedures and submit all relevant documentation according to any and all rules, regulations and laws that may apply.

Specifications are subject to change without notice for ongoing product modifications and improvements.

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