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.

If a fuse is blown or a Ground Fault Circuit Interrupter (GFCI) is tripped, check the wiring and the selection of the peripheral devices.

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

Do not restart the drive immediately operate the peripheral devices if a fuse is blown or a GFCI is tripped.

Check the wiring and the selection of peripheral devices to identify the cause. Contact your supplier before restarting the drive or the peripheral devices if the cause cannot be identified.

Do not expose the drive to halogen group disinfectants.

Failure to comply may cause damage to the electrical components in the drive.

Do not pack the drive in wooden materials that have been fumigated or sterilized. Do not sterilize the entire package after the product is packed.

■ General Application Precautions

Selection

Installing a Reactor

Use an AC reactor or DC link choke in the following situations:

- to suppress harmonic current.
- to smooth peak current that results from capacitor switching.
- when the power supply is above 600 kVA.
- when the drive is running from a power supply system with thyristor converters.

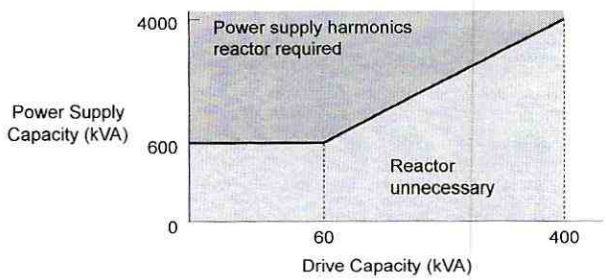


Figure i.1 Installing a Reactor

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 overload rating of the drive determines the starting and accelerating characteristics of the motor. Expect lower running torque than when running the motor from line power. To get more starting torque, use a larger drive or increase both the motor and drive capacity.

Emergency/Fast Stop

During a drive fault condition, a protective circuit is activated and drive output is shut off. The motor may coast to a stop or attempt to decelerate depending on parameter settings. If the emergency/fast stop cannot stop the load as fast as desired, a customer-supplied mechanical brake may be required. Test emergency stop circuitry before putting drive into operation.

■ Repetitive Starting/Stopping

Applications with frequent starts and stops often exceed 150% of their rated current values. Heat stress generated from repetitive high current can shorten the life span of the IGBTs. The expected lifetime for the IGBTs is about 8 million start and stop cycles with a 4 kHz carrier frequency and a 150% peak current.

Yaskawa recommends lowering the carrier frequency, particularly when audible noise is not a concern. The user can also choose to reduce the load, increase the acceleration and deceleration times, or switch to a larger drive. This will help keep peak current levels under 150%. Be sure to check the peak current levels when starting and stopping repeatedly during the initial test run, and make adjustments accordingly.

■ Installation

Enclosure Panels

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

Installation Direction

NOTICE: *Install the drive upright as specified in the manual.* ***Refer to Mechanical Installation on page 48*** *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 400 Hz. Be sure to set the upper limit for the frequency of the drive to prevent the possible danger of accidentally operating equipment at higher than rated speed. The default setting for the maximum output frequency is 60 Hz.*

Lower Limits

NOTICE: *Many pumps have a minimum safe operating speed. Be sure to properly set the minimum pump speed in to protect the pump from damage.*

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 inertia moment. 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.

■ 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 60755).

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

Magnetic Contactor Installation

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! *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

Yaskawa recommends using ring terminals on all drive models. UL/cUL approval requires the use of UL Listed closed-loop crimp terminals when wiring the drive main circuit terminals. 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 is usually designed to sufficiently cool the motor at the rated speed. As the self-cooling capability of such a motor reduces with the speed, applying full torque at low speed will possibly damage the motor. To prevent motor damage from overheat, reduce the load torque as the motor slows. ***Figure i.2*** shows the allowable load characteristics for a Yaskawa standard motor. A motor designed specifically for operation with a drive should be used when 100% continuous torque is needed at low speeds.

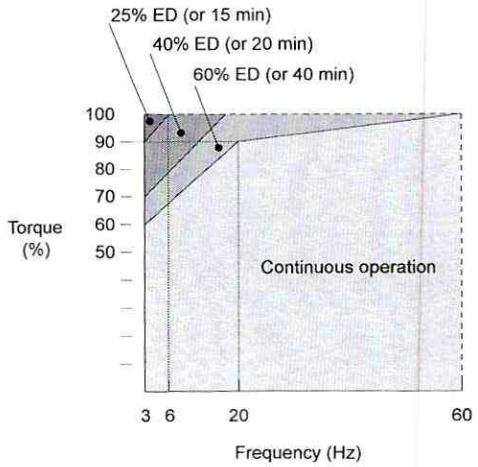


Figure i.2 Allowable Load Characteristics for a Yaskawa Motor

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 (drive current derating may be required).

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, use shock absorbing mounts to the motor base 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

Multi-Pole Motor

Because the rated current will differ from a standard motor, be sure to check the maximum current when selecting a drive. Always stop the motor before switching between the number of motor poles. If a regen overvoltage (oV) fault occurs or if overcurrent protection (oC) is triggered, the motor will coast to stop.

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 excessive current to flow and can damage drive components. 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.

■ Notes on Power Transmission Machinery

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

◆ Drive Label Warning Example

Always heed the warning information listed in *Figure i.3*.

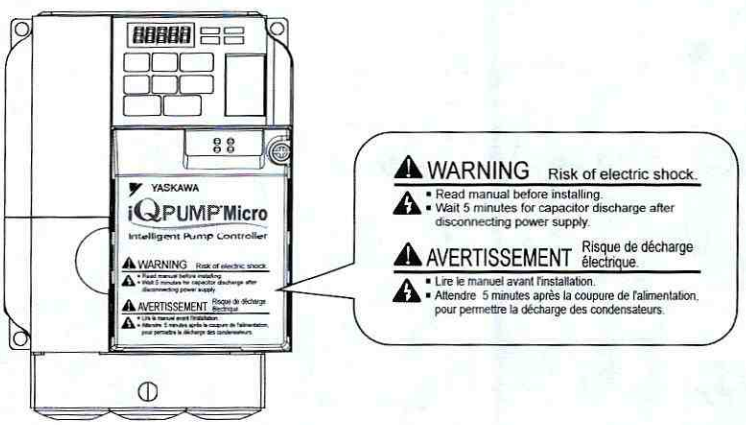


Figure i.3 Warning Information Example

◆ Warranty Information

■ Restrictions

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

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

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

i.2 Receiving

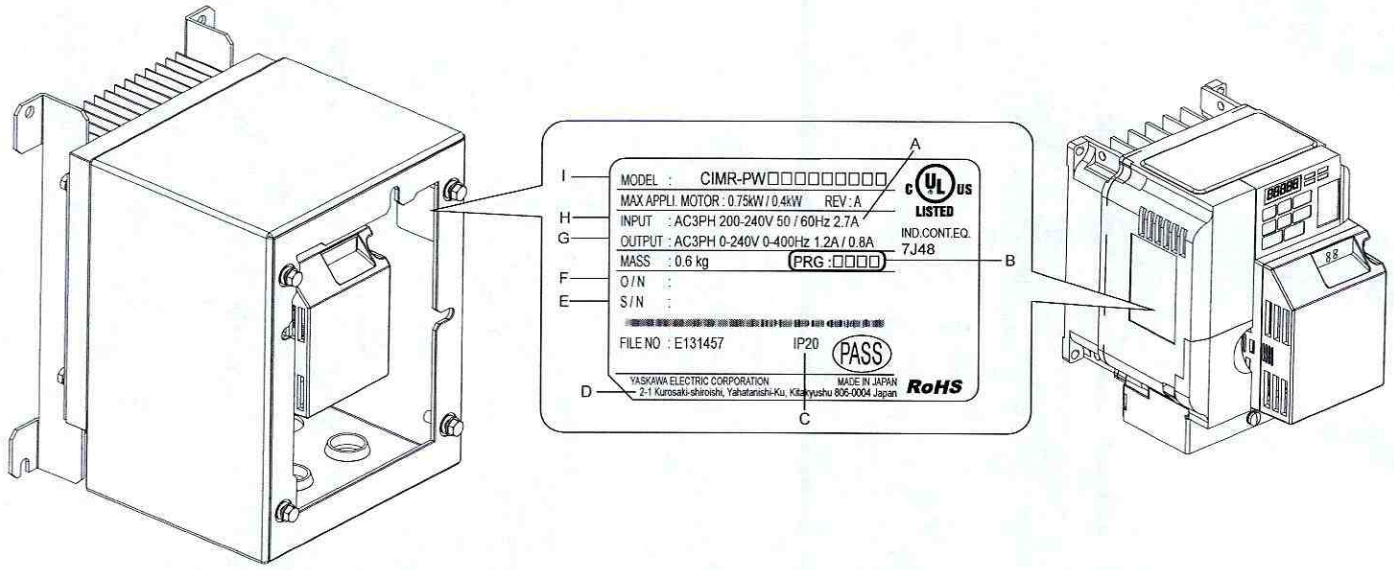
◆ Model Number and Nameplate Check

Please perform the following tasks after receiving the drive:

- Inspect the drive for damage.

  If the drive appears damaged upon receipt, contact the shipper immediately.
- Verify receipt of the correct model by checking the information on the nameplate.
- If you have received the wrong model or the drive does not function properly, contact your supplier.

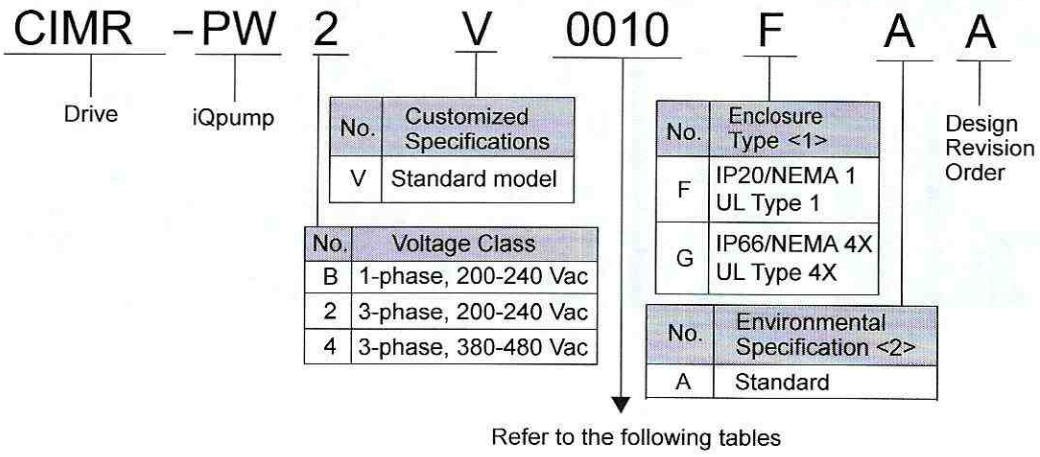
◆ Nameplate



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

Figure i.4 Nameplate Information Example

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



<1> *Refer to Mechanical Installation on page 48* for differences regarding enclosure protection types and component descriptions.

<2> Please contact Yaskawa for details regarding Environmental Specifications.

■ Single-Phase 200 V Class

Drive Model	Max. Motor Capacity kW (HP)	Rated Output Current A
BV0006	1.1 (1)	6.0
BV0010	2.2 (3)	9.6
BV0012	3.0 (3)	12.0
BV0018	3.7 (5)	17.5

■ Three-Phase 200 V Class

Drive Model	Max. Motor Capacity kW (HP)	Rated Output Current A
2V0006	1.1 (1.5)	6.0
2V0010	2.2 (3)	9.6
2V0012	3.0 (3)	12.0
2V0020	5.5 (5)	19.6
2V0030	7.5 (10)	30.0
2V0040	11 (10)	40.0
2V0056	15 (20)	56.0
2V0069	18.5 (25)	69.0

■ Three-Phase 400 V Class

Drive Model	Max. Motor Capacity kW (HP)	Rated Output Current A
4V0002	0.75 (1)	2.1
4V0004	1.5 (2)	4.1
4V0005	2.2 (3)	5.4
4V0007	3.0 (3)	6.9
4V0009	3.7 (5)	8.8
4V0011	5.5 (7.5)	11.1
4V0018	7.5 (10)	17.5
4V0023	11 (15)	23.0
4V0031	15 (20)	31.0
4V0038	18.5 (25)	38.0

i.3 Mechanical Installation

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

◆ Installation Environment

To help prolong the optimum performance life of the drive, install the drive in the proper environment. *Table i.1* describes the appropriate environment for the drive.

Table i.1 Installation Environment

Environment	Conditions
Installation Area	Indoors
Ambient Temperature	IP20/NEMA 1, UL Type 1 enclosure: -10 °C to +40 °C (14 °F to 104 °F) IP66/NEMA 4X, UL Type 4X enclosure: -10 °C to +40 °C (14 °F to 104 °F) Drive reliability improves in environments without wide temperature fluctuations. When using an enclosure panel, install a cooling fan or air conditioner in the area to ensure that the air temperature inside the enclosure does not exceed the specified levels. Do not allow ice to develop on the drive.
Humidity	95% RH or less and free of condensation
Storage Temperature	-20 °C to +60 °C (-4 °F to +104 °F)
Surrounding Area	Install the drive in an area free from: • oil mist and dust • metal shavings, oil, water or other foreign materials • radioactive materials • combustible materials (e.g., wood) • harmful gases and liquids • excessive vibration • chlorides • direct sunlight For IP66/NEMA 4X, UL Type 4X enclosure drives, install the drive in an environment suitable for IP66/NEMA 4X, UL Type 4X enclosures: • NEMA 4X, UL Type 4X – Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, hose-directed water, and corrosion; and that will be undamaged by the external formation of ice on the enclosure. • IP66 – Dust-tight enclosures to do not allow any dust to penetrate. The enclosure guards the drive against powerful jetting water sprayed from any direction and is protected against access to hazardous parts with a wire.
Altitude	Up to 1000 meters without derating; up to 3000 meters with output current, ambient temperature, and voltage derating.
Vibration	10 to 20 Hz at 9.8 m/s^2 20 to 55 Hz at 5.9 m/s^2
Orientation	Install the drive vertically to maintain maximum cooling effects.

NOTICE: *Prevent foreign matter such as metal shavings or wire clippings from falling into the drive during installation and project construction. 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 startup, as the cover will reduce ventilation and cause the drive to overheat.*

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

◆ Installation Orientation and Spacing

NOTICE: *Install the drive upright as illustrated in **Figure i.5**. Failure to comply may damage the drive due to improper cooling.*

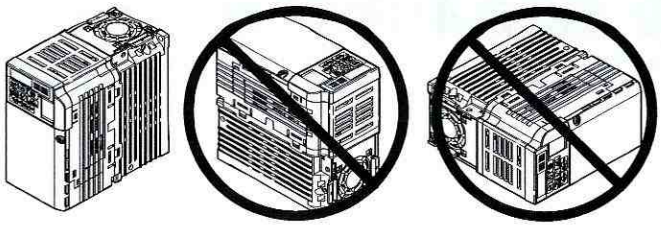
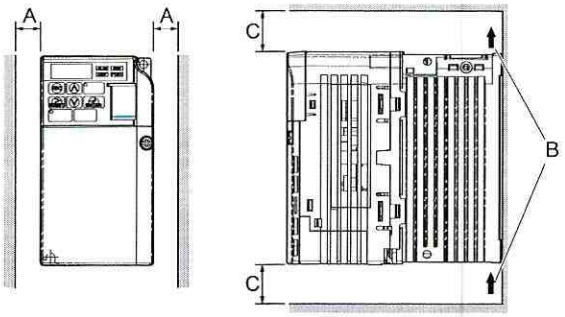


Figure i.5 Correct Installation Orientation

■ Single Drive Installation

Figure i.6 shows the required installation spacing to maintain sufficient space for airflow and wiring for IP20/NEMA 1, UL Type 1 and IP66/NEMA 4X, UL Type 4X enclosures. Install the heatsink against a closed surface to avoid diverting cooling air around the heatsink.



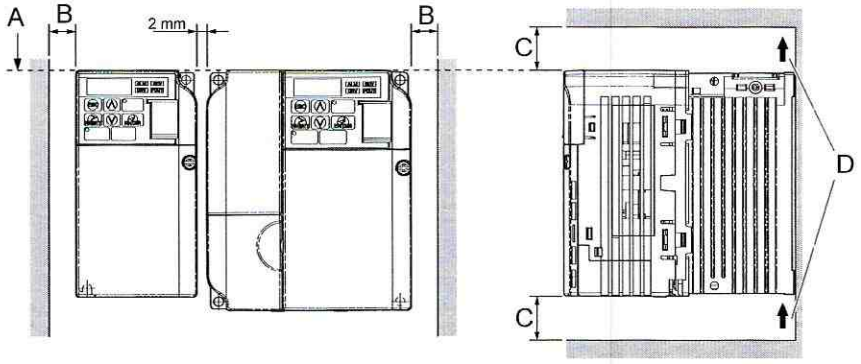
A – 30 mm minimum
B – Airflow direction
C – 100 mm minimum

Figure i.6 Correct Installation Spacing

Note: IP20/NEMA 1, UL Type 1 and IP66/NEMA 4X, UL Type 4X enclosure models require the same amount of space above and below the drive for installation.

■ Multiple Drive Installation

When installing multiple drives into the same enclosure panel, mount the drives according to *Figure i.6*. When mounting drives with a minimum side-by-side clearance of 2 mm according to *Figure i.7*, derating must be considered and parameter L8-35 must be set.



A – Line up the tops of the drives.
B – 30 mm minimum
C – 100 mm minimum
D – Airflow direction

Figure i.7 Space Between Drives (Side-by-Side Mounting)

Note: When installing drives of different heights in the same enclosure panel, the tops of the drives should line up. Leave space between the top and bottom of stacked drives for cooling fan replacement if required. Using this method, it is possible to replace the cooling fans later.

NOTICE: *When mounting IP20/NEMA 1, UL Type 1 enclosure drives side by side, the top covers of all drives must be removed as shown in Figure i.8.*

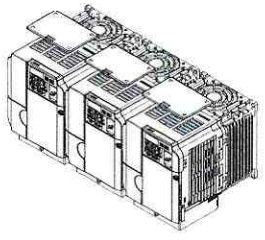


Figure i.8 IP20/NEMA 1, UL Type 1 Side-by-Side Mounting in Enclosure

◆ Drive Dimensions

NOTICE

Refer to the iQpump Micro User Manual TOEP YAIQPM 03 for IP20/NEMA 1, UL Type 1 and IP66/NEMA 4X, UL Type 4X dimensions.

The iQpump Micro User Manual TOEP YAIQPM 03 is available 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.9***. It is possible to run the drive via the digital operator without connecting digital I/O wiring. ***Refer to Start-Up Programming and Operation on page 67*** for instructions on operating the drive

NOTICE: *Inadequate branch short circuit protection could result in damage to the drive. Install adequate branch circuit short circuit protection per applicable codes. The drive is suitable for circuits capable of delivering not more than 31,000 RMS symmetrical amperes, 240 Vac maximum (200 V Class) and 480 Vac maximum (400 V Class).*

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

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

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

NOTICE: *The minimum load for the multi-function relay output MA-MB-MC is 10 mA. If a circuit requires less than 10 mA (reference value), connect it to a photocoupler output (P1, P2, PC). Improper application of peripheral devices could result in damage to the photocoupler output of the drive.*

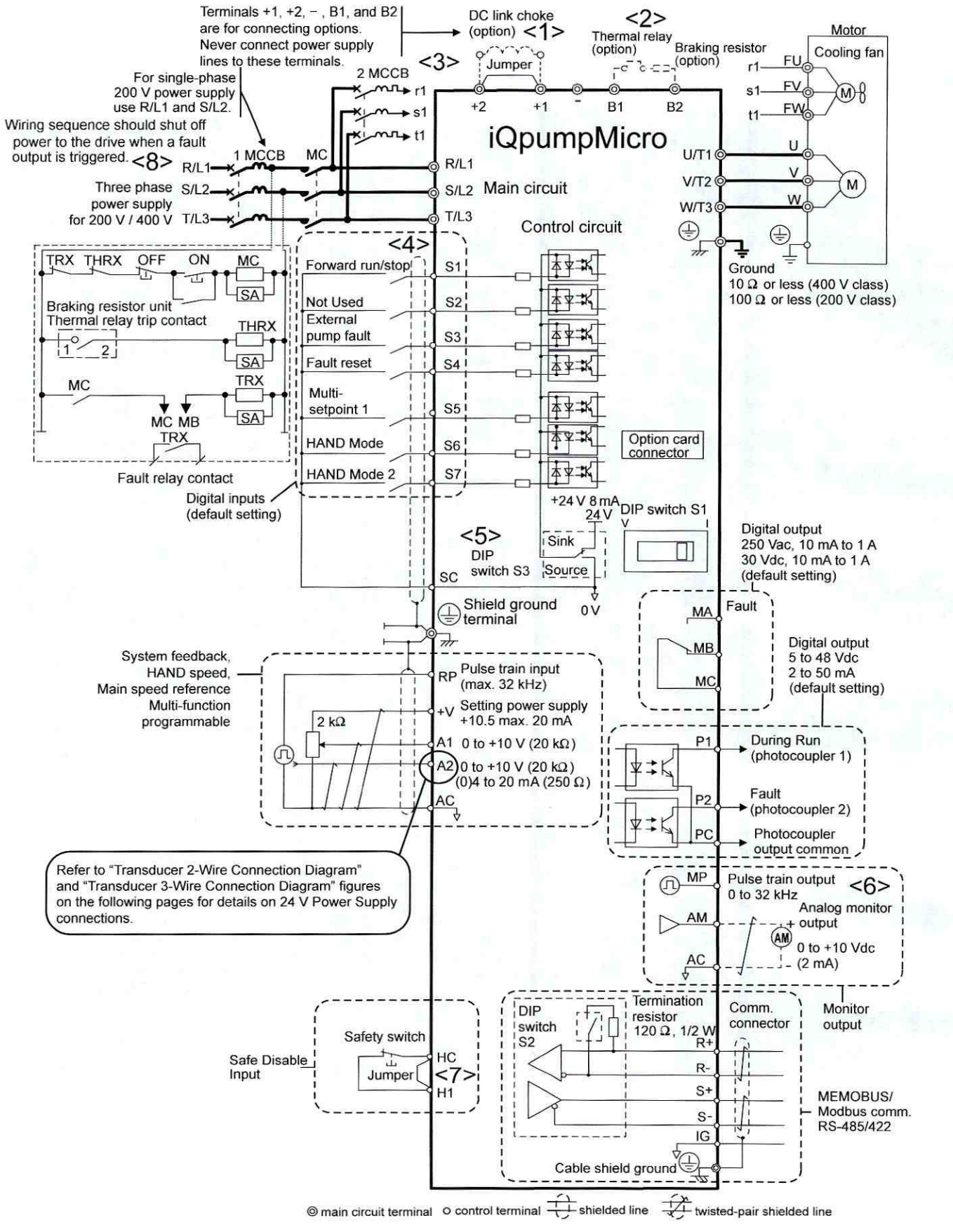


Figure i.9 Drive Standard Connection Diagram

<1> Remove the jumper when installing an optional DC link choke.

<2> The MC on the input side of the main circuit should open when the thermal relay is triggered.

<3> Self-cooled motors do not require separate cooling fan motor wiring.

<4> Connected using sequence input signal (S1 to S7) from NPN transistor; Default: sink mode (0 V com).

<5> Use only a +24 V internal power supply in sinking mode; the source mode requires an external power supply.

<6> Monitor outputs work with devices such as analog frequency meters, ammeters, voltmeters and wattmeters; they are not intended for use as a feedback-type of signal.

<7> Disconnect the wire jumper between HC and H1 when utilizing the safety input. ***Refer to Wiring the Control Circuit Terminal on page 61*** for details on removing the jumper. The wire length for the Safe Disable input should not exceed 30 m.

<8> Note that if the drive is set to trigger a fault output whenever the fault restart function is activated (L5-02 = 1), then a sequence to interrupt power when a fault occurs will result in shutting off the power to the drive as the drive attempts to restart itself. The default setting for L5-02 is 0 (fault output active during restart attempt).

WARNING! *Sudden Movement Hazard. Do not close the wiring for the control circuit unless the multifunction input terminal parameter is properly set (S5 for 3-Wire; H1-05 = "0"). 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! *When 3-Wire sequence is used, set the drive to 3-Wire sequence before wiring the control terminals and ensure parameter b1-17 is set to 0 (drive does not accept a run command at power up (default). If the drive is wired for 3-Wire sequence but set up for 2-Wire sequence (default) and if parameter b1-17 is set to 1 (drive accepts a Run command at power up), the motor will rotate in reverse direction at power up of the drive and may cause injury.*

WARNING! *When the application preset function is executed (or A1-06 is set to any value other than 0) the drive I/O terminal functions change. This may cause unexpected operation and potential damage to equipment or injury.*

Figure i.10 illustrates an example of a 3-Wire sequence.

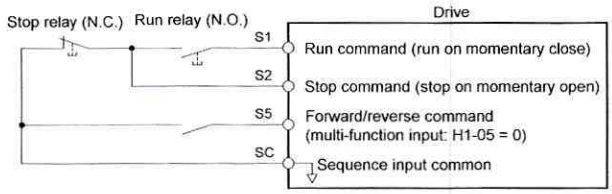


Figure i.10 3-Wire Sequence

◆ Transducer Connection Diagrams

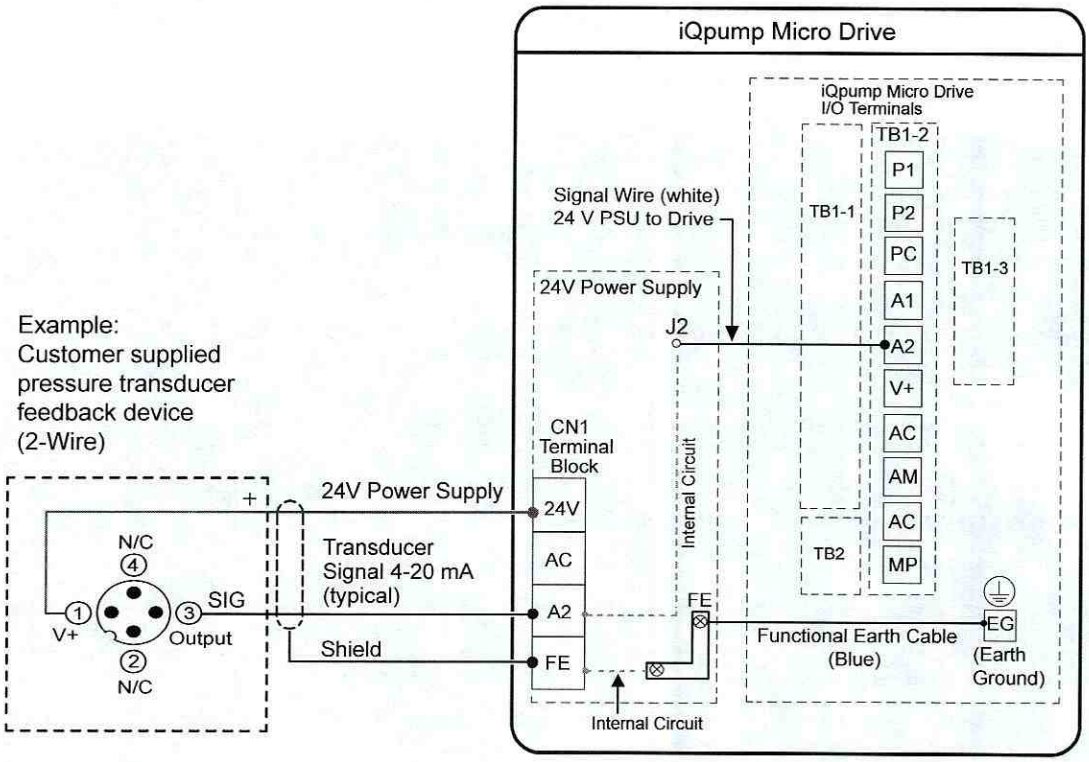


Figure i.11 Transducer 2-Wire Connection Diagram

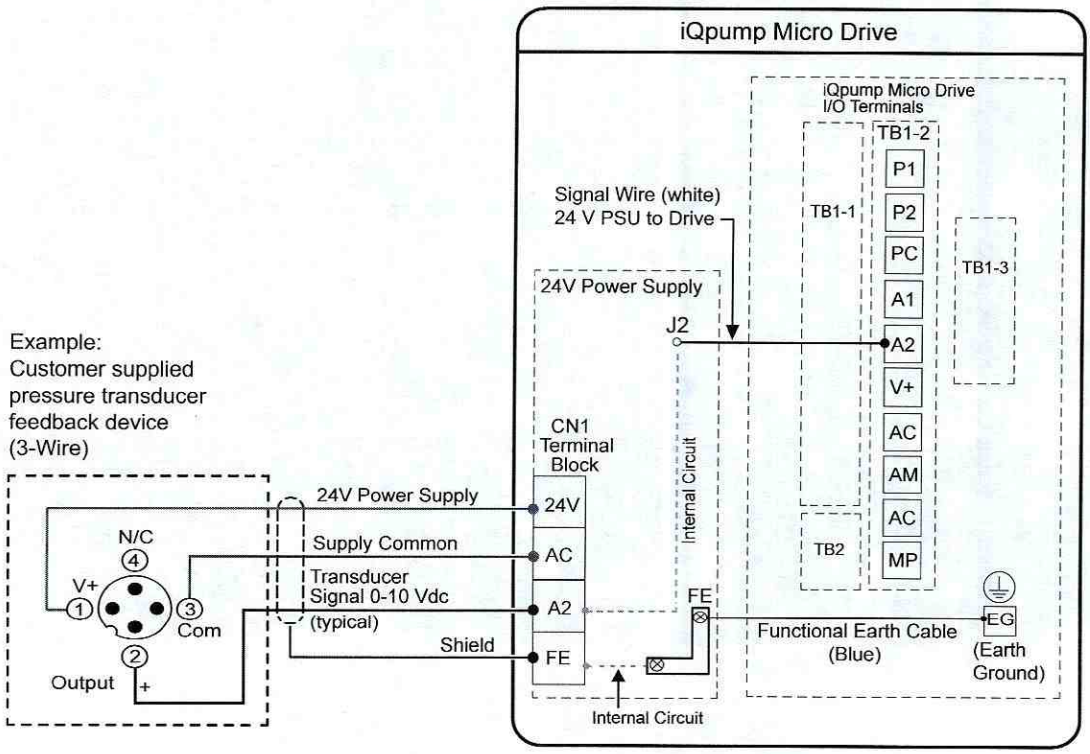


Figure i.12 Transducer 3-Wire Connection Diagram

i.5 Main Circuit Wiring

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

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

◆ Main Circuit Terminal Functions

Table i.2 Main Circuit Terminal Functions

Terminal	Type	Function	Reference
R/L1 S/L2 T/L3	Main circuit power supply input	Connects line power to the drive. Drives with single-phase 200 V input power use terminals R/L1 and S/L2 only. Do NOT use T/L3.	–
U/T1 V/T2 W/T3	Drive output	Connects to the motor.	*58*
B1 B2	Braking resistor	Available for connecting a braking resistor or the braking resistor unit option.	–
⊕1 ⊕2	DC link choke connection	These terminals are shorted at shipment. Remove the shorting bar between ⊕1 and ⊕2 when connecting a DC link choke to this terminal.	–
⊕1 ⊖	DC power supply input	For connecting a DC power supply.	–
⏚ (2 terminals)	Ground	Grounding Terminal	*58*

◆ Wire Gauges and Tightening Torques

Select the appropriate wires and crimp terminals from *Table i.3* through *Table i.5*.

Note:
1. Wire gauge recommendations based on drive continuous current ratings using 75 °C 600 Vac vinyl-sheathed wire assuming ambient temperature within 30 °C and wiring distance shorter than 100 m.
2. Terminals ⊕1, ⊕2, ⊖, B1 and B2 are for connecting optional devices such as a braking resistor. Do not connect other non-specified devices to these terminals.

- 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) = √3 x wire resistance (Ω/km) x wire length (m) x current (A) x 10^{-3}
- Refer to instruction manual TOBP C720600 00 for braking unit or braking resistor unit wire gauges.
- *Refer to UL Standards Compliance on page 112* for information on UL compliance.

■ Single-Phase 200 V Class

Table i.3 Wire Gauge and Torque Specifications

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N•m (lb.in.)
BV0006	R/L1, S/L2, T/L3	12	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
BV0010	R/L1, S/L2, T/L3	10	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N•m (lb.in.)
BV0012	R/L1, S/L2, T/L3	10	14 to 10	M4	2.3 to 2.5 (20.4 to 22.1)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
BV0018	R/L1, S/L2, T/L3	8	12 to 8	M5	2.3 to 2.5 (20.4 to 22.1)
	U/T1, V/T2, W/T3	10	12 to 8		
	⊖, ⊕1, ⊕2	–	12 to 8		
	B1, B2	–	12 to 8		
	⏚	8	12 to 8		2 to 2.5 (17.7 to 22.1)

■ Three-Phase 200 V Class

Table i.4 Wire Gauge and Torque Specifications

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N•m (lb.in.)
2V0006	R/L1, S/L2, T/L3	14	18 to 14	M3.5	0.8 to 1.0 (7.1 to 8.9)
	U/T1, V/T2, W/T3	14	18 to 14		
	⊖, ⊕1, ⊕2	–	18 to 14		
	B1, B2	–	18 to 14		
	⏚	14	18 to 14		
2V0010	R/L1, S/L2, T/L3	12	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
2V0012	R/L1, S/L2, T/L3	12	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
2V0020	R/L1, S/L2, T/L3	10	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	10	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
2V0030	R/L1, S/L2, T/L3	8	10 to 6	M4	2.1 to 2.3 (18.6 to 20.4)
	U/T1, V/T2, W/T3	8	10 to 6		
	⊖, ⊕1, ⊕2	–	10 to 6		
	B1, B2	–	14 to 10		
	⏚	8	10 to 6	M5	2 to 2.5 (17.7 to 22.1)
2V0040	R/L1, S/L2, T/L3	6	10 to 6	M4	2.1 to 2.3 (18.6 to 20.4)
	U/T1, V/T2, W/T3	8	10 to 6		
	⊖, ⊕1, ⊕2	–	10 to 6		
	B1, B2	–	14 to 10		
	⏚	6	10 to 6	M5	2 to 2.5 (17.7 to 22.1)

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N•m (lb.in.)
2V0056	R/L1, S/L2, T/L3	4	6 to 4	M6	5.4 to 6.0 (47.8 to 53.1)
	U/T1, V/T2, W/T3	4	6 to 4		
	⊖, ⊕1, ⊕2	–	6 to 4		
	B1, B2	–	10 to 6	M5	2.7 to 3.0 (23.9 to 26.6)
	⏚	6	8 to 4	M6	5.4 to 6.0 (47.8 to 53.1)
2V0069	R/L1, S/L2, T/L3	3	8 to 2	M8	9.9 to 11 (87.6 to 97.4)
	U/T1, V/T2, W/T3	3	8 to 2		
	⊖, ⊕1, ⊕2	–	8 to 2		
	B1, B2	–	8 to 6	M5	2.7 to 3.0 (23.9 to 26.6)
	⏚	6	6 to 4	M6	5.4 to 6.0 (47.8 to 53.1)

■ Three-Phase 400 V Class

Table i.5 Wire Gauge and Torque Specifications

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N•m (lb.in.)
4V0002 4V0004	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	14	14 to 10		
4V0005 4V0007 4V0009	R/L1, S/L2, T/L3	14	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
4V0011	R/L1, S/L2, T/L3	12	14 to 10	M4	1.2 to 1.5 (10.6 to 13.3)
	U/T1, V/T2, W/T3	14	14 to 10		
	⊖, ⊕1, ⊕2	–	14 to 10		
	B1, B2	–	14 to 10		
	⏚	10	14 to 10		
4V0018	R/L1, S/L2, T/L3	10	14 to 6	M4	2.1 to 2.3 (18.6 to 20.4)
	U/T1, V/T2, W/T3	10	14 to 6		
	⊖, ⊕1, ⊕2	–	14 to 6		
	B1, B2	–	14 to 10		
	⏚	8	14 to 6	M5	2 to 2.5 (17.7 to 22.1)
4V0023	R/L1, S/L2, T/L3	10	10 to 6	M4	2.1 to 2.3 (18.6 to 20.4)
	U/T1, V/T2, W/T3	10	10 to 6		
	⊖, ⊕1, ⊕2	–	10 to 6		
	B1, B2	–	14 to 10		
	⏚	8	10 to 6	M5	2 to 2.5 (17.7 to 22.1)

Drive Model	Terminal	Recomm. Gauge AWG, kcmil	Wire Range AWG, kcmil	Screw Size	Tightening Torque N•m (lb.in.)
4V0031	R/L1, S/L2, T/L3	8	10 to 6	M5	3.6 to 4.0 (31.8 to 35.4)
	U/T1, V/T2, W/T3	8	10 to 6		
	⊖, ⊕1, ⊕2	–	10 to 6		
	B1, B2	–	14 to 10		2.7 to 3.0 (23.9 to 26.6)
	⏚	6	10 to 6	M6	5.4 to 6.0 (47.8 to 53.1)
4V0038	R/L1, S/L2, T/L3	6	10 to 6	M5	3.6 to 4.0 (31.8 to 35.4)
	U/T1, V/T2, W/T3	8	10 to 6		
	⊖, ⊕1, ⊕2	–	10 to 6		
	B1, B2	–	10 to 8		2.7 to 3.0 (23.9 to 26.6)
	⏚	6	10 to 6	M6	5.4 to 6.0 (47.8 to 53.1)

◆ Main Circuit Terminal Power Supply and Motor Wiring

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

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

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

NOTICE: *Do not connect phase-advancing capacitors or LC/RC noise filters to the output circuits. Improper application of noise filters could result in damage to the drive.*

NOTICE: *Do not connect the AC power line to the output motor 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.*

■ Cable Length Between Drive and Motor

When the cable length between the drive and the motor is too long (especially at low frequency output), note that the cable voltage drop may cause reduced motor torque. Drive output current will increase as the leakage current from the cable increases. An increase in leakage current may trigger an overcurrent situation and weaken the accuracy of the current detection.

Adjust the drive carrier frequency according to the following table. If the motor wiring distance exceeds 100 m because of the system configuration, reduce the ground currents.

Refer to ***Table i.6*** to set the carrier frequency to an appropriate level.

Table i.6 Cable Length Between Drive and Motor

Cable Length	50 m or shorter	100 m or shorter	Longer than 100 m
Carrier Frequency	15 kHz or less	5 kHz or less	2 kHz or less

Note: When setting carrier frequency, calculate the cable length as the total distance of wiring to all connected motors when running multiple motors from a single drive.

■ Ground Wiring

Follow the precautions to wire the ground for one drive or a series of drives.

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

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

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

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

Refer to ***Figure i.13*** when using multiple drives. Do not loop the ground wire.

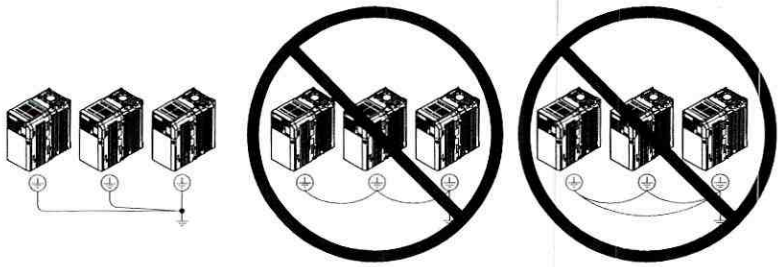


Figure i.13 Multiple Drive Wiring

◆ Control Circuit Terminal Block Functions

Drive parameters determine which functions apply to the multi-function digital inputs (S1 to S7), multi-function digital outputs (MA, MB), multi-function pulse inputs and outputs (RP, MP) and multi-function photocoupler outputs (P1, P2). The default is called out next to each terminal in ***Figure i.9***.

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

■ Input Terminals

Table i.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 **Note:** Drive preset to sinking mode. When using source mode, set DIP switch S3 to allow for a 24 Vdc (±10%) external power supply. *Refer to Sinking/Sourcing Mode Switch on page 63.*
	S2	Multi-function input 2 (Not used/Through mode)	
	S3	Multi-function input 3 (External pump 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 (HAND Mode)	
	S7	Multi-function input 7 (HAND Mode 2)	
	SC	Multi-function input common (Control common)	Sequence common
Safe Disable Input	HC	Power supply for safe disable input	+24 Vdc (max 10 mA allowed)
	H1	Safe disable input	Open: Output disabled Closed: Normal operation **Note:** Disconnect wire jumper between HC and H1 when using the safe disable input. The wire length should not exceed 30 m.
Main Frequency Reference Input	RP	Multi-function pulse train input (frequency reference)	Response frequency: 0.5 to 32 kHz (Duty Cycle: 30 to 70%) (High level voltage: 3.5 to 13.2 Vdc) (Low level voltage: 0.0 to 0.8 Vdc) (input impedance: 3 kΩ)
	+V	Analog input power supply	+10.5 Vdc (max allowable current 20 mA)
	A1	Multi-function analog input 1 (frequency reference)	Input voltage 0 to +10 Vdc (20 kΩ) resolution 1/1000
	A2	Multi-function analog input 2 (frequency reference)	Input voltage or input current (Selected by DIP switch S1 and H3-09) 0 to +10 Vdc (20 kΩ), Resolution: 1/1000 4 to 20 mA (250 Ω) or 0 to 20 mA (250 Ω), Resolution: 1/500
	AC	Frequency reference common	0 Vdc

■ Output Terminals

Table i.8 Control Circuit Output Terminals

Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Multi-Function Digital Output <1>	MA	N.O. (fault)	Digital output 30 Vdc, 10 mA to 1 A; 250 Vac, 10 mA to 1 A Minimum load: 5 Vdc, 10 mA (reference value)
	MB	N.C. output (fault)	
	MC	Digital output common	

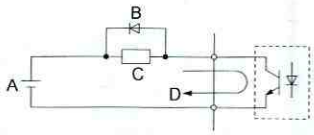
Type	No.	Terminal Name (Function)	Function (Signal Level) Default Setting
Multi-Function Photocoupler Output	P1	Photocoupler output 1 (During run)	Photocoupler output 48 Vdc, 2 to 50 mA <2>
	P2	Photocoupler output 2 (Frequency agree)	
	PC	Photocoupler output common	
Monitor Output	MP	Pulse train output (Output frequency)	32 kHz (max) <3> <4>
	AM	Analog monitor output	0 to 10 Vdc (2 mA or less) Resolution: 1/1000
	AC	Monitor common	0 V

<1> Do not assign functions to digital relay outputs that involve frequent switching. This may shorten relay performance life. Switching life is estimated at 200,000 times (assumes 1 A, resistive load).

<2> Connect a suppression diode as shown in ***Figure i.14*** when driving a reactive load such as a relay coil. Ensure the diode rating is greater than the circuit voltage.

<3> When set for sourcing. +5 V/1.5 kΩ or higher, +8 V/3.5 kΩ or higher, +10 V/10 kΩ or higher.

<4> When set for sinking, the external power supply should be +12 Vdc, ±5% with 16 mA or less.



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

Figure i.14 Connecting a Suppression Diode

■ Serial Communication Terminals

Table i.9 Control Circuit Terminals: Serial Communications

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

◆ Terminal Configuration

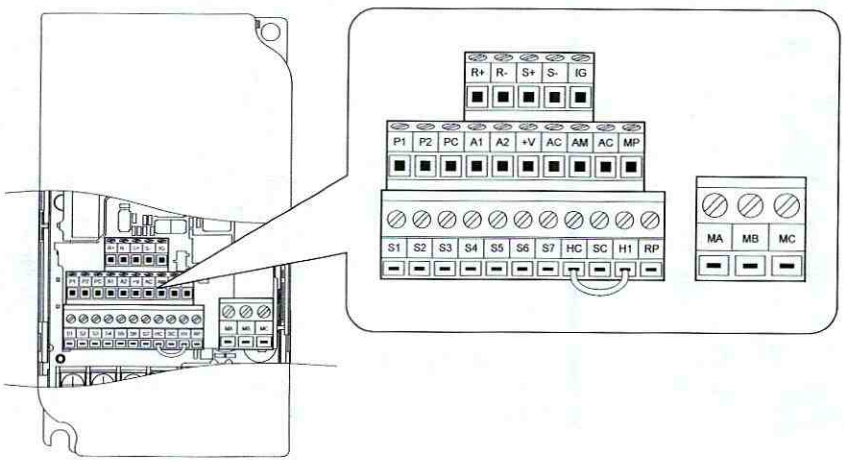


Figure i.15 Removable Control Circuit Terminal Block

■ Wire Size and Torque Specifications

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

Table i.10 Wire Size and Torque Specifications (Same for All Models)

Terminal	Screw Size	Tightening Torque N•m (in-lbs)	Bare Wire Terminal		Ferrule-Type Terminal		
			Applic. wire size mm² (AWG)	Recomm. mm² (AWG)	Applic. wire size mm² (AWG)	Recomm. mm² (AWG)	Wire Type
MA, MB, MC	M3	0.5 to 0.6 (4.4 to 5.3)	Stranded: 0.25 to 1.5 (24 to 16) Single: 0.25 to 1.5 (24 to 16)	0.75 (18)	0.25 to 1.0 (24 to 17)	0.5 (20)	Shielded line, etc.
S1-S7, SC, RP, +V, A1, A2, AC, HC, H1, P1, P2, PC, MP, AM, AC, S+, S-, R+, R-, IG	M2	0.22 to 0.25 (1.9 to 2.2)	Stranded: 0.25 to 1.0 (24 to 18) Single: 0.25 to 1.5 (24 to 16)	0.75 (18)	0.25 to 0.5 (24 to 20)	0.5 (20)	

■ Ferrule-Type Wire Terminations

Crimp a ferrule to signal wiring to improve wiring simplicity and reliability. Use CRIMPFOX 6, a crimping tool manufactured by PHOENIX CONTACT.

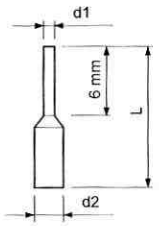


Figure i.16 Ferrule Dimensions

Table i.11 Ferrule Terminal Types and Sizes

Size mm² (AWG)	Type	L (mm)	d1 (mm)	d2 (mm)	Manufacturer
0.25 (24)	AI 0.25-6YE	10.5	0.8	2.0	PHOENIX CONTACT
0.34 (22)	AI 0.34-6TQ	10.5	0.8	2.0	
0.5 (20)	AI 0.5-6WH	12	1.1	2.5	
0.75 (18)	AI 0.75-6GY	12	1.3	2.8	
1.0	AI 1-6RD	12	1.5	3.0	

◆ 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, B1, B2, U/T1, V/T2, W/T3, ⊖, ⊕1, ⊕2) 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 and MC 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 (UL standard) when connecting to the control terminals. Improper application of peripheral devices could result in drive performance degradation due to improper power supply.*

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.*

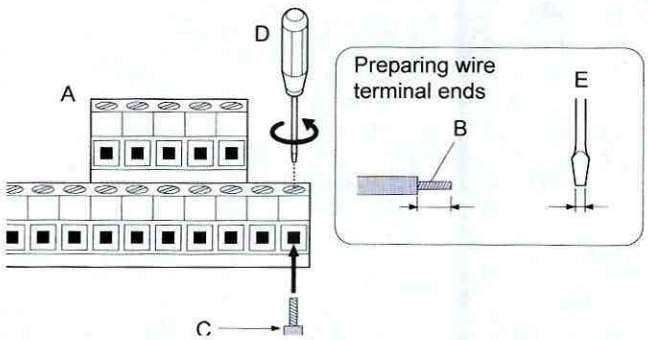
NOTICE: *Connect the shield of shielded cable to the appropriate ground terminal. Improper equipment grounding could result in drive or equipment malfunction or nuisance trips.*

Wire the control terminals using *Figure i.17* as a guide. Prepare the ends of the control circuit wiring as shown in *Figure i.18. Refer to Wire Size and Torque Specifications on page 61.*

NOTICE: *Do not tighten screws beyond the specified tightening torque. Failure to comply may damage the terminal block.*

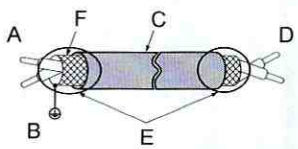
NOTICE: *Use shielded twisted-pair cables as indicated to prevent operating faults. Improper wiring practices could result in drive or equipment malfunction due to electrical interference.*

Connect control wires as shown in the following figure:



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

Figure i.17 Terminal Board Wiring Guide

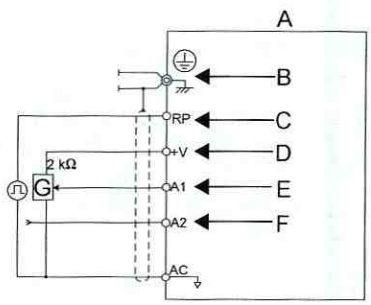


A – Drive side
B – Connect shield to ground terminal of drive.
C – Insulation
D – Control device side
E – Shield sheath (Insulate with tape)
F – Shield

Figure i.18 Preparing the Ends of Shielded Cables

When setting the frequency by analog reference from an external potentiometer, use shielded twisted-pair wires and ground the shield of twisted-pair wires to the ground terminal of the drive.

NOTICE: *The analog signal lines 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.*



A – Drive
B – Ground terminal (shield connection)
C – (RP) Pulse train (maximum 32 kHz)
D – (+V) Frequency setting power source +10.5 Vdc maximum 20 mA
E – (A1) Main speed frequency reference 0 to +10 Vdc (20 kΩ)
F – (A2) Multi-function analog input 0 to +10 Vdc (20 kΩ) or 4 to 20 mA (250 Ω)/ 0 to 20 mA (250 Ω)
G – Frequency setting potentiometer

Figure i.19 Wiring the Frequency Reference to the Control Circuit Terminals (External Reference)

◆ Sinking/Sourcing Mode Switch

Set the DIP switch S3 on the front of the drive to switch the digital input terminal logic between sinking mode and sourcing mode; the drive is preset to sinking mode.

Table i.12 Sinking/Sourcing Mode Setting

Set Value	Details
SINK	Sinking Mode (0 V common): default setting
SOURCE	Sourcing Mode (+24 V common)

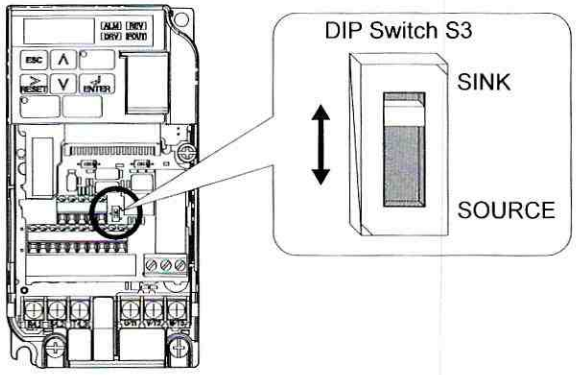


Figure i.20 DIP Switch S3

■ Transistor Input Signal Using 0 V Common/Sink Mode

When controlling the digital inputs by NPN transistors (0 V common/sinking mode), set the DIP switch S3 to SINK and use the internal 24 V power supply.

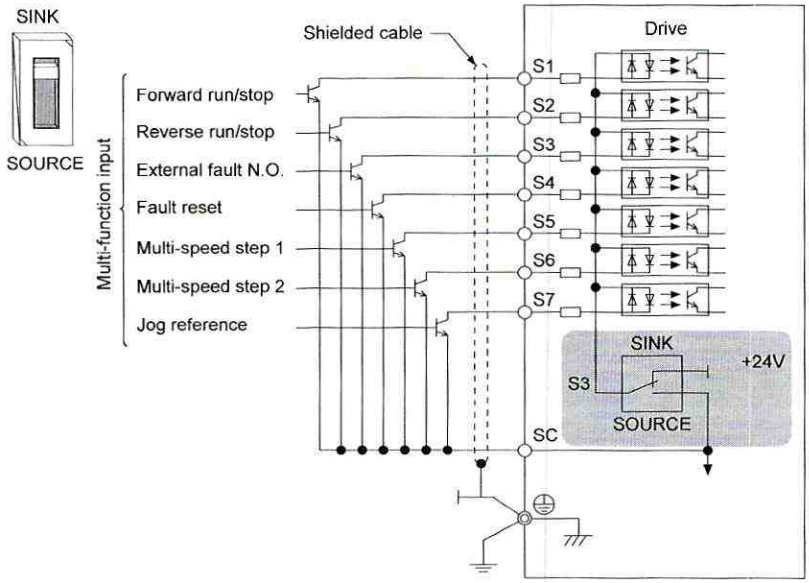


Figure i.21 Sinking Mode: Sequence from NPN Transistor (0 V Common)

■ Transistor Input Signal Using +24 V Common/Source Mode

When controlling digital inputs by PNP transistors (+24 V common/sourcing mode), set the DIP switch S3 to SOURCE and use an external 24 V power supply.

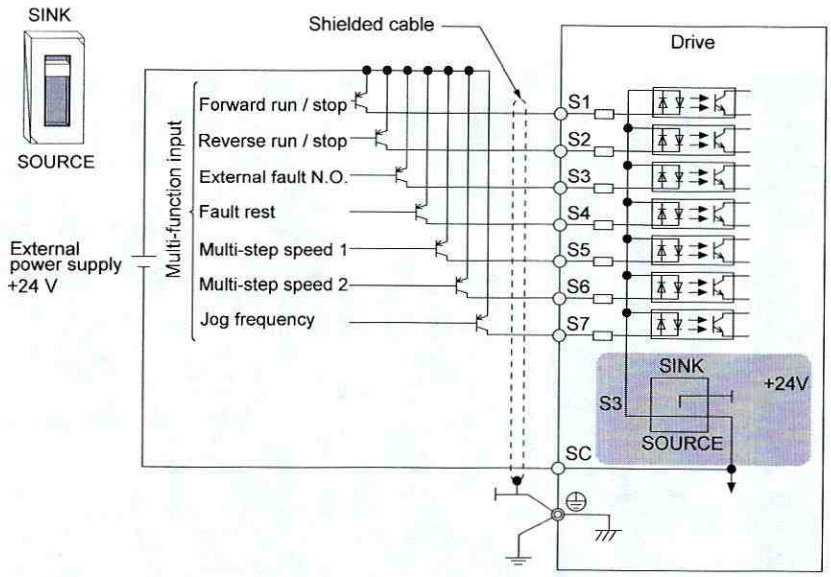


Figure i.22 Source Mode: Sequence from PNP Transistor (+24 V Common)

◆ DIP Switch S1 Analog Input Signal Selection

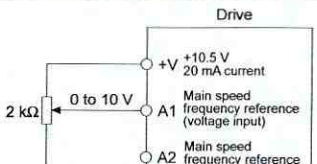
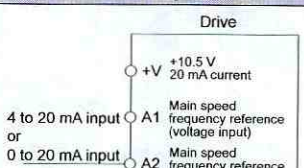
The main frequency reference can either be a voltage or current signal input. For voltage signals both analog inputs, A1 and A2, can be used, for current signals A2 must be used.

When using input A2 as a voltage input, set DIP switch S1 to "V" (left position) and program parameter H3-09 to 0 (0 to +10 Vdc with lower limit) or 1 (0 to +10 Vdc without lower limit).

To use current input at terminal A2, set the DIP switch S1 to "I" (default setting) and set parameter H3-09 = 2 or 3 (4-20 mA or 0-20 mA). Set parameter H3-10 = 0 (frequency reference).

Note: If Terminals A1 and A2 are both set for frequency reference (H3-02 = 0 and H3-10 = 0), the addition of both input values builds the frequency reference.

Table i.13 Frequency Reference Configurations

Voltage Input	Current Input
	

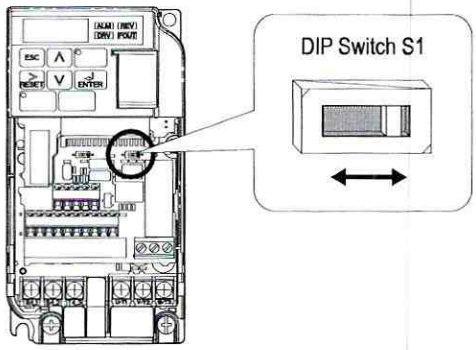


Figure i.23 DIP Switch S1

Table i.14 DIP Switch S1 Settings

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

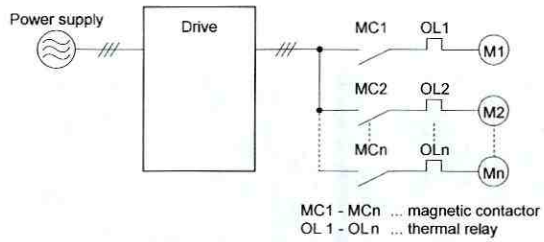
Table i.15 Parameter H3-09 Details

No.	Parameter Name	Description	Setting Range	Default Setting
H3-09	Frequency ref. (current) terminal A2 signal level selection	Selects the signal level for terminal A2. 0: 0 to +10 V, unipolar input (with lower limit) 1: 0 to +10 V, bipolar input (no lower limit) 2: 4 to 20 mA 3: 0 to 20 mA	0 to 3	2

◆ Wiring Checklist

☑	No.	Item	Page
		Drive, peripherals, option cards	
☐	1	Check drive model number to ensure receipt of correct model.	*46*
☐	2	Check for correct braking resistors, DC link chokes, noise filters, and other peripheral devices.	–
		Installation area and physical setup	
☐	3	Ensure area surrounding the drive complies with specifications.	*48*
		Power supply voltage, output voltage	
☐	4	The voltage from the power supply should fall within the input voltage specification range of the drive.	–
☐	5	The voltage rating for the motor should match the drive output specifications.	*46*
		Main circuit wiring	
☐	6	Confirm proper branch circuit protection exists per National and Local codes.	*51*
☐	7	Properly wire the power supply to drive terminals R/L1, S/L2 and T/L3.	–
☐	8	Properly wire the drive and motor together. The motor lines and drive output terminals R/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.	*58*
☐	9	Use 600 Vac vinyl-sheathed wire for the power supply and motor lines.	*55*
☐	10	Use the correct wire gauges for the main circuit. Refer to ***Table i.3***, ***Table i.4***, or ***Table i.5***.	*55*
		When using comparatively long motor cable, calculate the amount of voltage drop. Motor rated voltage (V) x 0.02 ≥ 3 x voltage resistance (Ω/km) x cable length (m) x motor rated current (A) x 10^{-3}	*55*
		If the cable between the drive and motor exceeds 50 m, adjust the carrier frequency (C6-02) accordingly.	*58*
☐	11	Properly ground the drive.	*58*
☐	12	Tightly fasten all terminal screws. Refer to ***Table i.3***, ***Table i.4***, or ***Table i.5***.	*55*

i.5 Main Circuit Wiring

☑	No.	Item	Page
☐	13	Set up overload protection circuits when running multiple motors from a single drive.  **Note:** Close MC1 through MCn before operating the drive.	–
☐	14	If using a braking resistor or dynamic braking resistor unit, install a magnetic contactor. Properly install the resistor, and ensure that overload protection shuts off the power supply.	–
☐	15	Verify phase advancing capacitors are NOT installed on the output side of the drive.	–
		Control circuit wiring	
☐	16	Use twisted-pair cables for all drive control circuit wiring.	–
☐	17	Ground the shields of shielded wiring to the GND ⏚ terminal.	*61*
☐	18	If using a 3-Wire sequence, set parameters for MFDI terminals S1 through S7, and properly wire control circuits.	*53*
☐	19	Check for any other wiring mistakes. Only use a multimeter to check wiring.	–
☐	20	Properly fasten the control circuit terminal screws in the drive. Refer to ***Table i.3***, ***Table i.4***, or ***Table i.5***.	*55*
☐	21	Pick up all wire clippings.	–
☐	22	Ensure that no frayed wires on the terminal block are touching other terminals or connections.	–
☐	23	Properly separate control circuit wiring and main circuit wiring.	–
☐	24	Analog signal line wiring should not exceed 50 m.	–
☐	25	Safe Disable Input wiring should not exceed 30 m.	–

i.6 Start-Up Programming and Operation

◆ Keys, Displays, and LEDs on the Standard LED Operator

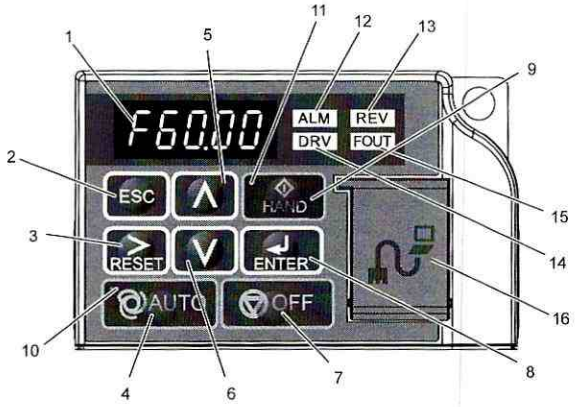


Table i.16 Keys and Displays on the LED Operator

No.	Display	Name	Function
1	F60.00	Data Display Area	Displays the frequency reference, parameter number, etc.
2	ESC	ESC Key	Returns to the previous menu.
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.
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 as set by P5-01. • Set the drive to HAND mode. • When P5-03 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.
11	HAND	HAND Light	Lit while the drive is in HAND mode.
12	ALM	ALM LED Light	Lit or flashing when the drive detects an alarm or error.
13	REV	REV LED Light	Lit when motor is rotating in reverse.
14	DRV	DRV LED Light	Lit when in Drive Mode or Auto-Tuning.
15	FOUT	FOUT LED Light	Lit then displaying output frequency.

No.	Display	Name	Function
16	–	Communication Port	Port used for USB Copy Unit, LCD Operator Keypad, and for connecting to a PC. **NOTICE:** *Use only specified cable when making connections to the drive. Failure to comply may damage the drive.* **NOTICE:** *Do not open the port cover wider than 90 degrees. Failure to comply may break the port cover and leave the unprotected port susceptible to damage.*

◆ Menu Structure for Digital LED Operator

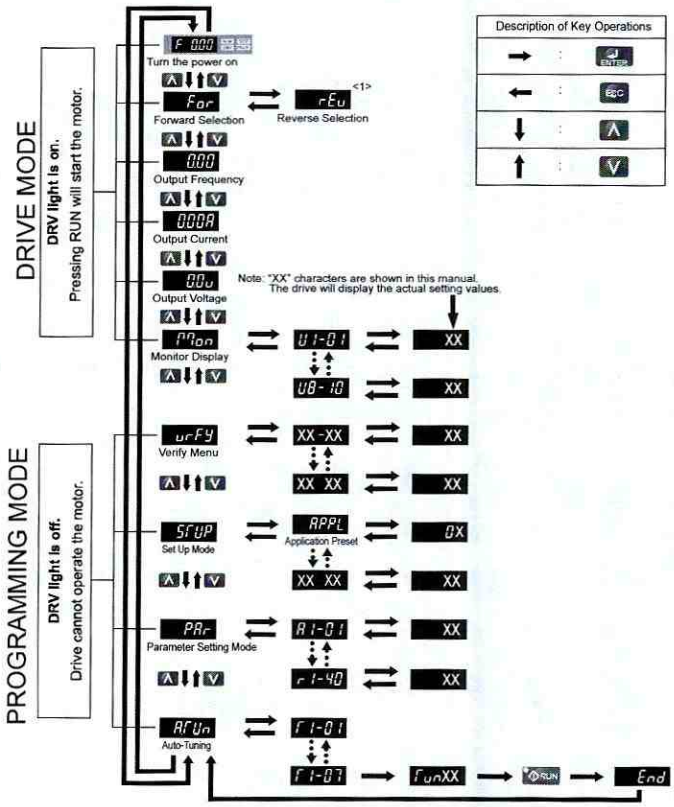


Figure i.24 Digital LED Operator Screen Structure

<1> Reverse can only be selected when LOCAL is set.

■ Powering Up the Drive

Review the following checklist before turning the power on.

Item to Check	Description
Power supply voltage	Ensure the power supply voltage is correct: 200 V class: single-phase 200 to 240 Vac 50/60 Hz 200 V class: 3-phase 200 to 240 Vac 50/60 Hz 400 V class: 3-phase 380 to 480 Vac 50/60 Hz
	Properly wire the power supply input terminals (R/L1, S/L2, T/L3). (for single-phase 200 V class models, wire only R/L1 and S/L2)
	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	Uncouple the motor from the load.

◆ Keys and Displays on the Optional HOA Keypad

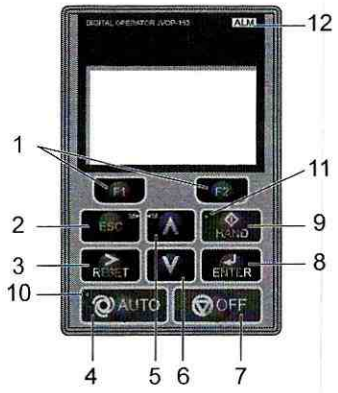


Figure i.25 Keys and Displays on the HOA Keypad

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.
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 as set by P5-01. • Set the drive to HAND mode. • When P5-03 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.
11	HAND	HAND Light	Lit while the drive is in HAND mode.
12	ALM	ALM LED Light	Lit or flashing when the drive detects an alarm or error.

◆ LCD Display

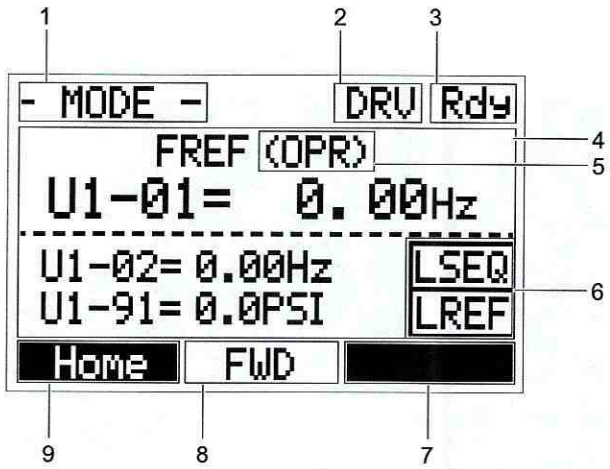


Figure i.26 LCD Display

Table i.17 Display and Contents

No.	Name	Display	Content
1	Operation Mode Menus	MODE	Displayed when in Mode Selection.
		QMONI: Use F1/F2	Instructions to access the Quick Monitors.
		MENU: Use UP/ DWN	Instructions to access the next menu item.
		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. **Note:** This display will blink when b1-02 is set to 1 (Digital Inputs).
		LSEQ	Displayed when the Run command is supplied from the HOA keypad.
		RREF	Displayed when the Run command is supplied from a remote source. **Note:** This display will blink when b1-01 is set to 1 (Analog Inputs).
		LREF	Displayed when the Run command is supplied from the HOA keypad.
7	Function Key 2 (F2)	<-MONITOR->	Pressing F2 displays the next Quick Monitor.
		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.