RSi GM2 Series

Variable Frequency Drive

1.0 to 15HP - 230V
1.0 to 15HP - 460V

Instruction Manual

890054-00-00

BENSHAW

Applied Motor Controls

Safety Information

Read and follow all safety instructions in this manual precisely to avoid unsafe operating conditions, property damage, personal injury, or even death.

Safety Symbols in This Manual

⚠ Danger

Indicates an imminently hazardous situation which, if not avoided, will result in severe injury or even death.

⚠ Warning

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

⚠ Caution

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

Safety Information

⚠ Danger

- Never remove the product cover or touch the internal printed circuit board (PCB) or any contact points when the power is on. Also, do not start the product when the cover is open. This may cause an electrical shock due to the exposure of high voltage terminals or live parts.
- Even if the power is off, do not open the cover unless it is absolutely necessary like for the wiring operation or for regular inspection. Opening the cover may still cause an electrical shock even after the power is blocked because the product has been charged for a long period of time.
- Wait at least 10 minutes before opening the covers and exposing the terminal connections. Before starting work on the inverter, test the connections to ensure all DC voltage has been fully discharged. Otherwise it may cause an electrical shock and result in personal injury or even death.

⚠ Warning

- Make sure to install ground connection between the equipment and the motor for safe use. Otherwise it may cause an electrical shock and result in personal injury or even death.
- Do not turn on the power if the product is damaged or faulty. If you find that the product is faulty, disconnect the power supply and have the product professionally repaired.
- The inverter becomes hot during operation. Avoid touching the inverter until it has cooled to avoid burns. Avoid touching the inverter until it has cooled to avoid burns.

- Do not allow foreign objects, such as screws, metal chips, debris, water, or oil to get inside the inverter. Allowing foreign objects inside the inverter may cause the inverter to malfunction or result in a fire.
- Do not operate the switch with wet hands. Otherwise it may cause an electrical shock and result in personal injury or even death.
- Check the information about the protection level for the circuits and devices.

  The connection terminals and parts below have electrical protection class 0. This means that the protection class of the circuit depends on basic insulation and there is a danger of electric shock if the basic insulation is not working properly. Therefore, take the same protective measures as handling the power line when connecting wires to the terminals or the device below, or when installing or using the devices.
  - Multi-function (digital) Input: P1–P5, CM
  - Analog Input/Output: VR, V1, I2, AO
  - Digital Output: 24, A1/B1/C1, A2/C2
  - Communication: S+/ S-
  - Fan
- The protection level of this equipment is electrical protective class 1.

Caution

- Do not change the inside of the product at your own discretion. This may result in injury or damage to the product due to failure or malfunction. Also, products changed at your own discretion will be excluded from the product warranty.
- Do not use the inverter for single phase motor operation as it has been designed for three phase motor operation. Using a single phase motor may damage the motor.
- Do not place heavy objects on top of electric cables. Heavy objects may damage the cable and result in electric shock.

Note

Following IEC 60439-1, the maximum allowed short-circuit current at the power source is 100kA. Based on the selected breaker, the GM2 inverter is suitable for use in circuits capable of delivering up to a maximum of 100 kA symmetrical current at the drive's maximum rated voltage.

Table of Contents

1 Preparing the Installation

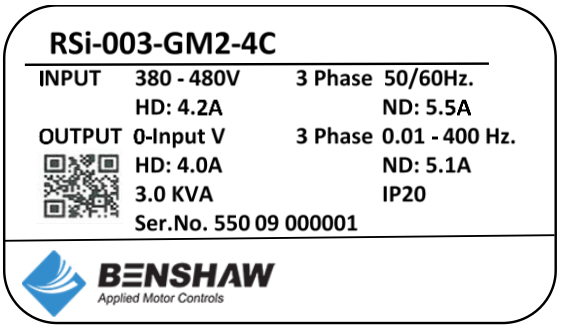
This chapter provides details on product identification, part names, correct installation and cable specifications. To install the inverter correctly and safely, carefully read and follow the instructions.

1.1 Product Identification

The GM2 Inverter is manufactured within a range of 1 HP ~ 15 HP (Normal Duty) and 0.5 HP ~ 10 HP (Heavy Duty) for both 240V or 480V input voltage ratings. Product model and specifications are detailed on the label. Check the product specification before installing the product and make sure that it is suitable for the intended use. For more detailed product specifications, refer to **11.1 input and Output Specification** on page **253**.

> **Note**
>
> Open the packaging and check the product name and model. Verify that the product is free from defects. If the product is found to be faulty, contact your supplier.

Label



RSi - 003 - GM2 - 4 C

RSi - Ready Start Inverter

003 - HP Rating (Normal Duty)

001 - 1 HP
002 - 2 HP
003 - 3 HP
005 - 5 HP
007 - 7.5 HP
010 - 10 HP
015 - 15 HP

GM2 - Inverter Model #

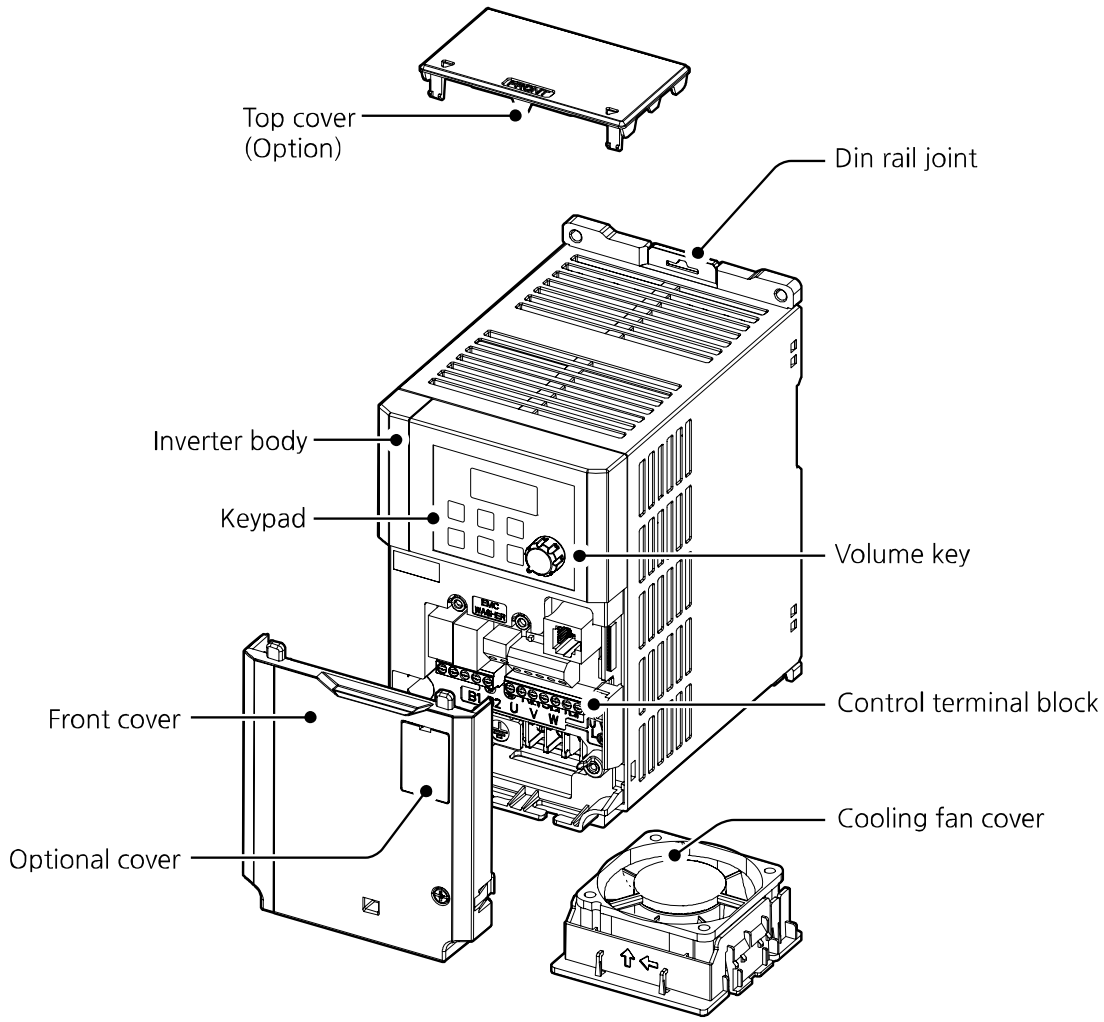
4 - Voltage Rating
2 - 240V
4 - 480V

C - Chassis (UL Open / IP20)

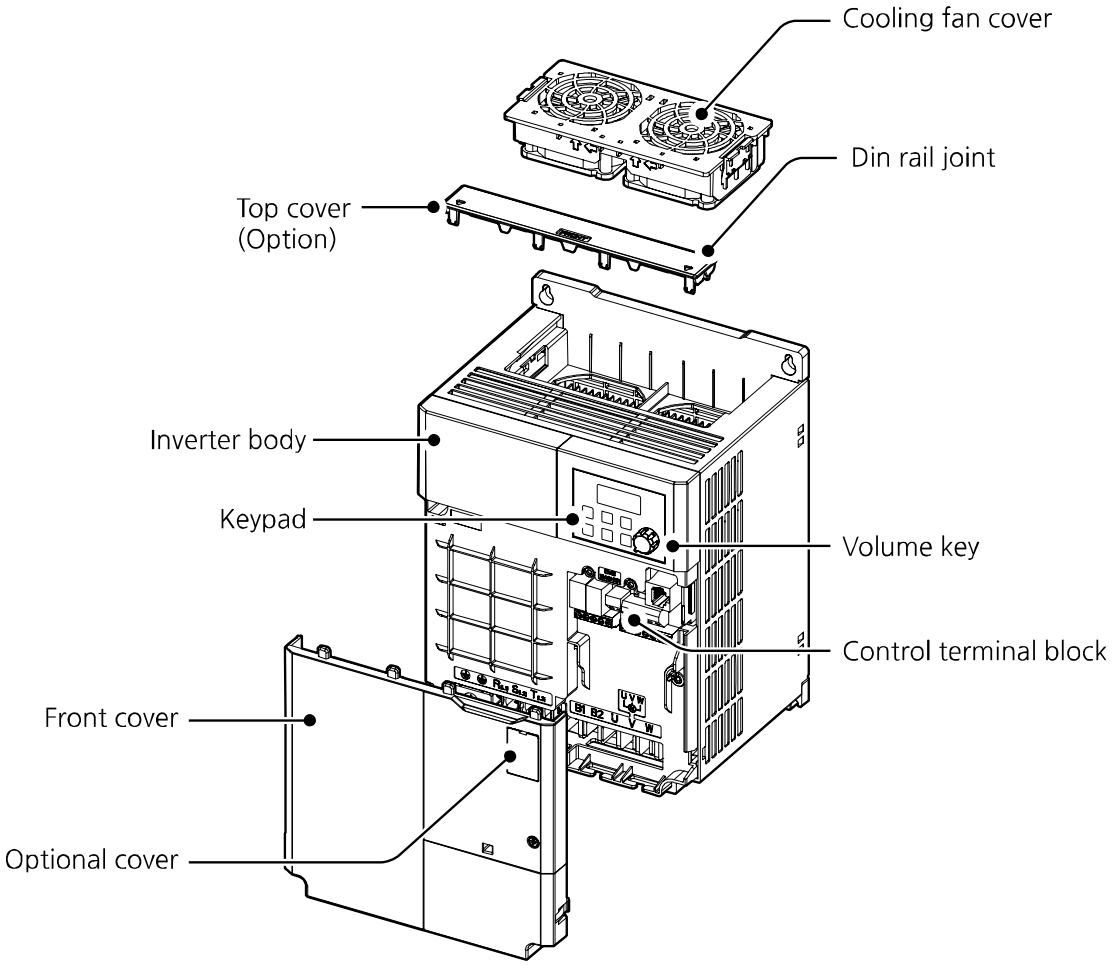
1.2 **Part Names**

See the assembly diagram below to identify names and locations of parts on the inverter. Detailed images may vary between product groups.

ND: 1.0 HP ~ 7.5 HP, 240V/480V
HD: 0.5 HP ~ 5.0 HP
HD: 0.4 kW ~ 4.0 kW



ND: 10 HP ~ 15 HP, 240V/480V
HD: 7.5 HP ~ 10 HP
HD: 5.5 kW ~ 7.5 kW

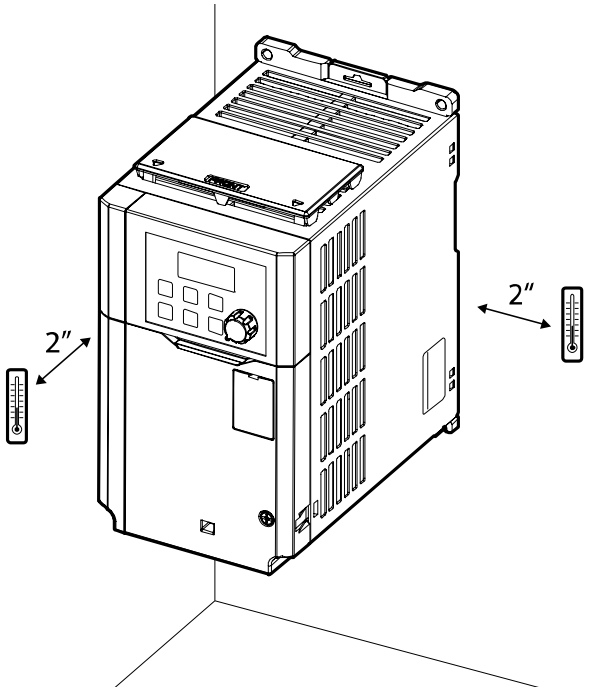


1.3 Installation Considerations

Inverters are composed of various precision electronic devices and the installation environment can significantly impact the lifespan and reliability of the product. The table below details the ideal installation and operating conditions for the inverter.

Items	Description
Ambient temperature*	Normal Duty: 14°F ~ 104°F (-10~40℃) Heavy Duty: 14°F ~ 122°F (-10~50℃)
Ambient humidity	Less than 95% relative humidity (no condensation)
Storage temperature	-4°F ~ 149°F (-20~65°C)
Environmental factors	An environment free from corrosive or flammable gases, oil residue, and dust
Operating altitude Vibration	Lower than 3,280 ft (1,000 m) above sea level (Apply derating of 1% on voltage/output current for every 328 ft. (100m) above 3,280 ft. (1,000 m), maximum of 13123 ft. (4,000m). Less than 1G (9.8 m/sec^2)
Air Pressure	70–106 kPa

* The ambient temperature is the temperature measured at a point 2″ (5 cm) from the surface of the inverter.



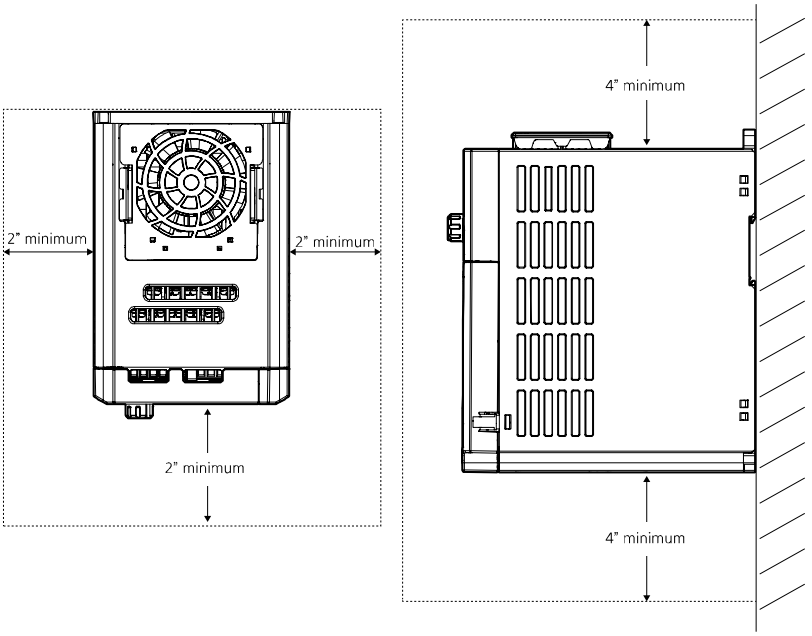
⚠ Caution

Do not allow the ambient temperature to exceed the allowable range while operating the inverter.

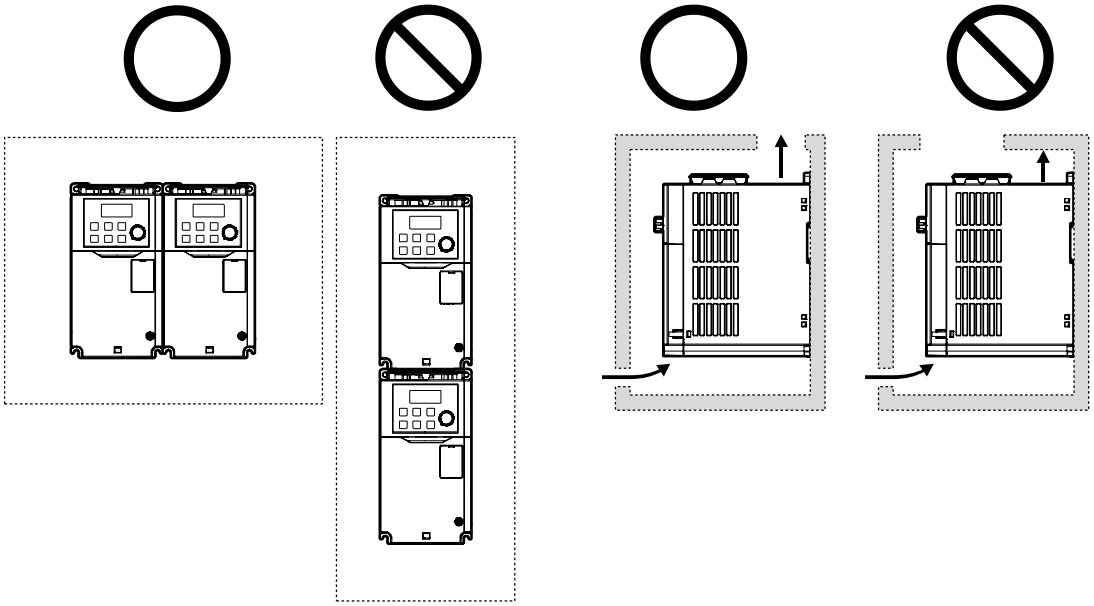
1.4 Selecting the Installation Site

When selecting an installation location consider the following points:

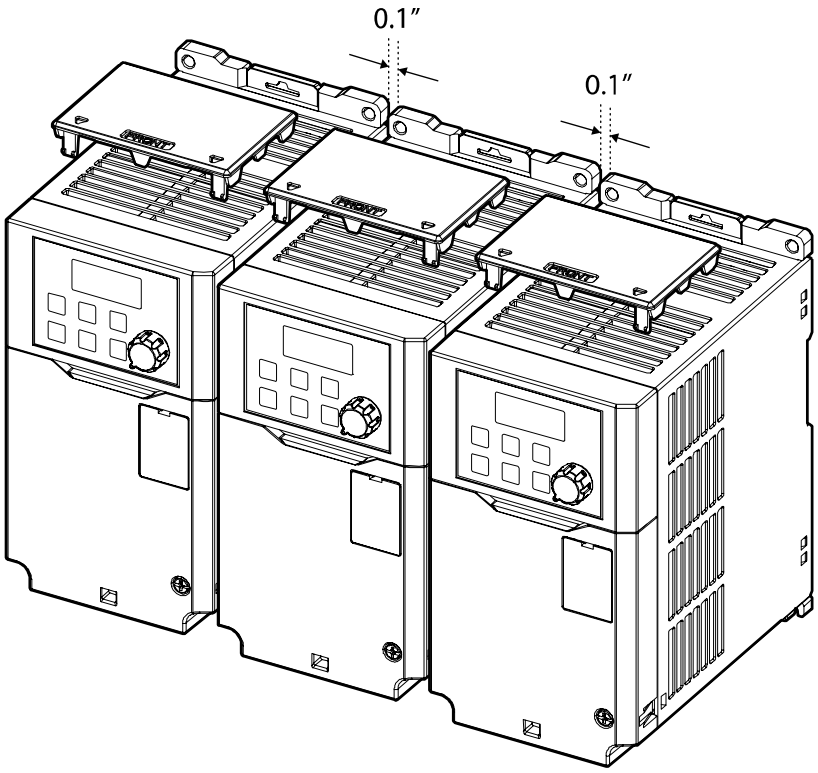
- The location must be free from vibration, and the inverter must be installed on a wall that can support the inverter's weight.
- The inverter can become very hot during operation. Install the inverter on a surface that is fire-resistant or flame-retardant and with sufficient clearance around the inverter to allow air to circulate.



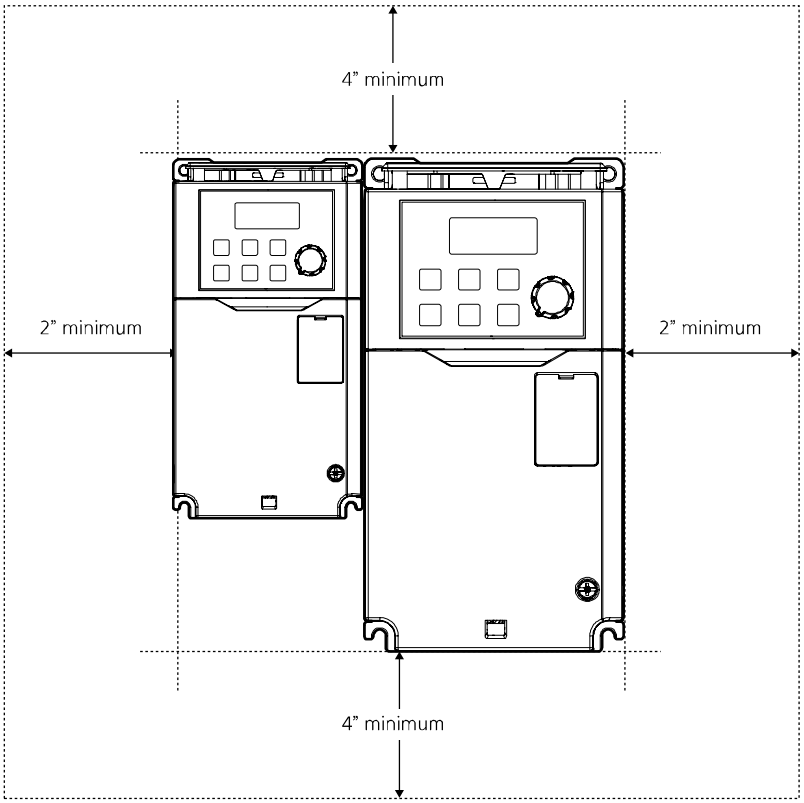
- Make sure that sufficient air circulation is provided around the product. When installing the product inside the panel, carefully consider the position of the product's cooling fan and the ventilation louvers. The product must be placed for the cooling fan to discharge heat satisfactorily during the operation.



- If you are installing multiple inverters in one location, side-by-side mounting is acceptable with minimal spacing (~2.5mm) between inverters. Do not install the cover (option) shown in diagram.



- If you are installing multiple inverters of different ratings, provide sufficient clearance above and below and to side walls to meet the clearance specifications of the larger inverter.



1.5 Cable Selection

When you install power and signal cables in the terminal blocks, only use cables that meet the required specification for the safe and reliable operation of the product. Refer to the following information to assist you with cable selection.

Caution

- Wherever possible use cables with the largest cross-sectional area for main power wiring to ensure that voltage drop does not exceed 2%.
- Use copper cables rated for 600 V, 75°C for power terminal wiring.
- Use copper cables rated for 300 V, 75°C for control terminal wiring.

Ground Cable and Power Cable Specification

	Capacity		Ground		Power Terminal Wiring				Terminal Block Size
					mm²		AWG		
	kW	HP	mm²	AWG	R/S/T	U/V/W	R/S/T	U/V/W	
3–Phase 200 V	0.4	0.5	4	12	1.5	1.5	16	16	M3
	0.75	1.0							
	1.5	2.0	4	12	4	2.5	12	14	M4
	2.2	3.0							
	4	5.0	6	10	6	6	10	10	M4
	5.5	7.5	6	10	16	10	6	8	M4
	7.5	10							
3–Phase 400 V	0.4	0.5	2.5	14	1.5	1.5	16	16	M3.5
	0.75	1.0							
	1.5	2.0							
	2.2	3.0							
	4	5.0	6	10	2.5	2.5	14	14	M4
	5.5	7.5	6	10	10	6	8	10	M4
	7.5	10							

Signal (Control) Cable Specifications

Terminals	Control Terminal Wiring			
	Without Crimp Terminal Connectors		With Crimp Terminal Connectors	
	mm²	AWG	mm²	AWG
P1 ~ P5, CM, 24	0.8	18	0.5	20
A1/B1/C1/A2/C2, VR/V1/I2/AO/CM, S+/S-				

2 Installing the Inverter

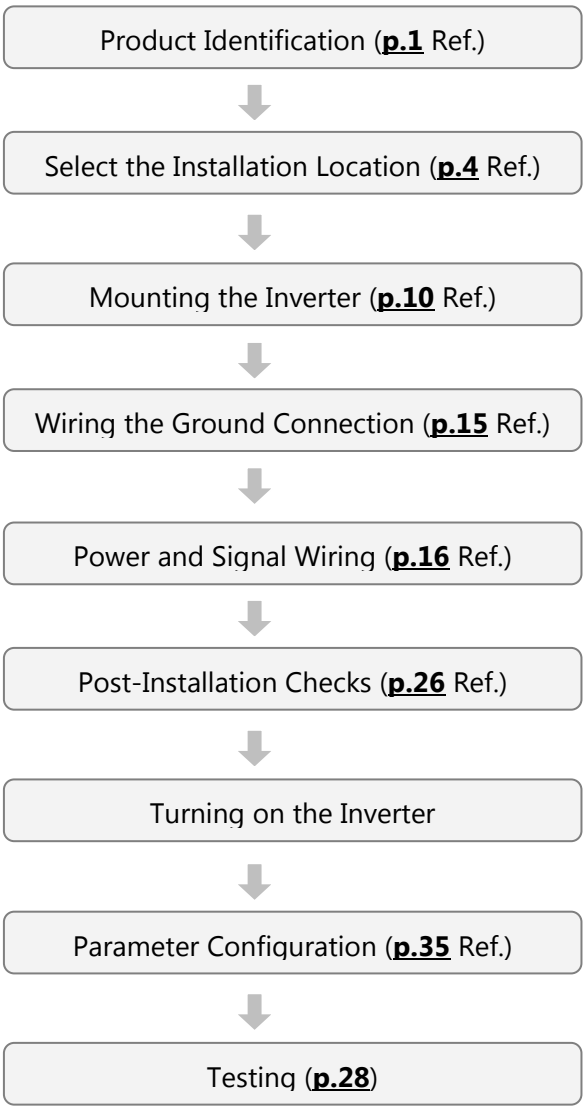
This chapter describes the physical and electrical installation methods, including mounting and wiring of the inverter. Refer to the flowchart and basic configuration diagram provided to understand the procedures and installation methods to be followed to install the product correctly.

DIN Rail Mounting

The inverters include provisions for standard DIN rail (35mm x 7.5mm) mounting. If using DIN rail, skip section 2.1, Panel / Wall Mounting.

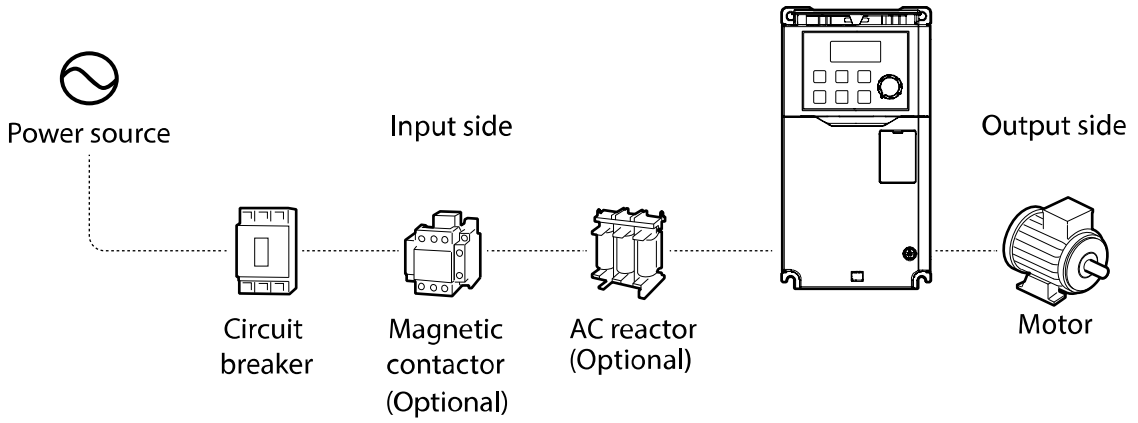
Panel / Wall Mounting Installation Flowchart

The flowchart lists the sequence to be followed during installation. Install the product following the flowchart and to test the operation. For more information on each step, refer to the pages below.



Basic Configuration

The diagram below shows the basic system configuration. Use the diagram for reference when configuring the system by connecting the product with peripheral devices. Ensure that the product has a suitable rating for the configuration and that all the required peripherals and optional devices (brake unit, reactors, noise filters, etc.) are available.



Caution

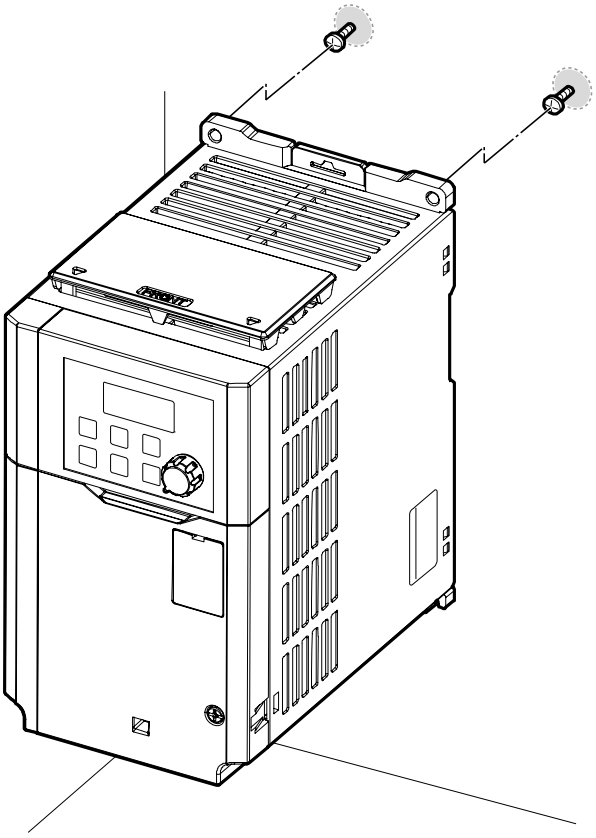
- Note that the illustrations in this user manual may represent the product with the inverter cover removed or the circuit breaker removed for explanation. When operating the inverter, make sure to follow the instructions of user manual after fully installing the necessary parts, such as the cover and circuit breaker.
- Do not start or stop the inverter with a magnetic contactor. This may cause damage to the inverter.
- If the inverter is damaged and loses control, the machine may cause a dangerous situation. Install an additional safety device such as an emergency brake to prevent these situations.
- High levels of current draw during power-on can affect the system. Ensure that correctly rated circuit breakers are installed to operate safely during power-on situations.
- Reactors can be installed to improve the power factor. If the input power exceeds 10 times of inverter capacity (KVA rating), a line reactor must be installed within 30 ft (9.14m) from the inverter input.

2.1 Mounting the Inverter

Mount the inverter on a wall or inside a panel following the procedures provided below. Before installation, ensure that there is sufficient space to meet the clearance specifications, and that there are no obstacles impeding the cooling fan's air flow.
Select a wall or panel suitable to support the installation. Refer to **11.3 External Dimensions** on page **257** and check the inverter's mounting bracket dimensions.

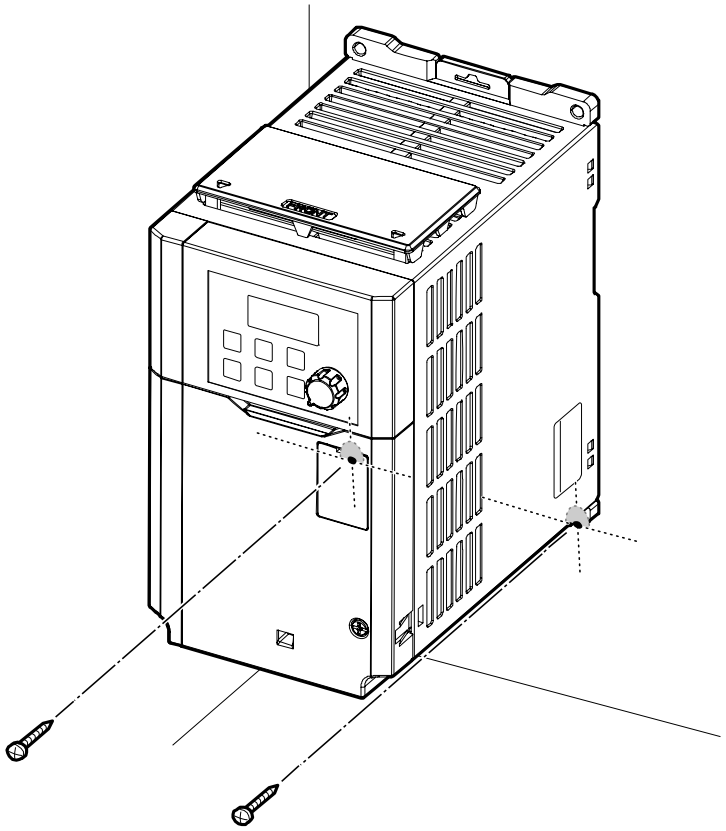
1 Use a level to draw a horizontal line on the mounting surface, and then carefully mark the mounting holes.

2 Drill the two upper mounting bolt holes, and then mount the inverter with the top mounting bolts. Do not fully tighten the bolts at this time. Fully tighten the mounting bolts after the inverter has been mounted.



3 With the inverter temporarily installed, mark the location for the bottom mounting bolts. Remove the inverter and drill holes for the bottom mounting bolts.

4 Mount the inverter on a wall or inside a panel using all mounting bolts. Fully tighten the upper mounting bolts, then install two lower mounting bolts and tighten fully. Ensure that the inverter is placed flat on the mounting surface, and that the installation surface can securely support the weight of the inverter.



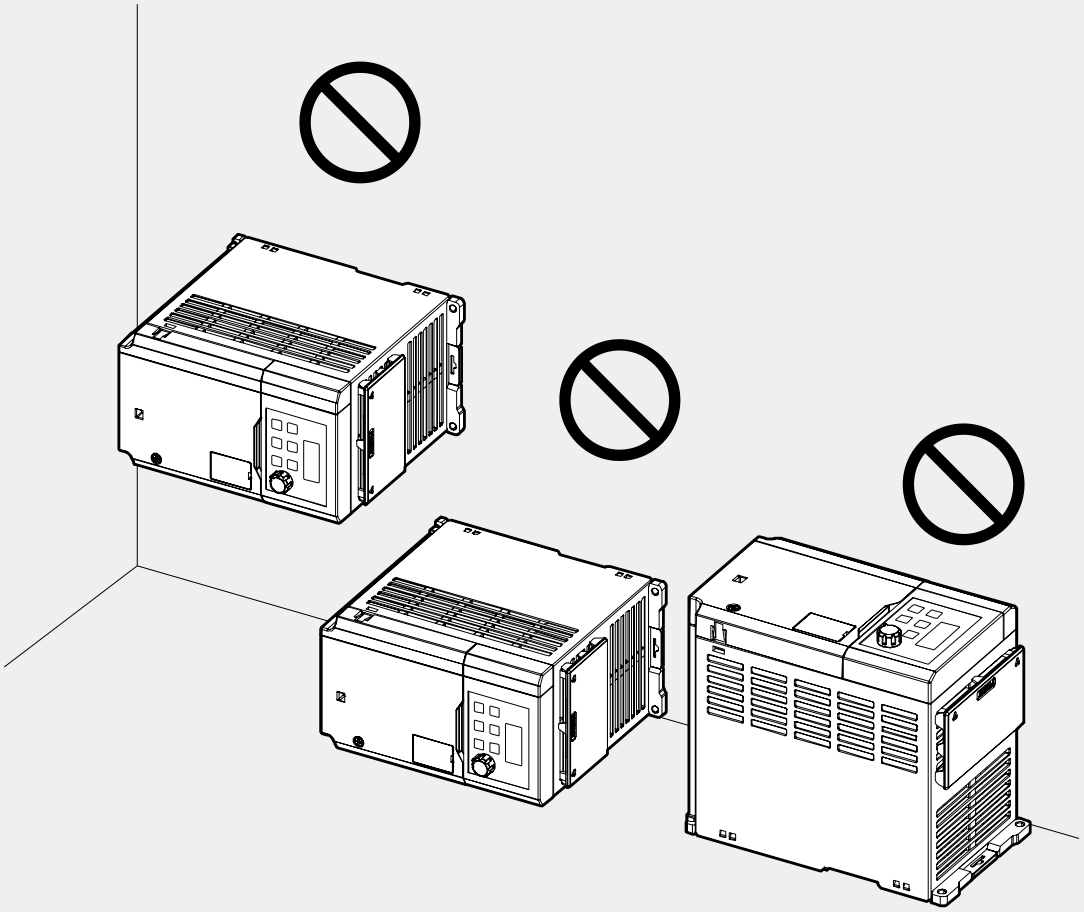
Note

The dimensions of the mounting holes vary based on the frame size. Refer to **11.3 External Dimensions** on page **257** for detailed information about your model.

Caution

- Do not handle the inverter by lifting with the inverter's covers or plastic surfaces. The covers are removeable and may come off if handled by the covers, causing injuries or damage to the product. Always handle the inverter by the metal frames.

- Do not install the inverter on the floor or mount it sideways on a wall. The inverter must be installed vertically, on a wall or inside a panel, with its rear flat on the mounting surface.



2.2 Wiring

Follow the seven steps for Cover removal, Ground Wire, Power Wire, Control Wire connections and EMC Filter connection. Complete the cable connections by connecting appropriately rated cables for ground, power and control terminal blocks. Read the following information carefully before carrying out wiring connections to the inverter. All warning instructions must be followed.

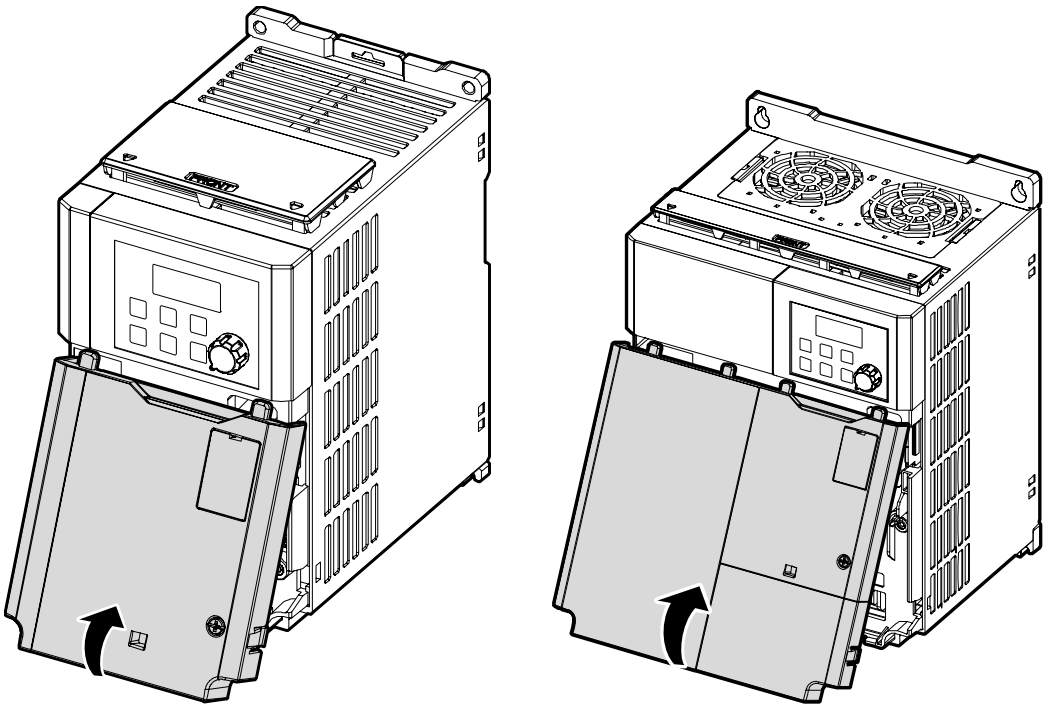
⚠ Caution

- Install the inverter before carrying out wiring connections.
- Ensure that no small metal debris, such as wire cut-offs, remain inside the inverter. Metal debris in the inverter may cause inverter failure.
- Tighten terminal screws to their specified torque. Loose terminal block screws may allow the cables to disconnect and cause short circuits or inverter failure. Refer to **11.4 Terminal Screw Specification** on page **261** for torque specifications.
- Do not place heavy objects on top of electric cables. Heavy objects may damage the cable and result in electric shock.
- Verifiy the power supply system for this equipment (inverter) is a grounded system. When connected to an ungrounded or asymmetrical grounded power supply, refer to **Step 6, Disabling of the EMC filter**.
- The equipment may generate direct current in the protective ground wire. When installing the residual current device (RCD) or residual current monitoring (RCM), only Type B RCDs and RCMs can be used.
- Use cables with the largest cross-sectional area, appropriate for power terminal wiring, to ensure that voltage drop does not exceed 2%.
- Use copper cables rated at 600 V, 75°C for power terminal wiring.
- Use copper cables rated at 300 V, 75°C for control terminal wiring.
- Separate control circuit wires from the main circuits and other high voltage circuits (200 V relay sequence circuit).
- Check for short circuits or wiring failure in the control circuit. They could cause system failure or device malfunction.
- Use shielded cables for control terminal wiring. Failure to do so may cause malfunction due to interference. When grounding is needed, use shielded twisted pair (STP) cables.
- If you need to re-wire the terminals due to wiring-related faults, ensure that the inverter keypad display is turned off and the charge lamp under the front cover is off before working on wiring connections. The inverter may hold a high voltage electric charge long after the power supply has been turned off.

Step1 Remove the front cover

The front cover must be removed to access the power and control terminals. Note that the disassembling procedure of front cover and control terminal cover may vary depending on the product group. Disassemble each cover in the following order:

1 Loosen the screw that secures the front cover. Push and hold the latch on the right side of the cover. Then remove the cover by lifting it from the bottom and moving it away from the front of the inverter.

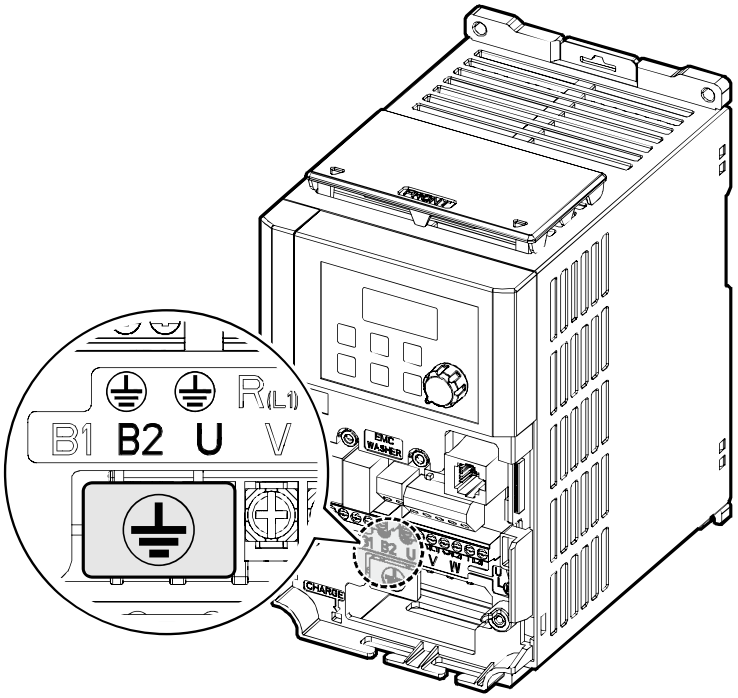


Note

If you have installed the remote keypad, remove the plastic cover under the lower-right part of the control terminal cover, and then connect the remote keypad cable to the RJ-45 connector.

Step2 Ground Connection

Locate the ground terminal and connect an appropriately rated ground cable to the terminals. Refer to **1.5 Cable Selection** on page **7** to find the appropriate cable specification for your installation.



1 Connect the other ends of the ground cables to the supply earth (ground) terminal.

Note

- 200 V products require Class 3 grounding. Resistance to ground must be < 100Ω.
- 400 V products require Special Class 3 grounding. Resistance to ground must be less than < 10 Ω.

⚠ Warning

Make sure to install ground connection between the equipment and the motor for safe use. Otherwise it may cause an electrical shock and result in personal injury or even death.

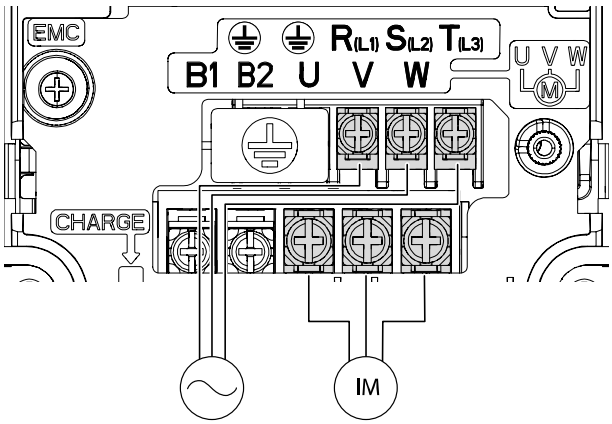
Step3 Power Terminal Wiring

The following illustrations show the terminal layout of the power terminals for each of the inverter ratings. Refer to the label and descriptions to understand the function and location of each terminal before making wiring connections. Ensure that the cables selected meet or exceed the specifications in **1.5 Cable Selection** on page **7** before installing them.

> ⓘ Caution
>
> - Apply rated torques to the terminal screws. Loose screws may cause short circuits and malfunctions. Tightening the screw too much may damage the terminals and cause short circuits and malfunctions.
> - Use copper wires only with 600 V, 75℃ rating for the power terminal wiring, and 300 V, 75℃rating for the control terminal wiring.
> - Do not connect two wires to one terminal when wiring the power.
>   Power supply wiring must be connected to the R, S, and T terminals. Arrangement of the phase sequence is not necessary. Connecting them to the U, V, W terminals causes internal damages to the inverter. Motor should be connected to the U, V, and W Terminals.

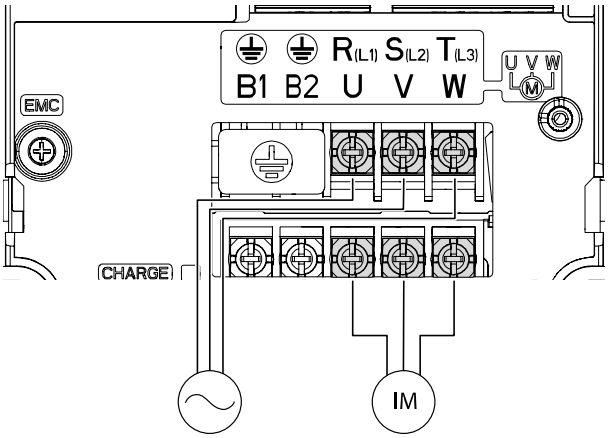
HD 0.5 HP -> 1 HP (0.4 kW -> 0.75 kW)

ND 1.0 HP -> 2.0 HP (0.75 kW -> 1.5 kW)



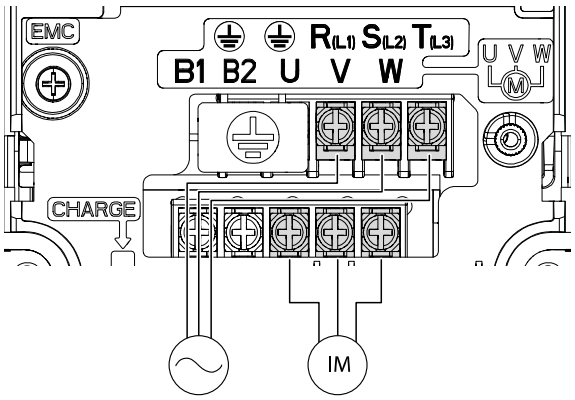
HD 2.0 HP -> 3.0 HP (1.5 kW -> 2.2 kW)

ND 3.0 HP -> 5.0 HP (2.2 kW -> 4.0 kW)



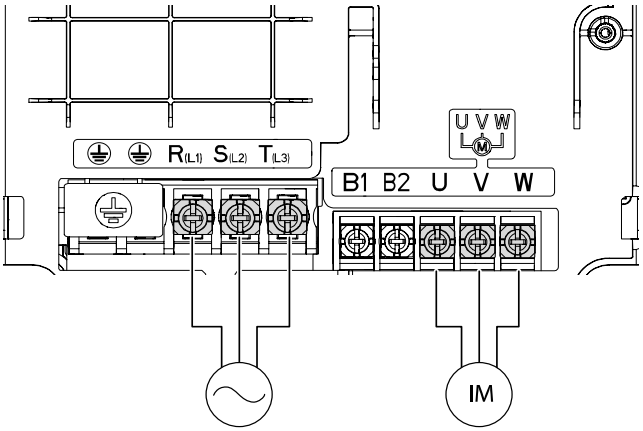
HD 5.0 HP (4.0 kW)

ND 7.5 HP (5.5 kW)



HD 7.5 HP -> 10 HP (5.5 kW -> 7.5 kW)

ND 10.0 HP -> 15 HP (7.5 kW -> 11 kW)



Power Terminal Labels and Descriptions

Terminal Labels	Name	Description
	Ground Terminal	Connect earth grounding.
R(L1)/S(L2)/T(L3)	AC power input terminal	Mains supply AC power connections.
B1/B2	Brake resistor terminals	Brake resistor wiring connection.
U/V/W	Motor output terminals	3-phase induction motor wiring connections.

Note

- When operating Brake resistor, the motor may vibrate under the Flux braking operation. In this case, please turn off the Flux braking (Pr.50).
- **Motor Cable Length**:
  1.0 HP (0.75kW) -> 5.0 HP (4.0kW) ----------maximum 165 ft (50m)
  7.5 HP (5.5 kW) -> 15 HP (11kW) ----------maximum 665 ft (202m)
- Long cable runs can cause reduced motor torque in low frequency applications due to voltage drop. Long cable runs also increase a circuit's susceptibility to stray capacitance and may trigger over-current protection devices or result in malfunction of equipment connected to the inverter. Voltage drop is calculated by using the following formula:
  Voltage Drop (V) = [$\sqrt{3}$ X cable resistance (mΩ/m) X cable length (m) X current (A)] / 1000
- Use cables with the largest possible cross-sectional area to ensure that voltage drop is minimized over long cable runs. Lowering the carrier frequency and installing a micro surge filter may also help to reduce voltage drop.

Distance	< 165 ft (50 m)	< 330 ft (100 m)	> 330 ft (100 m)
Allowed Carrier Frequency	< 15 kHz	< 5 kHz	< 2.5 kHz

⚠ Warning

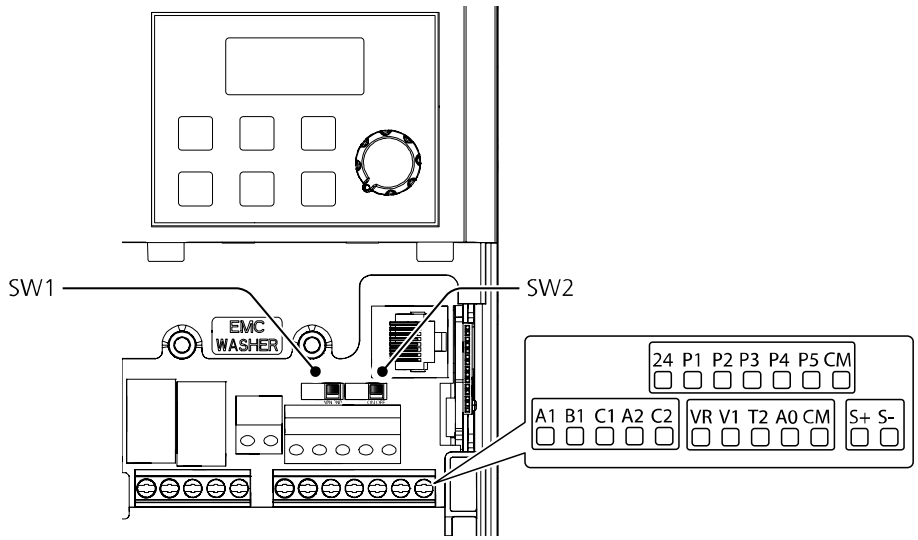
Do not apply power to the inverter until installation has been fully completed and the inverter is ready to be operated. Otherwise it may cause an electrical shock and result in personal injury or even death.

Caution

- Power supply cables must be connected to the R, S, and T terminals and output wiring to the motor must be connected to the U, V, and W terminals. Opposite connections may damage the product.
- Power Terminals (R/S/T, U/V/W and B1/B2) provide a Screw Clamp type connection. It is recommended to use a Ring type terminal to meet UL connection requirements eventhough the terminals will accept Spade, Slotted Ring, Ferrule and bare wire connections,
- The inverter's power terminal connections can cause harmonics that may interfere with other communication devices located near to the inverter. To reduce interference the installation of noise filters or line filters may be required.
- Are power factor correction capacitors, surge protection and electromagnetic interference filters installed correctly?
- If a contactor is installed on the output side of the inverter (motor side), do not operate the contactor in conjunction with the inverter start/stop control.
- Metal debris in the inverter may cause inverter failure.

Step 4 Control Terminal Wiring

The illustrations below show the detailed layout of control wiring terminals, and control board switches. Ensure that the cables selected meet or exceed the specifications in 1.5 **Cable Selection** on page **7** before installing them.

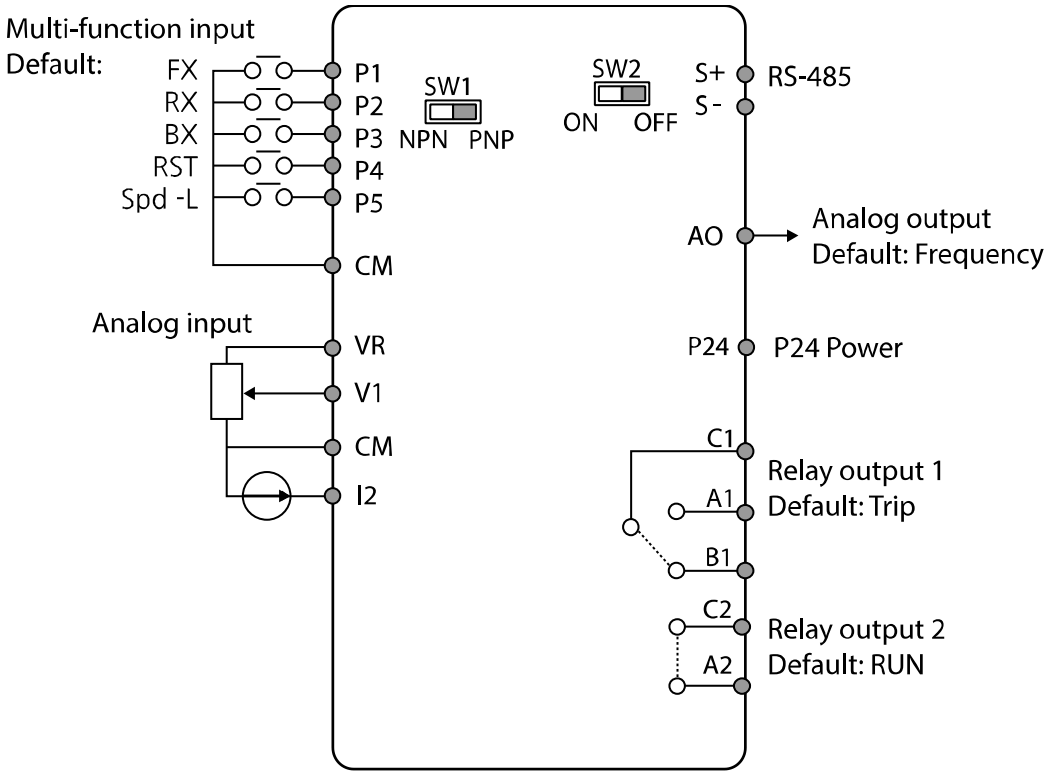


Control Board Switches

Switch	Description
SW1	NPN/PNP mode selection switch
SW2	Terminating Resistor selection switch

Connector

Name	Description
RJ-45 Connector	Connect to Remote Keypad, Smart Copier or connection for RS-485 communication.



Input Terminal Labels and Descriptions

Category	Terminal Labels	Name	Description
Multi-function (digital) terminal configuration	P1–P5	Multi-function (digital) Input 1-5	Configurable multi-function (digital) input terminals. Factory defaults are setup as follows: • P1: Fx • P2: Rx • P3: BX • P4: RST • P5: Speed-L
	CM	Sequence common terminal	Common terminal for multi-function (digital) terminals, RS-485 communication, and analog inputs and outputs.
Analog input	VR	12V source terminal for frequency reference setting	Source voltage for reference frequency via analog voltage input. • Maximum Voltage Output: 12 V • Maximum Current Output: 100 mA • Potentiometer: 1/5 kΩ
	V1	Frequency setting (voltage) terminal	Voltage input for 0 - 10V reference frequency. • Unipolar: 0–10 V (12 V Max.) • Bipolar: -10–10 V (±12 V Max.)

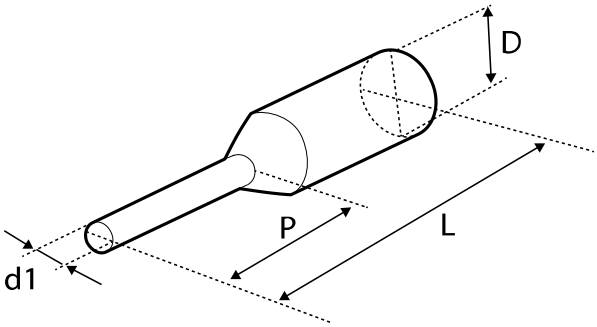
Category	Terminal Labels	Name	Description
	I2	Current input for frequency reference input Terminal	Current input for 0(4) - 20mA reference frequency. • Input current: 4–20 mA • Maximum Input current: 20 mA • Input resistance: 249 Ω

Output/Communication Terminal Labels and Descriptions

Category	Terminal Labels	Name	Description
Analog output	AO	Voltage output terminal	Analog output voltage terminal configurable to output frequency, output current, output voltage, or a DC voltage. • Output Voltage: 0–10 V • Maximum output voltage/current: 12 V, 10 mA • Factory default output: Frequency
Digital Output	24	External 24V power source	Maximum Current Output: 100 mA
	A1/C1/B1	Relay 1 Output	Configurable (Form C) relay (OU.31), activates when programmed condtion is met. Ratings: AC 250 V <1 A, DC 30 V < 1 A. • Normal operation: B1 and C1 contacts are closed, A1 and C1 are open • Activated Condition: A1 and C1 contacts are closed, B1 and C1 are open • Default setting is (29) Trip
	A2/C2	Relay 2 Output	Configurable (Form A) relay (OU.33), activates when programmed condtion is met. Ratings: AC 250 V <1 A, DC 30 V < 1). • Normal operation: A2 and C2 contacts are open. • Activated condition: A2 and C2 contacts are closed. • Default setting is (14) Run
RS-485 Communication	S+/S-	RS-485 signal terminal	Used to send or receive RS-485 signals. Refer to **7 RS-485 Communication Features** on page **179** for more details.

Pre-insulated Crimp Terminal

Use pre-insulated crimp terminal connectors to increase reliability of the control terminal wiring. Refer to the specifications below to determine the crimp terminals to fit various cable sizes.

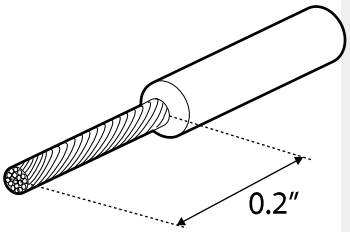


Cable Spec.		Dimensions (inches/mm)			
AWG	mm^2	L*	P	d1	D
22	0.50	0.4/12.0	0.2/6.0	0.05/1.3	0.13/3.2
20	0.75	0.4/12.0	0.2/6.0	0.06/1.5	0.13/3.4
18	1.0	0.4/12.0	0.2/6.0	0.07/1.7	0.14/3.6

* If the length (L) of the crimp terminals exceeds 0.5″ (12.7mm) after wiring, the control terminal cover may not close fully.

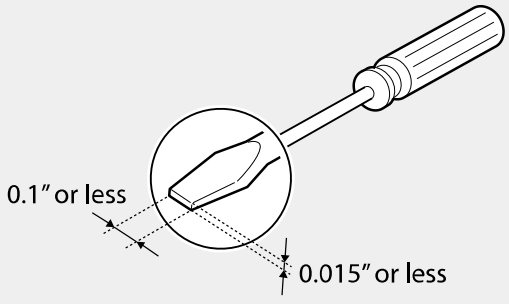
Wired connection to control terminals

To connect cables to the control terminals without using crimp terminals, refer to the following illustration detailing the correct length of exposed conductor at the end of the control cable.



Note

- While making wiring connections at the control terminals, ensure that the total cable length does not exceed 165 ft (50 m).
- Ensure that the length of any safety related wiring does not exceed 100 ft (30m).
- Use ferrite material to protect signal cables from electro-magnetic interference.
- Take care when supporting cables using cable ties, to apply the cable ties no closer than 6 inches from the inverter. This provides sufficient access to fully close the front cover.
- When making control terminal cable connections, use a small flat-tip screw driver (0.1 in wide (2.5 mm) and 0.015 in thick (0.4 mm) at the tip).

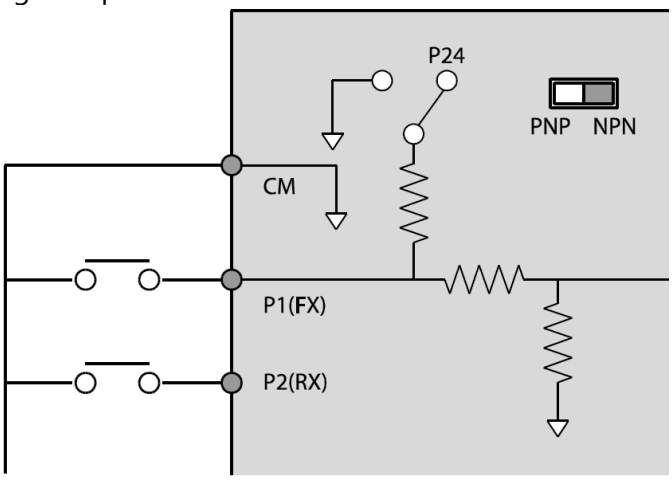


Step 5 PNP/NPN Mode Selection

The GM2 inverter supports both PNP (Source) and NPN (Sink) modes for activating the digital inputs at the control board terminals. Select an appropriate mode to suit switching requirements using the PNP/NPN selection switch (SW1) on the control board. The following describes each mode along with connection diagrams.

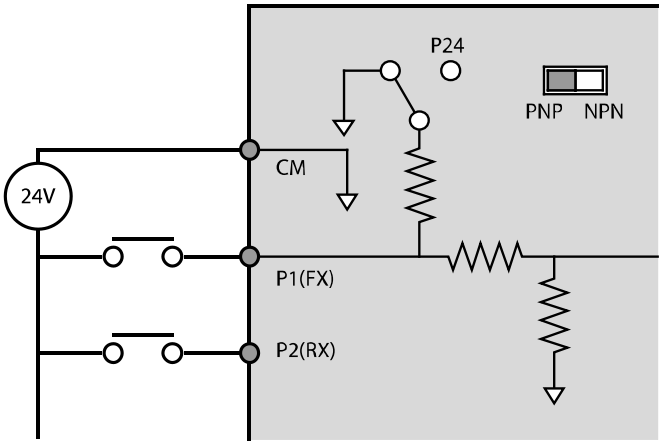
NPN Mode (Sink)

This is the factory default setting of the inverter. With SW1 in the NPN position, connect an external contact (switch, relay, transistor) between Px and CM. When the external contact closes, the input is activated by connecting the internal 24V source to CM (sink). CM is the common ground terminal for all digital input terminals.



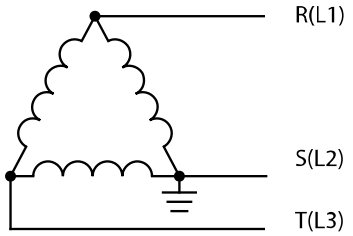
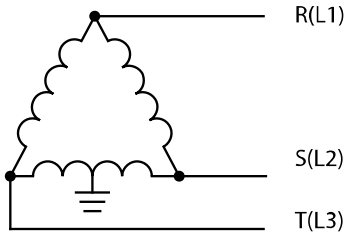
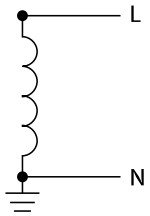
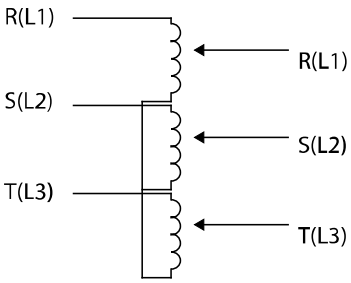
PNP Mode (Source)

With SW1 in the PNP position, the input is activated by applying 24V to the digital input. Connect an external contact (switch, relay, transistor) between 24 and Px terminal. When the contact closes, the input is activated by connecting 24V to the digital input (source). The 24V source can be from the inverters 24 terminal or an external supply. When using an external 24V source, connect the external source (-) to the CM terminal. CM is the common ground terminal for all digital inputs.



Step 6 Disabling the EMC Filter for Power Sources with Asymmetrical Grounding

Applies to 480V models only. When connecting the inverter to a power source with asymmetrical grounding (see figures below), the internal EMC filter must be disabled.
The Built-in EMC filter is enabled by factory default. The EMC filter prevents electromagnetic interference by reducing emissions from the inverter. Current leakage increases when the EMC filter feature is enabled.

Asymmetrical Grounding Connection			
One phase of a delta connection is grounded		Intermediate grounding point on one phase of a delta connection	
End of a single phase is grounded		A 3-phase connection without grounding	

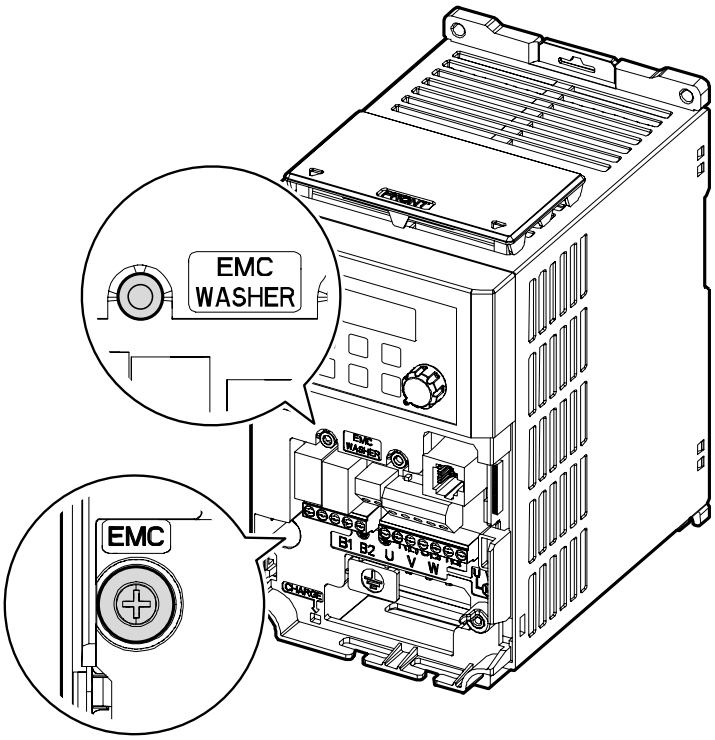
⚠ Danger

- Disable the EMC filter if the inverter uses a power source with an asymmetrical grounding structure, for example a grounded delta connection. Otherwise it may cause an electrical shock and result in personal injury or even death.
- Before opening the cover to start working, wait at least 10 minutes after the power is disconnected and check that the DC voltage of the product is discharged. Otherwise it may cause an electrical shock and result in personal injury or even death.

Before using the inverter, confirm the grounding system of the power source.

Disable the EMC filter if the power source has an asymmetrical grounding connection. Check the location of the EMC filter screw. To disable, remove the screw and install the plastic washer. Washer is located under the control terminal block.

Steel bolt	Steel bolt + Plastic washer
	
EMC ON	EMC OFF



Step 7 Assembling the front cover

After completing the wiring and basic configurations, assemble the front cover. Note that the assembly procedure may vary according to the product group or frame size of the product.

2.3 Post-Installation Checklist

After completing the installation, check the items in the following table to make sure that the inverter has been safely and correctly installed.

Items	Details	Ref.	Result
Installation Location/Power I/O Verification	Is the installation location appropriate?	**p.4**	
	Does the environment meet the inverter's operating conditions?	**p.5**	
	Does the power source match the inverter's rated input?	**p.11253**	
	Is the inverter's rated output sufficient to supply the equipment? (Derating is applied in specific conditions. Refer to **11.6 Continuous Current Derating** on page **263** for more details.)	**p.253**	
Power Terminal Wiring	Is a circuit breaker installed on the input side of the inverter?	**p.9**	
	Is the circuit breaker correctly rated?		
	Are the power source cables correctly connected to the input terminals of the inverter? (Caution: connecting the power source to the U/V/W terminals may damage the inverter.)	**p.16**	
	Are the motor output cables connected in the correct phase order? (Caution: motors will rotate in reverse direction if the three phase cables are not wired in the correct sequence.)	**p.16**	
	Are the cables used in the power terminal connections correctly rated?	**p.7**	
	Is the inverter grounded correctly?	**p.15**	
	Are the power terminal screws and the ground terminal screws tightened to their specified torques?	**p.16**	
	Are the overload protection circuits installed correctly on the motors (if multiple motors are run using one inverter)?	-	
	Is the inverter separated from the power source by a magnetic contactor (if a braking resistor is in use)?	**p.9**	
	Are power factor capacitors, surge protection and electromagnetic interference filters installed correctly? (These devices MUST not be installed on the output side of the inverter.)	**p.16**	
Control Terminal Wiring	Are shielded twisted pair (STP) cables used for control terminal wiring?	-	
	Is the shielding of the STP wiring properly grounded?	-	

Items	Details	Ref.	Result
	If 3-wire operation is required, are the multi-function (digital) input terminals programmed prior to the connection of the control wiring?	**p.19**	
	Are the control cables properly wired?	**p.19**	
	Are the control terminal screws tightened to their specified torques?	**p.19**	
	Is the total cable length of all control wiring less than 165 ft (50 m)?	**p.22**	
	Is the total length of safety wiring less than 100 ft (30 m)?	**p.22**	
Miscellaneous	Are optional cards connected correctly?	-	
	Is there any debris left inside the inverter?	-	
	Are any cables contacting adjacent terminals, creating a potential short circuit risk?	-	
	Are the control terminal wires separated from the power terminal wires?	-	
	Are fuses installed for the power source?	-	
	Are the connections to the motor separated from other connections?	-	

Note

Shielded twisted pair (STP) cable has a highly conductive, shielded screen around twisted cable pairs. STP cables protect conductors from electromagnetic interference.

2.4 Test Run

After the post-installation checklist has been completed, follow the instructions below to test the inverter.

1 Turn on the power supply to the inverter. Ensure that the keypad display light is on.

Verify Motor Rotation

2 On the keypad, set the drv parameter (command source) in the Operation group to 0 (Keypad).

3 Program 10.00 Hz. as a reference frequency.

4 Press the [RUN] key. Motor starts forward operation.

5 Observe the motor's rotation from the load side and ensure that the motor rotates counterclockwise (forward).

If rotation is not correct

Switch the cables at the U and V terminals.

If rotation is correct

6 Set the drv parameter to the final command source if not using the keypad for Start/Stop.

7 Set the Frq parameter (reference frequency source) to the final source (V1, I2, etc.) if not using the keypad for reference frequency.

8 Set a reference frequency, and then check the following:

- If V1 is selected as the frequency reference source, does the reference change according to the input voltage?
- If I2 is selected as the frequency reference source, does the reference change according to the input current?

9 Set the acceleration and deceleration time.

10 Start the motor and check the following:

- Again, ensure that the motor rotates in the correct direction.
- Ensure that the motor accelerates and decelerates according to the set times, and that the motor speed reaches the reference frequency.

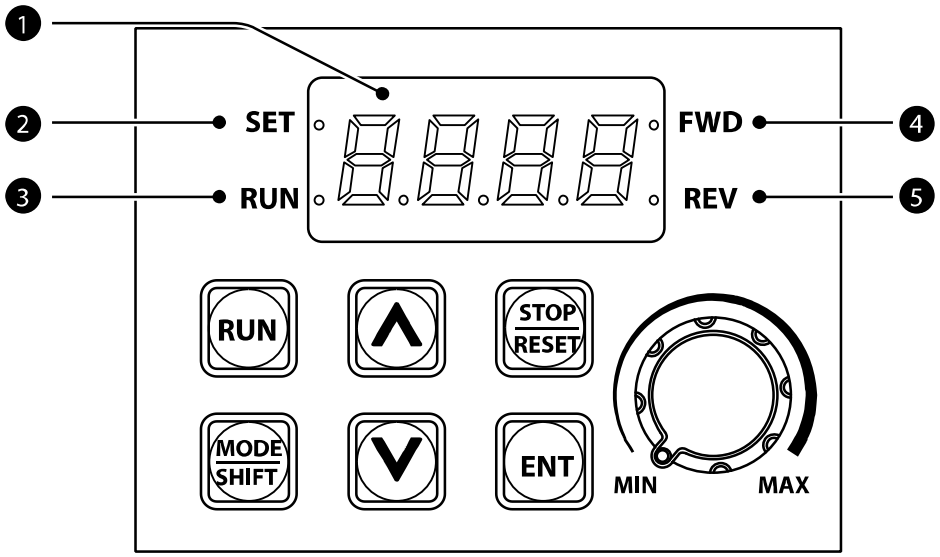
3 Perform Basic Operations

This chapter describes:

- The keypad layout - display and buttons (or keys)
- Button (or key) operation
- Parameter groups and navigation
- Viewing and changing parameter settings
- Specific examples for setting the most common functions

3.1 About the Keypad

The keypad is composed of two main components – the display and the operation keys (or buttons). Refer to the following illustration to identify part names and functions.



3.1.1 About the Display

The following table lists the names and functions of the display and LED indicators.

No.	Name	Function
❶	7-Segment Display	Displays current operational status and parameter information.
❷	SET Indicator	LED flashes during parameter configuration and when the ESC key operates as the multi-function (digital) key.
❸	RUN Indicator	LED turns on (steady) during an operation, and flashes during acceleration or deceleration.
❹	FWD Indicator	LED turns on (steady) during forward operation.
❺	REV Indicator	LED turns on (steady) during reverse operation.

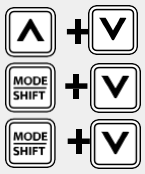
The table below shows how characters (letters and numbers) are displayed.

Display	Number / character	Display	Number / character	Display	Number / character	Display	Number / character
	0		A		K		U
	1		B		L		V
	2		C		M		W
	3		D		N		X
	4		E		O		Y
	5		F		P		Z
	6		G		Q		
	7		H		R		
	8		I		S		
	9		J		T		

3.1.2 **Operation Keys**

The following table lists the names and functions of the keypad's operation keys.

Key	Name	Function
	[RUN] key	Used to start and run the inverter.
	[STOP/RESET] key	STOP: Stops the inverter. See caution. RESET: Resets the inverter after a fault occurs.
	[▲] key, [▼] key	Up/Down, Increase/Decrease parameter values and settings.
	[MODE/SHIFT] key	MODE - Moves between parameter groups. SHIFT - In Program mode (SET LED lit), moves to the digit on the left.
	[ENTER] key	ENTER - To view and change parameter setting (SET LED flashes). ENTER - After changes, to apply changes. ENTER - At fault code to access fault information.

Key	Name	Function
	ESC*	* Operates as ESC key when two keys are entered at the same time. - While in the group navigation mode, use ESC to go to the initial screen (the frequency display screen). - While in the parameter change mode (SET LED lit), use ESC to go to group navigation mode without saving.
	Potentiometer [Volume]	Used to set the reference frequency when parameter Frq is set to 4 (V0).

Caution

Install a separate emergency stop switch in the circuit. The [STOP/RESET] key on the keypad works only when the inverter has been configured to accept the stop command from the keypad. Command Source parameter drv is set to 0 (Keypad).

3.1.3 **Control Menu**

The following table lists the parameter groups and a description of functions within each group.

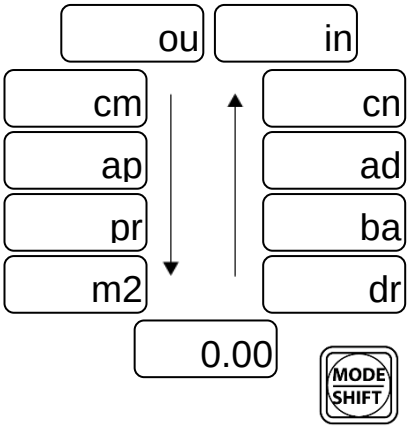
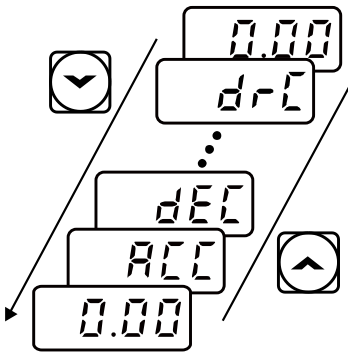
Group	Keypad Display	Description
Operation	-	Configures Acc/Dec times, Start/Stop and Reference Frequency sources.
Drive	dr	Configures drive Control Mode, Jog operation, Motor HP setting, torque boost, and parameter Read/Write/Save/Initialize.
Basic	ba	Configures all other motor parameters, 2nd Control and 2nd Reference Frequency sources and Auto Tuning for SVC control.
Advanced	ad	Configures Acc/Dec patterns, Start/Stop modes, frequency limits, Energy savings, Safe Mode, Regen Avoidance, Braking and Fore Mode.
Control	cn	Configures SVC, Torque Limits, Speed Search, KEB, Ride Through and Safe Stop features.
Input Terminal	in	Configures input terminal-related features, including all digital inputs and analog inputs (V0, V1 and I2).
Output Terminal	ou	Configures output terminal-related features including Relay1 and Relay2 outputs and analog output (AO1).
Communication	cm	Configures communication features for RS-485 and other communication options.
Application	ap	Configures functions related to PID control including Sleep and Wake Up functions..
Protection	pr	Configures all motor and inverter protection features along with Fault history.
Motor 2	m2	Configures secondary motor related features. The 2nd motor appears on the keypad only when one of the multi-function (digital) input terminals (In.65~In.69) has been set to 26 (2nd Motor).

3.2 Learning to Use the Keypad

The keypad enables movement between groups and parameter codes. It also enables users to select and configure functions. At parameter level, you can set parameter values and turn on or off specific functions, or decide how the functions will be used. Refer to **8 Table of Functions** on page **202** for a complete parmeter list.
Confirm the correct values (or the correct range of the values), and then follow the examples below to configure the inverter with the keypad.

3.2.1 Group and Parameter Code Selection

Follow the examples below to learn how to switch between groups and parameter codes.

Step	Instruction	Keypad Display
1	[MODE] button - Move to the group you want using the [MODE] key. Press the [MODE] key for longer than 1 second to move in the opposite direction.	
2	Up amd Down keys - [▲] and [▼] keys move up and down through the parmeter codes within each group. Locate the code that you require.	
3	Press the [ENT] key to view the parameter setting. The SET LED will be lit. Make changes using the Up and Down keys. Press [ENT] again to save the change and return to the parameter code.	-

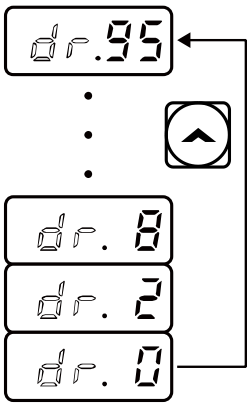
Note When moving up and down through the codes using the [▲] and [▼] keys in each group, there are cases where specific parmeter codes are not shown or will not increase or decrease. This is because the parameter code is not set to be displayed (see example) or is a view only parameter.

Example) If Ad.24 (frequency limit) code is set to 0 (No), Ad.25 (frequency lower limit value) and Ad.26 (frequency upper limit value) codes will not be displayed. Ad.24 (frequency limit) code must be set to 1 (Yes) to display Ad.25 (frequency lower limit value) and Ad.26 (frequency upper limit value) codes.

3.2.2 **Navigating Directly to Different Codes (Jump Codes)**

The following examples detail navigating to code dr. 95, from the initial code in the Drive group (dr. 0). Using the arrow keys, pressing [UP] will loop backwards from dr.0 to dr.95. The table shows how to program in the parameter number and jump directly to it. These examples apply to all groups whenever you need to navigate to a specific parameter code number.

Using arrow keys:

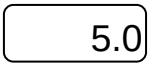
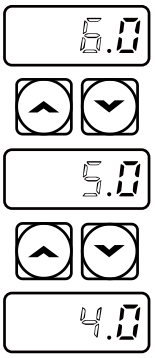


Using Jump Code:

Step	Instruction	Keypad Display
1	Ensure that you are currently at the first code of the Drive group (dr.0).	dr.0
2	Press the [ENT] key. Number "9" will flash.	9
3	Press the [▼] key and change the ones' place number to "5", so the destination code is "5".	5
4	Press the [MODE] to move to the tens' place. The cursor will move to the left and "05" will be displayed. At this time, the number "0" will be flashing.	05
5	Press the [▲] key to change the tens' place number to "9", so the destination code is "95".	95
6	Press the [ENT] key. Code dr.95 is displayed.	dr.95

3.2.3 Setting Parameter Values

The example below shows how to directly enter parameter values, such as frequency references, supply voltages, and motor speeds. You can also enable or disable other features. Follow the instructions below to set or modify parameter values.

Step	Instruction	Keypad Display
1	Select the group and code to setup or modify parameter settings, and then press the [ENT] key. The first number on the right side of the display will flash.	
2	Move to the place value to edit using the MODE/SHIFT key, change the value using the [▲] and [▼] keys, and then press the [ENT] key. Press the [MODE] key for longer than 1 second to move to the left place value. The selected value will flash on the display.	
3	Press the [ENT] key again to save the changes.	-

Note

- A flashing number on the display indicates that the keypad is waiting for an input from the user. Changes will be saved when the [ENT] key is pressed while the number is flashing. The setting change will be canceled if you press any other key.
- Each parameter has default features and ranges specified. Refer to **8 Table of Functions** on page **202** for information about the features and ranges before setting or modifying parameter values.

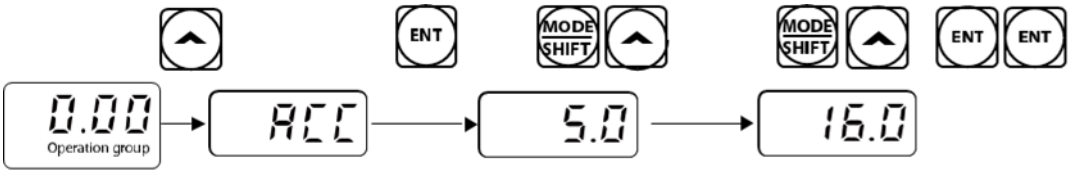
Enable or Disable features of parameters.. When a parameter has choices of Enable/Disable (On/Off), represented by bits (0000 through 1111), select whether or not to activate a function. Program the bits individually where enable (On) is represented by the upper segment being lit and disable (Off) is represented by the lower segment being lit.

Items	Enable state of function	Disable state of function
Keypad		

3.3 Actual Application Examples

3.3.1 Acceleration Time Configuration

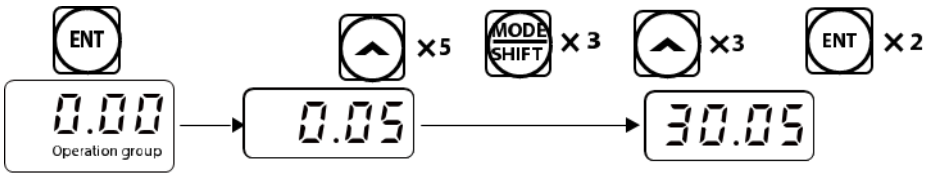
The following demonstrates how to modify the Acceleration time (ACC) parameter value (from 5.0 to 16.0) in the Operation group.



Step	Instruction	Keypad Display
1	Ensure that the first code of the Operation group is selected, and code 0.00 (Reference frequency) is displayed.	0.00
2	Press the [▲] key. The display will change to the ACC code in the Operation group.	ACC
3	Press the [ENT] key. The number "5.0" will be displayed, with "0" flashing. This indicates that the current acceleration time is set to 5.0 seconds. The flashing value is ready to be modified by using the keypad.	5.0
4	Press the [MODE/SHIFT] key to shift to the required units position (ones, tens, hundreds, etc.). "5" in the ones' place from "5.0" will flash. This indicates the flashing value, "5" is ready to be modified.	5.0
5	To make the target value "16.0", press the [▲] key to change the ones' place value to "6".	6.0
6	Press the [MODE/SHIFT] key to move to the tens' position. "0" in the tens' place from "06.0" will flash.	06.0
7	To make the target value "16.0", press the [▲] key to change the tens' value to "1", and then press the [ENT] key. The selected value will flash on the display.	16.0
8	Press the [ENT] key again to save the changes. "ACC" will be displayed. The change to the acceleration time setup has been completed.	ACC

3.3.2 Frequency Reference Configuration

The following demonstrates configuring a reference frequency of 30.05 Hz from the first code in the Operation group.



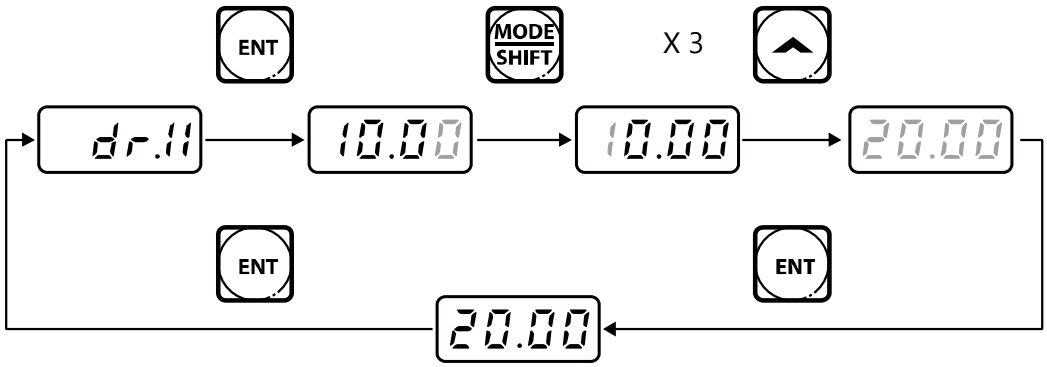
Step	Instruction	Keypad Display
1	Ensure that the first code of the Operation group is selected, and code 0.00 (Reference frequency) is displayed.	0.00
2	Press the [ENT] key. The default value "0.00" will be displayed and "0" in the second decimal place will flash.	0.00
3	Press the [MODE/SHIFT] key 3 times to move to the tens' place value. "0" in the tens' place will flash.	00.00
4	To make the target value "30.05", press the [▲] key to change the tens' place value to "3."	30.00
5	Press the [MODE/SHIFT] key 2 times. The "0" in the second decimal place will flash.	30.00
6	To make the target value "30.05", press the [▲] key to change the second decimal place value to "5", and then press the [ENT] key. The selected value will flash on the display.	30.05
7	Press the [ENT] key again to save the changes. Flashing stops. The frequency reference has been configured to 30.05 Hz.	30.05

Note

- A flashing number on the display indicates that the keypad is waiting for an input from the user. Changes will be saved when the [ENT] key is pressed while the number is flashing. The setting change will be canceled if you press any other key.
- The GM2 inverter display can display up to 4 digits. However, 5-digit figures can be used and are accessed by pressing the [MODE/SHIFT] key, to allow keypad input.

3.3.3 Jog Frequency Configuration

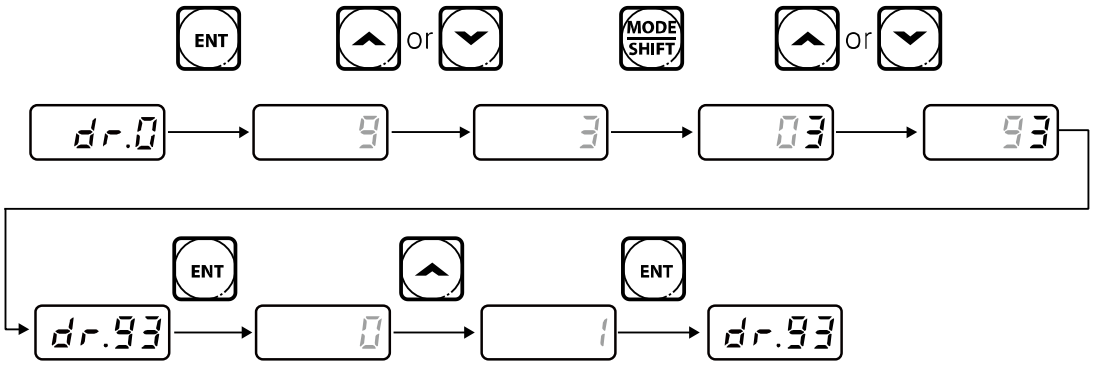
The following demonstrates how to configure Jog Frequency by modifying code dr.11 (Jog Frequency) in the Drive group from 10.00 Hz to 20.00 Hz. You can configure other parameters in different groups exactly the same way.



Step	Instruction	Keypad Display
1	Go to parameter dr.11 in the Drive group.	dr.11
2	Press the [ENT] key. The current Jog Frequency value (10.00).	10.00
3	Press the [MODE/SHIFT] key 3 times to move to the tens' position. "1" in the tens' position will flash.	10.00
4	To make the target value "20.00", press the [▲] key to change the tens' value to "2", and then press the [ENT] key. The selected value will flash on the display.	20.00
5	Press the [ENT] key again to save the changes. Code dr.11 will be displayed. The parameter change has been completed.	dr.11

3.3.4 **Parameter Initialization**

The following demonstrates parameter initialization using code dr.93 (Parameter Initialization) in the Drive group.
Jumping to parameter dr.93 is used.



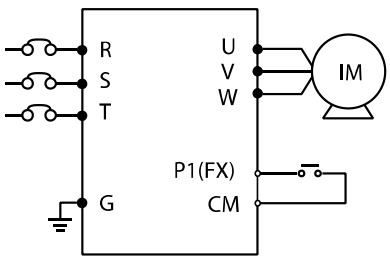
Step	Instruction	Keypad Display
1	Go to code 0 in the Drive group.	dr.0
2	Press the [ENT] key. The current parameter value "9" will be displayed.	9
3	To make the target value "93", press the [▼] key to change the ones' position to "3".	3
4	Press the [MODE/SHIFT] key to move to the tens' position.	03
5	To make the target value "93", press the [▲] or [▼] key to change the tens' position value "9".	93
6	Press the [ENT] key. Code dr.93 will be displayed.	dr.93
7	Press the [ENT] key once again. The current value for parameter dr.93 is set to 0 (No, do not initialize).	0
8	Press the [▲] key to change the value to 1 (All Grp), and then press the [ENT] key. The parameter value will flash.	1
9	Press the [ENT] key once again. Parameter initialization begins. Parameter initialization is complete when code dr.93 reappears on the display.	dr.93

Note

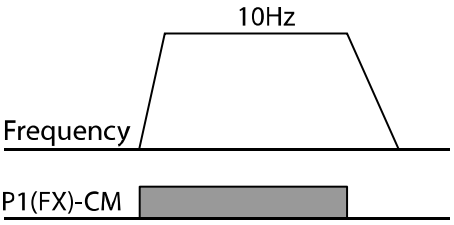
Following parameter initialization, all parameters are reset to factory default values. Ensure that parameters are reconfigured before running the inverter.

3.3.5 Frequency Setting (Keypad) and Operation (via Terminal Input)

Step	Instruction	Keypad Display
1	Turn on the inverter.	-
2	Ensure that the first code of the Operation group is selected, and code 0.00 (Reference frequency) is displayed, then press the [ENT] key. The first number on the right side of the display will flash.	0.00
3	Press the [MODE/SHIFT] key 3 times to move to the tens' position. "0" in the tens' place will flash.	00.00
4	Press the [▲] key to change it to 10.00, and then press the [ENT] key. The selected value will flash on the display.	10.00
5	Press the [ENT] key again to save the changes. The reference frequency has been changed.	10.00
6	Refer to the wiring diagram at the bottom of the table, and turn on the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes and the FWD indicator light comes on steady. The current acceleration frequency is displayed.	SET RUN 10.00 FWD REV
7	When the frequency reference is reached (10 Hz), open the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes again and the current deceleration frequency is displayed. When the frequency reaches 0 Hz, the RUN and FWD indicator lights turn off, and the frequency reference, 10.00, is displayed again.	SET RUN 10.00 FWD REV



[Wiring Diagram]



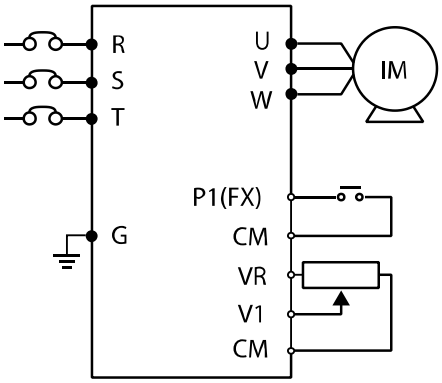
[Operation Pattern]

Note

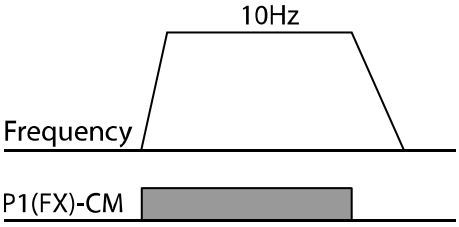
The instructions in the table are based on the factory default parameter settings. The inverter may not work correctly if the default parameter settings were changed. In such cases, initialize all parameters to reset the values to the factory default parameter settings before following the instructions in the table (refer to **5.21 Parameter Initialization** on page **137**).

3.3.6 **Frequency Setting (Potentiometer) and Operation (Terminal Input)**

Step	Instruction	Keypad Display
1	Turn on the inverter.	-
2	Ensure that the first code of the Operation group is selected, and code 0.00 (Reference frequency) is displayed.	0.00
3	Press the [▲] key 4 times. Move to the Frq (Frequency reference source) parameter.	frq
4	Press the [ENT] key. The Frq parameter in the Operation group is currently set to 0 (keypad).	0
5	Press the [▲] key to change the parameter value to 2 (V1, 0-10V reference frequency input with potentiometer), and then press the [ENT] key. The parameter value will flash.	2
6	Press the [ENT] key once again. The Frq parameter will be displayed again. The frequency input has been configured for V1 (0-10VDC, potentiometer).	frq
7	Press the [▼] key 4 times. Move to the first code of the Operation group (0.00). From here frequency setting values can be monitored.	0.00
8	Adjust the potentiometer (0-10V) to increase or decrease the frequency reference to 10 Hz.	-
9	Refer to the wiring diagram at the bottom of the table, and connect a switch between the P1 (FX) and CM terminals. When closed, the RUN indicator light flashes and the FWD indicator light comes on steady. The accelerating frequency is displayed.	
10	When the frequency reference is reached (10 Hz), open the switch between the P1 (FX) and CM terminals. The RUN indicator light flashes again and the decelerating frequency is displayed. When the frequency reaches 0 Hz, the RUN and FWD indicator lights turn off, and the frequency reference, 10.00, is displayed again.	



[Wiring Diagram]

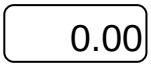
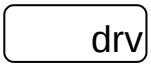
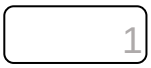
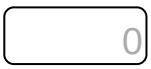
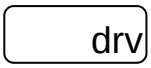
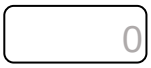
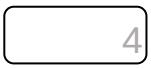
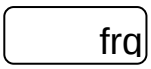
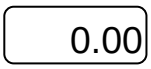


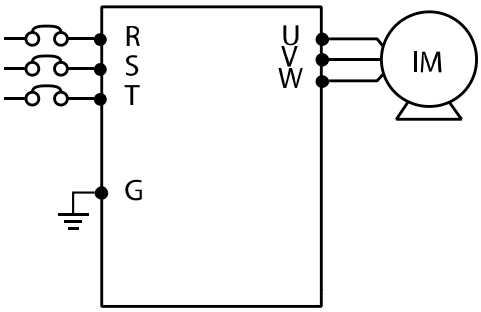
[Operation Pattern]

Note

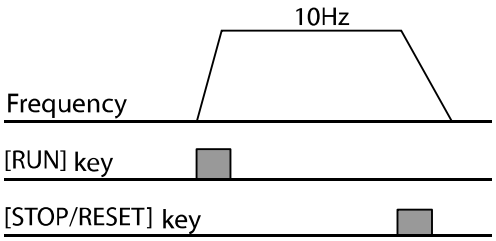
The instructions in the table are based on the factory default parameter settings. The inverter may not work correctly if the default parameter settings were changed. In such cases, initialize all parameters to reset the values to factory default parameter settings before following the instructions in the table (refer to **5.21 Parameter Initialization** on page **137**).

3.3.7 Frequency setting with (internal) potentiometer and start command with the keypad [RUN] key

Step	Instruction	Keypad Display
1	Turn on the inverter.	-
2	Ensure that the first code of the Operation group is selected, and code 0.00 (Reference frequency) is displayed.	
3	Press the [▲] key 3 times. Move to the drv (command source) parameter in the operation group	
4	Press the [ENT] key. The drv parameter is currently set to 1 (Fx/Rx1 start command set from the terminal block).	
5	Press the [▼] key to change the parameter value to 0 (Keypad), and then press the [ENT] key. The parameter value will flash.	
6	Press the [ENT] key once again. The drv parameter is displayed again. The command source (Start/Stop) input has been configured for the keypad.	
7	Press the [▲] key 1 times. Move to the Frq (Frequency reference source) parameter.	
8	Press the [ENT] key. The Frq parameter in the Operation group is currently set to 0 (keypad).	
9	Press the [▲] key to change the parameter value to 4 (V0, Set frequency input to (internal) potentiometer), and then press the [ENT] key. The parameter value will flash.	
10	Press the [ENT] key once again. The Frq parameter will be displayed again. The frequency input has been configured for the V0, potentiometer.	
11	Press the [▼] key 4 times. Move to the first code of the Operation group (0.00). From here frequency setting values can be monitored	
12	Adjust the (internal) potentiometer to increase or decrease the reference frequency to 10 Hz.	-
13	Press the [RUN] key. The RUN indicator light flashes and the FWD indicator light comes on steady. The accelerating frequency is displayed.	
14	When the frequency reaches the reference (10 Hz), press the [STOP/RESET] key on the keypad. The RUN indicator light flashes again and the decelerating frequency is displayed. When the frequency reaches 0 Hz, the RUN and FWD indicator lights turn off, and the reference frequency, 10.00, is displayed again.	



[Wiring Diagram]



[Operation Pattern]

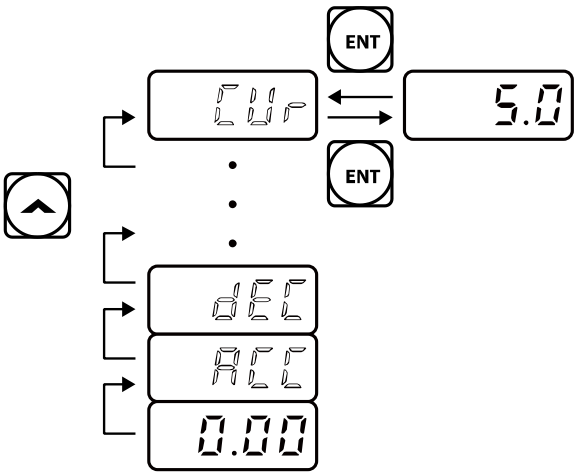
Note

The instructions in the table are based on the factory default parameter settings. The inverter may not work correctly if the default parameter settings are changed. In such cases, initialize all parameters to reset the values to factory default parameter settings before following the instructions in the table (refer to **5.21 Parameter Initialization** on page **137**).

3.4 Monitoring the Operation

3.4.1 Output Current Monitoring

The following demonstrates how to monitor the output current in the Operation group using the keypad.



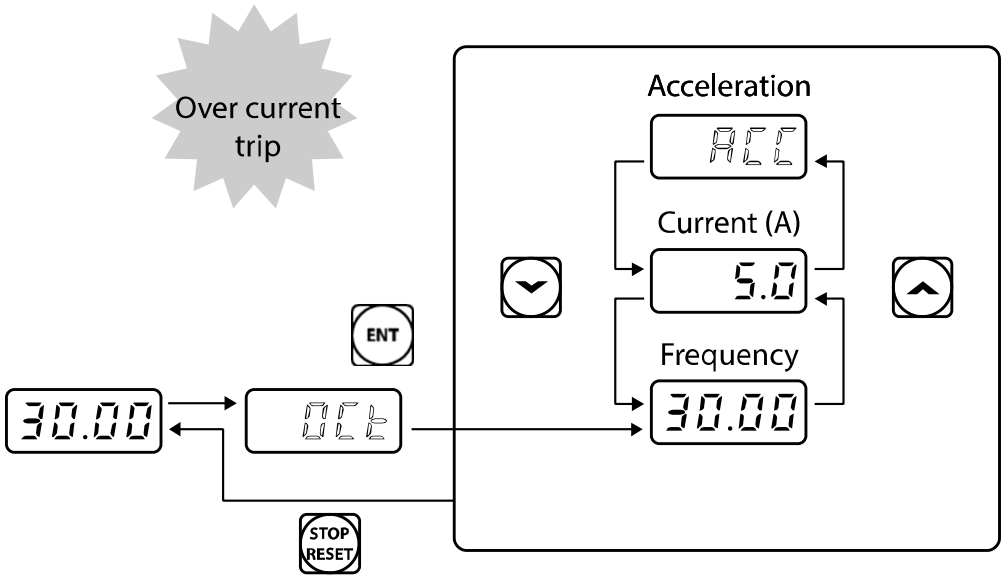
Step	Instruction	Keypad Display
1	Ensure that the first code of the Operation group is selected, and code 0.00 (Reference frequency) is displayed.	0.00
2	Press the [▲] or [▼] key to move to the CUr parameter.	CUr
3	Press the [ENT] key. The output current (5.0 A) is displayed.	5.0
4	Press the [ENT] key once again. Returns to the CUr parameter.	CUr

Note

You can monitor the RPM, dCL (DC link voltage monitor) and vOL (output voltage monitor) parameters in the Operation group in the same way as shown in the example above.

3.4.2 Trip Condition Monitor

The following demonstrates how to monitor fault conditions in the Operation group using the keypad.



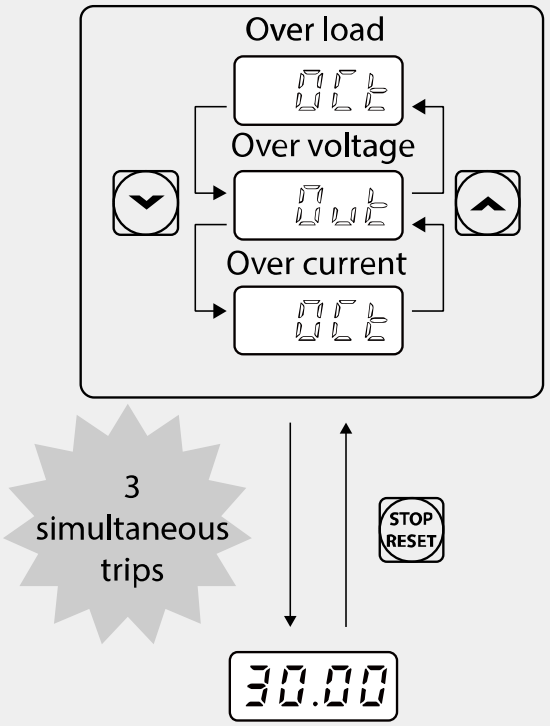
Step	Instruction	Keypad Display
1	Refer to the example keypad display. An over current trip fault has occurred.	oct
2	Press the [ENT] key, and then the [▲] key. The operating frequency at the time of the fault (30.00 Hz) is displayed.	30.00
3	Press the [▲] key. The output current at the time of the fault (5.0 A) is displayed.	5.0
4	Press the [▲] key. The operation status at the time of the fault is displayed. ACC on the display indicates that the fault occurred during acceleration.	acc
5	Press the [STOP/RESET] key. The inverter resets and the fault condition is cleared. The frequency reference is displayed on the keypad. The fault is stored in the Fault History, Parameters Pr.91 ~ Pr.95.	30.00

Note

You can review the fault history with parameters Pr.91 through Pr.95 in the Protection Group.

Note

- If multiple faults occur at the same time, a maximum of 3 fault records can be retrieved as shown in the following example.



- If a warning situation occurs while operating with the entered frequency, a warn display and the current screen will flash in 1 second intervals. Refer to **6.2.6 Under Load Fault and Warning** on page **169** for more details.

4 Learning Basic Features

This chapter describes basic features of the GM2 inverter. Check the reference page in the table to see the detailed description for each of the basic features.

Basic Tasks	Use Example	Ref.
Set the keypad as the frequency reference source.	Configures the inverter to setup and modify the frequency reference using the Keypad.	**p.51**
Set analog input V1 as the frequency reference source.	Configures the inverter to setup and modify the frequency reference using analog input V1.	**p.52**
Set analog input V0 as the frequency reference source.	Configures the inverter to setup and modify the frequency reference using the built-in potentiometer, V0.	**p.57**
Set analog input I2 as the frequency reference source.	Configures the inverter to setup and modify the frequency reference using analog input I2.	**p.57**
Set RS-485 communications as the frequency reference source.	Configures the inverter to set the frequency reference using Modbus communications via the RS-485 terminals (S+/S-) or an Ethernet cable (RJ45 port).	**p.59**
Apply a Frequency Hold to the output frequency.	Hold the inverter output frequency steady using a digital input.	**p.59**
Multi-step frequency configuration	Control the inverter output frequency using up to three digital inputs assigned as preset (fixed) speed inputs. Allows up to seven different preset speeds.	**p.60**
Set the keypad as the Start/Stop (command) source.	Configures inverter start/stop operation using the [RUN] and [STOP/RESET] buttons on the keypad.	**p.62**
Set the digital input terminals as the Start/Stop (command) source.	Configures inverter start/stop operation using digital inputs at the FX/RX terminals.	**p.62**
Set RS-485 communications as the Start/Stop (command) source.	Configures inverter start/stop operation using Modbus communications via the RS-485 terminals (S+/S-) or an Ethernet cable (RJ45 port).	**p.64**
Forward or Reverse Run Prevention	Configures the inverter to prevent motor rotation direction.	**p.64**
Start at power-on	Configures the inverter to automatically start when power Is applied.	**p.65**
Automatic fault reset and restart.	Configures the inverter to automatically reset a fault and restart operation.	**p.66**
Acc/Dec Time Based on Maximum Frequency	Configures the acceleration and deceleration times for a motor based on the maximum frequency.	**p.67**
Acc/Dec Time Based on Operating frequency	Configures acceleration and deceleration times for a motor based on the frequency reference.	**p.68**
Multi-step Acc/Dec Time Configuration	Control the inverter acceleration and deceleration times using up to three digital inputs assigned as XCEL inputs. Allows up to seven different acceleration times and seven different deceleration times.	**p.69**
Acc/Dec time switch frequency	Sets a switching frequency to change between two different Acc and Dec times.	**p.71**
Acc/Dec pattern configuration	Select either linear or S-curve acceleration and deceleration patterns.	**p.72**

Basic Tasks	Use Example	Ref.
Acc/Dec stop command configuration	Disables the current acceleration or deceleration rate and holds the inverter output frequency (motor speed) at the most recent speed.	**p.74**
Linear V/F pattern operation	Increase and decrease the inverter output at a fixed V/F ratio. Used for constant torque loads regardless of the frequency.	**p.74**
Square reduction V/F pattern operation	Increase and decrease the inverter output with a variable V/F ratio. Typical variable torque loads are fans and pumps.	**p.76**
User V/F pattern operation	Enables setting the V/F pattern specific to motor/load characteristics. Up to four points can be programmed.	**p.77**
Manual torque boost	Increase output voltage at start and during low speed operation. This configuration is for loads that require a large amount of starting torque, such as elevators or lifts.	**p.78**
Auto torque boost	Automatically increases the voltage when a large amount of starting torque is required.	**p.79**
Motor output voltage adjustment	Sets the output voltage to match the motor's rated voltage.	**p.80**
Accelerating start	Accelerating start is the typical method used to start a motor. The motor accelerates directly to the reference frequency when the run command is applied.	**p.80**
DC braking at start	Configures the inverter to perform DC injection braking to stop motor rotation before performing a normal accelerating start.	**p.80**
Deceleration stop	Deceleration stop is the typical method used to stop a motor. When the run command is removed, the motor decelerates to 0 Hz and stops.	**p.82**
DC braking after stop	Configures the inverter to perform DC injection braking during deceleration. The frequency at which DC injection braking occurs must be defined.	**p.83**
Free-run stop	When the run command is removed, the inverter output is turned off and the motor/load coasts to a stop.	**p.84**
Power braking	Configures the inverter to provide optimal motor deceleration, without tripping the over voltage protection.	**p.84**
Start/maximum frequency configuration	Defines the start frequency and the maximum frequency.	**p.85**
Frequency Limits - Upper and Lower Limits	Configures the inverter output (operating) frequency limits by defining an upper limit and a lower limit.	**p.85**
Frequency jump	Configures the inverter to avoid running a motor at mechanically resonating frequencies.	**p.86**
2nd Operation Configuration	Switch between two different start/stop (command) sources and two different reference frequency sources.	**p.87**
Multi-function (digital) Input Terminal Control	For the digital input terminals, apply filters, select activation metod (NO/NC operation), and view status.	**p.88**

4.1 Frequency Reference Configuration

The GM2 inverter provides several methods to setup and modify the frequency reference. Choices include the keypad, analog inputs of voltage (V0 or V1) and current (I2), RS-485 (Modbus), or Fieldbus option cards.

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	KeyPad-1	0–8	-
			1	KeyPad-2		
			2	V1		
			4	V0		
			5	I2		
			6	Int 485		
			8	Fieldbus		

4.1.1 Set the Frequency Reference from the Keypad - Direct Input

You can modify the frequency reference using the keypad. Set parameter Frq (Frequency reference source) in the Operations group to 0 (Keypad-1). Program the frequency reference at the 0.00 (Main screen) in the Operations group.

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	KeyPad-1	0–8	-
	0.00	Target frequency	0.00		Min to Max Frq*	Hz

* You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.

4.1.2 Set the Frequency Reference from the Keypad - Using [▲] and [▼] keys

You can use the [▲] and [▼] keys like a potentiometer to modify the frequency reference. Set parameter Frq (Frequency reference source) in the Operations group 1 (Keypad-2). This allows the frequency reference to be increased or decreased using the [▲] and [▼] keys at the 0.00 (Main screen).

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	1	KeyPad-2	0–8	-
	0.00	Target frequency	0.00		Min to Max Frq*	Hz

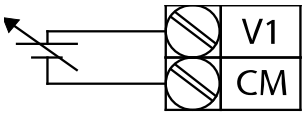
* You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.

4.1.3 Set the Frequency Reference using the V1 Terminal

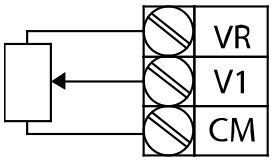
You can modify the frequency reference using the V1 input terminal at the control board. Use voltage inputs ranging from 0 to 10 V (unipolar) or from -10 to +10 V (bipolar) for both directions, where negative voltage inputs are used for reverse operations. Scaling of the voltage range is done with In.08 through In.11 (unipolar) and In.12 through In.15 (bipolar). View the input voltage at In.05.

4.1.3.1 Setting a Frequency Reference for 0–10 V Input

Set parameter Frq in the Operations group to 2 (V1) and set parameter In.06 (V1 Polarity) to 0 (unipolar). Connect an external 0-10V source (PLC or other) to the V1-CM terminals. When connecting a potentiometer, use the VR terminal (voltage reference, +10V) as the 10V source. See connection diagrams below.



[Connecting to external 0-10V source]



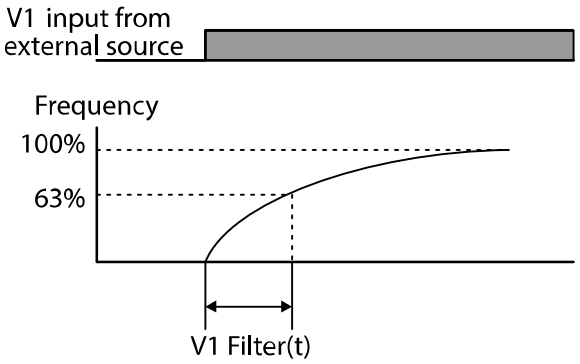
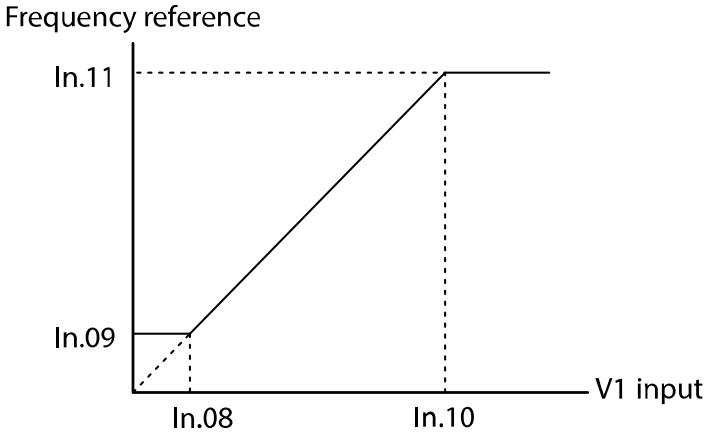
[Connecting potentiometer]

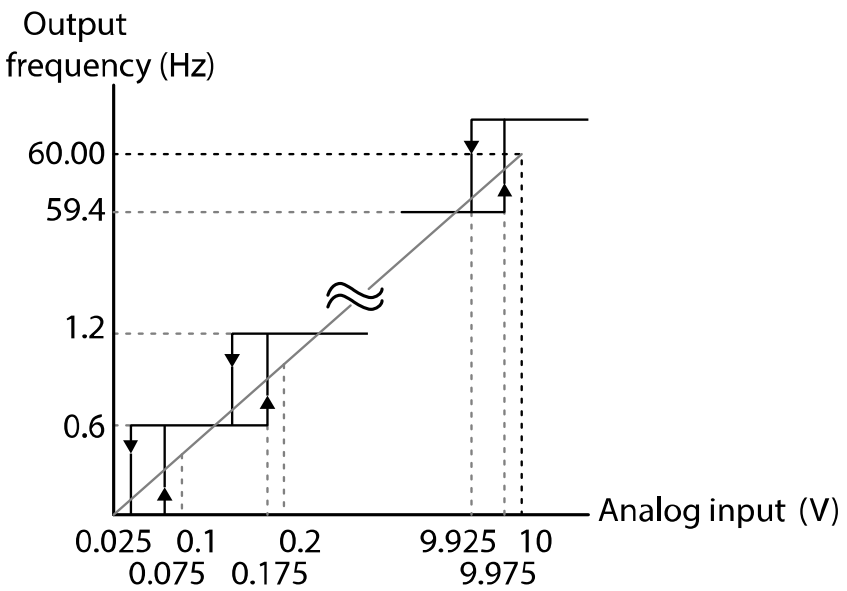
0–10 V Input Voltage Settings

Group	Code	Name	Setting	Setting Range	Unit
Operation	Frq	Frequency reference source	2 V1	0–8	-
In	01	Frequency for maximum analog input	Maximum frequency	Start Frequency–Max. Frequency	Hz
	05	V1 input voltage display	0.00	0.00–12.00	V
	06	V1 input polarity selection	0 Unipolar	0–1	-
	07	V1 input filter time constant	100	0–10000	msec
	08	V1 minimum input voltage	0.00	0.00–10.00	V
	09	Output (%) at V1 minimum	0.00	0.00–100.00	%
	10	V1 maximum input voltage	10.00	0.00–12.00	V
	11	Output (%) at V1 maximum	100.00	0–100	%
	16	Rotation direction options	0 No	0–1	-
	17	V1 quantization level	0.04	0.00*, 0.04–10.00	%

* Quantizing is disabled if "0" is selected.

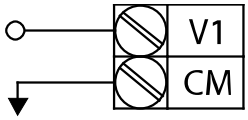
0–10 V Input Voltage Setting Details

Code and Features	Description
In.01 Freq at 100%	Configures the output frequency at the maximum analog input voltage. The frequency set with In.01 becomes the maximum frequency when the value set in code In.11 (for unipolar) or In.15 (for bipolar) is 100%.
In.05 V1 Monitor[V]	Display the value of the input voltage at V1.
In.07 V1 Filter	In.07 is a low-pass filter (time constant) setting that can be applied to the analog signal. Noise on the analog signal causes the inverter ouput frequency to fluctuate. This setting filters the analog signal to provide a clean input signal. Higher settings of the time constant filter will decrease variations in inverter output frequency, however this slows the response time of the inverter output when changing the V1 input signal. The In.07 value (t, time) indicates the time required for the output frequency to reach 63% of the V1 input. 
In.08 ,V1 min. Volt In.09, % output at V1 min. In.10, V1 max. Volt In.11, % output at V1 max.	These parameters are used to configure the offset and gradient level (slope) values of the analog input to the required inverter output. • Set code In.01 to 60.00 and use default values for In.02 through In.16. Motor will run at 60.00 Hz when a 10 V input is provided at V1. • Set In.11 to 50% and use default values for In.01–In.16. Motor will run at 30.00 Hz (50% of the In.01) when a 10 V input is provided at V1. 
In.16 V1 Inverting	Inverts the input value of V1. Set In.16 to 1 (Yes) if you need the motor to run in the opposite direction from the current rotation.

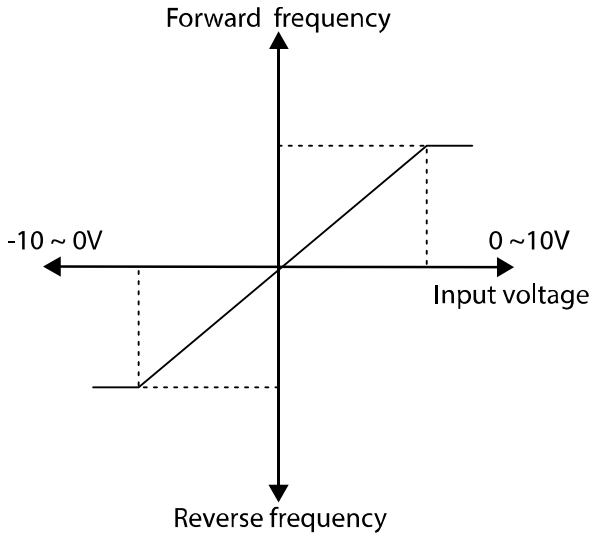
Code and Features	Description
In.17 V1 Quantizing	**Quantizing** may be used when the noise level is high in the analog input signal. The inverter output frequency changes in consistant intervals (steps) based on measuring (quantizing) the height (value) of the analog input signal. Delicate control (resolution) of the output frequency is not as good compared to standard resolution of 0.1%. Parameter values for quantizing refer to a percentage based on the maximum input. Therefore, when In.17 is set to 1% of the analog maximum input of 10 V and with a maximum frequency of 60 Hz, the output frequency will increase or decrease by 0.6 Hz per 0.1V difference. With quantizing applied, changes to the inverter output frequency for analog signal increase and analog signal decrease are treated differently. When the input signal increases, the output frequency starts increasing when the height becomes equivalent to 3/4 of the quantizing value. From then on, the output frequency increases according to the quantizing value. When the input signal decreases, the output frequency starts decreasing when the height becomes equivalent to 1/4 of the quantizing value. Although the noise can be reduced using the low-pass filter (In.07), the inverter output response to the input signal takes longer with higher filter times. It can become difficult to control the output frequency when the input signal is delayed, a period of long pulse (ripple) may occur on the output frequency. 

4.1.3.2 Setting a Frequency Reference for -10–+10 V Input

Set parameter Frq in the Operations group to 2 (V1) and set parameter In.06 (V1 Polarity) to 1 (bipolar). Connect an external -10- +10V source (PLC or other) to the V1-CM terminals.



[Connecting to -10 –+10 V external source]



[Bipolar input voltage and output frequency]

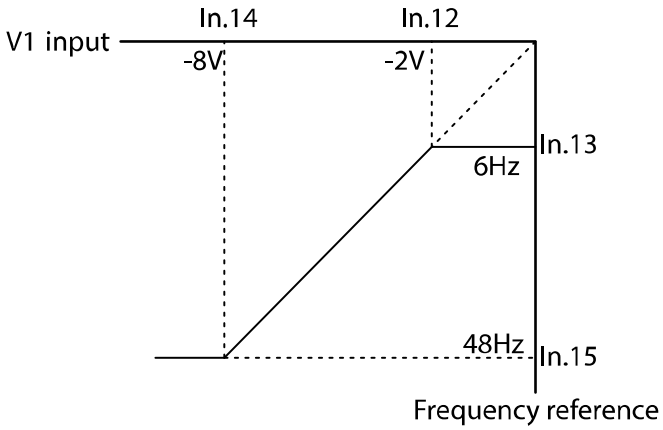
-10V - +10V Input Voltage Settings

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	2	V1	0–8	-
In	01	Frequency for maximum analog input	60.00		0–Max Frequency	Hz
	05	V1 input voltage display	0.00		-12.00–+12.00 V	V
	06	V1 input polarity selection	1	Bipolar	0–1	-
	12	V1 Minimum input voltage	0.00		-10.00–0.00 V	V
	13	Output (%) at V1 Minimum	0.00		-100.00–0.00%	%
	14	V1 Maximum input voltage	-10.00		-12.00–0.00 V	V
	15	Output (%) at V1 Maximum	-100.00		-100.00–0.00%	%

Rotational Directions for Different Voltage Inputs

Run command	Input voltage	
	0–10 V	-10–0 V
FWD	Fwd	Rev
REV	Rev	Fwd

-10–+10 V Voltage Input Setting Details

Code and Features	Description
In.12 V1 min. Volt In.13 % Output at V1 min. In.14 V1 max. Volt In.15 % Output at V1 max.	These parameters are used to configure the offset and gradient level (slope) values of the analog input to the required inverter output. These parameters are displayed only when In.06 is set to 1 (bipolar). • Set In-12 to -2 V, set In.13 to 10%, set In.14 to -8 V, and In.15 to 80%. The output frequency will vary within the range of 6–48 Hz. 

4.1.4 Set the Frequency Reference using V0, Built-in Potentiometer

You can modify the frequency reference using the built-in potentiometer. Set Frq (Frequency reference source) to 4 (V0). View the frequency reference at the 0.00 (Main screen) in the Operations group. Scaling of the V0 input is done with In.38 through In.41. View the input voltage at In.35.

V0 Input Voltage Settings

Group	Code	Name	Setting	Setting Range	Unit
Operation	Frq	Frequency reference source	4 V0	0–8	-
In	01	Frequency for maximum analog input	60.00	0–Max Frequency	Hz
	35	V0 input voltage display	0.00	0.00–5.00	V
	37	Time constant of V0 input filter	100	0–10000	ms
	38	V0 minimum input voltage	0.00	0.00–5.00	V
	39	Output (%) at minimum voltage	0.00	0–100	%
	40	V0 maximum input voltage	5.00	0.00–5.00	V
	41	Output (%) at maximum voltage	100.00	0.00–100.00	%
	46	Changing rotation direction of V0	0 No	0–1	-
	47	V0 quantization level	0.04	0.00*, 0.04–10.00	%

4.1.5 Setting the Reference Frequency using Input Current (I2)

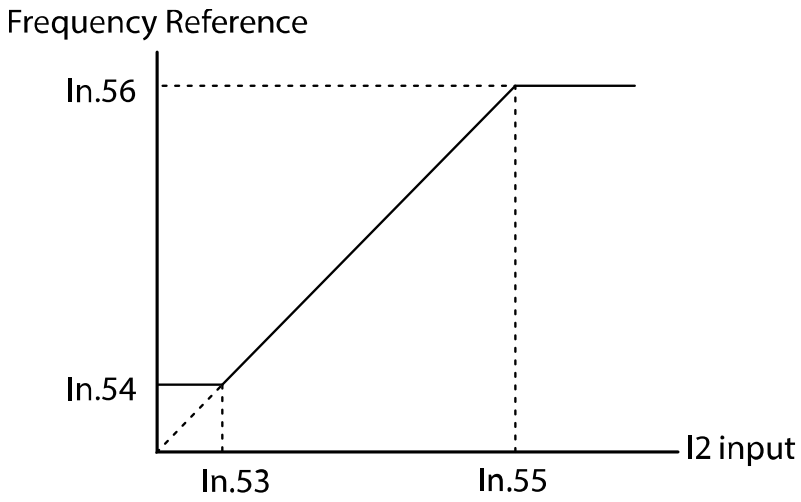
You can modify the frequency reference using the I2 input terminal at the control board. Set Frq (Frequency reference source) in the Operation group to 5 (I2) and apply 4–20 mA input current to I2. Scaling of the input current range is done with In.53 through In.56. View the input current at In.50.

Input Current (I2) Settings

Group	Code	Name	Setting	Setting Range	Unit
Operation	Frq	Frequency reference source	5 I2	0–8	-
In	01	Frequency for maximum analog input	60.00	0–Max Frequency	Hz
	50	I2 input current display	0.00	0.00–20.00	mA
	52	Time constant of I2 input filter	100	0–10000	ms
	53	I2 minimum input current	4.00	0.00–20.00	mA
	54	Output (%) at I2 minimum current	0.00	0–100	%
	55	I2 maximum input current	20.00	0.00–20.00	mA
	56	Output (%) at I2 maximum current	100.00	0.00–100.00	%
	61	Changing rotation direction of I2	0 No	0–1	-
	62	I2 quantization level	0.04	0.00*, 0.04–10.00	%

* Quantizing is disabled if "0" is selected.

Input Current (I2) Setting Details

Code and Features	Description
In.01 Freq at 100%	Configures the output frequency at the maximum analog input current. The frequency set with In.01 becomes the maximum frequency when the value set in In.56 is set to 100%.
In.50 I2 Monitor	Display the value of the input current at I2.
In.52 I2 Filter	In.52 is a low-pass filter (time constant) setting that can be applied to the analog signal. Noise on the analog signal causes the inverter ouput frequency to fluctuate. This setting filters the analog signal to provide a clean input signal. Higher settings of the time constant filter will decrease variations in inverter output frequency, however this slows the response time of the inverter output when changing the I2 input signal. The In.52 value (t, time) indicates the time required for the output frequency to reach 63% of the I2 input.
In.53 I2 min. current In.54 Output (%) at I2 min. In.55 I2 max. current In.56 Output (%) at I2 max.	These parameters are used to configure the offset and gradient level (slope) values of the analog input to the required inverter output. • Set In.01 to 60.00 and use default settings for In.53 through In.56. Motor will run at 60 Hz. when 20 mA input current is applied to the I2 terminal. • Set In.56 to 50.00 and use default settings for In.53 through In.55. The motor will run at 30 Hz. when 20 mA input current is applied to the I2 terminal. 

4.1.6 Setting the Frequency Reference using RS-485 Communication

Set parameter Frq (Frequency reference source) 6 (Int 485). Control the inverter with upper-level controllers (PCs or PLCs) via RS-485 communications using the (S+/S-) input terminals of the control board. Refer to **7 RS-485 Communication Features** on page **179** for more details.

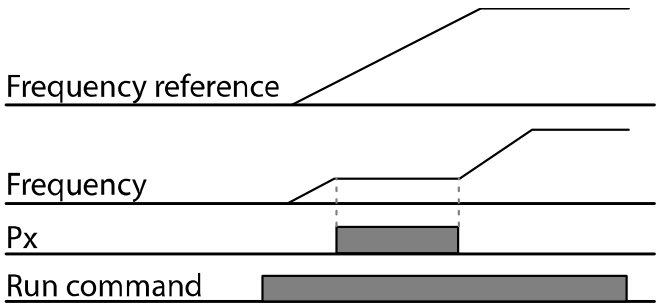
RS-485 Communication Settings

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	6	Int 485	0–8	-
CM	01	Built-in communication inverter ID	-	1	1–250	-
	02	Built-in communication protocol	0	ModBus RTU	0–2	-
			1	Reserved		
			2	LS INV 485		
	03	Built-in communication speed	3	9600 bps	0–7	-
	04	Built-in communication frame setting	0	D8/PN/S1	0–3	-
			1	D8/PN/S2		
			2	D8/PE/S1		
			3	D8/PO/S1		

4.2 Frequency Hold by Digital Input

When using an analog input as the frequency reference, you can apply a hold of the output frequency at any point. Set a digital input to 21 (Analog Hold). When the input is activated, the output frequency will be maintained (held constant) until the input is de-activated.

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	2	V1	0–8	-
			4	V0		
			5	I2		
In	65~69	Px terminal setting options	21	Analog Hold	0–52	-



4.3 Multi-step Frequency Configuration

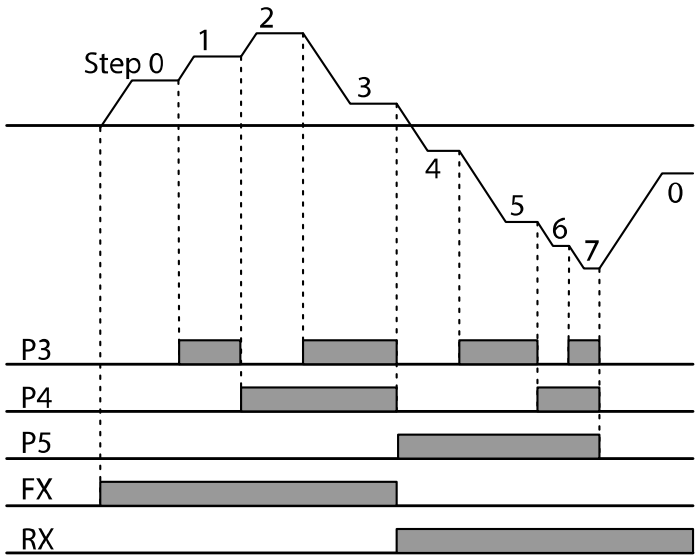
Multi-step operations (Fixed Speed Inputs) can be assigned to the Px terminals. Step 0 uses the frequency reference source set with Frq in the Operations group. Steps 1 through 7 can be configured using (3) digital input terminals. Set Px terminals to 7 (Speed-L), 8 (Speed-M) and 9 (Speed-H). These are recognized as binary inputs (000 ~ 111) and work in combination with Fx or Rx run commands. The inverter operates according to the frequencies set with parameters St1, St2 and St3 (step frequencies 1~3) and bA.53 ~ bA.56 (step frequencies 4–7). and the binary command combinations.

Multi-step Frequency Settings

Group	Code	Name	Setting		Setting Range	Unit
Operation	St1~St3	Multi-step frequency 1–3	-		0–Max Frequency	Hz
bA	53–56	Multi-step frequency 4–7	-		0–Max Frequency	Hz
In	65–69	Px terminal setting options	7	Speed-L	0–52	-
			8	Speed-M		-
			9	Speed-H		-
	89	Multi-step command delay time	1		1–5000	ms

Multi-step Frequency Setting Details

Code and Features	Description
Operation group St1~St3	Configure multi-step frequencies 1–3.
bA.53 ~ bA–56 Step Freq 4–7	Configure multi-step frequencies 4–7.

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>In.65 ~ In.69
Px Define</td><td>Choose (3) of the digital input terminals (P1 ~ P5) to setup as multi-step inputs. Set (3) of the correspondinig parameters (In.65~In.69) to 7 (Speed-L), 8 (Speed-M), or 9 (Speed-H).
Example using terminals P3, P4 and P5 set to Speed-L, Speed-M and Speed-H respectively, the following multi-step operation will be available.
 

[Multi-step operation]

<table>
<tr><th>Speed</th><th>Fx/Rx</th><th>P5</th><th>P4</th><th>P3</th></tr>
<tr><td>0</td><td>✓</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>1</td><td>✓</td><td>-</td><td>-</td><td>✓</td></tr>
<tr><td>2</td><td>✓</td><td>-</td><td>✓</td><td>-</td></tr>
<tr><td>3</td><td>✓</td><td>-</td><td>✓</td><td>✓</td></tr>
<tr><td>4</td><td>✓</td><td>✓</td><td>-</td><td>-</td></tr>
<tr><td>5</td><td>✓</td><td>✓</td><td>-</td><td>✓</td></tr>
<tr><td>6</td><td>✓</td><td>✓</td><td>✓</td><td>-</td></tr>
<tr><td>7</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>
[Multi-step speed inputs]</td></tr>
<tr><td>In.89
InCheck Time</td><td>Set the time for the inverter to check for other digital inputs. Set In.89 to 100 ms and when an input signal is received at P5, the inverter will search for inputs at other terminals for 100 ms, before proceeding to accelerate or decelerate based on P5's configuration.</td></tr>
</table>

4.4 Command Source (Start/Stop) Configuration

The GM2 inverter provides several methods to Start and Stop the inverter. Choices include the keypad, digital input terminals, RS-485 (Modbus), or Fieldbus option cards.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	0	Keypad	0–4	-
			1	Fx/Rx-1		
			2	Fx/Rx-2		
			3	Int 485		
			4	Fieldbus		

4.4.1 Setting the Keypad as a Command Input Device

The keypad can be selected as a command input device to start and stop the inverter. Set parameter drv (command source) to 0 (Keypad). Press the [RUN] key on the keypad to start and the [STOP/RESET] key to stop.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	0	Keypad	0–4	-

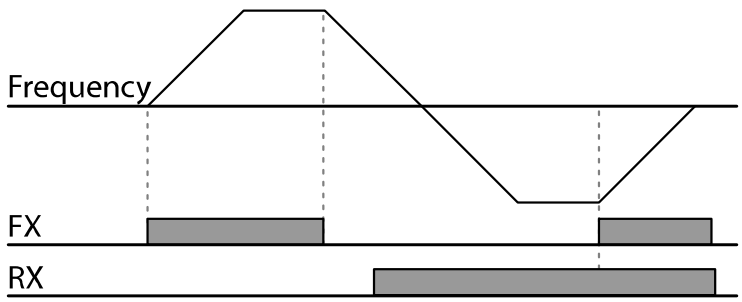
4.4.2 Setting the Terminal Block as a Command Input Device - Fwd/Rev Run Commands

Digital input terminals can be selected as the command input device. Set parameter drv (command source) to 1 (Fx/Rx-1). Choose (2) of the digital input terminals (P1 ~ P5) to setup as Forward and Reverse. Set (2) of the correspondinig parameters (In.65~In.69) to 1 (Fx) and 2 (Rx) respectively. Activating either terminal constitutes a run command. Activating both terminals constitutes a stop command.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	1	Fx/Rx-1	0–4	-
In	65–69	Px terminal setting options	1	Fx	0–52	-
			2	Rx		

Fwd/Rev Command using Digital Input Terminals – Setting Details

Code and Features	Description
Operation group drv– Cmd Source	Set to 1 (Fx/Rx-1).
In.65–69 Px Define	Assign a terminal for forward (Fx) operation. Assign a terminal for reverse (Rx) operation.



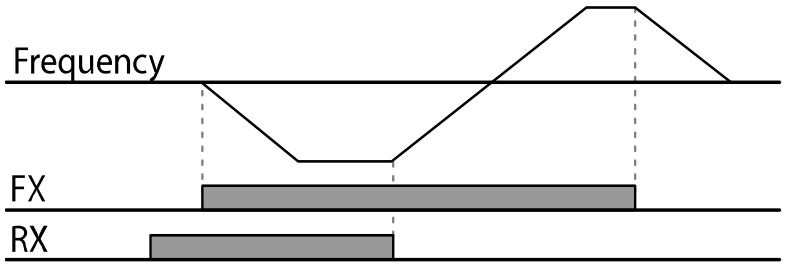
4.4.3 Setting the Terminal Block as a Command Input Device - Run and Rotation Direction Commands

Set parameter drv (command source) to 2 (Fx/Rx-2). This configuration (Fx/Rx-2) assigns the Fx terminal as the Start/Stop input terminal and assigns the Rx terminal as the rotational direction input terminal (Open: Fwd, Closed: Rev). Choose (2) of the digital input terminals (P1 ~ P5) to setup as Forward and Reverse. Set (2) of the correspondinig parameters (In.65~In.69) to 1 (Fx) and 2 (Rx) respectively.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	2	Fx/Rx-2	0–4	-
In	65~69	Px terminal setting options	1	Fx	0–52	-
			2	Rx		

Run Command and Fwd/Rev Command Using Digital Input Terminals – Setting Details

Code and Features	Description
drv– Cmd Source	Set to 2 (Fx/Rx-2).
In.65 ~ 69 Px Define	Assign a terminal for run command (Fx). Assign a terminal for changing rotation direction (Rx).



4.4.4 Setting RS-485 Communications as a Command Input Device

Set drv (command source) to 3 (Int 485). Control the inverter with upper-level controllers (PCs or PLCs) via RS-485 communications using the (S+/S-) input terminals of the control board. Refer to **7 RS-485 Communication Features** on page **179** for more details.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	3	Int 485	0–4	-
CM	01	Built-in communication inverter ID	1		1–250	-
	02	Built-in communication protocol	0	ModBus RTU	0–2	-
	03	Built-in communication speed	3	9600 bps	0–7	-
	04	Built-in communication frame setting	0	D8/PN/S1	0–3	-

4.5 Forward or Reverse Run Prevention

The rotation direction can be configured to prevent motors from rotating in a specific direction. Set Ad.09 to prevent rotation in either the Fwd or Rev direction.

Group	Code	Name	Setting		Setting Range	Unit
Ad	09	Run prevention options	0	None	0–2	-
			1	Forward Prev		
			2	Reverse Prev		

Forward/Reverse Run Prevention Setting Details

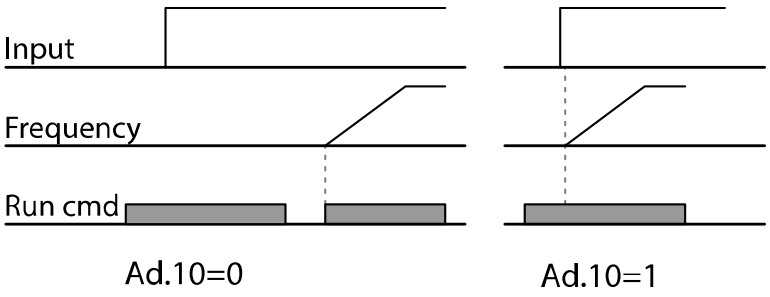
Code and Features	Description
Ad.09 Run Prevent	Choose a direction to prevent.

Configuration		Function
0	None	Do not set run prevention.
1	Forward Prev	Set forward run prevention.
2	Reverse Prev	Set reverse run prevention.

4.6 Power-on Run

The inverter can be set to start operating (output power to the motor) as soon as the inverter powers up. **See caution below**. When Ad.10, Power-on Run is set to 1 (yes) and a run command remains enabled, the inverter will start immediately upon power up. Parameter drv (command source) must be set to 1 (Fx/Rx-1) or 2 (Fx/Rx-2) along with an active run command. If drv is set to Keypad, Power On Run does not function.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	1, 2	Fx/Rx-1 or Fx/Rx-2	0–4	-
Ad	10	Start with power on	1	Yes	0–1	-



Note

- **Power On Run and Speed Search** - A fault may be triggered if the inverter starts operation while the load is still rotating. With Power On Run enabled, the inverter will begin its operation in a normal V/F pattern and accelerate the motor. To prevent faults, set speed search CN-71, bit 4 to 1. The inverter will perform a speed search at the beginning of the operation.
- With Power On Run not enabled, if the inverter has a run command enabled upon power up, it will not start. The digital input (Run command) must first be de-activated and reapplied to begin operation.

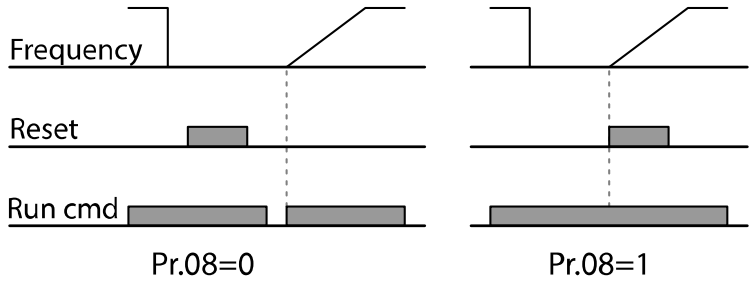
Caution

Take caution - With Power On Run enabled and a Run command applied, the motor will begin rotating as soon as the inverter powers up.

4.7 Reset and Restart

The inverter can be set to automatically reset faults and restart operations. **See caution below**. When Pr.08 is set to 1 (yes) and a run command remains enabled, the inverter will reset the fault and restart. The number of restarts is set with Pr.09 (# of restarts) and the delay time between each restart is set with Pr.10 (restart delay time). When a fault occurs, the inverter cuts off the output and the motor will free-run. Another fault may be triggered if the inverter begins its operation while motor load is in a free-run state.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	1, 2	Fx/Rx-1 or Fx/Rx-2	0–4	-
Pr	08	Selection of startup on trip reset	1	Yes	0–1	
	09	Number of automatic restarts	0		0–10	
	10	Auto restart delay time	1.0		0–60	sec



Note

- **Automatic Reset/Restart and Speed Search**: A fault may be triggered if the inverter starts operation while the load is still rotating. With Automatic reset/restart enabled, the inverter will begin its operation in a normal V/F pattern and accelerate the motor. To prevent faults, set speed search CN-71, bit 2 to 1. The inverter will perform a speed search at the beginning of the operation.
- With automatic reset/restart not enabled, if the inverter has a run command enabled during a fault reset, it will not start. The digital input (Run command) must first be de-activated and reapplied to begin operation.

Caution

Take caution - With Automatic Reset/Restart enabled and a Run command applied, the motor will begin rotating as soon as the inverter is reset.

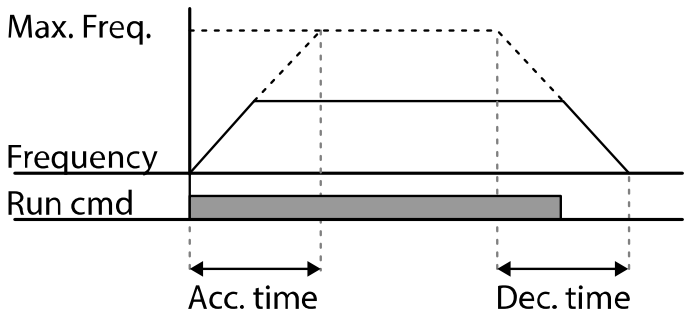
4.8 Setting Acceleration and Deceleration Times

4.8.1 Acc/Dec Time Based on Maximum Frequency

Acc/Dec times are based on maximum frequency (bA.08 set to 0 (MaxFreq)), not on inverter operating frequency. Acceleration time set at ACC refers to the time required for the inverter to reach the maximum frequency from a stopped (0 Hz) state. Likewise, deceleration time set at dEC refers to the time required to decelerate from the maximum frequency to a stopped state (0 Hz).

Group	Code	Name	Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–600.0	sec
	dEC	Deceleration time	10.0		0.0–600.0	sec
dr	20	Maximum frequency	60.00		40.00–400.00	Hz
bA	08	Acc/Dec reference frequency	0	Max Freq	0–1	-
	09	Time scale setting	1	0.1sec	0–2	-

Acc/Dec Time Based on Maximum Frequency – Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>bA.08
Acc/Dec reference frequency</td><td>Set bA.08 to 0 (Max Freq) to setup Acc/Dec time based on maximum frequency.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Max Freq</td><td>Set the Acc/Dec time based on maximum frequency.</td></tr>
<tr><td>1</td><td>Delta Freq</td><td>Set the Acc/Dec time based on operating frequency.</td></tr>
</table>
Example: maximum frequency is 60.00 Hz, the Acc/Dec times are set to 5 seconds. With a frequency reference of 30 Hz, the time required to reach 30 Hz is 2.5 seconds.

</td></tr>
<tr><td>bA.09
Time scale</td><td>Set the time scale for all time-related values. Set to 0 (0.01sec) when more precise Acc/Dec times are required. Set to 2 (1sec) when the time display and setting require less precision or need to be extended above 60.00 secs.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>0.01sec</td><td>Sets 0.01 second as the minimum unit.</td></tr>
<tr><td>1</td><td>0.1sec</td><td>Sets 0.1 second as the minimum unit.</td></tr>
<tr><td>2</td><td>1sec</td><td>Sets 1 second as the minimum unit.</td></tr>
</table></td></tr>
</table>

Caution

Note that the time values may change automatically when the units are changed. If the acceleration time is set at 6000 seconds, changing bA.09 from a time scale of 1 second to 0.01 second will result in a modified acceleration time of 60.00 seconds.

4.8.2 Acc/Dec Time Based on Operating frequency

Acc/Dec times can be set based on the time required to reach the next step frequency from the existing operating frequency. Set bA.08 (Acc/Dec reference frequency) to 1 (Delta Freq).

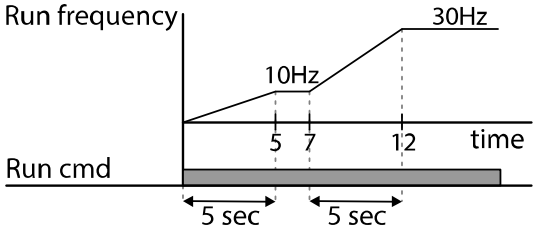
Group	Code	Name	Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–600.0	sec
	dEC	Deceleration time	10.0		0.0–600.0	sec
bA	08	Acc/Dec reference frequency	1	Delta Freq	0–1	-

Acc/Dec Time Based on Operating frequency – Setting Details

Code and Features	Description
bA.08 Acc/Dec reference frequency	Set bA.08 to 1 (Delta Freq) to set Acc/Dec times based on Delta frequency.

Configuration		Function
0	Max Freq	Set the Acc/Dec time based on maximum frequency.
1	Delta Freq	Set the Acc/Dec time based on operating frequency.

Example: Acc/Dec times are set to 5 seconds and step frequencies are used in 2 steps, at 10 Hz and 30 Hz. The time to accelerate will be as follows.



4.8.3 Multi-step Acc/Dec Time Configuration

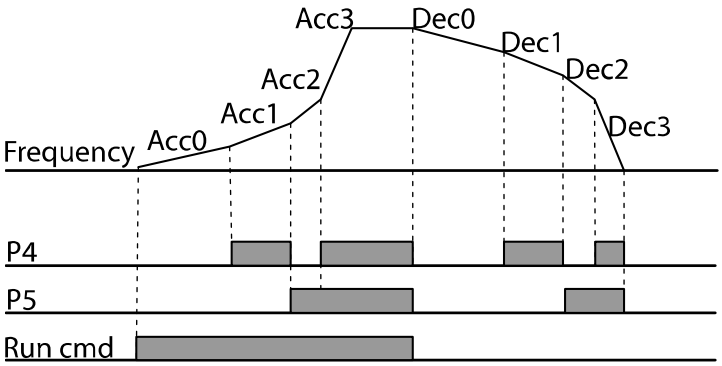
Digital input terminals can be configured for different Acc and Dec times. Up to 7 acceleration times and 7 deceleration times can be set. Choose (up to 3) digital input terminals (P1 ~ P5) and set the corresponding parameters (In.65~In.69) to 11 (XCEL-L), 12 (XCEL-M) and 49 (XCEL-H). These are recognized as binary inputs (000 ~ 111). Acc times and Dec times are set with bA.70 through bA.83.

Group	Code	Name	Setting		Setting Range	Unit
Operation	ACC	Acceleration time	5.0		0.0–600.0	sec
	dEC	Deceleration time	10.0		0.0–600.0	sec
bA	70–82	Multi-step acceleration time 1–7	0.0		0.0–600.0	sec
	71–83	Multi-step deceleration time 1–7	0.0		0.0–600.0	sec
In	65–69	Px terminal setting options	11	XCEL-L	0–52	-
			12	XCEL-M		
			49	XCEL-H		
	89	Multi-step command delay time	1		1–5000	ms

Acc/Dec Time Setup via Multi-function (digital) Terminals – Setting Details

Code and Features	Description
bA.70 ~ bA.82 Acc Time 1–7	Set multi-step acceleration time 1–7.
bA.71 ~ bA.83 Dec Time 1–7	Set multi-step deceleration time 1–7.

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>In.65 ~ In.69
Px Define
(P1–P5)</td><td>
Choose and configure the terminals to use for multi-step Acc/Dec time inputs.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>11</td><td>XCEL-L</td><td>Acc/Dec command-L</td></tr>
<tr><td>12</td><td>XCEL-M</td><td>Acc/Dec command-M</td></tr>
<tr><td>49</td><td>XCEL-H</td><td>Acc/Dec command-H</td></tr>
</table>
Acc/Dec commands are recognized as binary code inputs and will control the acceleration and deceleration based on parameter values set with bA.70 ~ bA–82 and bA.71 ~ bA–83.

Example: P4 and P5 terminals are set as XCEL-L and XCEL-M respectively, the following operation will be available.


<table>
<tr><th>Acc/Dec time</th><th>P5</th><th>P4</th></tr>
<tr><td>0</td><td>-</td><td>-</td></tr>
<tr><td>1</td><td>-</td><td>✓</td></tr>
<tr><td>2</td><td>✓</td><td>-</td></tr>
<tr><td>3</td><td>✓</td><td>✓</td></tr>
</table>
[Configuration of multi-function (digital) terminals P4 and P5]
</td></tr>
<tr><td>In.89
InCheck Time</td><td>Set the time for the inverter to check for other digital inputs. Set In.89 to 100 ms and when an input signal is received at P4 or P5, the inverter will search for inputs at other terminals for 100 ms, before proceeding to accelerate or decelerate based on P4 or P5’s configuration.</td></tr>
</table>

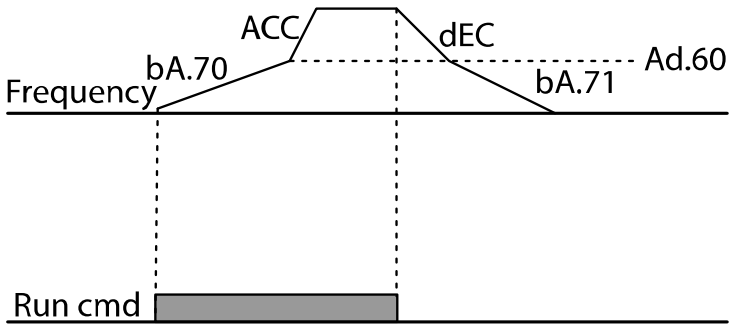
4.8.4 Acc/Dec Time Switch Frequency

You can set a switch frequency (Ad.60) to switch between 2 different Accel times and 2 different Decel times. Parameters bA.70 (step accel time1) and bA.71 (step decel time1) are in effect below the switch frequency. Parameters ACC (Accel time) and Dec (Decel time) are in effect above the switch frequency.

Group	Code	Name	Setting	Setting Range	Unit
Operation	ACC	Acceleration time	5.0	0.0–600.0	sec
	dEC	Deceleration time	10.0	0.0–600.0	sec
bA	70	Multi-step acceleration time 1	20.0	0.0–600.0	sec
	71	Multi-step deceleration time 1	20.0	0.0–600.0	sec
Ad	60	Acc/Dec time transition frequency	30.00	0–Max Frequency	Hz

Acc/Dec Time Switch Frequency Setting Details

Code and Features	Description
Ad.60 Acc/Dec time transition frequency	Set the Acc/Dec transition frequency (Ad.60). Acc/Dec gradients configured at bA.70 and bA.71 will be used when the inverter's operating frequency is at or below the switch frequency. When the operating frequency exceeds the switch frequency, Acc/Dec gradients configured at ACC and dEC will be used. If you configure any of the P1–P5 digital input terminals for multi-step Acc/Dec gradients (XCEL-L, XCEL-M, XCEL-H), Ad.60 Acc/Dec switch frequency will not operate.



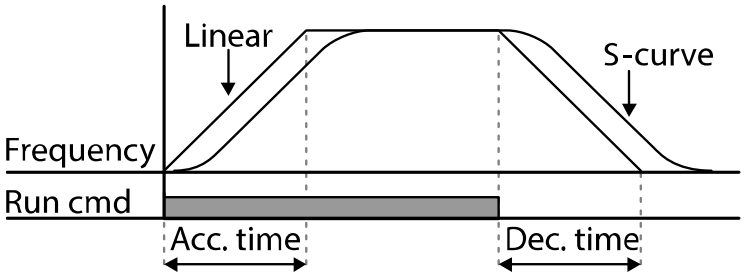
4.9 Acc/Dec Pattern Configuration

A Linear Accel and Decel pattern features a linear increase (and decrease) of the output frequency at a fixed rate. An S-curve pattern provides a smoother and more gradual increase (and/or decrease) of output frequency. Acc/Dec gradient level patterns can be configured to enhance and smooth the inverter's acceleration and deceleration curves. This is ideal for lift-type loads or elevators. An S-curve can be set with Ad.01 (accel) and Ad.02 (decel) and gradient levels can be adjusted using Ad.03 ~ Ad.06.

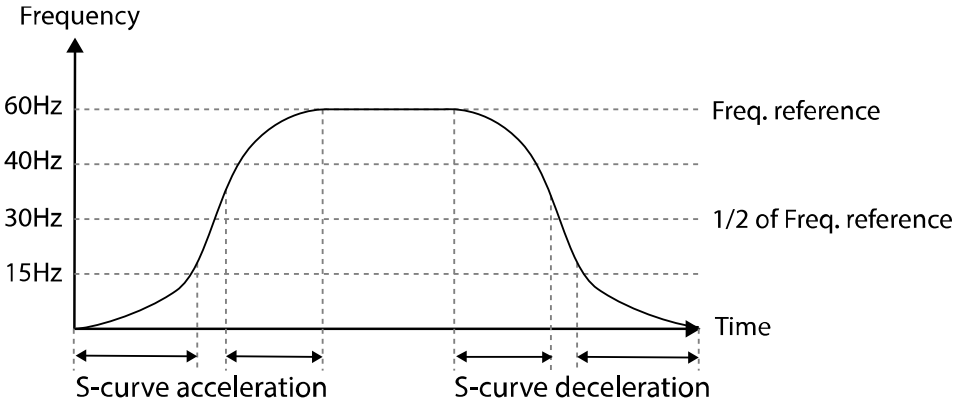
Group	Code	Name	Setting		Setting Range	Unit
bA	08	Acc/Dec reference frequency	0	Max Freq	0–1	-
Ad	01	Acceleration pattern	0	Linear	0–1	-
	02	Deceleration pattern	1	S-curve		-
	03	S-curve acceleration start point gradient	40		1–100	%
	04	S-curve acceleration end point gradient	40		1–100	%
	05	S-curve deceleration start point gradient	40		1–100	%
	06	S-curve deceleration end point gradient	40		1–100	%

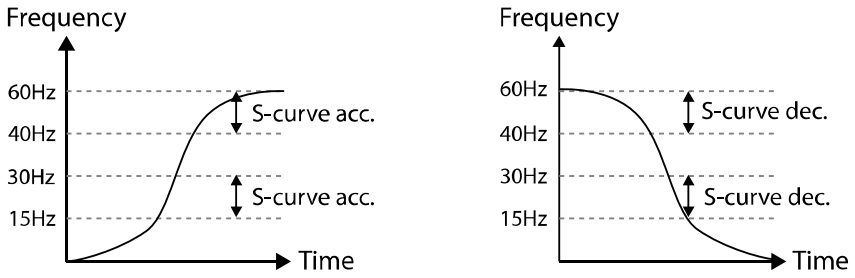
Acc/Dec Pattern Setting Details

Code and Features	Description
Ad.01 Acceleration Pattern	Select 0 (Linear) or 1 (S-Curve) Acceleration Pattern
Ad.02 Deceleration Pattern	Select 0 (Linear) or 1 (S-Curve) Deceleration Pattern
Ad.03 Acc S Start	Ad.03 sets the gradient level at the start of the acceleration curve. The set percentage applies to 50% below the first half of the total acceleration curve. When the frequency reference is set at 60 Hz and Ad.03 is set to 50%, S-Curve acceleration will be applied to 0–15 Hz. (50% below half the reference frequency). Linear acceleration will be applied to the 15-30 Hz. section.
Ad.04 Acc S End	Ad.04 sets the gradient level at the end of the acceleration curve. The set percentage applies to the second half of the total acceleration curve where operating frequency is reaching the reference frequency. When the reference frequency is 60 Hz. and Ad.04 is set to 50%, S-Curve acceleration will be applied to 45-60 Hz. (50% above half the reference frequency). Linear acceleration will be applied to the 30–45 Hz. section.
Ad.05 Dec S Start –	Sets the gradient level at the start of S-curve deceleration. S-Curve deceleration is applied to the portion of the deceleration curve that is 50% above half the reference frequency (60-45 Hz.). Same as S-Curve End acceleration.
Ad.06 Dec S End	Sets the gradient level at the end of S-curve deceleration. S-Curve deceleration is applied to the portion of the deceleration curve that is 50% below half the reference frequency (15-0 Hz.). Same as S-Curve start acceleration.



[Linear vs. S-Curve Acceleration / deceleration pattern configuration]





[Acceleration / deceleration S-curve pattern configuration]

Caution

The actual Acc/Dec times become greater than user defined Acc/Dec times when S-curve Acc/Dec patterns are applied. Example:

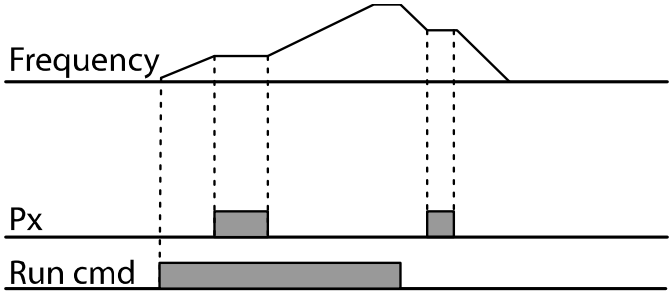
The Actual Acc/Dec time during an S-curve application

Actual acceleration time = ACC + (ACC x Ad.03/2) + (ACC x Ad.04/2)
Settings: ACC = 10 secs., Ad.03 = 50%, Ad.04 = 50%
Actual acceleration time = 10 + (10 x .5/2) + (10 x .5/2) = 15 secs.
Actual deceleration time = Dec + (Dec x Ad.05/2) + (Dec x Ad.06/2)

4.10 **Stopping the Acc/Dec Operation**

Configures a digital input terminal to stop acceleration or deceleration and operate the inverter at a fixed frequency.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal	25	XCEL Stop	0–52	-



4.11 **V/F Control**

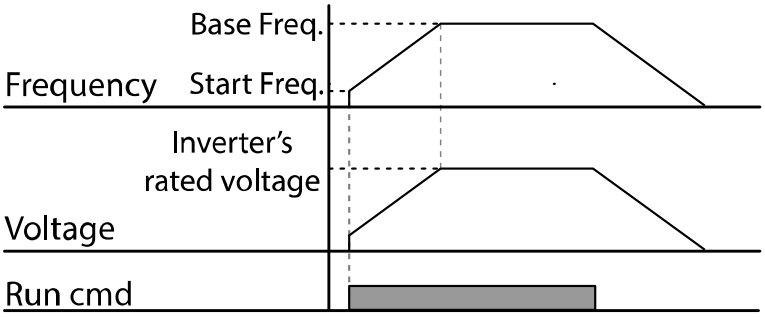
Configure the inverter's output voltages, gradient levels and output patterns to achieve a target output frequency with V/F control. The amount of torque boost used during low frequency operations can also be adjusted.

4.11.1 **Linear V/F Pattern Operation**

A linear V/F pattern (also refered to as scaler V/Hz.) configures the inverter output voltage and frequency to increase or decrease at a fixed rate throughout the speed range. This V/F characteristic is refered to as a constant V/F ratio (or V/Hz.) and is applied to loads that require constant torque regardless of the speed.

Group	Code	Name	Setting		Setting Range	Unit
dr	09	Control mode	0	V/F	0–4	-
	18	Base frequency	60.00		30.00–400.00	Hz
	19	Start frequency	0.50		0.01–10.00	Hz
bA	07	V/F pattern	0	Linear	0–3	-

Linear V/F Pattern Setting Details

Code and Features	Description
dr.18 Base Freq	Sets the base frequency. A base frequency is the inverter's output frequency when applying the motor's rated voltage. Refer to the motor's nameplate to set this parameter.
dr.19 Start Freq	Sets the start frequency. A start frequency is a frequency at which the inverter starts to output voltage. The inverter does not produce output voltage when the reference frequency is lower than the start frequency. However, if a deceleration stop is made while operating above the start frequency, output voltage will continue until the operating frequency reaches a full-stop. 

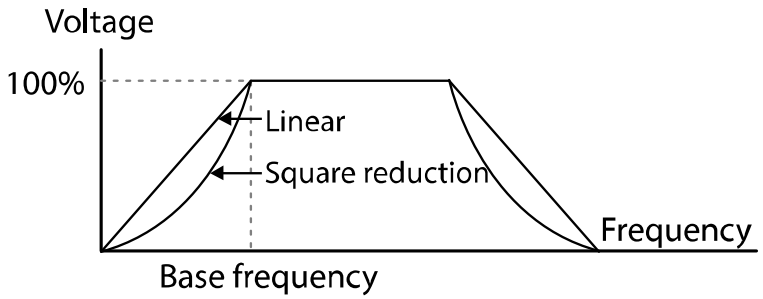
4.11.2 **Square Reduction V/F Pattern Operation**

Square reduction V/F pattern is ideal for variable torque loads such as fans and pumps that do not require high torque at frequencies lower than base frequency. The inverter provides a non-linear V/F acceleration and deceleration pattern to sustain enough torque throughout the speed range.

Group	Code	Name	Setting		Setting Range	Unit
bA	07	V/F pattern	1	Square	0–3	-
			3	Square2		

Square Reduction V/F Pattern Operation - Setting Details

Code and Features	Description		
bA.07 V/F Pattern	Sets the parameter value to 1 (Square) or 2 (Square2) according to the load's start characteristics.		
	Configuration		Function
	1	Square	The inverter produces output voltage proportional to 1.5 square of the operating frequency.
	3	Square2	The inverter produces output voltage proportional to 2 square of the operating frequency. This setup is ideal for variable torque loads such as fans or pumps.



4.11.3 **User V/F Pattern Operation**

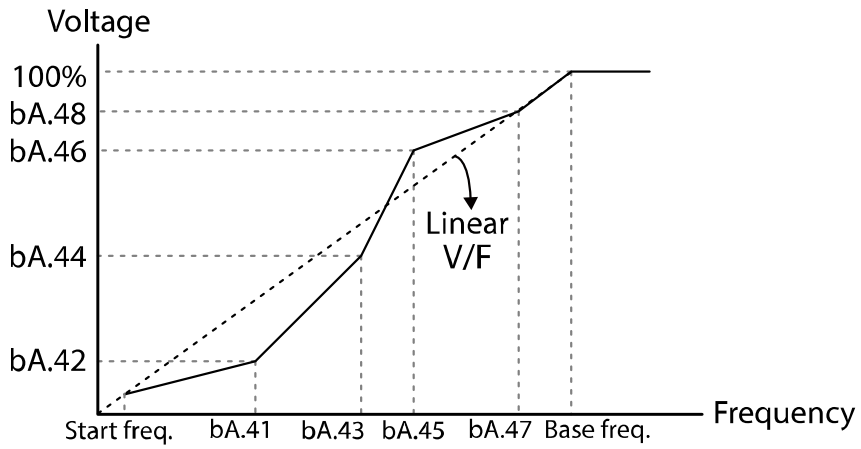
The inverter allows the configuration of user-defined V/F patterns to suit the characteristics of special motors/loads.

Group	Code	Name	Setting	Setting Range	Unit
bA	07	V/F pattern	2 User V/F	0–3	-
	41	User Frequency 1	15.00	0–Max Frequency	Hz
	42	User Voltage 1	25	0–100	%
	43	User Frequency 2	30.00	0–Max Frequency	Hz
	44	User Voltage 2	50	0–100	%
	45	User Frequency 3	45.00	0–Max Frequency	Hz
	46	User Voltage 3	75	0–100	%
	47	User Frequency 4	Maximum frequency	0–Max Frequency	Hz
	48	User Voltage 4	100	0–100%	%

User V/F Pattern Setting Details

Code and Features	Description
bA.41 User Freq 1 ~ bA.48 User Volt 4	Select arbitrary frequencies between the start and the maximum frequencies to set the user frequency (User Freq x). Set the voltage to correspond to each user frequency with user voltage (User Volt x).

The 100% output voltage in the figure below is based on the parameter settings of bA.15 (motor rated voltage). If bA.15 is set to 0 it will be based on the input voltage.



Caution

- When a normal induction motor is in use, care must be taken not to configure the output pattern away from a linear V/F pattern. Non-linear V/F patterns may cause insufficient motor torque or motor overheating due to over-excitation.
- With a user V/F pattern is in use, forward torque boost (dr.16) and reverse torque boost (dr.17) do not operate.

4.12 Torque Boost

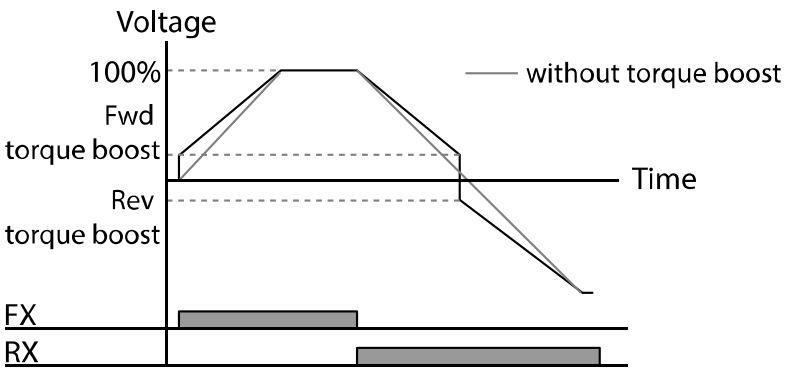
4.12.1 Manual Torque Boost

Manual torque boost enables users to adjust output voltage during motor starting and low speed operation. This setting improves motor starting properties and increases low speed torque. Configure manual torque boost for loads that require high starting torque.

Group	Code	Name	Setting		Setting Range	Unit
dr	15	Torque boost mode	0	Manual	0–1	-
	16	Forward Torque boost	2.0		0.0–15.0	%
	17	Reverse torque boost	2.0		0.0–15.0	%

Manual Torque Boost Setting Details

Code and Features	Description
dr.16 Fwd Boost	Set torque boost for forward operation.
dr.17 Rev Boost	Set torque boost for reverse operation.



Caution

Excessive torque boost will result in over-excitation and motor overheating.

4.12.2 **Auto Torque Boost**

In V/F operation, auto torque boost adjusts the output voltage when the motor cannot be started due to lack of starting torque. It provides a calculated voltage boost based on torque current.

Group	Code	Name	Setting		Setting Range	Unit
dr	15	Torque boost mode	1	Auto	0–1	-
dr	26	Auto torque boost filter gain	2		1–1000	-
dr	27	Auto torque boost motoring voltage gain	50.0		0.0–300.0	%
dr	28	Auto torque boost regeneration voltage gain	50.0		0.0–300.0	%

Set dr.15 (Torque Boost mode) to 1 (auto). Parameters dr.26, dr.27, and dr.28 can be adjusted when there is a lack of starting torque or when excessive current is flowing. This method outputs voltage by adding a voltage boost quantity calculated using torque current values from the manual torque boost settings (dr.16, dr.17).

Auto Torque Boost does not require Auto-Tuning but does require motor's nameplate ratings entered in the following parameters:

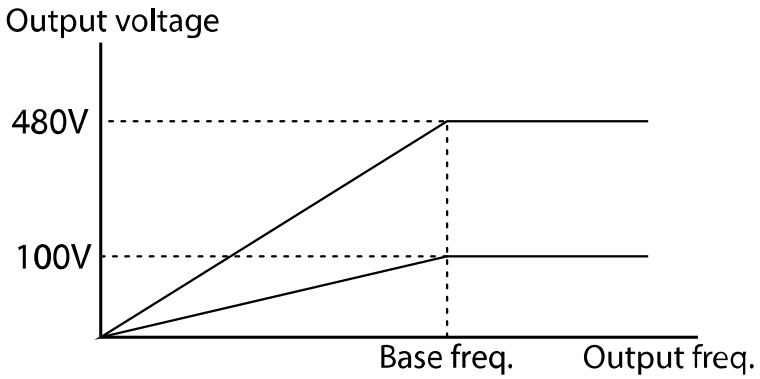
Code	Name	Setting Range
dr.18	Base frequency	30.00–400.00 (Hz)
bA.12	Rated slip speed	0–3000 (Rpm)
bA.13	Motor rated current	1.0–1000.0 (A)
bA.14	Motor noload current	0.0–1000.0 (A)

If you do not use motor's nameplate ratings, each parameter is set to a default value and the auto boost function may not be as effective.

4.13 **Motor Output Voltage Adjustment**

Output voltage settings are required when a motor's rated voltage differs from the input voltage to the inverter. Set the voltage to the motor's rated operating voltage. The set voltage becomes the output voltage at the inverter's base frequency. If bA.15 (motor rated voltage) is set to 0, the inverter corrects the output voltage based on the input voltage in the stopped condition. If the frequency is higher than the base frequency, when the input voltage is lower than the parameter setting, the input voltage will be the inverter output voltage.

Group	Code	Name	Setting	Setting Range	Unit
bA	15	Motor rated voltage	0	0, 100-480	V



4.14 **Start Mode Setting**

Select a start mode to use when the run command is applied with the motor in the stopped condition. Select 0 (acceleration start) or 1 (DC Brake Start). Excitation current (Pre-Excite) can also be applied by activating a digital input.

4.14.1 **Accelerating Start**

Acceleration start is the typical acceleration mode used when starting a motor from a stopped condition. If there are no other settings applied, the motor accelerates to the frequency reference when the run command is applied.

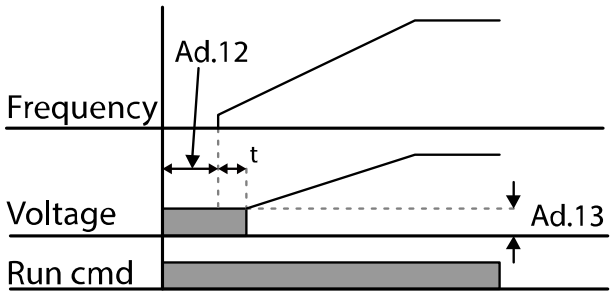
Group	Code	Name	Setting		Setting Range	Unit
Ad	07	Start Mode	0	Acc	0–1	-

4.14.2 **DC Braking At Start**

This start mode supplies a DC voltage for a set amount of time to provide DC braking before an inverter starts to accelerate a motor. Use when the motor is rotating due to its inertia, DC braking will stop the motor, allowing the motor to accelerate from a stopped condition. DC braking can also be used when a mechanical brake is connected to a motor shaft and constant torque is required after the release of the mechanical brake. DC braking at start will not operate if the control mode (dr.09) is set to IM Sensorless.

Group	Code	Name	Setting		Setting Range	Unit
Ad	07	Start Mode	1	Dc-Start	0–1	-
	12	Start DC braking time	0.00		0.00–60.00	sec

Group	Code	Name	Setting	Setting Range	Unit
	13	Amount of applied DC	50	0-Rated Current of Inverter/Rated Current of Motor x 100%	%



Caution

The amount of DC braking required is based on the motor's rated current. If the DC braking current is too high or brake time is too long, the motor may overheat or be damaged. The maximum amount of applied DC current is limited to the inverter rated current.

4.14.3 **Initial Excitation (Pre-excite)**

The inverter can supply excitation current to the motor when controlled by a digital input during a stopped condition. When a digital input is set to 34 (Pre-excite) and activated, the inverter will output DC voltage to the motor. The amount of current is set with Ad.13 (% of DC current) and is based on the ratio of inverter/motor rated current. The current is limited to inverter rated current.

Group	Code	Name	Setting		Setting Range	Unit
Ad	13	Amount of applied DC	50		0-Rated Current of Inverter/Rated Current of Motor x 100%	%
In	65~69	Px terminal setting options	34	Pre excite	-	-

Caution

The amount of DC braking required is based on the motor's rated current. If the DC braking current is too high or brake time is too long, the motor may overheat or be damaged. The maximum amount of applied DC current is limited to the inverter rated current.

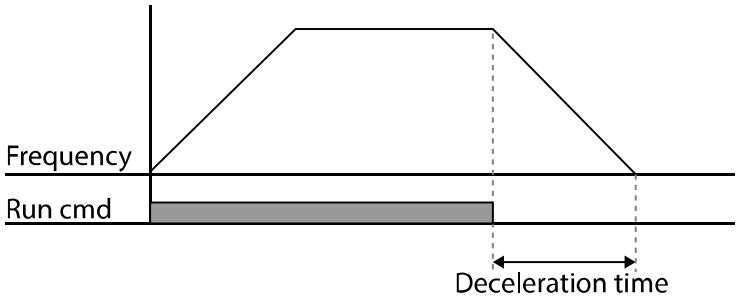
4.15 **Stop Mode Setting**

Select a stop mode to stop the inverter operation. Select 0 (deceleration), 1 (DC Brake), 2 (Free-Run (coast)) or 4 (Power Braking).

4.15.1 **Deceleration Stop**

Deceleration stop is the typical deceleration mode used when stopping a motor. If there are no other settings applied, the inverter decelerates the motor from the frequency reference down to 0 Hz and stops.

Group	Code	Name	Setting		Setting Range	Unit
Ad	08	Stop Mode	0	Dec	0–4	-



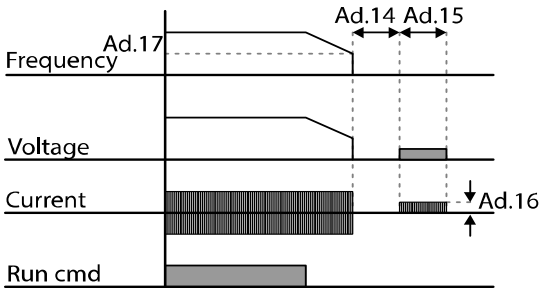
4.15.2 **DC Braking After Stop**

DC Braking can be applied to the motor during deceleration. The inverter stops the motor by supplying DC power to the motor. Settings include a delay time, a brake time, a brake current level and a brake frequency. During deceleration, when the inverter output frequency reaches the DC braking frequency, the inverter supplies DC voltage to the motor and stops it.

Group	Code	Name	Setting	Setting Range	Unit
Ad	08	Stop Mode	0 | Dec	0–4	-
	14	Output block time before braking	0.10	0.00–60.00	sec
	15	DC braking time	1.00	0–60	sec
	16	DC braking rate	50	0-Rated Current of Inverter/Rated Current of Motor x 100%	%
	17	DC braking frequency	5.00	0.00–60.00	Hz

DC Braking After Stop Setting Details

Code and Features	Description
Ad.14 Dc-Block Time	Set a delay time after the inverter output turns off and before applying DC braking. If the inertia of the load is high, or if DC braking frequency (Ad.17) is set too high, a fault may occur due to overcurrent conditions when the inverter applies DC voltage to the motor. To prevent overcurrent faults, adjust the delay time before DC braking.
Ad.15 Dc-Brake Time	Set the time duration of the DC voltage applied to the motor.
Ad.16 Dc-Brake Level	Set the amount of DC braking to apply. The parameter setting is based on the rated current of the motor. The maximum value of the DC braking current is limited to the inverter rated current. Maximum Dc-Brake Level = Rated Current of Inverter/Rated Current of Motor x 100%
Ad.17 Dc-Brake Freq	Set the DC Brake frequency to start DC braking. When the inverter output frequency is reached, the inverter starts DC Braking. If the dwell frequency is set lower than the DC braking frequency, dwell operation will not work and DC braking will start instead.

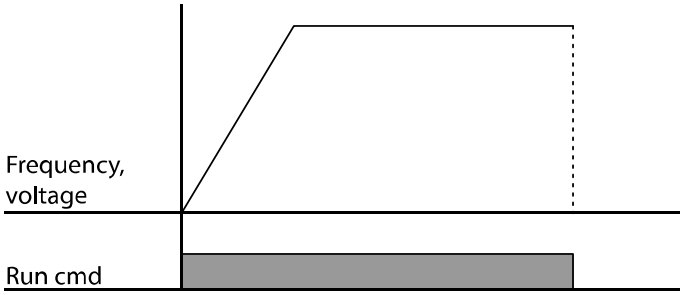


⚠ Caution Note that the motor can overheat or be damaged if an excessive amount of DC Braking is applied or the DC Brake time is too long.

4.15.3 **Free Run Stop**

When the run command is removed, the inverter output turns off and the motor/load coasts to a stop.

Group	Code	Name	Setting		Setting Range	Unit
Ad	08	Stop Mode	2	Free-Run	0–4	-



Caution

Note: With high inertia loads, the load's inertia will cause the motor to continue rotating. The inverter does not control the motor during Free-Run.

4.15.4 **Power Braking**

Power Braking is applied during deceleration when the inverter's DC voltage rises above a specified level due to motor regenerated energy. The inverter determines the optimum deceleration rate and will adjust the deceleration time or will reaccelerating the motor. Power braking can be used when short deceleration times are needed without brake resistors or when optimum deceleration is needed without causing an over voltage fault.

Group	Code	Name	Setting		Setting Range	Unit
Ad	08	Stop Mode	4	Power Braking	0–4	-

Caution

- To prevent overheating or damaging the motor, do not apply power braking to the loads that require frequent deceleration.
- Stall prevention and power braking only operate during deceleration.
- Power braking takes priority over stall prevention. In other words, when both bit3 and bit4 of Pr.50 (stall prevention and flux braking) are set, power braking will take precedence and operate.
- Note if deceleration time is too short or inertia of the load is too great, an overvoltage fault stll may occur.
- Note when power braking is used, the actual deceleration time can be longer than the pre-set deceleration time.

4.16 **Frequency Limit**

The inverter output frequency can be limited by setting frequency limit parameters. These include start frequency, maximum frequency, upper and lower frequency limits.

4.16.1 **Frequency Limit Using Maximum Frequency and Start Frequency**

Group	Code	Name	Setting	Setting Range	Unit
dr	19	Start frequency	0.50	0.01–10.00	Hz
	20	Maximum frequency	60.00	40.00–400.00	Hz

Frequency Limit Using Maximum Frequency and Start Frequency - Setting Details

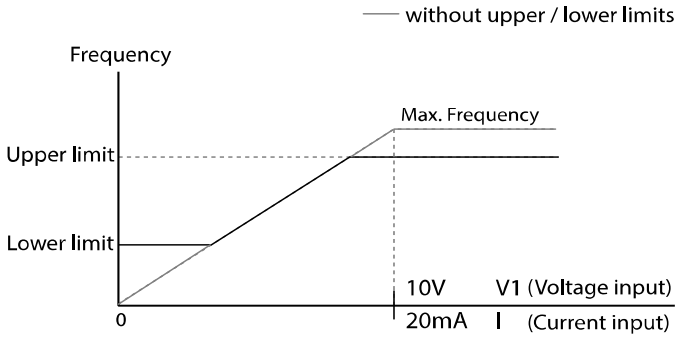
Code and Features	Description
dr.19 Start Freq	Set the lower limit value for speed unit parameters that are expressed in Hz or rpm. If an input frequency is lower than the start frequency, the parameter value will be 0.00.
dr.20 Max Freq	Set upper and lower frequency limits. All frequency selections are restricted to frequencies from within the upper and lower limits. This restriction also applies when you in input a frequency reference using the keypad.

4.16.2 **Frequency Limit Using Upper and Lower Limit Frequency Values**

Group	Code	Name	Setting	Setting Range	Unit
Ad	24	Frequency limit	0 No	0–1	-
	25	Frequency lower limit value	0.50	0.0–maximum frequency	Hz
	26	Frequency upper limit value	Maximum frequency	Lower limit–maximum frequency	Hz

Frequency Limit Using Upper and Lower Limit Frequencies - Setting Details

Code and Features	Description
Ad.24 Freq Limit	When set to 1 (Yes), frequency limits can be applied to the output of the inverter. Frequencies can be set above the minimum and below the maximum frequency to operate within the specified range.
Ad.25 Freq Limit Lo Ad.26 Freq Limit Hi	Set the lower and upper limits of the inverter output frequencies. The base frequency (dr.18) still remains as the output frequency at motor rated voltage.

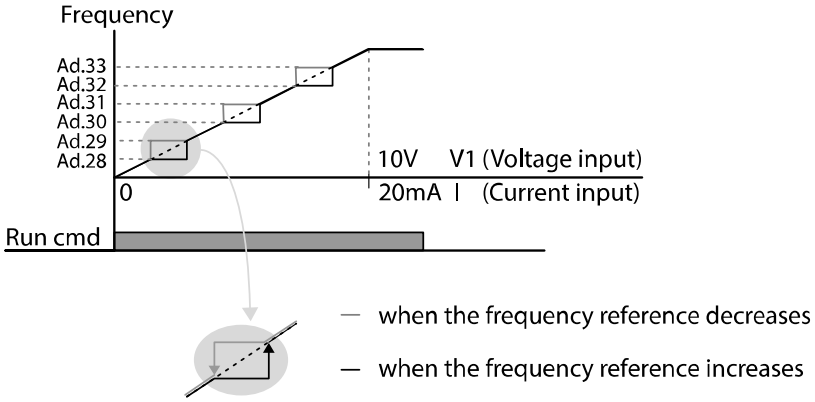


4.16.3 **Frequency Jump**

Use frequency jump to avoid mechanical resonance frequencies. Jump through up to three frequency bands during acceleration and deceleration. Reference frequencies cannot be set within the pre-set jump frequency band.

When the reference frequency is increased it will be maintained at the lower limit of a jump frequency band. As the reference frequency continues to increase and exceeds the range of a jump frequency band, it will jump to the upper limit of the jump frequency band. Decreasing reference frequencies operate in the same manner, jumping from upper limit to lower limit. Jump frequencies apply to all reference frequency sources (voltage, current, RS-485 communication, keypad setting).

Group	Code	Name	Setting	Setting Range	Unit
Ad	27	Frequency jump	0 No	0–1	-
	28	Jump frequency lower limit 1	10.00	0.00–Jump frequency upper limit 1	Hz
	29	Jump frequency upper limit 1	15.00	Jump frequency lower limit 1–Maximum frequency	Hz
	30	Jump frequency lower limit 2	20.00	0.00–Jump frequency upper limit 2	Hz
	31	Jump frequency upper limit 2	25.00	Jump frequency lower limit 2–Maximum frequency	Hz
	32	Jump frequency lower limit 3	30.00	0.00–Jump frequency upper limit 3	Hz
	33	Jump frequency upper limit 3	35.00	Jump frequency lower limit 3–Maximum frequency	Hz



4.17 2nd Operation Mode

2nd Operation Mode is commonly refered to as Hand-Off-Auto switching or Local-Off-Remote switching. The inverter can be operated (Start/Stop and Reference frequency) with two types of operating modes and switch between them as required. The first Start/Stop source and Reference Frequency source are set with parameters **drv** and **Frq** in the Operations group. The second Start/Stop source and Reference Frequency source are set with parameters **bA.04** and **bA.05**. A digital input terminal set to 2nd Source will provide the switching input. Set the reference frequency after switching between operating modes as the inverter will run at the selected reference frequency.
Select one of the digital input terminals (P1~P5) and set the corresponding parameter (In.65 ~ In.69) to 15 (2nd Source). When the digital input is open (or off), parameters drv and Frq operate the inverter (start/stop and speed). When the input is closed (or on), parameters bA.04 and bA.05 operate the inverter (start/stop and speed).

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	1	Fx/Rx-1	0–4	-
	Frq	Frequency reference source	2	V1	0–8	-
bA	04	2nd command source	0	Keypad	0–4	-
	05	2nd frequency source	0	KeyPad-1	0–8	-
In	65~69	Px terminal setting options	15	2nd Source	0–52	-

2nd Operation Mode Setting Details

Code and Features	Description
In.65~69 Px terminal	Set one of P1~P5 to 15 (2nd Source).
bA.04 Cmd 2nd Src bA.05 Freq 2nd Src	Select a 2nd Start/Stop source (bA.04) and a 2nd Reference Frequency source (bA.05). When the digital input is closed (or on), parameters bA.04 and bA.05 operate the inverter. The 2nd command source settings cannot be changed while operating with the 1st command source (Main Source).

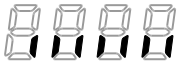
Caution

- Before switching operating modes using 2nd source, check the 2nd command source (Start/Stop input). The operating state will change if the Start/Stop input is closed (On). Before switching, ensure that the 2nd command source is correctly set.
- Depending on the parameter settings, the inverter may stop operating when you switch the command modes.

4.18 **Multi-function (digital) Input Terminal Control**

Filter time constants (On Delay and Off Delay) can be applied independently to the digital inputs. Longer time settings will delay the response of the input. Additionally, the digital inputs can be configured independently as a normally open input or a normally closed input. The status of the inputs can be viewed at In.90.

Group	Code	Name	Setting	Setting Range	Unit
	84	Multi-function (digital) input terminal filter selection	0 0000*		
In	85	Multi-function (digital) input terminal On filter	10	0–10000	ms
	86	Multi-function (digital) input terminal Off filter	3	0–10000	ms
	87	NO/NC selection of operation command	0 0000*	-	-
	88	Fx Rx NO/NC selection of start command	0	0–1	-
	90	Multi-function (digital) input terminal status	0 0000*	-	-

* Displayed as  on the keypad. Terminal numbering is P5-P4-P3-P2-P1

Multi-function (digital) Input Terminal Control Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>In.84
DI Delay Sel</td><td>Select whether or not to activate the time values set at In.85 and In.86 to selected terminals. If the terminal is not enabled, the time values are set to the default values. If enabled, the set time values at In.85 and In.86 apply to the corresponding terminals.
<table>
<tr><td>Items</td><td>Enable state of terminal</td><td>Disable state of terminal</td></tr>
<tr><td>Keypad</td><td>  </td><td>  </td></tr>
</table></td></tr>
<tr><td>In.85 DI On Delay
In.86 DI Off Delay</td><td>Set the delay times for the selected terminals in In.84. When the terminal receives a change of state input it is recognized as On or Off after the set time.</td></tr>
<tr><td>In.87
DI NC/NO Sel</td><td>Select terminal contact types for each input terminal. The position of the lit segment corresponds to an “A” or “B” type contact input. With the bottom segment on, it indicates that the terminal is configured as an A terminal (Normally Open) contact. With the top segment on, it indicates that the terminal is configured as a B terminal (Normally Closed) contact. Terminals are numbered P5–P1, from right to left.
<table>
<tr><td>Items</td><td>B contact status</td><td>A contact status</td></tr>
<tr><td>Keypad</td><td>  </td><td>  </td></tr>
</table></td></tr>
<tr><td>In.88
Fx/Rx NO/NC Sel</td><td>Select whether to use the Fx and Rx terminals as NO (Normal Open) only or to use as NO (Normal Open) or NC (Normal Close). If set to 1: NO only, the Fx and Rx terminals cannot be set as NC. If set to 0: NO/NC, the Fx and Rx terminals also be set as NC.</td></tr>
<tr><td>In.90
DI Status</td><td>Display the status of each contact. When a digital input is configured as an “A” type terminal using dr.87, the On (closed) condition is indicated by the top segment turnedg on. The Off condition is indicated when the bottom segment is turned on. When a digital input is configured as a “B” type terminal, the segment lights behave conversely. Terminals are numbered P5–P1, from right to left.
<table>
<tr><td>Items</td><td>Bit On when A contact input is closed</td><td>Bit Off when A contact input is open</td></tr>
<tr><td>Keypad</td><td>  </td><td>  </td></tr>
</table></td></tr>
</table>

4.19 **Fire Mode Operation**

Fire Mode operation is for use in emergency situations. When enabled, Fire Mode allows the inverter to provide continuous operation ignoring the majority of faults. Primarily used for fire pump operation, but can be applied when continuous operation is required due to emergencies.

When enabled, Fire mode forces the inverter to ignore all minor faults and repeats a Reset/Restart of major faults, regardless of the Reset/Restart count limit.

Fire Mode Parameter Settings

Group	Code	Name	Setting		Setting Range	Unit
Ad	80	Fire Mode selection	0	None	0–2	-
			1	Fire Mode		
			2	Fire Mode Test		
	81	Fire Mode frequency	60		0–60	
	82	Fire Mode run direction	0	Fwd	0–1	
			1	Rev		
	83	Fire Mode operation count	Not configurable		-	-
In	65~69	Px terminal setting options	51	Fire Mode	0–52	-

Fire Mode Parameter Settings Details

Code	Description	Details
Ad.80	Fire mode selection	When set to 1 (Fire Mode), enables Fire Mode operation controlled with a digital input. When set to 2 (Fire Mode Test), allows testing of Fire Mode operation.
Ad.81 Fire Mode frequency	Fire mode frequency reference	The frequency set at Ad. 81 (Fire mode frequency) is used for the inverter operation in Fire mode. The Fire mode frequency takes priority over the Jog frequency, Multi-step frequencies, and the keypad input frequency.
Ad.82	Fire Mode Run direction	Set the direction of motor rotation during Fire Mode operation.
Ad.83	Fire Mode count	Counts the number of Fire Mode operations. Does not increase count during Fire Mode testing.
ACC Acc Time **Dec** Dec Time	Fire mode Acc/Dec times	During Fire Mode operation, the inverter accelerates and decelerates based on the times set in ACC and Dec parameters. When the Px terminal in activated, the inverter accelerates based on the time set in ACC. When the Px terminal is de-activated, the inverter decelerates based on the time set in Dec.
In.65~In.69 Px terminal	Px terminal setting	Set to 51 (Fire Mode). When the digital input is activated, the inverter will operate in Fire Mode.

<table>
<tr><th>Code</th><th>Description</th><th>Details</th></tr>
<tr><td>Pr.10 Retry Delay</td><td>Fault process</td><td>The majority of faults are ignored during Fire mode operation. The fault history is saved. Output relays set to trip functions are disabled.
Faults that are ignored in Fire mode
BX, External Trip, Low Voltage Trip, Inverter Overheat, Inverter Overload, Overload, Electrical Thermal Trip, Input/Output Open Phase, Motor Overload, Fan Trip, No Motor Trips, and other minor faults.

For the following faults, the inverter performs a Reset/Restart until the trip conditions are cleared. The retry delay time set at Pr. 10 (Retry Delay) applies while the inverter performs a Reset/Restart.
Faults that force a Reset/Restart in Fire mode
Over Voltage, Over Current1 (OC1), Ground Fault

The inverter stops operating when the following faults occur:
Faults that stop inverter operation in Fire mode
H/W Diag, Over Current 2 (Arm-Short)</td></tr>
</table>

Caution

Fire Mode Operation voids warranty as Fire mode operation may result in inverter malfunction. Note that when Ad.83 Fire mode count is greater than "0", the warranty is voided.

5 Learning Advanced Features

This chapter describes the advanced features of the GM2 inverter. Check the reference page in the table to see the detailed description for each of the application features.

Advanced Tasks	Use Example	Ref.
Auxiliary frequency operation	Use the main and auxiliary frequencies with the predefined formulas to create various operating conditions. Auxiliary frequency operation is ideal for Draw Operation* as this feature enables fine-tuning of operating speeds.	**p.94**
Jog operation	Jog operation is a kind of a manual operation. The inverter operates to a set of parameter settings predefined for Jog operation, while the Jog command is applied.	**p.98**
Up-down operation	Control the speed of the motor using digital inputs set to Up (increase) and Down (decrease).	**p.100**
3-wire operation	3-wire operation is used to latch an input signal when using a momentary input. This configuration is typically used to operate the inverter by a push button.	**p.102**
Safe Operation mode	This safety feature is used as a Run Enable input or as an interlock to allow inverter operation only after the input is closed. This feature is useful for safety and/or interlocking operation with other equipment.	**p.103**
Dwell operation	Use this feature for the lift-type loads such as elevators, when the torque needs to be maintained while the brakes are applied or released.	**p.105**
Slip compensation	This feature ensures that the motor rotates at a constant speed, by compensating for the motor slip as a load increases.	**p.107**
PID Control	PID control provides automatic control of the inverter's output frequency for automated control of flow, pressure, and temperature.	**p.108**
Auto tuning	Used to automatically measure the motor control parameters to optimize the inverter's control mode performance.	**p.115**
Sensorless vector control	An efficient mode to control magnetic flux and torque without special sensors. Efficiency is achieved through the high torque characteristics at low current when compared with the V/F control mode.	**p.118**
Energy buffering	Used during power outages to maintain the DC link voltage for as long as possible by controlling the inverter output frequency, thus to delay a low voltage fault.	**p.123**
Energy saving operation	Used to save energy by reducing the voltage supplied to motors during low-load and no-load conditions.	**p.127**
Speed search operation	Used to prevent faults when a start command is applied while the motor is idling or free-running.	**p.128**
Auto restart operation	Used to automatically restart the inverter when a fault condition is reset.	**p.131**

Advanced Tasks	Use Example	Ref.
2nd Motor Operation	Used to switch equipment operation by connecting two motors to one inverter. Configure and operate the second motor when the input terminal is activated.	**p.134**
Commercial power source transition	Used to switch the power source to the motor from the inverter output to a commercial power source, and vice versa.	**p.135**
Cooling fan control	Used to control the cooling fan of the inverter.	**p.136**
Timer settings	Configure an output relay as a timer with On/Off delay times.	**p.139**
Brake control	Used to control the On/Off operation of an electro-mechanical braking system.	**p.140**
Relay On/Off control	Control the state of an output relay based on an analog input value.	**p.141**
Press regeneration prevention	Used during a press operation to handle motor regeneration, by increasing the motor operating speed.	**p.142**

* Draw operation is an open loop tension control. This feature allows a constant tension to be applied to the material that is drawn by a motor-driven device, by fine-tuning the motor speed using operating frequencies that are proportional to a ratio of the main frequency reference.

5.1 Operating with Auxiliary References

Frequency references can be configured with various calculated conditions that use the main and auxiliary frequency references simultaneously. The main frequency reference (Frq) is used as the operating frequency, while the auxiliary reference is used to modify and fine-tune the main reference.

Group	Code	Name	Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	0	Keypad-1	0–8	-
bA	01	Auxiliary reference source	1	V1	0–4	-
	02	Auxiliary command calculation type	0	M+(G*A)	0–7	-
	03	Auxiliary frequency reference gain	0.0		-200.0–200.0	%
In	65– 71	Px terminal setting options	40	dis Aux Ref	0–52	-

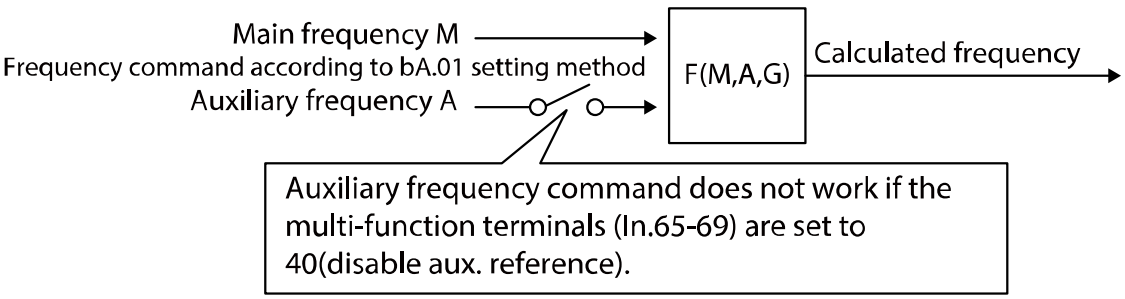
Auxiliary Reference Setting Details

Code and Features	Description		
bA.01 Aux Ref Src	Set the input type to be used for the auxiliary frequency reference.		
	Configuration		Function
	0	None	Auxiliary frequency reference is disabled.
	1	V1	Sets the V1 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference.
	3	V0	Select the potentiometer (volume dial) of keypad as auxiliary command.
	4	I2	Sets the I2 (current) terminal at the control terminal block as the source of auxiliary frequency reference.

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>bA.02
Aux Calc Type</td><td>The table below list the available calculated conditions for the main and auxiliary frequency references. Set the auxiliary reference gain with bA.03 (Aux Ref Gain) to configure the auxiliary reference and set the percentage to be reflected when calculating the main reference. Note that items 4–7 below may result in either plus (+) or minus (-) references (forward or reverse operation) even when unipolar analog inputs are used.

<table>
<tr><th colspan="2">Configuration</th><th>Calculating final reference frequency</th></tr>
<tr><td>0</td><td>M+(G*A)</td><td>Main reference+(bA.03xbA.01xIn.01)</td></tr>
<tr><td>1</td><td>M*(G*A)</td><td>Main referencex(bA.03xbA.01)</td></tr>
<tr><td>2</td><td>M/(G*A)</td><td>Main reference/(bA.03xbA.01)</td></tr>
<tr><td>3</td><td>M+{M*(G*A)}</td><td>Main reference+{Main referencex(bA.03xbA.01)}</td></tr>
<tr><td>4</td><td>M+G*2*(A-50)</td><td>Main reference+bA.03x2x(bA.01–50)xIn.01</td></tr>
<tr><td>5</td><td>M*{G*2*(A-50)}</td><td>Main referencex{bA.03x2x(bA.01–50)}</td></tr>
<tr><td>6</td><td>M/{G*2*(A-50)}</td><td>Main reference/{bA.03x2x(bA.01–50)}</td></tr>
<tr><td>7</td><td>M+M*G*2*(A-50)</td><td>Main reference+Main referencexbA.03x2x(bA.01–50)</td></tr>
</table>

M: Main frequency reference (Hz or rpm)
G: Auxiliary reference gain (%)
A: Auxiliary frequency reference (Hz or rpm) or gain (%)</td></tr>
<tr><td>bA.03 Aux Ref Gain</td><td>Adjust the gain of the auxiliary reference source selected in bA.01 (Aux Ref Src).</td></tr>
<tr><td>In.65–69 Px Define</td><td>Set one of the multi-function (digital) input terminals to 40 (dis Aux Ref) and activate it to disable the auxiliary frequency reference. The inverter will operate using the main frequency reference only.</td></tr>
</table>



The tables below provide examples of using the available calculated conditions for the main and auxiliary frequency references. Refer to the table to see how the calculations apply with each example. When the maximum frequency value is high, output frequency deviation may result due to analog input variation and deviations in the calculations.

Auxiliary Reference Operation E.g. #1

Keypad Frequency Setting is Main Frequency and V1 Analog Voltage is Auxiliary Frequency

- Main frequency: Keypad (operating frequency 30 Hz)
- Maximum frequency setting (dr.20): 400 Hz
- Auxiliary frequency setting (bA.01): V1[Display by percentage(%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain setting (bA.03): 50%
- In.01-32: Factory default output

Example: an input voltage of 6V is supplied to V1, and the frequency corresponding to 10 V is 60 Hz. The table below shows the auxiliary frequency A as 36 Hz[=60 Hz X (6 V/10 V)] or 60%[= 100% X (6 V/10 V)].

Setting*		Calculating final reference frequency
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M)+(50%(G)x36 Hz(A))=48 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz(M)x(50%(G)x60%(A))=9 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz(M)/(50%(G)x60%(A))=100 Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30 Hz(M)+{30[Hz]x(50%(G)x60%(A))}=39 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz(M)+50%(G)x2x(60%(A)–50%)x60 Hz=36 Hz
5	M[Hz]*{G[%]*2*(A[%]-50[%])}	30 Hz(M)x{50%(G)x2x(60%(A)–50%)}=3 Hz
6	M[Hz]/{G[%]*2*(A[%]-50[%])}	30 Hz(M)/{50%(G)x2x(60%–50%)}=300 Hz
7	M[Hz]+M[hZ]*G[%]*2*(A[%]-50[%])	30 Hz(M)+30 Hz(M)x50%(G)x2x(60%(A)–50%)=33 Hz

*M: Main frequency reference/ G: Auxiliary reference gain (%)/ A: Auxiliary frequency reference (Hz or rpm) or gain (%).

Auxiliary Reference Operation E.g. #2

Keypad Frequency Setting is Main Frequency and I2 Analog Voltage is Auxiliary Frequency

- Main frequency: Keypad (operating frequency 30 Hz)
- Maximum frequency setting (dr.20): 400 Hz
- Auxiliary frequency setting (bA.01): I2[Display by percentage(%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain setting (bA.03): 50%
- In.01-32: Factory default output

Example: an input current of 10.4 mA is applied to I2, with the frequency corresponding to 20 mA of 60 Hz. The table below shows auxiliary frequency A as 24 Hz (=60[Hz] X {(10.4[mA]-4[mA])/ (20[mA] - 4[mA])} or 40% (=100[%] X {(10.4[mA] - 4[mA])/ (20[mA] - 4[mA])}.

Setting*		Calculating final reference frequency
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M)+(50%(G)x24 Hz(A))=42 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz(M)x(50%(G)x40%(A))=6 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz(M)/(50%(G)x40%(A))=150 Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30 Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz(M)+50%(G)x2x(40%(A)–50%)x60 Hz=24 Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])	30 Hz(M)x{50%(G)x2x(40%(A)–50%)} = -3 Hz(Rever
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30 Hz(M)/{50%(G)x2x(60%–40%)} = -300 Hz(Revers
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz(M)+30 Hz(M)x50%(G)x2x (40%(A)–50%)=27

* M: Main frequency reference/ G: Auxiliary reference gain (%)/ A: Auxiliary frequency reference (Hz or rpm) or gain (%)

Auxiliary Reference Operation E.g. #3

V1 is Main Frequency and I2 is Auxiliary Frequency

- Main frequency: V1 (frequency command setting to 5 V and is set to 30 Hz)
- Maximum frequency setting (dr.20): 400 Hz
- Auxiliary frequency (bA.01): I2[Display by percentage (%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain (bA.03): 50%
- In.01-32: Factory default output

Example: an input current of 10.4 mA is applied to I2, with the frequency corresponding to 20 mA of 60 Hz. The table below shows auxiliary frequency A as 24 Hz(=60[Hz]x{(10.4[mA]-4[mA])/(20[mA]-4[mA])} or 40%(=100[%] x {(10.4[mA] - 4[mA]) /(20 [mA] - 4[mA])}.

Setting*		Calculating final reference frequency
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M)+(50%(G)x24 Hz(A))=42 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz(M)x(50%(G)x40%(A))=6 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz(M)/(50%(G)x40%(A))=150 Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30 Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz(M)+50%(G)x2x(40%(A)–50%)x60 Hz=24 Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])}	30 Hz(M)x{50%(G)x2x(40%(A)–50%)}=-3 Hz(Reverse)
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30 Hz(M)/{50%(G)x2x(60%–40%)}=-300 Hz(Reverse)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz(M)+30 Hz(M)x50%(G)x2x(40%(A)–50%)=27 Hz

* M: Main frequency reference/ G: Auxiliary reference gain (%)/ A: Auxiliary frequency reference (Hz or rpm) or gain (%)

5.2 Jog Operation

The jog operation allows for a temporary control of the inverter. There are two was to apply a jog and start command using the multi-function (digital) input terminals.

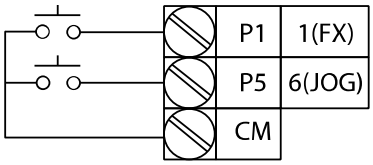
- Jog-1 using a digital input terminal set to **JOG** along with a start command (Fx or Rx).
- Jog-2 using a single digital input set to **FWD JOG** or **REV JOG.**

5.2.1 Jog Operation 1-Forward

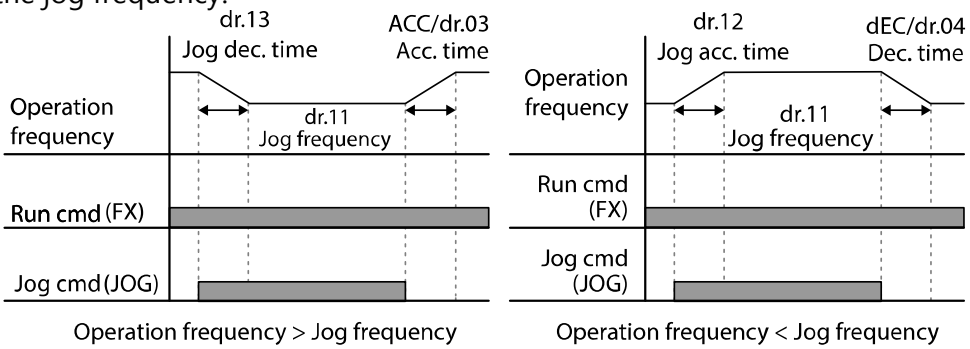
The jog operation is available in the forward (or reverse) direction, using two input terminals (Fx and JOG). The table below lists parameter settings for a forward jog operation with a separate Run (Fx) command.

Group	Code	Name	Setting		Setting Range	Unit
dr	11	Jog frequency	10.00		0.50–Max Frequency	Hz
	12	Jog run acceleration time	20.00		0.00–600.00	sec
	13	Jog run deceleration time	30.00		0.00–600.00	sec
In	65–69	Px terminal setting options	6	JOG	0–52	-
			1	Fx		

Forward Jog Description Details

Code and Features	Description
In.65~69 Px Define	Select 6 (JOG) function from In.65 ~ 69 for one of the inputs.  [Terminal settings for jog operation]
dr.11 JOG Frequency	Set the operating frequency.
dr.12 JOG Acc Time	Set the acceleration speed.
dr.13 JOG Dec Time	Set the deceleration speed.

If a signal is applied to the jog terminal while running (FX applied), the operating frequency changes to the jog frequency.



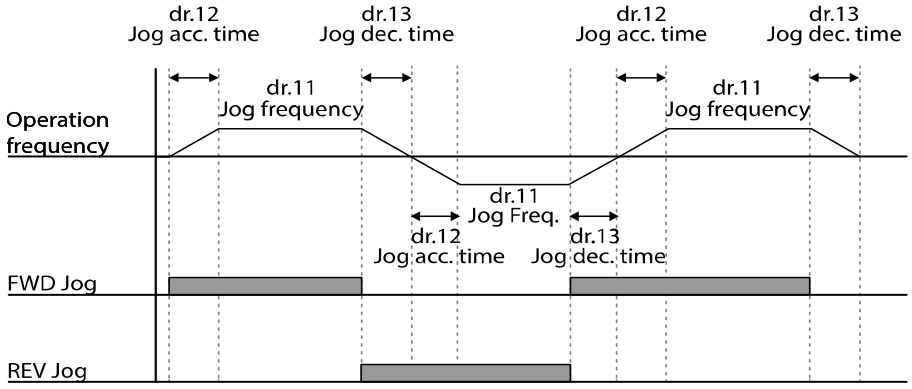
Operation frequency > Jog frequency

Operation frequency < Jog frequency

5.2.2 Jog Operation 2-Fwd/Rev Jog by Multi-function (digital) Terminal

A terminal that is set for a forward or reverse jog also starts the inverter. The table below lists parameter settings for a forward (or reverse) jog operation. A separate Run (Fx) command is not required.

Group	Code	Name	Setting		Setting Range	Unit
dr	11	Jog Frequency	10.00		0.50–Maximum frequency	Hz
	12	Jog run acceleration time	20.00		0.00–600.00	sec
	13	Jog run deceleration time	30.00		0.00–600.00	sec
In	65–69	Px terminal setting options	46	FWD JOG	0–52	-
			47	REV JOG		



NOTE: The priorities for speed reference inputs and associated Acc/Dec times via digital inputs are as follows:

Dwell overrides **Jog** overrides **Up/Down** overrides **Fixed Speed inputs** overrides **Frq setting**.

If a different operation command is entered during a jog operation (other than dwell), it is ignored and the operation maintains the jog frequency.

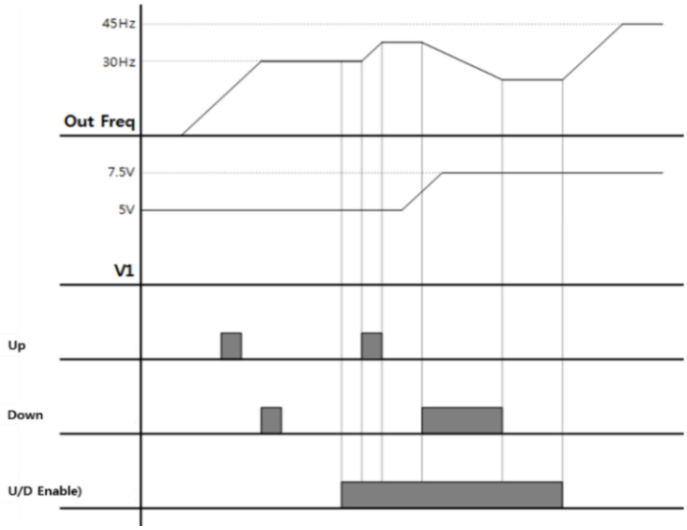
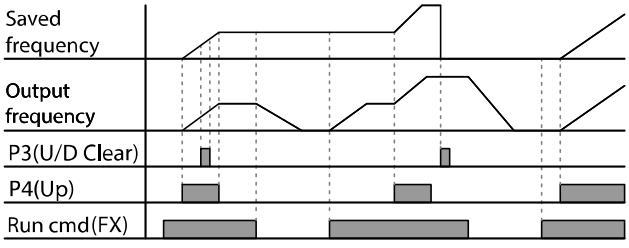
5.3 Up-down Operation

The inverter can control the speed of the motor using digital inputs set to the Up and Down functions. The Up/Down operation can be applied to systems that use upper-lower limit switches. Three digital inputs are required. One set to U/D Enable, and the other two for Up (increase speed) and Down (decrease speed) operation.

Group	Code	Name	Setting		Setting Range	Unit
Ad	65	Up-down operating frequency save	1	Yes	0–1	-
In	65–69	Px terminal setting options	17	Up	0–52	-
			18	Down		
			20	U/D Clear		
			27	U/D Enable		

The Up/Down operation will operate only when a multi-function (digital) terminal set to 27 (U/D Enable) is activated. The operation will follow the Up or Down inputs and will override other speed reference inputs. When the U/D Enable input is De-activated, the inverter will respond to the selected speed reference source.
If the frequency reference source parameter (Frq) is set as keypad, the frequency cannot be programmed using the keypad when U/D Enable terminal is activated.

Up-down Operation Setting Details

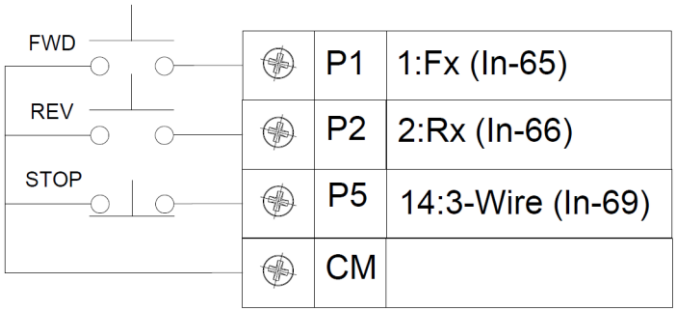
Code and Features	Description
In.65~69 Px Define	Select three terminals for Up/Down operation and set them to 17 (Up), 18 (Down) and 27 (U/D Enable), respectively. When the U/D Enable input and the Up input are activated, the inverter will accelerate. When the Up input is De-activated, the acceleration will stop and inverter will operate at a constant speed. When the U/D Enable input and the Down input are activated, the inverter will decelerate. When the Down input is De-activated, the deceleration will stop and inverter will operate at a constant speed. When both Up and Down inputs are activated, the inverter will operate at a constant speed. If the U/D Enable input is not activated, acceleration/deceleration will follow the speed reference set in the Frq parameter. If the U/D Enable input is activated during normal acceleration/deceleration, acceleration/deceleration will stop and the inverter will wait for Up or Down inputs. 
Ad.65 U/D Save Mode	When set to Yes, the operating frequency is saved automatically in the following conditions: the run command (Fx or Rx) is removed, a fault occurs, or the inverter is powered off. When the run command is reapplied, or when the fault is cleared, or when power is restored, the inverter resumes operation at the saved frequency. To delete the saved frequency, set one of the multi-function (digital) terminals to 20 (U/D Clear) and activate the input during constant speed operation. The saved frequency will be deleted. 

5.4 3-Wire Operation

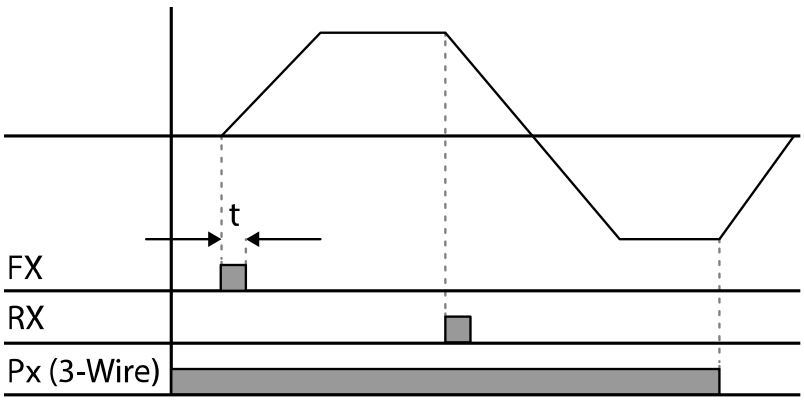
3-wire operation is used to latch the run command input signal (FWD or REV) when using a momentary input. This configuration is commonly used to operate the inverter with a set of momentary push buttons.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	1	Fx/Rx - 1	-	-
In	65–69	Px terminal setting options	14	3-Wire	0–52	-

To enable the 3-wire operation, the following circuit is necessary. The minimum input time (t) for 3-wire operation is 1ms, and the operation stops when the 3-Wire input terminal is de-activated (Stop button) or both forward and reverse commands are applied at the same time.



[Terminal connections for 3-wire operation]



[3-wire operation]

5.5 Safe Operation mode

This safety feature is used as a Run Enable/Disable input. When a digital input is set to 13 (Run Enable), the inverter will only operate when the input is closed (Enabled). The input must be closed to recognize other digital input functions. This feature is also useful for interlocking operation with other equipment.

A stop mode can be selected (Ad.71, Run Dis Stop) if the Run Enable input is opened during operation. Selections include coasting to a stop, Quick Stop and Quick Stop Resume. The deceleration time (Ad.72, Q-Stop Time) can be set for the Quick Stop functions..

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	13	RUN Enable	0-52	
Ad	70	Safe operation selection	0	Always Enable	0-1	
			1	DI Dependent		
	71	Safe operation stop options	0	Free-Run	0–2	-
	72	Safe operation deceleration time	5.0		0.0–600.0	sec

Safe Operation Mode Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>In.65~69 Px Define</td><td>Set one of the multi-function (digital) input terminals to 13 (RUN Enable) to operate in safe operation mode.</td></tr>
<tr><td>Ad.70 Run En Mode</td><td>
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Always Enable</td><td>Enables safe operation mode. Input must be closed (Enabled) to operate.</td></tr>
<tr><td>1</td><td>DI Dependent</td><td>Operation is in combination with the status of Run command (Fx input).</td></tr>
</table>
</td></tr>
<tr><td>Ad.71 Run Dis Stop</td><td>Set the stop method of the inverter when the Enable input terminal in opened during operation.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>1</td><td>Free-Run</td><td>Blocks the inverter output. Motor coasts to a stop.</td></tr>
<tr><td>2</td><td>Q-Stop</td><td>Decelerates the motor based on the deceleration time (Q-Stop Time) set in Ad.72. When stopped, the Run command must be reapplied to restart the inverter even if the Enable input is closed (Enabled).</td></tr>
<tr><td>3</td><td>Q-Stop Resume</td><td>Decelerates the motor based on the deceleration time (Q-Stop Time) set in Ad.72. If the Enable input is re-applied during deceleration and the run command is maintained, the inverter will resume normal operation.</td></tr>
</table>
</td></tr>
<tr><td>Ad.72 Q-Stop Time</td><td>Sets the deceleration time when Ad.71 (Run Dis Stop) is set to 1 (Q-Stop) or 2 (Q-Stop Resume).</td></tr>
</table>

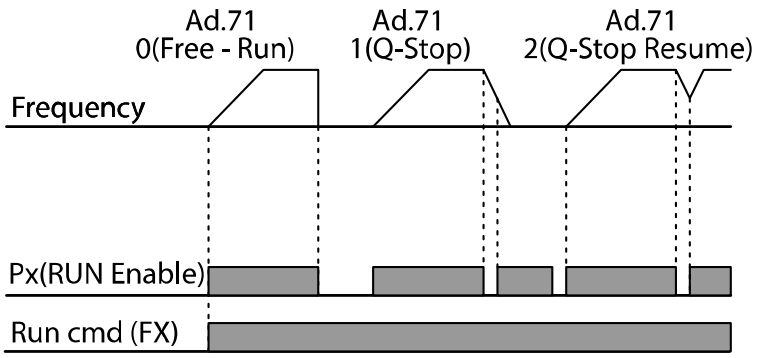
Q-Stop Function

When Ad.70 (Run En Mode) is set to 1 (DI Dependent) and Ad.71 is set to 2 (Q-Stop), if the Run Enable input is opened during operation, the inverter will decelerate to a stop based on the time set in Ad.72, Q-Stop Time. To re-start, the Enable input must be re-applied and the Run command (Fx) must be removed then re-applied.

Q-Stop Resume Function

The Quick Start resume function operates as follows:

> ⓘ Caution
>
> When Ad.70 (Run En Mode) is set to 1 (DI Dependent) and Ad.71 is set to 3 (Q-Stop Resume), this allows operation (Start/Stop) of the inverter based on the Run Enable input. If the Run Enable is opened during operation and the Run command (Fx) is maintained, closure of the Run Enable input will allow the inverter to operate (resume operation).



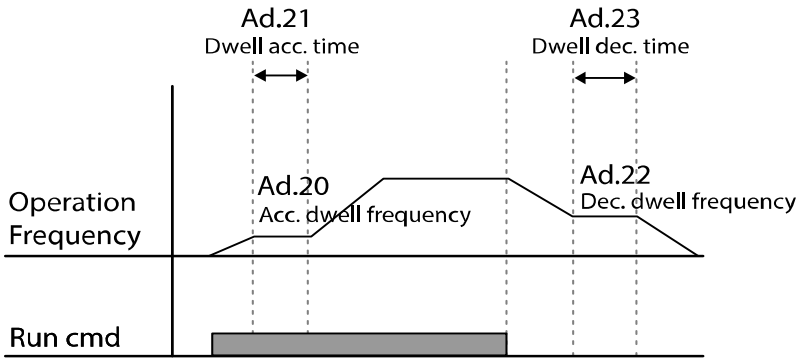
5.6 Dwell Operation

The dwell operation is used to maintain torque (speed) at programmed frequencies during the acceleration and deceleration process. This function is used in the application and release of the mechanical brakes on lift-type loads (elevators). Inverter dwell operation is based on the Acc/Dec dwell frequency (Ad.20, Ad.22) and the dwell time (Ad.21, Ad.23) set by the user. The following points also affect dwell operation:

- **Acceleration Dwell Operation:** When a run command is applied, acceleration continues up to the acceleration dwell frequency (Ad.20) and constant speed is maintained for the acceleration dwell time (Ad.21, Acc Dwell Time). After the Acc Dwell Time has passed, acceleration is carried out based on the acceleration time and the operating speed that was originally set.
- **Deceleration Dwell Operation**: When a stop command is applied, deceleration continues down to the deceleration dwell frequency (Ad.22) and constant speed is maintained for the deceleration dwell time (Ad.23, Dec Dwell Time). After the Dec Dwell Time has passed, deceleration is carried out based on the deceleration time that was originally set, then the operation stops.

When dr.09 (Control Mode) is set to 0 (V/F), the inverter can be used for applications requiring the use of dwell frequencies. An example is applying and releasing mechanical brakes on lift-type loads (elevators).

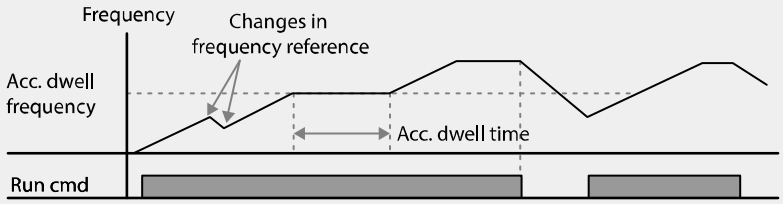
Group	Code	Name	Setting	Setting Range	Unit
Ad	20	Dwell frequency on acceleration	5.00	Start frequency–Maximum frequency	Hz
	21	Operation time during acceleration	0.0	0.0–10.0	sec
	22	Dwell frequency during deceleration	5.00	Start frequency–Maximum frequency	Hz
	23	Operation time during deceleration	0.0	0.0–60.0	sec



Note

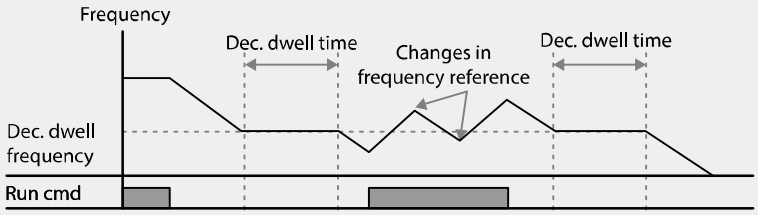
Dwell operation does not work when:

- Dwell operation time is set to 0 sec or dwell frequency is set to 0 Hz.
- Re-acceleration is attempted from stop or during deceleration. Only the first acceleration dwell operation is valid through the complete process.



[Acceleration dwell operation]

- Deceleration dwell operation is carried out whenever stop commands are entered and the deceleration dwell frequency is passed through. It does not work during a deceleration when the frequency (speed reference) is changed. This is not considered a deceleration due to a stop operation.



[Deceleration dwell operation]

Caution

When a dwell operation is carried out for a lift - type loads with mechanical brakes, motors can be damaged or their lifecycle may be reduced due to higher currents in the motor during the time the mechanical brake is applied.

5.7 Slip Compensation Operation

Slip refers to the variation between the set frequency (speed) and actual motor rotation speed. During operation a set frequency, the slip will vary as the load changes. As the load increases, slip will increase. Slip compensation is used for loads that require compensation of these speed variations.

Group	Code	Name	Setting		Setting Range	Unit
dr	09	Control mode	2	Slip Compen	-	-
	14	Motor capacity	2	0.75 kW (0.75 kW based)	0–15	-
bA	11	Number of poles	4		2–48	-
	12	Rated slip speed	90 (0.75 kW based)		0–3000	Rpm
	13	Rated motor current	3.6 (0.75 kW based)		1.0–1000.0	A
	14	Motor noload current	1.6 (0.75 kW based)		0.5–1000.0	A
	16	Motor efficiency	72 (0.75 kW based)		64–100	%
	17	Load inertia rate	0 (0.75 kW based)		0–8	-

Slip Compensation Operation Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>dr.09 Control Mode</td><td>Set dr.09 to 2 (Slip Compen) to operate in slip compensation mode.</td></tr>
<tr><td>dr.14 Motor Capacity</td><td>Set the capacity of the motor connected to the inverter.</td></tr>
<tr><td>bA.11 Pole Number</td><td>Enter the number of poles from the motor name plate.</td></tr>
<tr><td>bA.12 Rated Slip</td><td>Enter the slip RPM's from the motor name plate. This may be shown in Hz. If so, convert to RPM's. Slip frequency may also be calculated.
$f_s = f_r - \frac{Rpm \times P}{120}$
f_s=Rated slip frequency
f_r=Rated frequency
Rpm=Number of the rated motor rotations
P=Number of motor poles</td></tr>
<tr><td>bA.13 Rated Curr</td><td>Enter the rated current from the motor name plate.</td></tr>
<tr><td>bA.14 Noload Curr</td><td>Enter the measured no-load current at the rated frequency. If no-load current is difficult to measure, enter a current equivalent to 30–50% of the rated motor current.</td></tr>
<tr><td>bA.16 Efficiency</td><td>Enter the efficiency from the motor rating place.</td></tr>
<tr><td>bA.17 Inertia Rate</td><td>Select load inertia based on motor inertia.
<table>
<tr><th>Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Less than 10 times motor inertia</td></tr>
<tr><td>1</td><td>10 times motor inertia</td></tr>
<tr><td>2–8</td><td>More than 10 times motor inertia</td></tr>
</table></td></tr>
</table>

5.8 PID Control

Pid control is one of the most common automatic control methods. It uses a combination of proportional, integral, and differential (PID) control that provides effective control for automated systems.

The functions of PID control can be applied to the inverter operation for control of the following:

Code	Function
Speed control	Control speed by using feedback of the existing speed comparing it to a target speed. The inverter adjusts the output to maintain a constant speed (the target speed).
Pressure Control	Control pressure by using feedback of the existing pressure comparing it to a target pressure. The inverter adjusts the ouput to maintain a constant pressure.
Flow Control	Control flow by using feedback of the existing flow comparing it to a target flow. The inverter adjust the output to maintain a constant flow.
Temperature Control	Control temperature by using feedback of the existing temperature comparing it to a target temperature.The inverter adjusts the output to maintain a constant temperature.

5.8.1 Basic PID Operation

PID operates by controlling the output frequency of the inverter in automated process control systems to maintain speed, pressure, flow, and temperature.

Group	Code	Name	Setting		Setting Range	Unit
AP	01	Application function selection	2	Proc PID	0–2	-
	16	PID output monitor	-		-	-
	17	PID reference monitor	-		-	-
	18	PID feedback monitor	-		-	-
	19	PID reference setting	50.00		-100.00–100.00	%
	20	PID reference source	0	Keypad	0–7	-
	21	PID feedback source	0	V1	0–6	-
	22	PID controller proportional gain	50.0		0.0–1000.0	%
	23	PID controller integral time	10.0		0.0–200.0	sec
	24	PID controller differential time	0		0–1000	ms
	25	PID controller feed-forward compensation gain	0.0		0–1000	%
	26	Proportional gain scale	100.0		0.0–100.0	%
	27	PID output filter	0		0–10000	ms
	29	PID upper limit frequency	60.00		-300.00–300.00	Hz
	30	PID lower limit frequency	0.5		-300.00–300.00	Hz
	32	PID output scale	100.0		0.1–1000.0	%
	33	PID output inverse	0	No	0–1	-

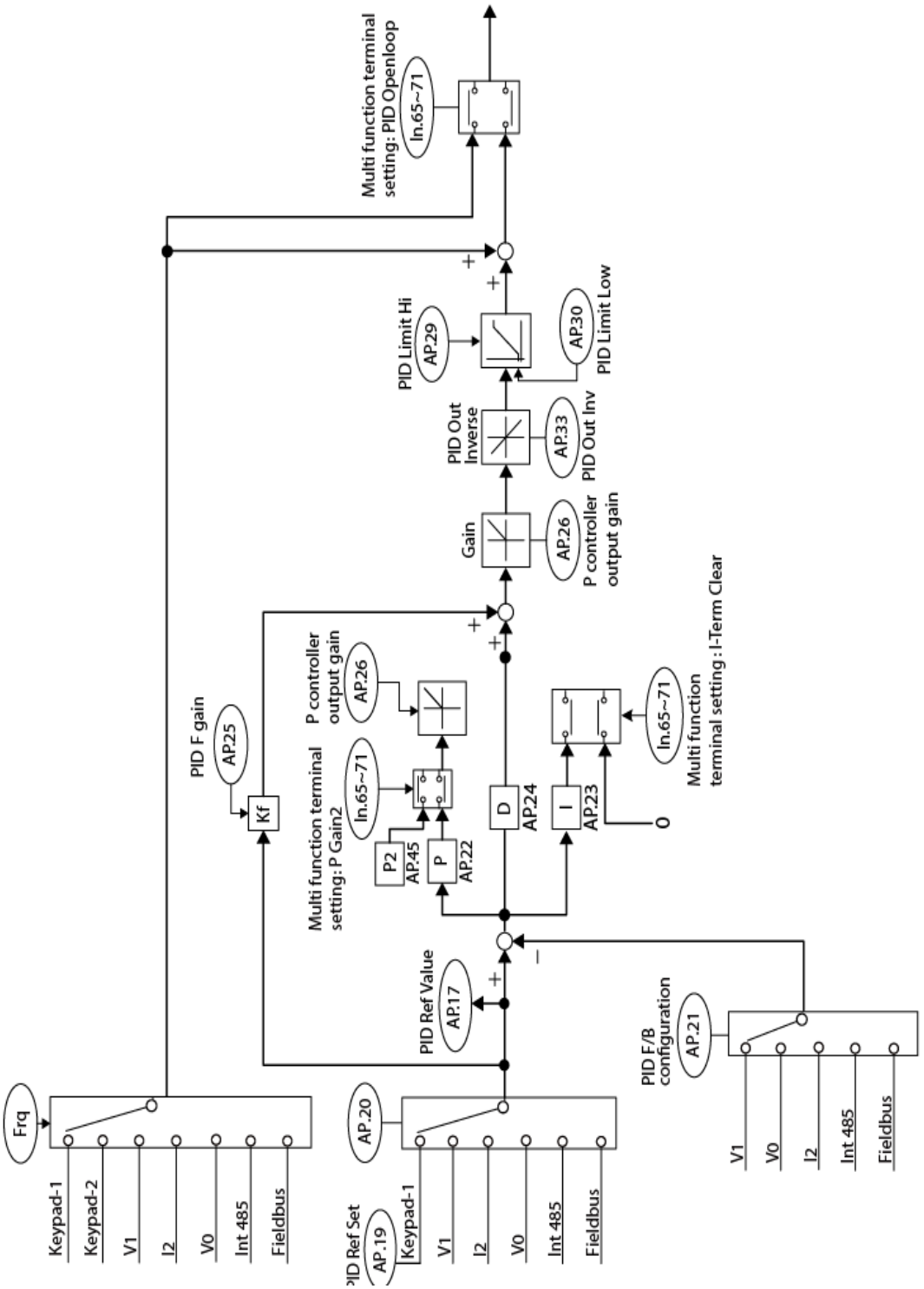
Group	Code	Name	Setting		Setting Range	Unit
	34	PID controller motion frequency	0.00		0–Max Frequency	Hz
	35	PID controller motion level	0.0		0.0–100.0	%
	36	PID controller motion delay time	600		0–9999	sec
	37	PID sleep mode delay time	60.0		0–999.9	sec
	38	PID sleep mode frequency	0.00		0–Max Frequency	Hz
	39	PID wake-up level	35		0–100	%
	40	PID wake-up mode selection	0	Below Level	0–2	-
	43	PID unit gain	100.0		0–300	%
	44	PID unit scale	2	x 1	0–4	-
	45	PID 2nd proportional gain	100.00		0–1000	%
In	65~69	Px terminal setting options	22	I-Term Clear	0–52	-
			23	PID Openloop		
			24	P Gain2		

PID Basic Operation Setting Details

Code and Features	Description
AP.01 App Mode	Set to 2 (Proc PID) to enable PID Control and select functions for the process PID.
AP.16 PID Output	Displays the existing output value of the PID controller. The gain and scale that were set at AP.43, 44 are applied on the display.
AP.17 PID Ref Value	Displays the existing reference value set for the PID controller. The gain and scale that were set at AP.43, 44 are applied on the display.
AP.18 PID Fdb Value	Displays the latest feedback value as input to the PID controller. The gain and scale that were set at AP.43, 44 are applied on the display.
AP.19 PID Ref Set	When AP.20 (PID reference source) is set to 0 (Keypad default), the reference value is entered here, AP.19. If the reference source (AP.20) is set to any other source, the setting values for AP.19 are void.

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>AP.20 PID Ref Source</td><td>Selects the reference source for PID control. The reference and feedback (AP.21) cannot be the same source. If V1 is set as the feedback source, V1 cannot be the reference source. To set V1 as a reference source (AP.20), change the feedback source (AP.21).
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>-10–10 V input voltage terminal</td></tr>
<tr><td>3</td><td>V0</td><td>Potentiometer (Volume dial) input on keypad</td></tr>
<tr><td>4</td><td>I2</td><td>I2 4–20 mA input voltage terminal</td></tr>
<tr><td>5</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>7</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
</table>
When using the keypad, the PID reference setting is entered in AP.19. The reference setting can be displayed at AP.17.</td></tr>
<tr><td>AP.21 PID F/B Source</td><td>Selects feedback source for PID control. The same items as AP.20 can be selected as the feedback source, except the keypad. Feedback cannot be set to the same as the reference (AP.20).</td></tr>
<tr><td>AP.22 PID P-Gain, AP.26 P Gain Scale</td><td>Sets the output ratio for differences (errors) between reference and feedback. If the P-gain is set to 50%, then 50% of the error is output. The setting range for P-gain is 0.0-1,000.0%. For ratios below 0.1%, use AP.26 (P Gain Scale).</td></tr>
<tr><td>AP.23 PID I- Time</td><td>Sets the time to output accumulated errors. When the error is 100%, the time taken for 100% output is set. When the integral time (PID I-Time) is set to 1 second, 100% output occurs after 1 second of the error remaining at 100%. Differences in a normal state can be reduced by PID I Time. When the multi-function (digital) terminal block is set to 21 (I-Term Clear) and is activated, all of the accumulated errors are deleted.</td></tr>
<tr><td>AP.24 PID D-Time</td><td>Sets the output volume for the rate of change in errors. If the differential time (PID D-Time) is set to 1 ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10 ms.</td></tr>
<tr><td>AP.25 PID F-Gain</td><td>Feed Forward Gain - Sets the ratio that adds the target to the PID output. Adjusting this value leads to a faster response.</td></tr>
<tr><td>AP.27 PID Out LPF</td><td>Used when the output of the PID controller changes too fast or the entire system is unstable, due to severe oscillation. In general, a lower value (default value=0) is used to speed up response time, but in some cases a higher value increases stability. The higher the value, the more stable the PID controller output is, but the slower the response time.</td></tr>
<tr><td>AP.29 PID Limit Hi, AP.30 PID Limit Lo</td><td>Apply limits to the output of the controller.</td></tr>
<tr><td>AP.32 PID Out Scale</td><td>Adjusts the volume of the controller output.</td></tr>
</table>

Code and Features	Description
AP.43 PID Unit Gain, AP.44 PID Unit Scale	Adjusts the size to fit the unit.
AP.45 PID P2-Gain	The PID controller's gain can be changed using the multi-function (digital) terminal. When a digital input terminal (In.65~69) is set to 24 (P Gain2), and when activated, the gain set in AP.22 and AP.23 will be switched to the gain set in AP.45.



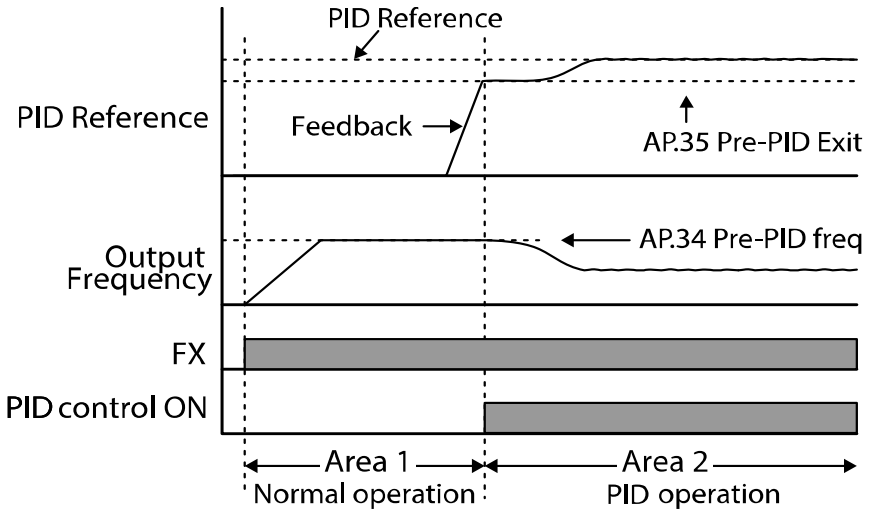
[PID control block diagram]

5.8.2 Pre-PID Operation

Pre-PID is a function that allows the inverter to run at a set frequency (AP.34) for a set amount of time (AP.36) prior to normal PI Control operation. There is also a Pre-PID exit value (AP.35) that must be set. The inverter will exit Pre-PID when the monitored feedback exceeds the Pre-PID Exit value. This must occur before the set time.

Pre-PID Operation Setting Details

Code and Features	Description
AP.34 Pre-PID Freq	Set the frequency to run at prior to PID operation. Pre-PID operation continues until the control variable (AP.35, Pre-PID Exit) is exceeded. or the time
AP.35 Pre-PID Exit, AP.36 Pre-PID Delay	When the actual feedback variable exceeds the value set at AP.35, PID control operation begins. It the time (AP.36, Pre-PID Delay) expires and the actual feedback variable is still less than the value set at AP.35, a "pre-PID Fail" fault will occur and the output will be blocked.

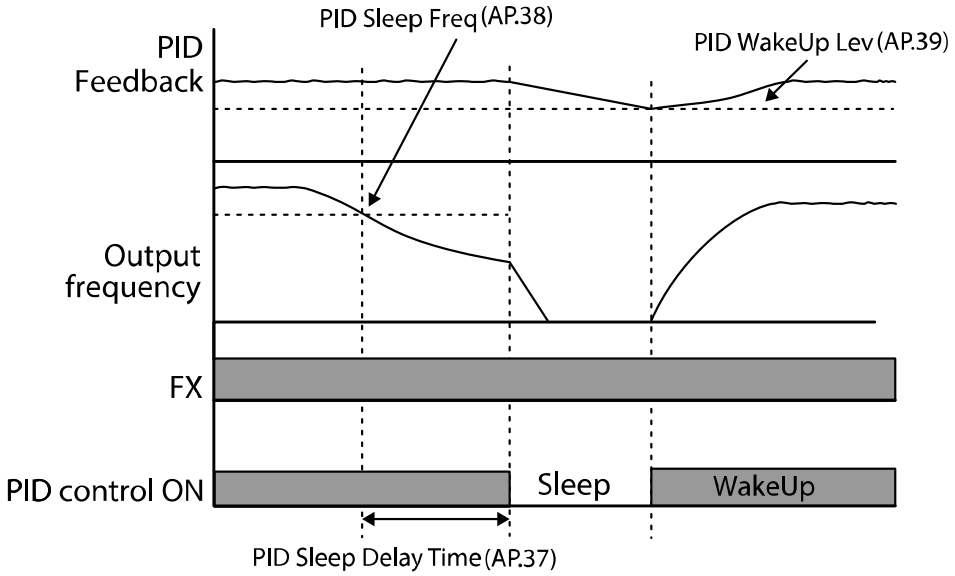


5.8.3 PID Operation Sleep mode

During normal PID Control operation, if demand becomes minimal and inverter operation is not required, the inverter can enter Sleep Mode. A sleep frequency can be set (AP.38, PID Sleep Freq) along with a sleep delay time (AP.37, PID Sleep DT). If the operation continues at a frequency below the sleep frequency for the time set in sleep delay time, the inverter will enter sleep mode. During sleep mode, the inverter continues to monitor the feedback of the process variable. A Wake Up level (AP.39, PID Wakeup Lev) can be set to resume normal PID Control operation. An additional setting of Wake Up mode (AP.40, WakeUp Mod) can be set to further define the Wake Up Level.

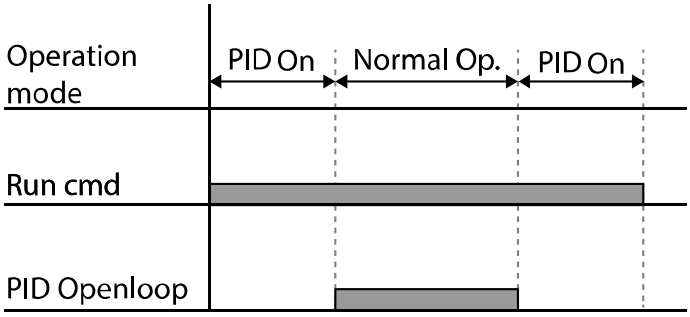
PID Operation Sleep Mode Setting Details

Code and Features	Description
AP.37 PID Sleep DT, AP.38 PID Sleep Freq	If an operating frequency lower than the value set in AP.38 is maintained for the time set at AP.37, the operation stops and the inverter will enter sleep mode.
AP.39 PID WakeUp Lev, AP.40 PID WakeUp Mod	When in Sleep Mode, normal PID Control operation will resume when: **AP.40 -> 0 (Below Level)**: the feedback variable is less than the value set in AP.39, PID WakeUp Lev setting. **AP.40 -> 1 (Above Level)**: the feedback variable is higher than the value set in AP.39. **AP.40 -> 2 (Beyond Level):** the difference between the reference value and the feedback variable is greater than the value set at AP.39.



5.8.4 PID Switching (PID Openloop)

When one of the multi-function (digital) terminals (In.65~69) is set to 23 (PID Openloop) and is activated, PID operation stops and is switched to general operation. When the terminal is de-activated, the PID operation resumes.



Note

When switching from PID operation to general operation, [%] values are converted to [Hz] values. The normal PID output, PID OUT, is unipolar, and is limited by AP.29 (PID Limit Hi) and AP.30 (PID Limit Lo). A 100.0% calculation of the PID OUT value is based on the dr.20 (MaxFreq) parameter setting.

5.9 Auto-tuning

The motor parameters can be measured automatically and can be used for auto torque boost or sensorless vector control.

Example - Auto-Tuning Based on 0.75kW, 200V, 60Hz, 4 Pole Motor

Group	Code	Name	Setting		Setting Range	Unit
dr	14	Motor capacity	1	0.75 kW	0–15	-
bA	11	Number of motor poles	4		2–48	-
	12	Rated slip speed	70		0–3000	Rpm
	13	Motor rated current	3.3		1.0–1000.0	A
	14	Motor noload current	1.7		0.5–1000.0	A
	15	Motor rated voltage	220		170–480	V
	16	Motor efficiency	83		64–100	%
	20	Auto tuning	0	None	-	-
	21	Stator resistance	2.951		Depends on the motor setting	Ω
	22	Leakage inductance	25.20		Depends on the motor setting	mH
	23	Stator inductance	171.1		Depends on the motor setting	mH
	24	Rotor time constant	137		25–5000	ms

Auto-Tuning Default Settings

Motor Capacity (kW)		Rated Current (A)	No-load Current (A)	Rated Slip Frequency (Rpm)	Stator Resistance (Ω)	Leakage Inductance (mH)
200 V	0.2	1.1	0.8	100	14.0	40.4
	0.4	1.9	1.0	90	6.42	38.8
	0.75	3.3	1.7	70	2.951	25.20
	1.5	5.9	2.7	70	1.156	12.07
	2.2	8.6	3.9	50	0.809	6.44
	3.7	13.8	5.7	50	0.485	4.02
	5.5	20.0	6.2	50	0.283	3.24
	7.5	25.5	7.4	50	0.183	2.523
400 V	0.2	0.7	0.5	100	28.00	121.2
	0.4	1.1	0.6	90	19.40	117.0
	0.75	1.9	0.9	70	8.97	76.3
	1.5	3.4	1.7	70	3.51	37.3
	2.2	4.3	2.3	50	3.069	24.92
	3.7	6.9	3.2	50	1.820	15.36
	5.5	11.5	3.6	50	0.819	9.77
	7.5	15.0	4.4	50	0.526	7.58

Auto Tuning Parameter Setting Details

Code	Description		
bA.20 Auto Tuning	Select one of the auto tuning options and then press the [ENT] key to run the auto tuning.		
	Configuration		Function
	0	None	Auto tuning function is not enabled. If the auto tuning function is ran, this will indicate that the auto tuning is complete.
	1	All (Rotation type)	Measures all motor parameters, including stator resistance (Rs), leakage inductance (Lsigma), stator inductance (Ls), no-load current (Noload Curr), and rotor time constant (Tr) while the motor is rotating.
			As the motor is rotating, if the load is connected to the motor, the parameters may not be measured accurately. For accurate measurements, remove the load attached to the motor. However, note that the rotor time constant (Tr) must be measured in a stopped position.
	2	All (static type)	Measures all parameters while the motor is in the stopped position. Measures stator resistance (Rs), leakage inductance (Lsigma), stator inductance (Ls), no-load current (Noload Curr), and rotor time constant (Tr).

Code	Description		
bA.20 Auto Tuning			As the motor is not rotating while the parameters are measured, the measurements are not affected when the load is connected to the motor spindle. However, when measuring parameters, do not rotate the motor spindle on the load side.
	3	Rs+Lsigma (rotating type)	Measures parameters while the motor is rotating. The measured motor parameters are used for auto torque boost or sensorless vector control.
	6	Tr (Static type)	Measures the rotor time constant (Tr) with the motor in the stopped position and Control Mode (dr.09) is set to 4 (IM Sensorless).
bA.14 Noload Curr,	Displays motor parameters measured by auto tuning.		
bA.21 Rs through bA.24 Tr	For parameters that are not included in the auto tuning measurement list, the default setting will be displayed.		

Caution

- Perform auto tuning ONLY after the motor has completely stopped running.
- Before you run auto tuning, check the motor pole number, rated slip, rated current, rated voltage and efficiency on the motor's name plate and enter the data. The default parameter setting is used for values that are not entered.
- When measuring all parameters when motor is static after selecting 2[(All(Static type)] at bA.20 (auto tuning), the accuracy is less than the method of selecting 1 (ALL) and measuring the parameters when the motor is rotating. This means that the performance sensorless operation may be lowered. Therefore, run static type auto tuning by selecting 2 (All) only when the motor cannot be rotated (when gearing and belts cannot be separated easily, or when the motor cannot be separated mechanically from the load).

5.10 **Sensorless Vector Control for Induction Motors**

Sensorless vector control provides a more accurate estimation of the motor rotation speed compared to V/F control. When auto tuning is completed, the inverter calculates motor speed and does not require the rotating speed feedback from the motor. Sensorless vector control can also generate greater torque at a lower level of current.

Group	Code	Name	Setting		Setting Range	Unit
dr	09	Control mode	4	IM Sensorless	-	-
	14	Motor capacity	Varies by Motor capacity		0–15	-
	18	Base frequency	60		30–400	Hz
bA	11	Number of motor poles	4		2–48	-
	12	Rated slip speed	Varies by Motor capacity		0–3000	Hz
	13	Motor rated current	Varies by Motor capacity		1–1000	A
	14	Motor noload current	Varies by Motor capacity		0.0–1000	A
	15	Motor rated voltage	220/380/440/480		170–480	V
	16	Motor efficiency	Varies by Motor capacity		64–100	%
	20	Auto tuning	1	All	-	-
Cn	09	Initial excitation time	1.0		0.0–60.0	sec
	10	Initial excitation amount	100.0		100.0–300.0	%
	21	Low-speed torque compensation gain	Varies by Motor capacity		50–300	%
	22	Output torque compensation gain	Varies by Motor capacity		50–300	%
	23	Speed deviation compensation gain	Varies by Motor capacity		50–300	%
	24	Main compensation of speed deviation	Varies by Motor capacity		50–300	%
	29	No load speed deviation compensation gain	1.06		0.50–2.00	-
	30	Speed response adjustment gain	4.0		2.0–10.0	-
	53	Torque limit setting	0	Keypad-1	0–12	-
	54	Forward direction retrograde torque limit	180.0		0.0–200.0	%
	55	Forward direction regenerative torque limit	180.0		0.0–200.0	%
	56	Reverse direction regenerative torque limit	180.0		0.0–200.0	%
	57	Reverse direction retrograde torque limit	180.0		0.0–200.0	%

Caution

For high-performance operation, the parameters of the motor connected to the inverter output must be measured. Use auto tuning (bA.20 Auto Tuning) to measure the parameters before you run sensorless vector operation. To run high-performance sensorless vector control, the inverter and the motor must have the same capacity. If the motor capacity is smaller than the inverter capacity by more than two levels, control may be inaccurate. In that case, change the control mode to V/F control. When operating with sensorless vector control, do not connect multiple motors to the inverter output.

5.10.1 Sensorless Vector Control Operation Setting for Induction Motors

To run sensorless vector control operation, set dr.09 (Control Mode) to 4 (IM sensorless), select the capacity of the motor at dr.14 (Motor Capacity), and enter the nameplate information of the motor in the below parameters.

Code	Input (Motor Name plate Information)
dr.18 Base Freq	Base frequency
bA.11 Pole Number	Number of motor poles
bA.12 Rated Slip	Rated slip
bA.13 Rated Curr	Rated current
bA.15 Rated Volt	Rated voltage
bA.16 Efficiency	Efficiency (when no information is on the name plate, default values are used.)

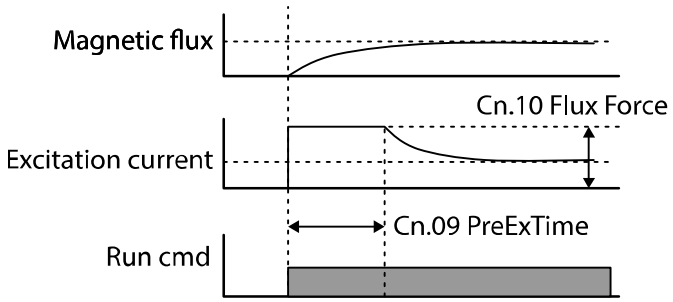
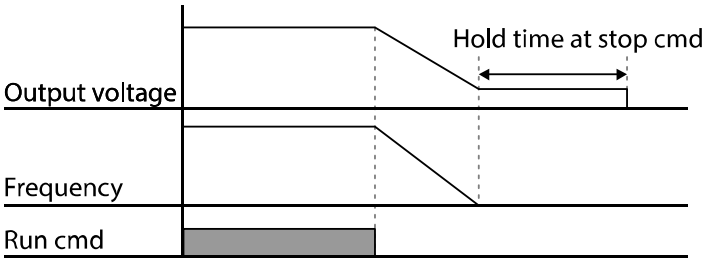
After setting the above, set bA.20 (Auto tuning) to 1 (All - rotation type) or 2 (All - static type) and run auto tuning. Rotation type auto tuning is more accurate than Static type. Set 1 (All -Rotation type) if the motor can be rotated.

Note

Excitation Current

A motor can be operated only after magnetic flux is generated by current flowing through the stator. When the motor is connected to the output of the inverter, excitation current flowing in the stator creates the magnetic flux required to operate the motor.

Sensorless Vector Control Operation Setting Details for Induction Motors

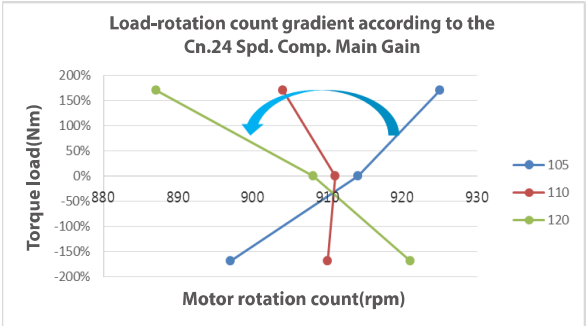
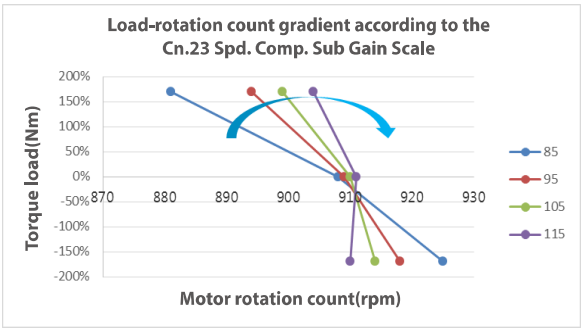
Code and Features	Description
Cn.09 PreExTime	Sets pre-excitation time. Pre-excitation is used at the start of the operation to perform excitation up to the motor's rated flux.
Cn.10 Flux Force	Allows for the reduction of the pre-excitation time. The motor flux increases up to the rated flux with the time constant as shown in the following figure. To reduce the time taken to reach the rated flux, a higher motor flux base value than the rated flux must be provided. When the magnetic flux reaches the rated flux, the provided motor flux base value is reduced. 
Cn.11 Hold Time	Sets the zero-speed control time (hold time) after deceleration in the stopped position. The output is blocked after the Hold Time. 
	For details of the following parameter settings, refer to **p.122** in the **5.10.2**
Cn.21 Out Trq. Comp. Gain at Low Spd	Cn.21 has an effect on the low-speed operations..
Cn.22 ScaleOut Trq. Comp. Gain	Cn.22 is related to the torque load quantity that can be produced by the inverter.
Cn.23 Spd. Comp. Sub Gain	Cn.23 has an effect on the motor speed.
Cn.24 Spd. Comp. Main Gain	Cn.24 has an effect on the motor speed.
Cn.29 Spd. Comp. Gain at No-load	Cn.29 mostly has an effect on the error level of the estimated frequency during no load.
Cn.30 Spd. Response Adjustment Gain	Cn.30 is the value that is mainly changed according to the load inertia.

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Cn.53 Torque Lmt Src</td><td>Select a source for torque limit setting. Either keypad, analog inputs (V1, V0 or I2) or communications. When setting torque limit, adjust the torque amount by limiting the speed controller output. Set the retrograde and regenerative limits for forward and reverse operation.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>KeyPad-1</td><td rowspan="2">Sets the torque limit with the keypad.</td></tr>
<tr><td>1</td><td>KeyPad-2</td></tr>
<tr><td>2</td><td>V1</td><td>Sets the torque limit with the V1 input terminal of the terminal block.</td></tr>
<tr><td>4</td><td>V0</td><td>Sets the torque limit with the potentiometer (volume dial) on the keypad.</td></tr>
<tr><td>5</td><td>I2</td><td>Sets the torque limit with the I2 input terminal of the terminal block.</td></tr>
<tr><td>6</td><td>Int 485</td><td>Sets the torque limit with the communication terminal of the terminal block.</td></tr>
<tr><td>8</td><td>FieldBus</td><td>Sets the torque limit with the Fieldbus communication option.</td></tr>
</table>
The torque limit can be set up to 200% of the rated motor torque.</td></tr>
<tr><td>Cn.54 FWD +Trq Lmt</td><td>Sets the torque limit for forward retrograde (motoring) operation.</td></tr>
<tr><td>Cn.55 FWD –Trq Lmt</td><td>Sets the torque limit for forward regenerative operation.</td></tr>
<tr><td>Cn.56 REV -Trq Lmt</td><td>Sets the torque limit for reverse regenerative operation.</td></tr>
<tr><td>Cn.57 REV +Trq Lmt</td><td>Sets the torque limit for reverse retrograde (motoring) operation.</td></tr>
<tr><td>In.02 Torque at 100%</td><td>When using an analog input as the Torque Limit source (Cn.53), sets the torque limit percentage at the maximum analog input.
For example, if V1 is used as the torque limit source and In.02 is set to 200%, the torque limit is 200% at 10 V.</td></tr>
</table>

Caution

Gain value can be adjusted according to the load characteristics. However, use with caution because motor overheating and system instability may occur depending on the Gain value settings.

5.10.2 **Sensorless Vector Control Operation Guide for Induction Motors**

Problem	Relevant Function Code	Troubleshooting
If the number of motor rotations drops due to the lack of torque	Cn.22 Out Trq. Comp. Gain	If there is a severe drop in the motor rotation to 36 RPM or more, increase the Cn.22 Out Trq. Comp. Gain value in 10% units.
If the motor rotation count error factor is 18 RPM or greater even though there is a sufficient amount of torque.	Cn.23 Spd. Comp. Sub Gain Cn.24 Spd. Comp. Main Gain	Change the Cn.24 Spd. Comp. Main Gain value in 5% units. Refer to the load-rotation count gradient according to the Cn.24 Spd. Comp. Main Gain value below. Example: The gradient slants counterclockWise as the Cn.24 Spd. Comp. Main Gain value increases.  Change the Cn.23 Spd. Comp. Sub Gain value in 5% units. Refer to the load-rotation count gradient according to the Cn.23 Spd. Comp. Sub Gain value below. Example: The gradient slants clockWise as Cn.23 Spd. Comp. Sub Gain value increases. 
If torque is lacking due to a load increase in low speed (5 Hz or less)	Cn.21 Out Trq. Comp. Gain at Low Spd	If torque is lacking under low speed, increase the Cn.21 value in 5% units.
If rotating in reverse direction due to a load increase in low speed (5 Hz or less)	Cn.21 Out Trq. Comp. Gain at Low Spd	If rotating in reverse direction due to a load increase in low speed, decrease the Cn.21 value 5% at a time.

Problem	Relevant Function Code	Troubleshooting
If low speed (3 Hz or less) out-of-phase occurs because the inertia of load is high.	Cn.30 Spd. Response Adjustment Gain	Sometimes control is not possible under a low speed due to high load inertia. In this case, increase the Cn.30 value by 1 unit at a time.
If motor rotation count error margin occurs during no load	Cn.29 Spd. Comp. Gain at No-load	If over 10 RPM of motor rotation count error occurs during no load operation, adjust the Cn.29 value by 0.01 unit at a time.
If speed response is required	Cn.30 Spd.Response Adjustment Gain	Although the speed response is improved the greater the Cn.30 value, speed control may become unstable. Excessive setup may cause an inverter trip.

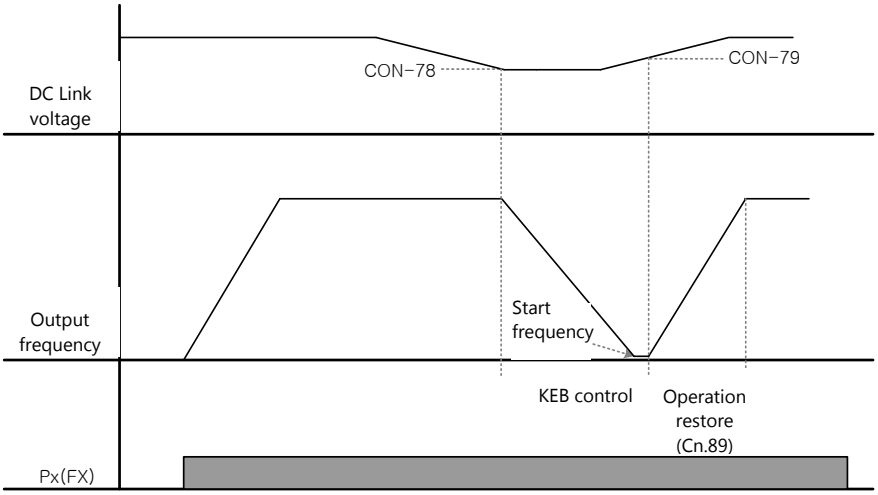
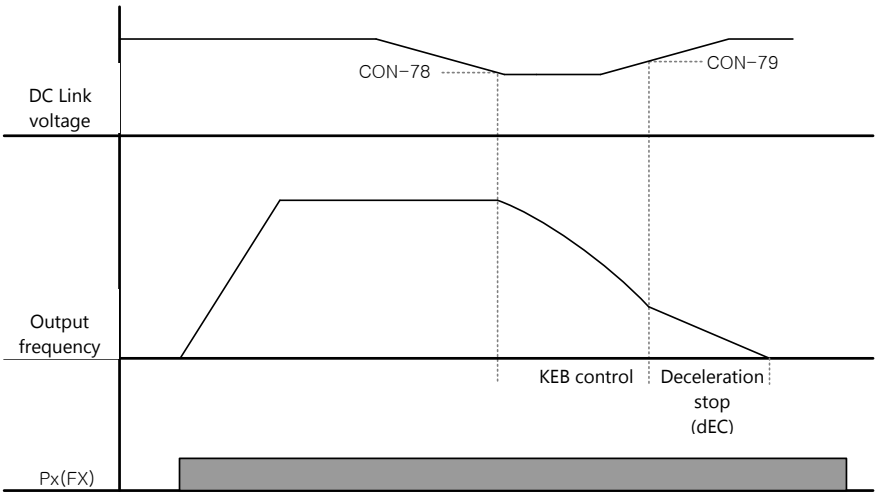
5.11 **Kinetic Energy Buffering - KEB**

When the input power is disconnected, the inverter's DC link voltage decreases, and a low voltage trip occurs blocking the output. Kinetic energy buffering operation can be used to decelerate the motor safely under these conditions. The inverter uses regenerative energy from the motor during the power outage to maintain the DC link voltage. This extends the time for a low voltage trip to occur. For the KEB feature to operate properly, parameter bA.19 (input voltage) must be set correctly.

Group	Code	Name	Setting		Setting Range	Unit
bA	19	Input power voltage settings	240/480		170–480	V
Cn	77	Energy buffering selection	0	None	0–2	-
			1	KEB-1		
			2	KEB-2		
	78	Energy buffering start level	125.0		110.0–200.0	%
	79	Energy buffering stop level	130.0		Cn.78–210.0	%
	80	Energy buffering P gain	1000		1–20000	-
	81	Energy buffering I gain	500		0–20000	-
	82	Energy buffering Slip gain	30.0		0–2000.0	%
	83	Energy buffering restoration frequency	10.0		0.0–600.0	sec
In	65~69	Px terminal function setting	52	KEB-1 Select	-	-

Kinetic Energy Buffering Operation Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Cn.77 KEB Select</td><td>Select the kinetic energy buffering operation when the input power is disconnected. If KEB-1 or KEB-2 is selected, it controls the inverter's output frequency and charges the DC link with regenerative energy from the motor. KEB-1 operation will allow the inverter to resume operation after power is restored. KEB-2 operation will decelerate the motor to a safe stop.
KEB-1 can be activated with a digital input. Set Px terminal (In.65~69) to 52 (KEB-1 Select), and activate the terminal block upon power loss to run the KEB-1 operation. If KEB-1 Select is selected via the terminal, KEB-1 or KEB-2 cannot be set in Cn.77.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>General deceleration is carried out until a low voltage trip occurs.</td></tr>
</table>
</td></tr>
</table>

Code and Features	Description		
	1	KEB-1	When the input power is disconnected, it charges the DC link with regenerated energy. When the input power is restored, the inverter changes to normal operation from the KEB-1 energy buffering operation. The acceeration time set in Cn.83 (KEB Acc Time) is applied when restoring to normal operation.
	2	KEB-2	When the input power is disconnected, it charges the DC link with regenerated energy. When the input power is restored, it changes from the KEB-2 energy buffering operation to the deceleration stop operation. The decel time set in the dEC parameter of the operations group is applied during the deceleration stop operation.
	[KEB-1]  [KEB-2]  		
Cn.78 KEB Start Lev, Cn.79 KEB Stop Lev	Sets the start and stop points of the kinetic energy buffering operation. The set values must be based on the low voltage trip level as 100% and the stop level (Cn.79) must be set higher than the start level (Cn.78).		

Code and Features	Description
Cn.80 KEB P Gain	The controller P Gain is for maintaining the voltage of the DC link section during the kinetic energy buffering operation. Change the setting value when a low voltage trip occurs right after a power failure.
Cn.81 KEB I Gain	The controller I Gain is for maintaining the voltage of the DC link section during the kinetic energy buffering operation. Sets the gain value to maintain the frequency during the kinetic energy buffering operation until the inverter stops.
Cn.82 KEB Slip Gain	The slip gain is for preventing a low voltage trip due to load when the kinetic energy buffering operation starts.
Cn.83 KEB Acc Time	When power is restored, sets the acceleration time of the operating frequency when the inverter returns to normal operation from KEB-1 mode.

⚠ Caution

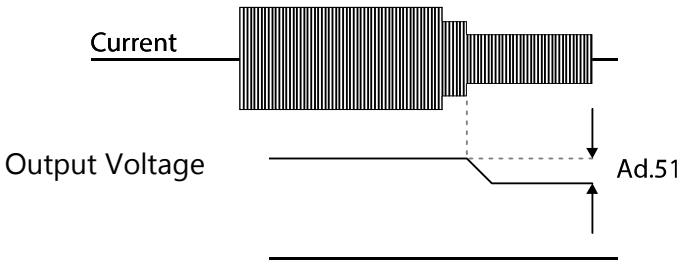
Depending on the duration of Instantaneous power interruptions and the amount of load inertia, a low voltage trip may occur even during a kinetic energy buffering operation. Motors may vibrate during kinetic energy buffering operation for some loads.

5.12 Energy Saving Operation

5.12.1 Manual Energy Saving Operation

When the inverter output current is lower than the current which is set at bA.13 (Motor Rated Current), the output voltage is reduced by the percentage set in Ad.51 (Energy Save). The voltage before the energy saving operation starts will become the base value of the percentage. Manual energy saving operation will not be carried out during acceleration and deceleration.

Group	Code	Name	Setting		Setting Range	Unit
Ad	50	Energy saving operation	1	Manual	-	-
	51	Energy saving amount	30		0–30	%



5.12.2 Automatic Energy Saving Operation

The amount of energy saving can be automatically calculated based on the rated motor current (bA.13) and the no-load current (bA.14). From the calculations, the output voltage can be adjusted.

Group	Code	Name	Setting		Setting Range	Unit
Ad	50	Energy saving operation	2	Auto	-	-

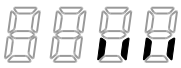
Caution

The inverter will exit the energy saving mode, when the reference frequency is changed or during acceleration and deceleration. The actual Acc/Dec time may take longer than the set Acc/Dec time due to the time required to return to normal operation.

5.13 **Speed Search Operation**

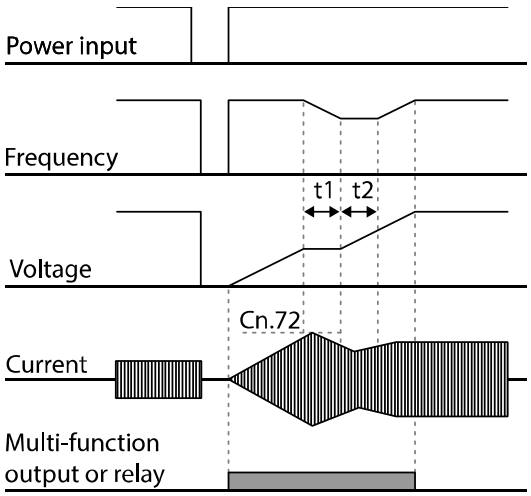
Speed Search is used to start the inverter while the motor/load are already spinning (idling). Speed Search synchronizes the inverter output (voltage and frequency) to that of the spinning motor. This is accomplished by ramping the output voltage up, then ramping the output frequency down.. Speed Search estimates the motor rotation speed based on the inverter output current, therefore it may not match the exact speed. Speed Search can prevent faults that occur when starting the inverter while the motor/load are spinning. There are two modes of Speed Search (Flying Start-1 and Flying Start-2). The main differerence is that Flying Start-2 can detect direction of motor rotation. There are also four conditional settings of Speed Search. These include normal starting, starting after a fault reset, starting after a power interruption, and auto-starting with the initial application of power to the inverter.

Group	Code	Name	Setting		Setting Range	Unit
Cn	70	Speed search mode selection	0	Flying Start-1	-	-
			1	Flying Start-2		
	71	Speed search operation selection	0000*		-	bit
	72	Speed search reference current	-	Below 75 kW	80–200	%
	73	Speed search proportional gain	100		0–9999	-
	74	Speed search integral gain	200		0–9999	-
	75	Output block time before speed search	1.0		0–60	sec
OU	31	Multi-function (digital) relay1 item	19	Speed Search	-	-
	33	Multi-function (digital) relay2 item				

*Displayed as  on the Keypad.

Speed Search Operation Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Cn.70 SS Mode</td><td>
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Flying Start-1</td><td>The speed search is carried out as it controls the inverter output current below the Cn.72 (SS Sup-Current) setting. Use when the direction of the idling motor and the direction of the start command are the same. A stable speed search function can be performed at about 10 Hz or lower.
However, if the direction of the idling motor and the direction of the start command are different, the speed search does not produce a satisfactory results. The direction of the idling motor cannot be established.</td></tr>
<tr><td>1</td><td>Flying Start-2</td><td>The speed search is carried out as it PI controls the ripple current which is generated by the counter electromotive force during no-load rotation. The counter electromotive force is proportional to the idle speed. This mode establishes the direction of the idling motor (forward/reverse), and the speed search function is stable regardless of the direction of the idling motor and direction of the start command. However because the ripple current is used, the frequency is not determined accurately at low speeds (about 10–15 Hz). Re-acceleration may start from zero speed.</td></tr>
</table>
Select a speed search type.</td></tr>
<tr><td>Cn.71 Speed Search</td><td>When the top LED segment is on, the corresponding bit is set to 1 (enabled). When the bottom LED segment is on, the corresponding bit is 0 (disabled).
<table>
<tr><th>Items</th><th>Bit On Status</th><th>Bit Off Status</th></tr>
<tr><td>Keypad</td><td>  </td><td>  </td></tr>
</table>
Speed search can be selected to operate among the following 4 conditions.
Type and Functions of Speed Search Setting
<table>
<tr><th colspan="4">Configuration</th><th rowspan="2">Function</th></tr>
<tr><th>bit4</th><th>bit3</th><th>bit2</th><th>bit1</th></tr>
<tr><td></td><td></td><td></td><td>✓</td><td>Speed search for general acceleration</td></tr>
<tr><td></td><td></td><td>✓</td><td></td><td>Initialization after a fault</td></tr>
<tr><td></td><td>✓</td><td></td><td></td><td>Restart after instantaneous power interruption</td></tr>
<tr><td>✓</td><td></td><td></td><td></td><td>Starting with power-on</td></tr>
</table></td></tr>
</table>

Code and Features	Description
	• **Speed search for general acceleration:** If bit 1 is set to 1 (enabled), speed search is enabled for normal accerlating starts with rotating motor/load. • **Initialization after a fault:** If Bit 2 is set to 1 (enabled) and Pr.08 (RST Restart) is set to 1 (Yes), after a fault reset, speed search accelerates the motor to the operating frequency used before the fault. • **Automatic restart after power interuption:** If bit 3 is set to 1 (enabled), and if a low voltage trip occurs due to a power interruption but the power is restored before the inverter power shuts down, speed search accelerates the motor back to its operating frequency prior to the low voltage trip. When an instantaneous power interruption occurs, the inverter generates a low voltage trip and blocks the output. When the input power returns, speed search accelerates the motor back to its operating frequency prior to the low voltage trip and the voltage is increased by the inverter's inner PI control. If the current increases above the value set at Cn.72, the voltage stops increasing and the frequency decreases (t1 zone). If the current decreases below the value set at Cn.72, the voltage increases again and the frequency stops decelerating (t2 zone). When the normal frequency and voltage are resumed, speed search accelerates the motor back to its operating frequency prior to the fault.  • **Starting with power-on:** Set bit 4 to 1 (enabled) and Ad.10 (Power-on Run) to 1 (Yes). If inverter input power is applied and the run command is active (on), speed search accelerates the motor up to the frequency reference.

Code and Features	Description
Cn.72 SS Sup-Current	During Flying Start-1 (Cn.70 set to 0), the amount of current is controlled. The percentage is based on the motor's rated current. If Cn.70 (SS mode) is set to 1 (Flying Start-2), this code is not visible.
Cn.73, Cn.74 SS P/I-Gain, Cn.75 SS Block Time	The P/I gain of the speed search controller can be adjusted. If Cn.70 (SS Mode) is set to 1 (Flying Start-2), different factory defaults are used based on motor capacity defined in dr.14 (Motor Capacity). Cn.75 (SS Block Time) prevents overvoltage faults due to counter electromotive force (emf).

Note

- If operated within the rated output, the GM2 series inverter is designed to withstand instantaneous power interruptions within 15 ms and maintain normal operation. Based on the rated heavy load current, safe operation during an instantaneous power interruption within 15ms is guaranteed for 240 V and 480 V inverters (whose rated input voltages are 200–240 VAC and 380–480 VAC respectively).
- The DC voltage inside the inverter may vary depending on the output load. If the power interruption time is longer than 15 ms, a low voltage trip may occur.

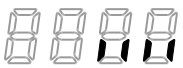
Caution

When operating in sensorless mode for proper operation during free-run, the speed search function (for general acceleration) must be set for smooth operation. If the speed search function is not set, an overcurrent trip or overload trip may occur.

5.14 **Auto Restart Settings**

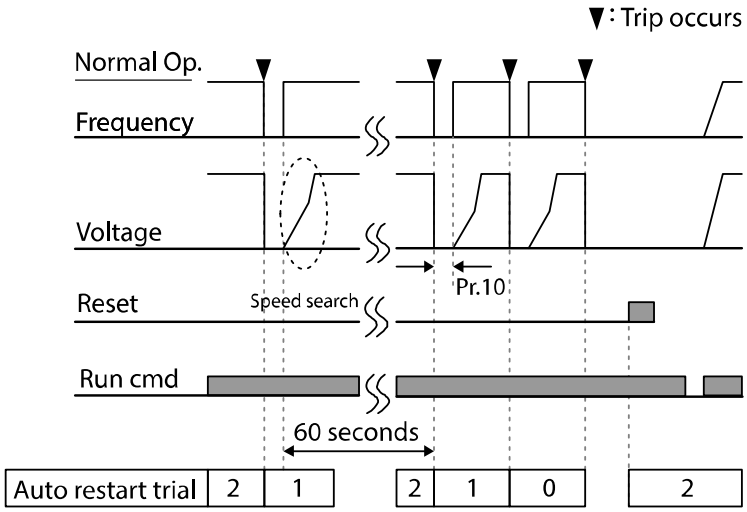
For continued operation, the inverter can be automatically reset and restarted after a fault. Enable the auto reset/restart function with parameter Pr.08. The number of reset/restart attempts and the time delay between attempts are set with parameters Pr.09 and Pr.10. Certain faults cannot be auto reset. These include low voltage, emergency stop (Bx), inverter overheating, and hardware diagnostic faults.

Group	Code	Name	Setting	Setting Range	Unit
Pr	08	Selection of startup on trip reset	0 No	0–1	-
	09	Number of automatic restarts	0	0–10	-
	10	Auto restart delay time	1.0	0.0–60.0	sec
Cn	71	Speed search operation selection	-	0000*–1111	bit
	72	Speed search reference current	150	80–200	%
	73	Speed search proportional gain	100	0–9999	
	74	Speed search integral gain	200	0–9999	
	75	Output block time before speed search	1.0	0.0–60.0	sec

*Displayed as  on the Keypad.

Auto Restart Setting Details

Code and Features	Description
Pr.08 RST Restart, Pr.09 Retry Number, Pr.10 Retry Delay	Operates when Pr.08 (RST Restart) is set to 1 (Yes). The number of auto restart attempts is set at Pr.09 (Restart Number). If a fault occurs during operation, the inverter automatically resets the fault and restarts after the set time programmed at Pr.10 (Retry Delay). At each restart, the inverter decreases the number of Retry attempts. Once the retry number count reaches 0, the inverter does not attempt any more automatic restarts. After an auto reset/restart, it will increase the number of allowable restarts every 60 secs. up to the Pr.09 setting. At auto restart, the acceleration options are identical to those of speed search operation. Codes Cn.72~75 can be set based on the load. Information about the speed search function can be found at 5.13 **Speed Search Operation** on page **128**.



[Example of auto restart with a setting of 2]

Caution

When auto reset/restart is enabled (Pr.08, RST Restart), the inverter will reset from a fault and automatically start to rotate.

5.15 Operational Noise Settings (Carrier Frequency Settings)

Group	Code	Name	Setting Range		Unit
Cn	04	Carrier Frequency	1.0HP~5.0HP (0.75W~4.0kW)	2.0~15.0	kHz
			7.5HP~15HP (5.5kW~11kW)	1.0~15.0	

Operational Noise Setting Details

Code and Features	Description
Cn.04 Carrier Freq	Power transistors (IGBT) at the output of the inverter generate and supply a high frequency switching voltage to the motor. This switching speed is refered to as the carrier frequency. Adustment of the carrier frequency affects motor operating noise. A higher carrier frequency reduces operational noise. A lower carrier frequency increases operational noise.

Refer to the table below for carrier frequency settings according to the load level, control mode, and capacity.

Capacity	Heavy Duty					Normal Duty				
	Setting Range				Initial Value	Setting Range				Initial Value
	V/F		S/L			V/F		S/L		
	Minimum	Maximum	Minimum	Maximum		Minimum	Maximum	Minimum	Maximum	
1.0HP~5.0HP (0.75kW~4.0 kW)	2	15	2	15	3	2	5	2	5	2
7.5HP~15HP (5.5~11kW)	1	15	2	15		1	5	2	5	

Note
Higher carrier frequency settings require derating of the output current of the inverter. For derating specifications, refer to 11.6 **Continuous Current Derating** on page **263**.

5.16 **2nd Motor Operation**

2nd motor operation is used when a single inverter switches its output between two motors. Parameters for the 2nd motor are set in the M2 parameter group. 2nd motor operation is enabled when a digital input terminal defined as “2nd motor” function is activated.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	26	2nd Motor	0–52	-

2nd Motor Operation Setting Details

Code and Features	Description
In.65–69 Px Define	Set one of the digital input terminals (P1~P5) to 26 (2nd Motor) to display the M2 (2nd motor) group. When activated, the inverter will monitor and control the 2nd motor according to the settings listed below. An external method of switching the inverter output between the 2 motors is required. **NOTE:** When the inverter is in operation, switching of the digital input will not be acknowledged. Pr.50 (Stall Prevent) must be set first, before M2.28 (M2.Stall Lev) settings can be used. Also, Pr.40 (ETH Trip Sel) must be set first, before M2.29 (M2.ETH 1min) and M2.30 (M2.ETH Cont) settings.

Parameter Setting at Multi-function (digital) Terminal Input on a 2nd Motor

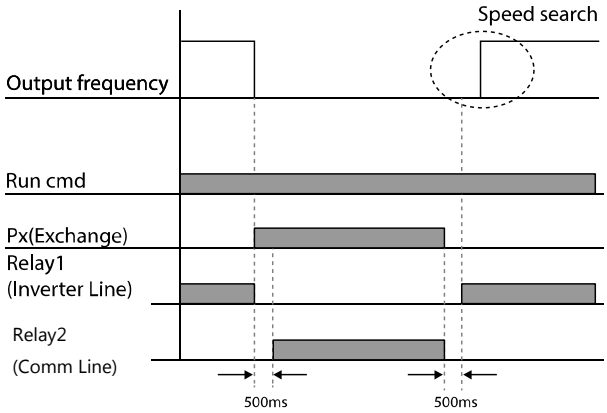
Code and Features	Description	Code	Description
M2.04 Acc Time	Acceleration time	M2.16 Inertia Rt	Load inertia rate
M2.05 Dec Time	Deceleration time	M2.17 Rs	Stator resistance
M2.06 Capacity	Motor capacity	M2.18 Lsigma	Leakage inductance
M2.07 Base Freq	Motor base frequency	M2.19 Ls	Stator inductance
M2.08 Ctrl Mode	Control mode	M2.20 Tr	Rotor time constant
M2.10 Pole Num	Pole number	M2.25 V/F Patt	V/F pattern
M2.11 Rate Slip	Rated slip	M2.26 Fwd Boost	Forward Torque boost
M2.12 Rated Curr	Rated current	M2.27 Rev Boost	Reverse torque boost
M2.13 Noload Curr	No-load Current	M2.28 Stall Lev	Stall prevention level
M2.14 Rated Volt	Motor rated voltage	M2.29 ETH 1min	Electronic thermal 1 minute rating
M2.15 Efficiency	Motor efficiency	M2.30 ETH Cont	Electronic thermal continuous rating

5.17 **Commercial Power Source Transition**

Power Source Transition is used to switch the power source to the motor from the inverter output to the main supply power source (commercial power source), and vice versa.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	16	Exchange	0–52	-
OU	31	Multi-function (digital) relay1 item	17	Inverter Line	-	-
	33	Multi-function (digital) relay2 item	18	Comm Line	-	-

Supply Power Transition Setting Details

Code and Features	Description
In.65~69 Px Define	Set one of the digital input terminals (P1~P5) to 16 (Exchange). Set the two output relays (Relay1 and Relay2) to 17 (Inverter) and 18 (Comm Line) respectively. When the digital input is activated, the output relays will change state. An external method of switching the inverter output to the commercial line is required. To reverse the transition, de-activate the digital input terminal.
OU.31 Relay 1, OU.33 Relay 2	Sets Relay1 to 17 (inverter line) and Relay2 to 18 (comm line). Relay operation sequence is as follows. 

5.18 **Cooling Fan Control**

This function controls the operation of the inverter's heat-sink cooling fan. It is used in situations with frequent starting and stopping, or noise free environment is required. The correct use of cooling fan control can extend the life of the cooling fan.

Group	Code	Name	Setting		Setting Range	Unit
Ad	64	Cooling fan control	0	During Run	0–2	-

Cooling Fan Control Detail Settings

Code and Features	Function		
	Configuration		Function
Ad.64 Fan Control	0	During Run	Cooling fan runs when the inverter is running. The cooling fan stops when the inverter stops. If the inverter heat sink temperature is higher than a set value, the cooling fan will operate regardless of the inverter's operation status.
	1	Always On	Cooling fan runs constantly when power is supplied to the inverter.
	2	Temp Control	With power connected and the start command on, the cooling fan will not operate unless the temperature in the heat sink reaches a set temperature.

Note

Regardless of setting Ad.64 to 0 (During Run), if the heat sink temperature reaches a set level, the cooling fan may run as a protection function. Also, for 480 V products, when the input voltage is 480 VAC or higher, the cooling fan operates continuously to protect the inverter regardless of the cooling fan control settings.

5.19 **Input Power Frequency and Voltage Settings**

Select the frequency of input power. When the frequency is set to 50 Hz, the frequencies set for 60 Hz (including the maximum frequency and base frequency) will change to 50 Hz. Likewise, changing the input power frequency setting from 50 Hz to 60 Hz will change all related settings from 50 Hz to 60 Hz.

Group	Code	Name	Setting		Setting Range	Unit
bA	10	input power frequency	0	60 Hz	0–1	-

Set Inverter input power voltage. Low voltage fault level changes automatically to the set voltage standard.

Group	Code	Name	Setting		Setting Range	Unit
bA	19	Input power voltage	200 V	240	170–240	V
			400 V	480	320–480	

5.20 **Parameter Save**

Changes to parameter settings in the compatible common area are not saved in the inverter memory. If power is cycled, changes will be lost. Set dr.92 to 1 (Parameter Save) to save the changed parameters into the inverter memory. The parameters cannot be saved if the inverter is operating.

Group	Code	Name	Setting		Setting Range	Unit
dr	92	Parameter save	0	None	0~1	-
			1	Parameter save		

5.21 **Parameter Initialization**

The parameters changed by the user can be initialized to the factory default settings. Initialize parameters in all groups by selecting 1 (All GRP) or select specific groups . The parameters cannot be initialized if the inverter is operating or during a fault condition.

Group	Code	Name	Setting		Setting Range	Unit
dr	93	Parameter initialization	0	No	0–14	-

Parameter Initialization Setting Details

Code and Features	Description		
	Configuration		Function
dr.93 Parameter Init	0	No	-
	1	Initialize all groups	Initialize all data. Select 1 (All Grp) and press [PROG/ENT] key to start initialization. On completion, 0 (No) will be displayed.
	2	Initialize dr group	Initialize data by groups. Select initialize group and press [PROG/ENT] key to start initialization. On completion, 0 (No) will be displayed.
	3	Initialize bA group	
	4	Initialize Ad group	
	5	Initialize Cn group	
	6	Initialize In group	
	7	Initialize OU group	
	8	Initialize CM group	
	9	Initialize AP group	
	11	Initialize AO group	
	12	Initialize Pr group	
	13	Initialize M2 group	
	14	Initialize Operation Group	

5.22 **Parameter Lock**

Use parameter lock to prevent unauthorized changes to parameter settings. To enable parameter lock, register a user password first in dr.94. To lock and unlock parameter changes, enter the password in dr.95.

Group	Code	Name	Setting	Setting Range	Unit
dr	94	Password registration	-	0–9999	-
	95	Parameter lock settings	-	0–9999	-

Parameter Lock Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>dr.94 (Parameter Register)</td><td>Register a password to prohibit parameter modifications. Follow the procedures below to register a password.
<table>
<tr><th>Step</th><th>Procedures</th></tr>
<tr><td>1</td><td>Press the [ENT] key on dr.94 code and the saved password input window will be displayed. If password registration is being made for the first time, enter 0. It is the factory default.</td></tr>
<tr><td>2</td><td>If a saved password has been set, enter the saved password.</td></tr>
<tr><td>3</td><td>If the entered password matches the saved password, then a new window to enter a new password will be displayed. (The process will not move to next stage until the user enters a valid password).</td></tr>
<tr><td>4</td><td>Register a new password.</td></tr>
<tr><td>5</td><td>After registration, Code dr.94 will be displayed.</td></tr>
</table></td></tr>
<tr><td>dr.95 (Parameter Lock)</td><td>Press the [ENT] key, if UL (Unlocked) is displayed the parameter lock feature is disabled. Press the [ENT] key again, a field to input password is shown. Enter the password and the Locked display is shown. When you press [ENT] key at a parameter to make a change, it will not be changed to edit mode. Enter password again to display UL (Unlocked). The change prevention feature is disabled.</td></tr>
</table>

Caution

If parameter lock function is enabled, no inverter operation related function changes can be made. It is very important that you memorize the password.

5.23 **Changed Parameter Display**

This feature displays all the parameters that are different from the factory defaults. Use this feature to track changed parameters.

Group	Code	Name	Setting		Setting Range	Unit
dr	89	Changed parameter display	0	View All	-	-

Changed Parameter Display Setting Details

Code and Features	Description		
dr.89 Changed Para	Configuration		Function
	0	View All	Display all parameters
	1	View Changed	Display changed parameters only

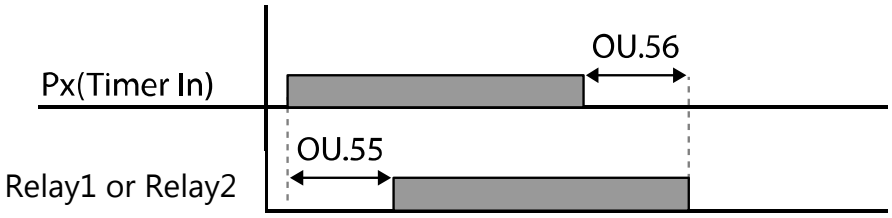
5.24 **Timer Settings**

Add a timer function to one of the output relays. Set a digital input to activate the timer and set On/Off delay times to one of the output relays.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	38	Timer In	0–52	-
OU	31	Multi-function (digital) relay1 item	28	Timer Out	-	-
	33	Multi-function (digital) relay2 item				
	55	Timer On delay	3.00		0.00–100	sec
	56	Timer Off delay	1.00		0.00–100	sec

Timer Setting Details

Code and Features	Description
In.65~69 Px Define	Choose one of the digital input terminals and set it to 38 (Timer In). Ativate the terminal to start the timer function.
OU.31 Relay1, OU.33 Relay 2	Set one relay to be used as a timer to 28 (Timer out).
OU.55 TimerOn Delay, OU.56 TimerOff Delay	Set the On Delay time. When the digital input is activiated, the output relay will change state after the On Delay time has passed. Set the Off Delay time. When the digital input is de-activated, the output relay will change state after the Off Delay time has passed.



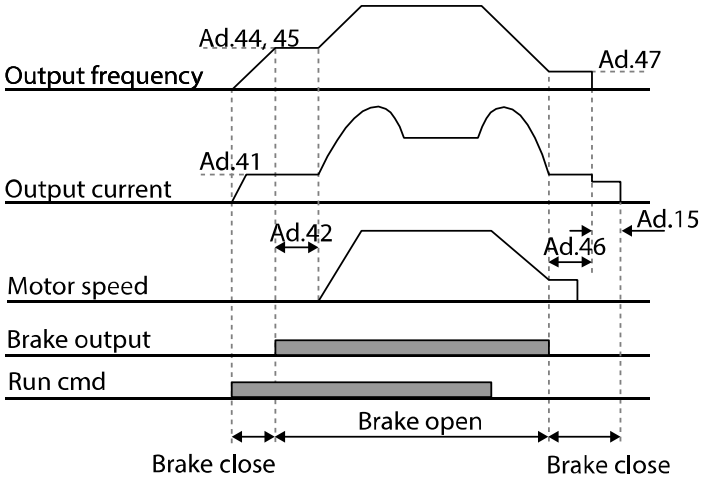
5.25 **Brake Control**

This feature controls the On/Off operation of the load's electro-mechanical braking system.

Group	Code	Name	Setting		Setting Range	Unit
dr	09	Control mode	0	V/F	-	-
Ad	41	Brake release current	50.0		0.0–180%	%
	42	Brake release delay time	1.00		0.0–10.0	sec
	44	Brake release Forward frequency	1.00		0–Max Frequency	Hz
	45	Brake release Reverse frequency	1.00		0–Max Frequency	Hz
	46	Brake engage delay time	1.00		0.00–10.00	sec
	47	Brake engage frequency	2.00		0–Max Frequency	Hz
OU	31	Multi-function (digital) relay1 item	35	BR Control**:**	-	-
	33	Multi-function (digital) relay2 item				

When brake control is activated, DC braking (Ad.12) at inverter start and dwell operation (Ad.20~23) do not operate.

- **Brake release sequence:** When a run command is applied**,** the inverter accelerates up to brake release frequency (Ad.44 Forward or Ad.45 Reverse). After reaching the brake release frequency, when the motor current reaches brake release current (Ad.41 BR Rls Curr), the output relay (OU.31 or OU.33) set to 35 (BR Cotrol) sends a release signal. Once the signal has been sent, acceleration will begin after maintaining frequency for brake release delay time (Ad.42 BR Rls Dly).
- **Brake engage sequence:** When a stop command is applied, the motor decelerates. When the output frequency reaches brake engage frequency (Ad.47 BR Eng Fr), the motor stops deceleration and the output relay (OU.31 or OU.33) set to 35 (BR Cotrol) sends a brake engage signal. Frequency is maintained for the brake engage delay time (Ad.46 BR Eng Dly) and will become 0 afterwards. If Stop Mode (Ad.08) is set to 1 (DC brake), inverter output is blocked after DC braking.



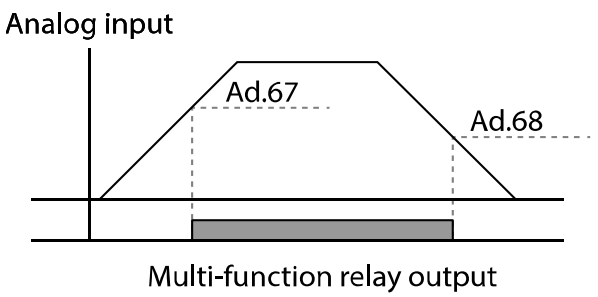
5.26 **Multi-function (digital) relay On/Off Control**

This feature operates an output relay (Relay1 or Relay2) based on the analog input level. Set the On level (Ad.67) to activate the relay and the Off level (Ad.68) to de-activate the relay.

Group	Code	Name	Setting		Setting Range	Unit
Ad	66	Output terminal on/off control mode	1	V1	-	-
	67	Output contact On level	90.00		Output contact off level–100.00%	%
	68	Output contact Off level	10.00		0.00–Output terminal on level	%
OU	31	Multi-function (digital) relay1 item	34	On/Off	-	-
	33	Multi-function (digital) relay2 item				

Multi-function (digital) relay On/Off Control Setting Details

Code and Features	Description
Ad.66 On/Off Ctrl Src	Select the analog input to use for On/Off control.
Ad.67 On-C Level, Ad.68 Off-C Level	Set the On and Off levels for the output relay.



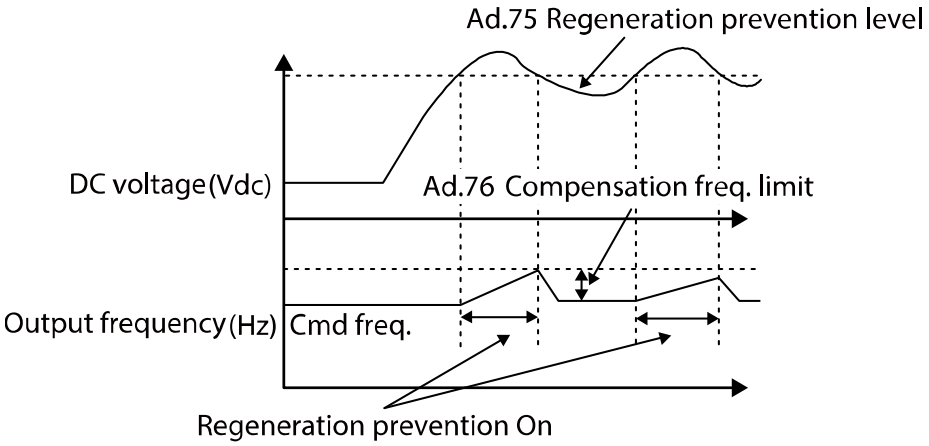
5.27 **Press Regeneration Prevention**

Press regeneration prevention is used during press operations to prevent braking during the regeneration process. When motor regeneration occurs during a press operation, the motor operating speed automatically increases to avoid the regeneration zone.

Group	Code	Name	Setting	Setting Range	Unit
Ad	74	Selection of regeneration evasion function for press	0 No	0–1	-
	75	Voltage level of regeneration evasion motion for press	350 V	200 V 300–400 V	V
			700 V	400 V 600–800 V	
	76	Compensation frequency limit of regeneration evasion	1.00 (Hz)	0.00–10.00 Hz	Hz
	77	Regeneration evasion P gain	50.0 (%)	0–100%	%
	78	Regeneration evasion I gain	500 (ms)	20–30000 ms	ms

Press Regeneration Prevention Setting Details

Code and Features	Description
Ad.74 RegenAvd Sel	Frequent regeneration voltage from a press load during constant motor speed operation may force excessive work on the brake unit which may damage or shorten the brake life. To prevent this situation, set Ad.74 (RegenAvd Sel) to 1 (Yes) to control DC link voltage and disable the brake unit operation.
Ad.75 RegenAvd Level	Set the DC Link voltage level to activate Regen Avoidance.
Ad.76 CompFreq Limit	Set a frequency limit above operating frequency during Regen Avoidance.
Ad.77 RegenAvd Pgain, Ad.78 RegenAvd Igain	Set the P gain and I gain in the DC link voltage suppress PI controller while in Regen Avoidance.



Note

Press regeneration prevention only operates during constant motor speed operation and does not operate during accelerations or decelerations. When regeneration prevention is activated, output frequency may change within the range set at Ad.76 (CompFreq Limit).

5.28 **Analog output**

The analog output terminal (AO) provides an output of 0–10 VDC. The analog output can represent one of a variety of signals. Scaling and filtering can also be applied to the signal.

5.28.1 **Voltage Analog Output**

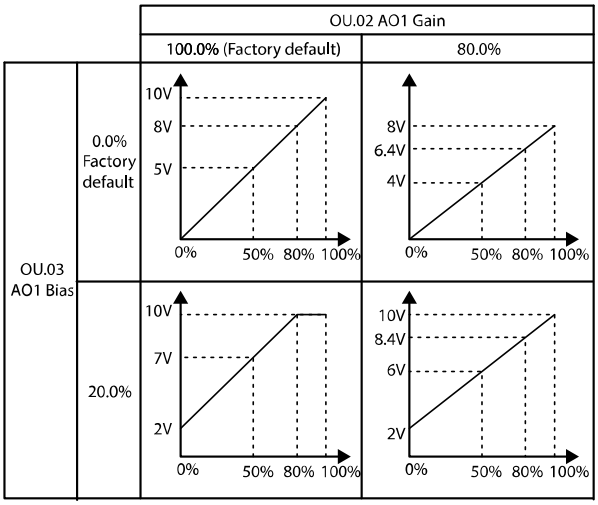
Group	Code	Name	Setting	Setting Range	Unit
OU	01	Analog output 1 item	0 Frequency	0–15	-
	02	Analog output 1 gain	100.0	-1000.0–1000.0	%
	03	Analog output 1 bias	0.0	-100.0–100.0	%
	04	Analog output 1 filter	5	0–10000	ms
	05	Analog constant output1	0.0	0.0–100.0	%
	06	Analog output1 monitor	0.0	0.0–1000.0	%

Voltage Analog Output Setting Details

Code and Features	Description
OU.01 AO1 Mode	Select a type of signal to output.

Configuration		Function
0	Frequency	AO output voltage based on operating frequency. Outputs 10V at the frequency set at dr.20 (Max Freq).
1	Output Current	AO output voltage based on inverter output current. Outputs 10V at 200% of inverter rated current (heavy load).
2	Output Voltage	AO output voltage based on inverter output voltage. Outputs 10 V at the voltage set in bA.15 (Motor Rated Voltage). If 0 V is set in bA.15, 10 V is based on the actual input voltage.

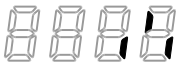
OU.01 AO1 Mode	3	DC Link Volt	AO output voltage based on inverter DC link voltage. Outputs 10 V when the DC link voltage is 410 Vdc for 240 V models, and 820 Vdc for 480V models.
	4	Torque	AO output voltage based on the generated torque. Outputs 10 V at 250% of motor rated torque.
	5	Output Power	AO output voltage based on output wattage. Outputs 10 V at 200% of rated output (KVA).
	6	Idse	Only when operating in Sensorless Vector (dr.09). Outputs 10 V at 200% of flux producing current. Outputs 0 V when operating in V/F or slip compensation.
	7	Iqse	Outputs the maximum voltage at 250% of rated torque producing current. $\text{rated torque current} = \sqrt{\text{rated current}^2 - \text{no load current}^2}$
	8	Target Freq	AO output voltage based on the target (reference) frequency. Outputs 10 V at the maximum frequency (dr.20).
	9	Ramp Freq	AO output voltage based on the frequency calculated with Acc/Dec function (bA.08). May vary with actual output frequency.
	12	PID Ref Value	AO output voltage based on the reference value (setpoint) of the PID controller. Outputs 6.6 V at 100%.
	13	PID Fdk Value	AO output voltage based on the feedback value of the PID controller. Outputs 6.6 V at 100%.
	14	PID Output	AO output voltage based on the PID output value of the PID controller. Outputs 10 V at 100%.
	15	Constant	AO output voltage based on OU.05 (AO1 Const%) value.

OU.02 AO1 Gain, OU.03 AO1 Bias	The Gain and Bias settings provide scaling adjustment of the analog output voltage. The graphs below illustrate adjustments of OU.02 (AO1 Gain) and OU.03 (AO1 Bias) percentages and the affect on the analog output voltage (AO1). The X-axis is the % value of the selected output item and the Y-axis is the corresponding output voltage (0–10 V) at the AO terminal.  Frequency setting example: Using default values of 100% Gain and 0% Bias and the maximum frequency set at dr.20 (Max Freq) is 60 Hz. When the output frequency is 30 Hz, the corresponding X-axis value is 50% or 5V output at AO terminal. The percent value of the analog output is based on the following equation. $$AO1 = \frac{Frequency}{MaxFreq} \times AO1\ Gain + AO1\ Bias$$
OU.04 AO1 Filter	Set the filter time constant on analog output.
OU.05 A01 Const%	If analog output at OU.01 (AO1 Mode) is set to 15 (Constant), the analog voltage output is dependent on the set parameter values (0–100%).
OU.06 AO1 Monitor	Monitors analog output value. Displays the maximum output voltage as a percentage(%) with 10 V as the standard.

5.29 **Digital Output**

5.29.1 **Multi-function (digital) relay Settings**

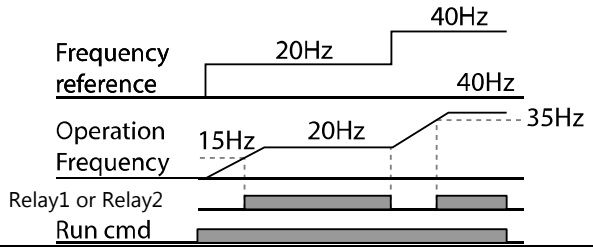
Group	Code	Name	Setting		Setting Range		Unit
OU	30	Fault output item	010*		000-111		bit
	31	Multi-function (digital) relay1 item	29	Trip	0 - 44		-
	33	Multi-function (digital) relay2 item	14	Run	0 - 44		-
	41	Multi-function (digital) output monitor	00**		00-11		bit
	50	Multi-function (digital) relay On delay	0		0.00–100.00 (s)		sec
	51	Multi-function (digital) relay Off delay	0		0.00–100.00 (s)		sec
	52	Multi-function (digital) relay contact selection	00**		Relay2, Relay1		bit
					0	A type (NO)	
					1	B type (NC)	
	53	Fault output On delay	0		0.00–100.00 (s)		sec
	54	Fault output Off delay	0		0.00–100.00 (s)		sec
	55	Timer On delay	0		0.00–100.00 (s)		sec
	56	Timer Off delay	0		0.00–100.00 (s)		sec
	57	Detection frequency	30		0.00–Max.frequency		Hz
	58	Detection frequency band	10				Hz

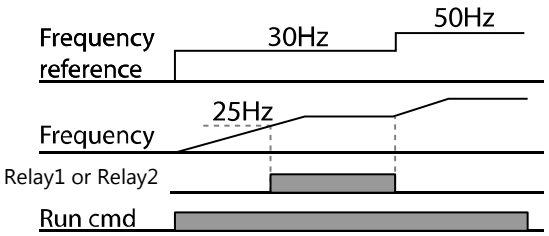
* Displayed as  on the keypad. ** Displayed as  on the keypad.

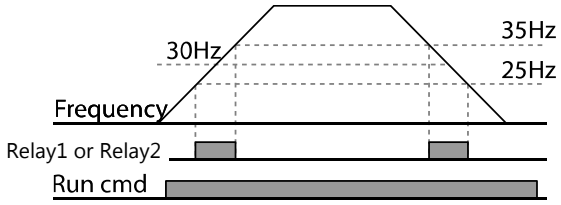
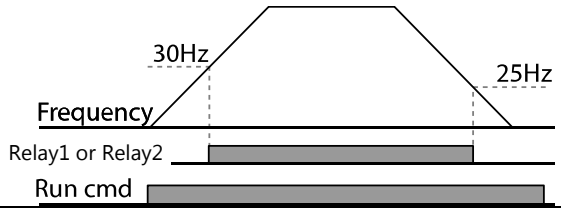
Multi-function (digital) relay Setting Details

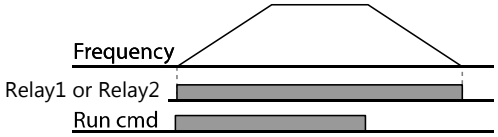
Code and Features	Description
OU.31 Relay1	Configure Relay 1 output function.
OU.33 Relay 2	Configure Relay 2 output function.

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>OU.31, OU.33
OU.31, OU.33</td><td>Set Relay output function.
<table>
<tr><th colspan="2">Function</th><th>Description</th></tr>
<tr><td>0</td><td>None</td><td>No output signal.</td></tr>
<tr><td>1</td><td>FDT-1</td><td>Relay changes state when the output frequency reaches the reference frequency within frequency bandwidth / 2.
Conditions are: Absolute value (Ref frequency–output frequency) <= frequency bandwidth/2 (OU.58 / 2).

Example: Frequency Reference is 20 Hz. Bandwidth (OU.58) is 10 Hz. Relay changes state at 15 Hz.
 
</td></tr>
<tr><td>2</td><td>FDT-2</td><td>Relay changes state when the reference frequency and detection frequency (OU.57) are equal and fulfills FDT-1 condition at the same time.
Conditions are: [Absolute value (Ref frequency-detection frequency) < frequency bandwidth/2] & [FDT-1]

Example: Frequency Reference is 30 Hz. Detection frequency (OU.57) is 30 Hz. Frequency bandwidth (OU.58) is 10 Hz. Relay changes state at 25 Hz.
 
</td></tr>
</table></td></tr>
</table>

Code and Features	Description		
	3	FDT-3	Relay changes state when the output frequency is **within** the frequency bandwidth (OU.58) centered around the detection frequency (OU.57). **Conditions are:** Absolute value (output frequency–operating frequency) < frequency bandwidth/2 **Example:** Detection frequency (OU.57) is 30 Hz. Frequency bandwidth (OU.58) is 10 Hz. Relay changes state when the output frequency is between 25 Hz. and 35 Hz. 
	4	FDT-4	Realy changes state based on separate conditions for acceleration and deceleration. • **During acceleration:** Output frequency ≧ Detection frequency • **During deceleration:** Output frequency > (Detection frequency–Frequency bandwidth/2) **Example:** Detection frequency (OU.57) is 30 Hz. Frequency bandwidth (OU.58) is 10 Hz. During acceleration, relay changes state when output frequency reaches detection frequency. During deceleration, the relay changes state when the output frequency is below the frequency bandwidth/2. 
	5	Over Load	Relay changes state when inverter trips on motor overload.
	6	Inverter overload (IOL)	Relay changes state when inverter trips on inverter overload.
	7	Under Load	Relay changes state when inverter trips on motor underload.
	8	Fan Warning	Relay changes state to provide a fan fault warning.
	9	Stall	Relay changes state when the inverter detects a motor stall condition.
	10	Over Voltage	Relay changes state when the inverter trips on Over Voltage.

Code and Features	Description		
	11	Low Voltage	Relay changes state when the inverter trips on Low Voltage.
	12	Over Heat	Relay changes state when the inverter trips on Overheat.
	13	Lost Command	Relay changes state when the inverter trips on Lost Command. Lost command includes lost reference frequency from: Analog input RS-485 communication Option Cards (Extended I/O and communications)
	14	RUN	Relay changes state when a run command is applied and the inverter outputs voltage. There is no output when reference frequency is at zero or during DC braking. 
	15	Stop	Relay changes state when a stop command is applied and when there is no inverter output voltage.
	16	Steady	Relay changes state during steady state operation.
	17	Inverter Line	Used in combination with "Comm Line" function. Relay maintains state while the motor is driven by the inverter output.
	18	Comm Line	Relay changes state when a digital input set to "exchange" function is applied. For details, refer to **5.17 Commercial Power Source Transition** on page **135**.
	19	Speed Search	Relay changes state during speed search operation. For details, refer to **5.13 Speed Search Operation** on page **128**.
	21	Regeneration	Relay changes state when the inverter/motor is operating in regeneration mode. Regeneration mode is determined by the DC link voltage level as set in Ad.79 (DB Unit turn-on voltage).
	22	Ready	Relay changes state when the inverter is in stand by operation and ready to receive a run command.
	23	FDT-5 (Zero speed)	Relay changes state when the output frequency is lower than the frequency set in OU.57 and OU.58.
	28	Timer Out	Used in combination with a digital input set to "Timer In" function. The relay changes state when the digital input is activated and after the time delay settings. For details, refer to **0 Timer Settings** on page **139**.
	29	Trip	Relay changes state after a fault condition. Refer to **5.29.2 TRIP Output Mode** on page **141** for more details.
	31	DB Warn%ED	Relay changes state when the Dynamic Brake Duty Cycle (Pr.66) is exceeded. Refer to **6.2.5 Dynamic Braking (DB) Configuration** on page **167**.

Code and Features	Description		
	34	On/Off Control	Relay changes state based on the analog input signal levels set with Ad.66~Ad.68. Refer to **5.26 Multi-function (digital) relay On/Off** Controlon page **141** for more details.
	35	BR Control	Used for external electro-mechanical brake control. Relay operates based on Ad.41~Ad.47 settings. Refer to **5.25 Brake Control** on page **140** for more details.
	40	KEB Operating	Relay changes state when the inverter is operating in KEB mode. Refer to **5.11 Kinetic Energy Buffering - KEB** on page **124** for more details. (This outputs in the energy buffering state before the input power restoration regardless of KEB-1 and KEB-2 mode settings.)
	42	Minor Fault	Relay changes state when inverter is in a warning mode.

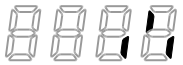
5.29.2 **Trip Output to Multi-function (digital) relay**

With Relay1 or Relay2 set to 29 (Trip), OU.30 (Fault Output) can further define relay activation during low voltage faults, all faults and auto restart functions. Additionally, On and Off time delays can also be applied specifically to a relay when set to 29 (Trip).

Group	Code	Name	Setting		Setting Range	Unit
OU	30	Fault output item	010*		-	bit
	31	Multi-function (digital) relay1 item	29	Trip	-	-
	33	Multi-function (digital) relay2 item	14	Run	-	-
	53	Fault output On delay	0.00		0.00–100.00	sec
	54	Fault output Off delay	0.00		0.00–100.00	Sec

* Displayed as  on the keypad.

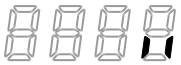
Trip Setting Details to Multi-function (digital) relay

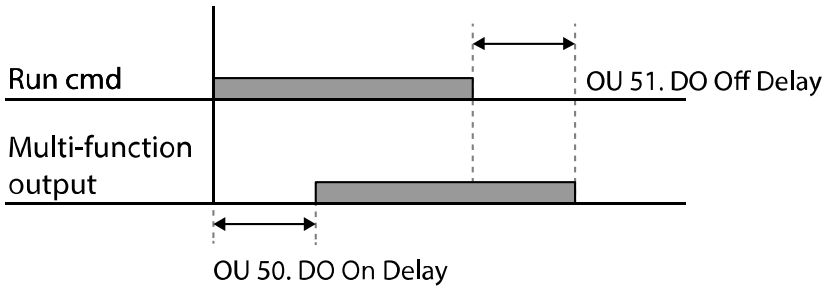
<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>OU.30 Trip Out Mode</td><td>Bit On/Off representation on display.
<table>
<tr><td>Items</td><td>Bit On Status</td><td>Bit Off Status</td></tr>
<tr><td>Keypad</td><td>  </td><td>  </td></tr>
</table>
Set OU.31 (Relay1) or OU.33 (Relay2) to 29 (Trip). When a fault occurs, the relay will be activated. Relay activation can be set based on trip type per the table below.
<table>
<tr><td colspan="3">Configuration</td><td rowspan="2">Function</td></tr>
<tr><td>bit3</td><td>bit2</td><td>bit1</td></tr>
<tr><td></td><td></td><td>✓</td><td>Operates when low voltage faults occur</td></tr>
<tr><td></td><td>✓</td><td></td><td>Operates when all faults other than low voltage occur</td></tr>
<tr><td>✓</td><td></td><td></td><td>Operates when auto restart fails (Pr. 08–09)</td></tr>
<tr><td colspan="4">010 Displayed as  on the keypad.</td></tr>
</table></td></tr>
<tr><td>OU.31 Relay1</td><td>Configure Relay 1 output function.</td></tr>
<tr><td>OU.33 Relay2</td><td>Configure Relay 2 output function.</td></tr>
<tr><td>OU.53 TripOut On Dly, OU.54 TripOut OffDly</td><td>When a trip occurs, the relay (Relay1 or Relay2) will be activated after the delay time set in OU.53 (On Dly). After a reset, the relay will be initialized after the delay time set in OU.54 (Off Dly).</td></tr>
</table>

5.29.3 Multi-function (digital) relay Terminal Delay Time Settings

Set On/Off delay times to adjust the relay operation time. The delay times set in OU.50 and OU.51 will be applied to both Relay 1 and Relay 2 except when the relay function is set to (29) Trip.

Group	Code	Name	Setting	Setting Range	Unit
OU	50	Multi-function (digital) output On delay	0.00	0.00–100.00	sec
	51	Multi-function (digital) output Off delay	0.00	0.00–100.00	sec
	52	Multi-function (digital) output contact selection	00*	00–11	bit

*Displayed as  on the Keypad.



Output Relay - NC/NO Selection Details

Code and Features	Description
OU.52 DO NC/NO Sel	Each relay can be set to operate as Type A or Type B. Type A is de-energized in its normal state. Type B is energized in its normal state. By setting the relevant bit to 0, it will operate as Type A (the NO contact is Open) or setting it to 1 will operate as Type B (the NO contact is Closed). Shown below in the table are Relay 1 and Relay 2 settings starting from the right bit.

Items	Bit On Status	Bit Off Status
Keypad		

Relay2 (bit 2), Relay1 (bit 1)	
00**	A type (NO)
11	B type (NC)

** Displayed as  on the keypad.

5.30 **Base Block**

This feature is used to remove the output of the inverter while operating but maintaining the operating status of a run relay. When a digital input set to 33 (Base Block) is activated during operation, the output is blocked and the motor will run freely. The output being blocked by the base block feature does not have effect on the relay and will be recognized as being in operation even if there is no inverter output. When the base block signal is de-activated, speed search operation will start with the value set in Cn.72~75 even if the Cn.71 speed search operation selection parameter is not activated.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	33	Base Block	1–52	-
OU	31	Multi-function (digital) relay1 item	14	Run	1–44	-
	33	Multi-function (digital) relay2 item			-	-

Base Block Operation Setting Details

Code and Features	Description
In 65–69 Px define	Set a digital input to 33 (Base Block).
OU.31 Relay 1 OU.33 Relay 2 Define	Set a multi-function (digital) relay terminal to 14 (Run). When the run command is applied, the inverter will accelerate up to the reference frequency. When the base block signal is applied during acceleration or constant speed operation, the inverter will block the output immediately and motor will free-run. When the base block signal is de-activated, the inverter will accelerate as a speed search operation until it reaches the reference frequency, without receiving a specific reset command. **"bb"** will be displayed on the keypad during the base block operation. De-activating the base block input will reset the inverter automatically and the base block will not be recorded in the trip history.

6 Learning Protection Features

Protection features provided by the GM2 series inverter are categorized into two types: Motor Protection (Overload, Underload, Over Heat (ETH), Stall Prevention, etc.) and Inverter Protection (Open Phase, Inverter Overload, Fan Fault, External Trip, etc.).

6.1 Motor Protection

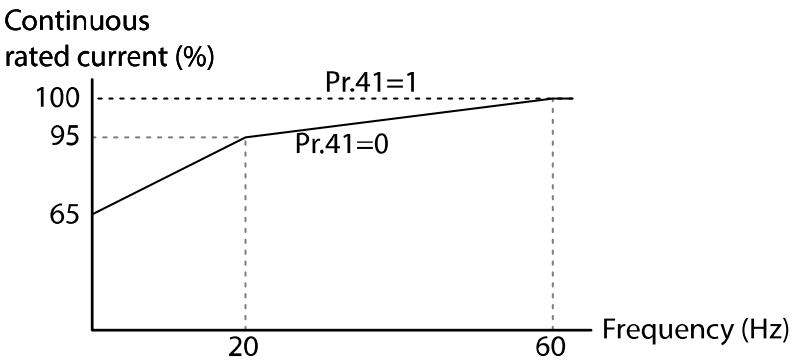
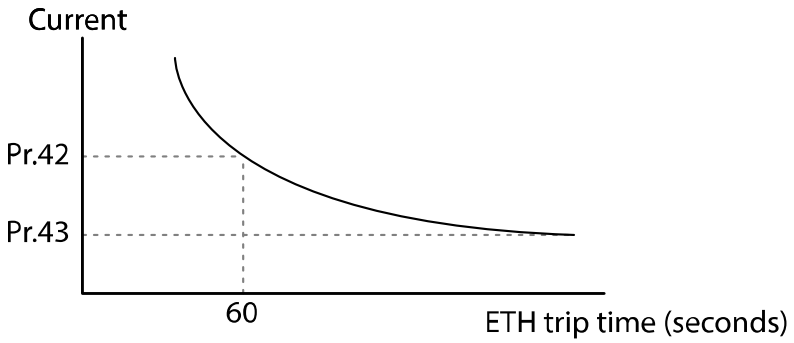
6.1.1 Electronic Thermal Motor Overheating Prevention (ETH)

ETH is a thermal protective function that uses the output current of the inverter to predict a rise in motor temperature without a separate temperature sensor. Protection of the motor is based on current, time and speed. The inverter responds to an ETH fault based on the setting of parameter Pr.40 (ETH Trip Selection).

Group	Code	Name	Setting		Setting Range	Unit
Pr	40	Electronic thermal prevention fault selection	0	None	0–2	-
	41	Motor cooling fan type	0	Self-cool	-	-
	42	Electronic thermal 1 minute rating	150		120–200	%
	43	Electronic thermal continuous rating	120		50–150	%

Electronic Thermal (ETH) Prevention Function Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Pr.40 ETH Trip Sel</td><td>ETH can be selected to provide motor thermal protection. Select 1 (Free-Run) or 2 (Dec) to activate the ETH function and to determine the stop method when an ETH fault occurs. The display will show “EtH”.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>The ETH function is not activated.</td></tr>
<tr><td>1</td><td>Free-Run</td><td>The inverter output is blocked. The motor coasts to a stop (free-run).</td></tr>
<tr><td>2</td><td>Dec</td><td>The inverter decelerates the motor to a stop.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Pr.41 Motor Cooling</td><td>Select motor cooling type (fan configuration) attached to the motor.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Self-cool</td><td>The cooling fan is connected to the motor shaft and the cooling effect varies with speed. Most universal induction motors have this design.</td></tr>
<tr><td>1</td><td>Forced-cool</td><td>Inverter Duty Motors - Rated for higher temperatures or have a separately powered fan which provides extended operation at low speeds.</td></tr>
</table>

</td></tr>
<tr><td>Pr.42 ETH 1min</td><td>The 1 minute trip level. Amount of current that can be continuously supplied to the motor for 1 minute. Percentage is based on the motor-rated current (bA.13).</td></tr>
<tr><td>Pr.43 ETH Cont</td><td>Continuous rated motor amps including service factor amps without tripping. Above this percentage, inverter will start accumulating over load.

</td></tr>
</table>

6.1.2 Overload Trip and Early Warning

The inverter provides motor overload protection and will trip on an Overload Fault **(OLt)** fault based on amount of current (% motor amps) and time. The inverter responds to an overload fault based on the setting of parameter Pr.20 (OL Trip Select). Select 1 (Free-Run) or 2 (Dec) to activate the overload function and to determine the stop method when an overload fault occurs. Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 5 (Overload) to provide an output signal.
The inverter can also provide an overload warning (**OLW)** based on the settings of parameters Pr.17 (OL Warn Select), Pr.18 (OL Warn Level) and PR-19 (OL Warn Time). Set parameter Pr.17 to 1 (Yes) to activate the overload warning function. Set the output current level in parameter Pr.18, set the time in Pr.19. Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 5 (Overload) to provide an output warning signal**. The inverter does not trip when warning levels are reached.**

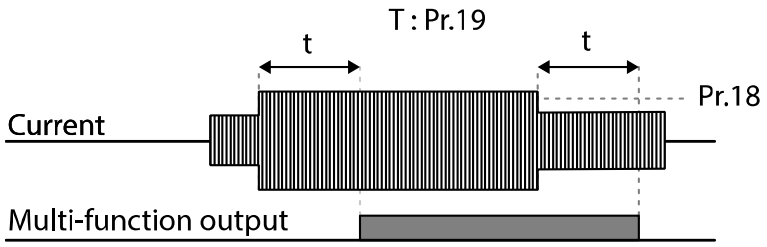
Group	Code	Name	Setting		Setting Range	Unit
Pr	04	Load level setting	1	Heavy Duty	-	-
	17	Overload warning selection	1	Yes	0–1	-
	18	Overload warning level	110		30–180	%
	19	Overload warning time	10.0		0–30	sec
	20	Motion at overload fault	1	Free-Run	-	-
	21	Overload fault level	150		30–200	%
	22	Overload fault time	60.0		0–60.0	sec
OU	31	Multi-function (digital) relay1 item	5	Over Load	-	-
	33	Multi-function (digital) relay2 item				

Overload Trip and Early Warning Setting Details

Code and Features	Description		
Pr.04 Load Duty	Select the inverter rated load level.		
	Configuration		Function
	0	Normal Duty	Used for light loads, like fans and pumps (overload tolerance: 120% of rated normal duty rated current for 1 minute).
	1	Heavy Duty	Used for heavy loads, like hoists and cranes (overload tolerance: 150% of rated heavy duty current for 1 minute).
Pr.20 OL Trip Select	Select the inverter protective action in the event of an overload fault.		
	Configuration		Function
	0	None	No protective action is taken.
	1	Free-Run	Inverter output is blocked and the motor will coast to a stop.
	3	Dec	The inverter decelerates the motor to a stop.

Code and Features	Description
Pr.21 OL Trip Level, Pr.22 OL Trip Time	When the current supplied to the motor is greater than the value set in the overload trip level (OL Trip Level) and continues for the overload trip time (OL Trip Time), the inverter output is either blocked or decelerates according to the Pr.20 selection.

Code and Features	Description
Pr.17 OL Warn Select	Set to 1 (Yes) to activate the overload warning function. If 0 (No) is selected, the function is disabled.
Pr.18 OL Warn Level, Pr.19 OL Warn Time	When the current to the motor is greater than the overload warning level (OL Warn Level) and continues at that level for the overload warning time (OL Warn Time), the multi-function (digital) output (Relay 1 or Relay 2) sends a warning signal. Multi-function (digital) relay outputs a signal if OU.31 or OU.33 are set to 5 (Over load). **The inverter does not trip when warning levels are reached.**



Note

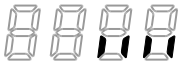
The overload warning signal will not work if the overload warn level (OL Warn Level) and the overload warn time (OL Warn Time) are set higher than the overload trip level (OL Trip Level) and overload trip time (OL Trip Time).

6.1.3 Stall Prevention and Flux Braking

The stall prevention function is a protective function that prevents motor stall caused by overloads. When high currents are sensed during acceleration and/or constant speed, the output frequency is decreased automatically. During deceleration, when the DC Link voltage increases, the deceleration time is extended.

Flux braking is used to determine the optimum deceleration time to avoid overvoltage trips and without utilizing brake resistors. When using flux braking, the output frequency is increased and the regenerative energy is expended at the motor. Flux braking does not operate in IM Sensorless Vector.

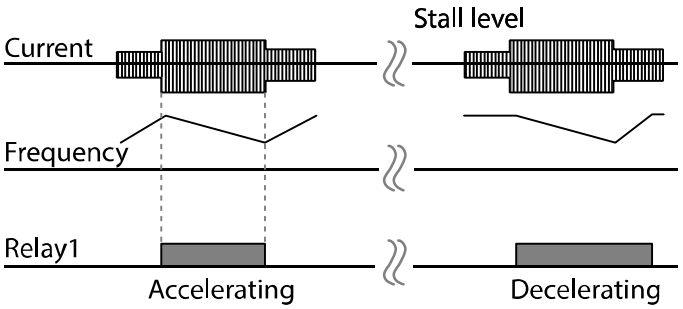
Group	Code	Name	Setting		Setting Range	Unit
Pr	50	Stall prevention motion and flux braking	0000*		-	bit
	51	Stall frequency 1	60.00		Start frequency–Stall Freq 1	Hz
	52	Stall level 1	180		30–250	%
	53	Stall frequency 2	60.00		Stall Freq 1–Stall Freq 3	Hz
	54	Stall level 2	180		30–250	%
	55	Stall frequency 3	60.00		Stall Freq 2–Stall Freq 4	Hz
	56	Stall level 3	180		30–250	%
	57	Stall frequency 4	60.00		Stall Freq 3–Maximum frequency	Hz
	58	Stall level 4	180		30–250	%
OU	31	Multi-function (digital) relay1 item	9	Stall	-	-
	33	Multi-function (digital) relay2 item				

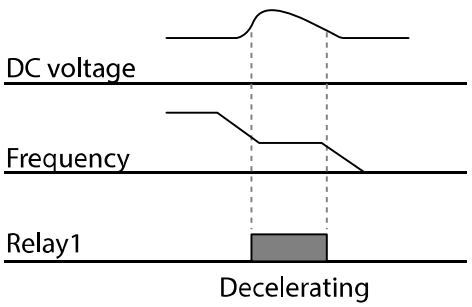
* Displayed as  on the Keypad.

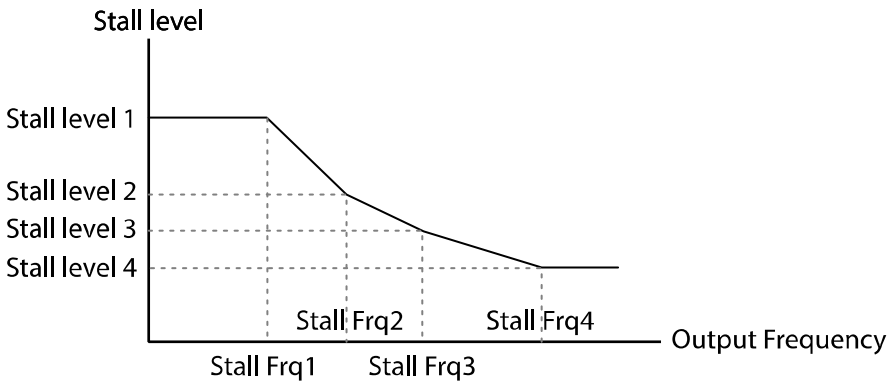
Stall Prevention Function and Flux Braking Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Pr.50 Stall Prevent</td><td>
When the top LED segment is on, the corresponding bit is set. When the bottom LED segment is on, the corresponding bit is off.
<table>
<tr><td>Items</td><td>Bit On Status</td><td>Bit Off Status</td></tr>
<tr><td>Keypad</td><td>  </td><td>  </td></tr>
</table>
Stall prevention can be configured for acceleration, deceleration, or constant speed operation.
<table>
<tr><td colspan="4">Configuration</td><td rowspan="2">Function</td></tr>
<tr><td>bit4</td><td>bit3</td><td>bit2</td><td>bit1</td></tr>
<tr><td></td><td></td><td></td><td>✓</td><td>Stall protection during acceleration</td></tr>
<tr><td></td><td></td><td>✓</td><td></td><td>Stall protection while operating at a constant speed</td></tr>
<tr><td></td><td>✓</td><td></td><td></td><td>Stall protection during deceleration</td></tr>
<tr><td>✓</td><td></td><td></td><td></td><td>Flux braking during deceleration</td></tr>
</table>
<table>
<tr><td colspan="2">Configuration</td><td>Function</td></tr>
<tr><td>0001</td><td>Stall protection during acceleration</td><td>If inverter output current exceeds the preset stall level (Pr. 52, 54, 56, 58) during acceleration, the motor stops accelerating and starts decelerating. When the current level drops below the preset level, the motor resumes</td></tr>
</table>
</td></tr>
</table>

Code and Features	Description		
			acceleration. If current level stays above the stall level, the motor decelerates to the start frequency (dr.19).
	0010	Stall protection while operating at constant speed	Similar to stall protection function during acceleration, the output frequency automatically decelerates when the current level exceeds the preset stall level. When the load current drops below the preset level, it resumes acceleration. During acceleration, the operation will follow the stall protection settings for acceleration.
	0100	Stall protection during deceleration	The inverter decelerates and keeps the DC link voltage below a certain level to prevent an over voltage fault during deceleration. As a result, deceleration times can be longer than the set time depending on the load.
	1000	Flux braking during deceleration	When using flux braking, deceleration time may be reduced because regenerative energy is expended at the motor.
	1100	Stall protection and flux braking during deceleration	Stall protection and flux braking operate together during deceleration to achieve the shortest and most stable deceleration performance.





Code and Features	Description
Pr.51 Stall Freq 1 ~ Pr.58 Stall Level 4	Additional stall protection levels can be configured for different frequencies, based on the load type. As shown in the graph below, the stall level can be set above the base frequency. The lower and upper limits are set using numbers that correspond in ascending order. For example, the range for Stall Frequency 2 (Stall Freq 2) becomes the lower limit for Stall Frequency 1 (Stall Freq 1) and the upper limit for Stall Frequency 3 (Stall Freq 3). 

Note

Stall protection and flux braking operate together only during deceleration. Turn on the third and fourth bits of Pr.50 (Stall Prevention) to achieve the shortest and most stable deceleration performance without triggering an overvoltage fault for loads with high inertia and short deceleration times. Do not use this function when frequent deceleration of the load is required, as the motor can overheat and may be damaged easily.
When operating Brake resistor, the motor may vibrate under the Flux braking operation. In this case, please turn off the Flux braking (Pr.50).

Caution

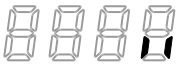
- Use caution when using stall protection during deceleration as the deceleration time can take longer than the time set. Acceleration stops when stall protection operates during acceleration.
- When the motor is operating, Stall Level 1 applies and determines the operation of stall protection.

6.2 Inverter and Sequence Protection

6.2.1 Input/Output open-phase protection

Open-phase monitoring and protection can be set to either or both the input and output of the inverter. The protection is used to prevent overcurrent levels at the inverter input and/or output due to an open-phase. An open-phase at output may cause the motor to stall due to a lack of torque. For input phase open, a voltage level can be set (Pr.06), below which the inverter will trip.

Group	Code	Name	Setting	Setting Range	Unit
Pr	05	Input/output open-phase protection	00*	-	bit
	06	Input voltage range during open-phase	15	1–100 V	V

*Displayed as  on the Keypad.

Input and Output Open-phase Protection Setting Details

Code and Features	Description
Pr.05 Phase Loss Chk, Pr.06 IPO V Band	Input and/or output phase protection can be selected. When the top LED segment is on, the corresponding bit is set On (1). When the bottom LED segment is on, the corresponding bit is Off (0). Bit 0 is for output phase monitoring, Bit 1 is for input phase monitoring.

Items	Bit On Status	Bit Off Status
Keypad		

Configuration		Function
Bit1	Bit0	
	✓	Output open-phase protection
✓		Input open-phase protection

Initial values off input voltage range during open-phase are shown as below.

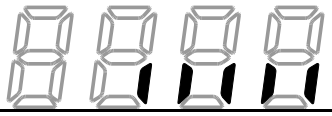
Items	Initial Value	Unit
1.0 HP ~ 5.0 HP (0.4 kW~4.0 kW) (240 V/480 V)	15	V
7.5 HP ~ 15 HP (5.5 kW~11 kW) (240 V/480 V)	13	V

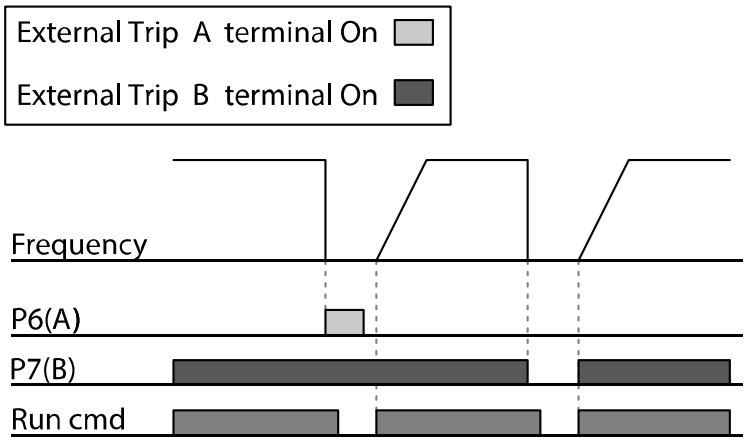
6.2.2 External Trip Signal

Set one of the multi-function (digital) input terminals In.65 ~ In.69 to 4 (External Trip). When activated, the inverter trips **(Ext)** and blocks the output. The five input terminals can be set independently to activate when closed or opened (set as NO or NC).

Group	Code	Name	Setting		Setting Range	Unit
In	65–69	Px terminal setting options	4	External Trip	-	-
	87	Multi-function (digital) input terminal selection			-	bit

External Trip Signal Setting Details

Code and Features	Description
In.87 DI NC/NO Sel	Selects the type of input contact. When the bottom LED segment is on, the input operates as Normally Open, close to trip. When the top LED segment is on, the input operates as Normally Closed, open to trip. The corresponding terminals for each bit are as follows: Bit 5 4 3 2 1 Terminals P5 P4 P3 P2 P1 



6.2.3 Inverter Overload Protection

In addition to motor overload settings, the inverters have built in inverter overload protection. When the inverter input current exceeds the rated current, a protective function is activated to prevent damages to the inverter. This inverter overload protection is based on inverse proportional characteristics.
An inverter overload warning signal (relay output) can be provided before the inverter overload protection function (IOL) operates. Set OU.31 or OU.33 to 6 (IOL). When the overcurrent time reaches 60% of the allowed overcurrent time (150%, 1 min), the relay will change state (signal output at 150%, 36 sec).

Group	Code	Name	Setting		Setting Range	Unit
OU	31	Multi-function (digital) relay1 item	6	IOL	-	-
	33	Multi-function (digital) relay2 item				

6.2.4 Speed Reference Loss

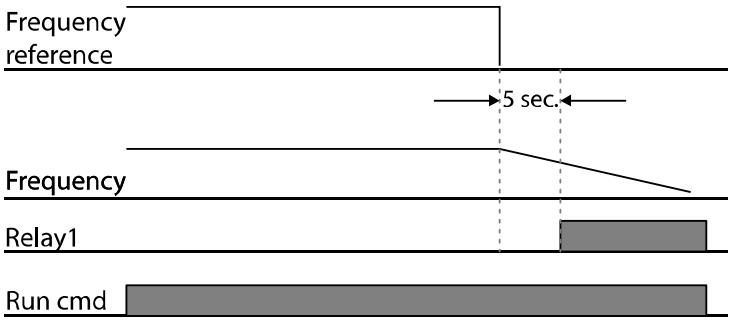
When setting the operating speed using an analog input, a pulsed input, through communications option or the keypad, the speed reference loss setting can be used to select the response of the inverter after the signal loss.
An output relay can be used to provide a signal when the speed reference is lost. Set OU.31 or OU.33 to 13 (Lost Command).

Group	Code	Name	Setting		Setting Range	Unit
Pr	12	Motion at reference frequency loss	1	Free-Run	-	-
	13	Time to determine reference frequency loss	1.0		0.0–120.0	sec
	14	Operating frequency at reference frequency loss	0.00		Start frequency–Max. frequency	Hz
	15	Analog input loss decision level	0	Half of x1		-
OU	31	Multi-function (digital) relay1 item	13	Lost Command	-	-
	33	Multi-function (digital) relay2 item				

Reference frequency Loss Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Pr.12 Lost Cmd Mode</td><td>The inverter responds to the Speed Reference Loss based on the setting of Pr.12 (Lost Command Mode).
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>The speed refernce becomes the operating frequency without any protection function.</td></tr>
<tr><td>1</td><td>Free-Run</td><td>The inverter blocks output. The motor coasts to a stop.</td></tr>
<tr><td>2</td><td>Dec</td><td>The motor decelerates and stops based on the time set at Pr.07 (Trip Dec Time).</td></tr>
<tr><td>3</td><td>Hold Input</td><td>The inverter calculates the average input value for 10 seconds before the loss of the speed reference and uses it as the speed reference.</td></tr>
<tr><td>4</td><td>Hold Output</td><td>The inverter calculates the average output frequency for 10 seconds before the loss of the speed reference and runs at that speed.</td></tr>
<tr><td>5</td><td>Lost Preset</td><td>The inverter operates at the frequency set at Pr.14 (Lost Preset F).</td></tr>
</table></td></tr>
<tr><td>Pr.15 AI Lost Level, Pr.13 Lst Cmd Time</td><td>Configure the voltage level and time delay for speed reference loss when using an analog input.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Half of x1</td><td>Based on the values set at In.08 and In.12, protective operation starts when the input signal is reduced to half of the initial value of the analog input set using the speed reference (Frq code in Operations group) and it continues for the time (speed loss decision time) set at Pr.13 (Lost Cmd Time). For example, set the reference frequency to 2 (V1) at the Frq code, and In.06 (V1 Polarity) to 0 (Unipolar). When the voltage input drops to less than half of the value set at In.08 (V1 Volt x 1), the protective function is activated.</td></tr>
<tr><td>1</td><td>Below of x1</td><td>The protective operation starts when the signal becomes smaller than the initial value of the analog input set by the speed reference and it continues for the speed loss decision time set at Pr.13 (Lost Cmd Time). Codes In.08 and In.12 are used to set the standard values.</td></tr>
</table></td></tr>
<tr><td>Pr.14 Lost Preset F</td><td>To run at a fixed speed, set the operation mode Pr.12 (Lost Cmd Mode) to 5 (Lost Preset). When the protection function operates, this sets the frequency for continued operation.</td></tr>
</table>

Example: Set Pr.15 (AI Lost Level) to 1 (Below x 1), Pr.12 (Lost Cmd Mode) to 2 (Dec), and Pr.13 (Lost Cmd Time) to 5 sec. Then it operates as follows:



Note

If speed reference is lost while using communication options or the integrated RS-485 communication, the protection function operates regardless of Pr.12 setting. Operates after the command loss decision time set at Pr.13 (Lost Cmd Time) has passed.

When using analog signals, when signal returns above the level set in Pr.15, the inverter clears the fault and returns to normal operation.

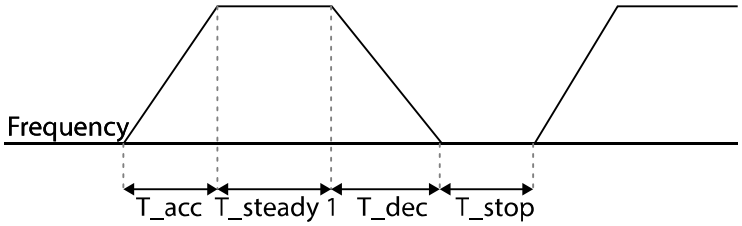
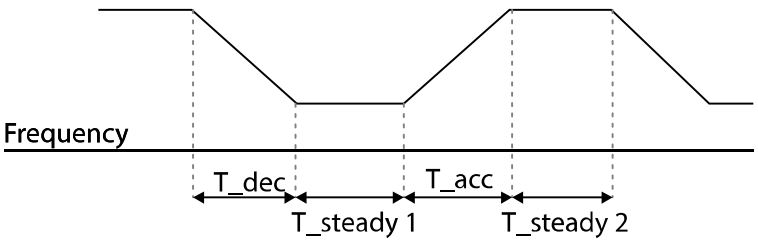
6.2.5 Dynamic Braking (DB) Configuration

The braking transistor (IGBT) and monitoring/control circuit is integrated inside the inverter. A brake resistor is connected externally to the inverter. See Section 11.5 for Brake Resistor Specifications. The standard for braking torque is 150% at a working rate, Pr.66 of 5% (%ED or duty cycle). If the Pr.66 %ED is increased to 10%, the rated capacity (W) of the brake resistor must be doubled.
An output relay can be used to provide a warning when the duty cycle (%ED) has been exceeded. Set OU.31 or OU.33 to 31 (DB Warn %ED).

Group	Code	Name	Setting		Setting Range	Unit
Pr	66	DB resistor %ED and warning level	10		0–30	%
OU	31	Multi-function (digital) relay1 item	31	DB Warn%ED	-	-
	33	Multi-function (digital) relay2 item				

Dynamic Breaking Resistor Setting Details

Code and Features	Description
Pr.66 DB Warn%ED	Set the Enable Duty (%ED). This sets the rate at which the braking resistor operates for one operation cycle. If the Enable Duty (%ED) is set to 0%, braking can be used without restriction. However, precaution is necessary as there is a risk of the inverter tripping and/or over heating of the resistor. The maximum time for continuous braking is 15 secs. and turns off after the 15 sec period has expired. The time when the next braking cycle is available (after the 15 seconds continuous) is calculated as below. $$T = \frac{(100\% - \%ED) \times 15}{\%ED}\,[s]$$

Code and Features	Description
	An example of braking resistor set up is as follows: $$\%ED = \frac{T\_dec}{T\_acc + T\_steady + T\_dec + T\_stop} \times 100\%$$  [Example 1] $$\%ED = \frac{T\_dec}{T\_dec + T\_steady1 + T\_acc + T\_steady2} \times 100\%$$  [Example 2] • **T_acc:** Acceleration time to set frequency • **T_steady:** Constant speed operation time at set frequency • **T_dec:** Deceleration time to a frequency lower than constant speed operation or the stop time from constant speed operation • **T_stop:** Stop time until operation resumes

Caution

Do not set the Enable Duty that will exceed the resistor's power rating. If overloaded, it can overheat and cause a fire. When using a resistor with a thermal switch, the switch output can be used as an external trip input signal to the inverter or shunt trip the main breaker.

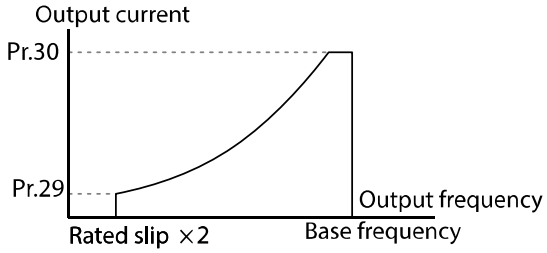
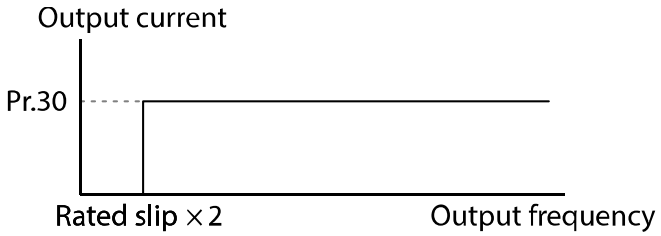
6.2.6 Under Load Fault and Warning

The inverter can be set to monitor and trip if needed, when low motor current conditions exist during operation. This will protect against pump cavitation, deadhead and dry running operating conditions. Set Pr.27, Under load fault selection to Free-Run or Decelerate to enable the protection. Current detection levels are set with Pr.29 and Pr.30. Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 7 (Under Load) to provide an output signal.

Group	Code	Name	Setting		Setting Range	Unit
Pr	04	Load level setting	0	Normal Duty	-	-
	25	Under load warning selection	1	Yes	0–1	-
	26	Under load warning time	10.0		0–600	sec
	27	Under load fault selection	1	Free-Run	-	-
	28	Under load fault time	30.0		0–600	sec
	29	Under load lower limit level	30		10–100	%
	30	Under load upper limit level	30		10–100	%
OU	31	Multi-function (digital) relay1 item	7	Under Load	0 - 44	-
	33	Multi-function (digital) relay2 item				

Under Load Trip and Warning Setting Details

Code and Features	Description
Pr.27 UL Trip Sel	Sets the inverter reaction to an under load condition. If set to 0 (None), underload is not monitored. If set to 1 (Free-Run), the output is blocked and the motor coasts to a stop. If set to 2 (Dec), the motor decelerates, then stops.
Pr.25 UL Warn Sel	To activate an under load warning, set to 1 (Yes) and set one of the relay outputs, Relay1 or Relay2 (OU.31 or OU.33) to 7(UnderLoad).
Pr.26 UL Warn Time, Pr.28 UL Trip Time	Delay times can be set to provide a warning signal (via the output relays) after the time set in Pr.26, UL Warn Time and a trip after the time set in Pr.28, UL Trip Time. This function does not operate if energy-saving operation is activated at Ad.50 (E-Save Mode).

Code and Features	Description
Pr.29 UL LF Level, Pr.30 UL BF Level	• Based on **Pr.04** Setting to **Normal Duty** The under load trip levels (% of motor amps) are based on a variable torque (quadratic) curve with the low level setting (Pr.29) when operating at 2 x slip frequency (bA.12) and the upper level setting (Pr.30) when operating at base frequency (dr.18).  • Based on **Pr.04** Setting to **Heavy Duty** The under load trip level (% of motor amps) is based on a constant torque curve when operating between 2 x slip frequency (bA.12) and the base frequency (dr.18). The trip level setting (Pr.30) applies throughout the speed range. Pr.29 is not used. 

6.2.7 **Fan Fault Detection**

The inverter monitors the cooling fan for proper operation. When an error or fan failure occurs, the inverter responds to the failure based on the setting of Pr.79 (cooling fan fault selection). The inverter will display a fan fault (Fan) or warning (FanW). Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 8 (Fan Warning) to provide an output signal.

Group	Code	Name	Setting		Setting Range	Unit
Pr	79	Cooling fan fault selection	0		Trip	-
			1		Warning	
OU	31	Multi-function (digital) relay1 item	8	FAN Warning	-	-
OU	33	Multi-function (digital) relay2 item				

Fan Fault Detection Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Pr.79 FAN Trip Mode</td><td>Set the cooling fan fault mode.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>Trip</td><td>The inverter output is blocked and the fan trip (Fan) is displayed.</td></tr>
<tr><td>1</td><td>Warning</td><td>The inverter continues operation and the fan warning (FanW) is displayed.</td></tr>
</table></td></tr>
<tr><td>OU.31 Relay 1, OU.33 Relay 2</td><td>Set either parameter OU.31 or OU.33 to 8 (FAN Warning), a fan warning signal is output and operation continues. However, the inverter will eventually trip on inverter overheat (OHt) protection.</td></tr>
</table>

6.2.8 Lifetime diagnosis of Components

Lifetime Diagnosis for Fans

A fan exchange warning can be provided by entering a percentage at Pr.87 (Fan exchange warning level). The % is based on 50,000 hours of operation. A fan exchange warning will appear on the keypad or as a relay output when either Relay1 or Relay2 (OU.31 or OU.33) are set to 37 (FAN Exchange).
The total fan usage level (%) appears at Pr.86. After exchanging fans, you can initialize the accumulated % to 0 by setting Pr.88 (Fan reset time) to 1 (Yes). The Fan status bit can be viewed at Pr.89.

<table>
<tr><th>Group</th><th>Cod</th><th>Name</th><th colspan="2">Setting</th><th>Setting Range</th><th>Unit</th></tr>
<tr><td rowspan="6">Pr</td><td>86</td><td>Accumulated percent of fan usage</td><td colspan="2">0.0</td><td>0.0–6553.5</td><td>%</td></tr>
<tr><td>87</td><td>Fan exchange warning Level</td><td colspan="2">90.0</td><td>0.0–100.0</td><td>%</td></tr>
<tr><td>88</td><td>Fan reset time</td><td>0</td><td>No</td><td></td><td></td></tr>
<tr><td rowspan="3">89</td><td rowspan="3">FAN Status</td><td>Bit</td><td>00 - 01</td><td rowspan="3">-</td><td rowspan="3">Bit</td></tr>
<tr><td>0</td><td>-</td></tr>
<tr><td>1</td><td>Fan Warning</td></tr>
<tr><td rowspan="2">OU</td><td>31</td><td>Multi-function (digital) relay1 item</td><td rowspan="2">37</td><td rowspan="2">FAN Exchange</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>33</td><td>Multi-function (digital) relay2 item</td></tr>
</table>

6.2.9 Low Voltage Fault

When the internal DC link voltage drops due to a power loss, the inverter turns off the output and a low voltage fault **(Lut)** occurs after the delay time set in Pr.81 (Low voltage fault delay time). When the voltage recovers, the fault clears and the inverter is ready to resume operation. Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 11 (Low Voltage) to provide an output signal.

Group	Code	Name	Setting		Setting Range	Unit
Pr	81	Low voltage trip decision delay time	0.0		0–60	sec
OU	31	Multi-function (digital) relay 1 item	11	Low Voltage	-	-
	33	Multi-function (digital) relay 2 item				

Low Voltage Fault Setting Details

Code and Features	Description
Pr.81 LVT Delay	When a low voltage condition occurs, the inverter blocks it output. A relay, if set to 11 (Low Voltage) will change state immediately. Then, after the delay time, the inverter generates a low voltage fault (Lut). The LVT Delay time does not apply to the relay outputs.

6.2.10 Output Block by Multi-function (digital) Terminal

Set one of the digital input terminals (P1 ~ P5) to 5 (BX). When activated (**bx** on display), the inverter response is determined by Pr.45 (Bx Trip Mode). Set to (0) coast to a stop, Set to (1) decelerate to a stop.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	5	BX	-	-
Pr	45	Bx Trip Mode	0	Coast	0 - 1	-
			1	Dec		

Output Block by Multi-function (digital) Terminal Setting Details

Code and Features	Description
In.65~69 Px Define	When a digital input terminal is set to 5 (BX) and is activated during operation, the inverter response is determined by Pr.45 (Bx Trip Mode). 0: Coast → The motor coasts to a stop 1: Decelerate → The motor decelerates to a stop. While 'bx' is displayed, the inverter's operating information (frequency and current) at the time of BX signal can be monitored. The inverter resumes operation when the BX terminal is de-activated provided that the Start/Run command is still active.

6.2.11 **Trip Status Reset**

After a fault, the inverter can be reset using the Keypad (Stop/Reset) button or a digital input.

Group	Code	Name	Setting		Setting Range	Unit
In	65~69	Px terminal setting options	3	RST	-	-

Trip Status Reset Setting Details

Code and Features	Description
In.65~69 Px Define	Set the multi-function (digital) input terminal to 3 (RST) and activate the terminal to reset the fault. A reset can also be performed by pressing the [Stop/Reset] button on the keypad.

6.2.12 **Operation Mode on Option Card Trip**

The inverter monitors communication between installed option cards and will fault on an "Option Trip" (**OPt**) when a communication error occurs. The inverter responds to an Option Trip based on the setting of Pr.80 (motion at option trip).

Group	Code	Name	Setting		Setting Range	Unit
Pr	80	Motion selection at option trip	0	None	0–2	-
			1	Free-Run		
			2	Dec		

Operation Mode on Option Trip Setting Details

Code and Features	Description		
	Configuration		Function
Pr.80 Opt Trip Mode	0	None	No operation.
	1	Free-Run	The inverter output is blocked and fault information is shown on the keypad.
	2	Dec	The motor decelerates to the value set at Pr.07 (Trip Dec Time).

6.2.13 **No Motor Trip**

The inverter can detect a low motor current condition and will trip on a "no motor trip" fault **(nmt)** if the inverter output current is below the Pr.32 detection level for the Pr.33 detection time. The inverter responds to a no motor trip condition when Pr.31 (No Motor detection) is set to (1) Free-Run. Pr.31 may be set to (0) None (default) for testing with no motor connected.

Group	Code	Name	Setting		Setting Range	Unit
Pr	31	No motor motion at detection	0	None	0–1	-
			1	Free-run	-	-
	32	No motor detection current level	5		1–100	%
	33	No motor detection time	3.0		0.1–10	sec

No Motor Trip Setting Details

Code and Features	Description
Pr.31 No Motor Detection	0: None → No action. 1: Free-Run → Activates trip based on Pr.32 and Pr.33 settings. Inverter will coast to a stop.
Pr.32 No Motor Level, Pr.33 No Motor Time	If the output current [based on the motor rated current (bA.13)] is lower than the value set at Pr.32 (No Motor Level), and if this continues for the time set at Pr.33 (No Motor Time), a 'no motor trip' occurs.

Caution

If bA.07 (V/F Pattern) is set to 1 (Square), a 'no motor trip' may occur due to lower output current. If so, set Pr.32 (No Motor Level) to a lower value than the factory default.

6.2.14 **Low Voltage Trip 2**

When Pr.82 (LV2 Selection) is set to Yes (1) and when a low voltage condition occurs, the inverter will trip and display the **Lu2** fault. When the voltage recovers, the Lu2 trip will not automatically clear. A fault reset of the inverter is required. The fault history will not be saved.

Group	Code	Name	Setting	Setting Range	Unit
Pr	82	LV2 Selection	Yes (1)	0/1	-

6.2.15 **Inverter pre-overheat warning**

The inverter provides overheat protection and will trip on an "Over Heat" fault (**OHt**) when the heat sink temperature exceeds 90°C. Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 12 (Over Heat) to provide an output signal.

The inverter can also provide a warning (**OH**) when the heat sink temperature exceeds the temperature set in Pr.77 (overheat warning temperature). The inverter responds to an overheat warning based on the setting of Pr.78 (overheat warning operation**).** Either Relay1 or Relay2 (OU.31 or OU.33) can be set to 41 (Pre Overheat) to provide an output signal.

Group	Code	Name	Setting	Setting Range		Unit
Pr	77	Pre-overheat warning temperature	90	10–110		℃
	78	Pre-overheat warning operation setting	0: None	0	None	-
				1	Warning	
				2	Free-Run	
				3	Dec	
OU	31, 33	Multi-function (digital) relay1 item Multi-function (digital) relay2 item	41: Pre Over Heat	0–44		-

Pre-overheat Warning Operation Setting Details

Code and Features	Description
Pr.77 Pre-overheat warning temperature	Set the pre-overheat warning temperature. Setting Range: 10–110[℃]
Pr.78 Pre-overheat warning operation setting	0: None → No pre-overheat warning operation 1: Warning → If the pre-overheat warning temperature is exceeded, warning message is displayed on the keypad and inverter will operate normally. 2: Free-Run → If the pre-overheat warning temperature is exceeded, a pre-overheat fault occurs and the motor will coast to a stop. 3: Dec → If the pre-overheat warning temperature is exceeded, a pre-overheat fault occurs and the motor will decelerate to a stop.
OU.31, OU.33 multi-function (digital) relay1, 2	41: Pre-overheat warning → Relay will activate when a pre-overheat warning or trip occurs.

6.2.16 **Torque Detection Protection Action**

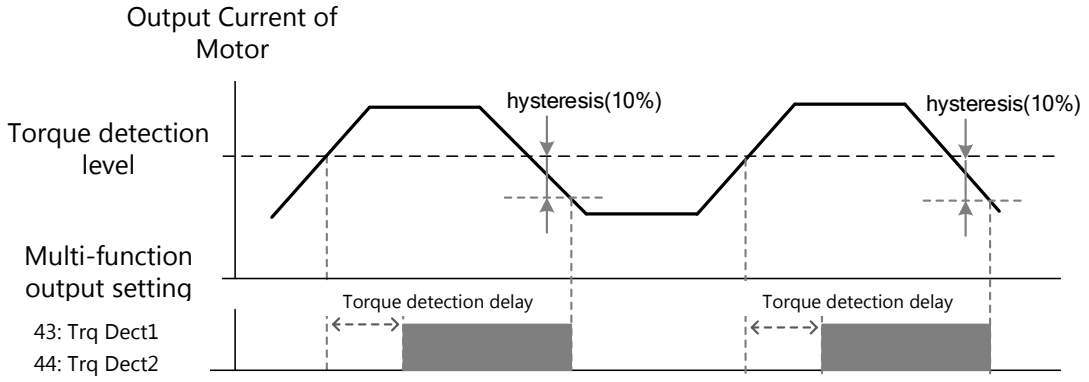
The inverter monitors and detects over and under torque conditions. This feature is activated when either Relay1 and/or Relay2 (OU.31 and/or OU.33) are set to 43 (Torque Detect 1) and/or 44 (Torque Detect 2). The torque levels and time delays are set in parameters OU.68, 69 or OU.71, 72. The inverter responds to the over/under torque condition based on the setting of OU.67 and OU.70. Selections include providing a warning or a trip, at a specific speed or throughout the speed range.

Group	Code	Name	Setting		Setting Range	Unit
OU	31, 33	Multi-function (digital) relay1 item Multi-function (digital) relay2 item	43	Prt Trq Det 1	0–44	-
			44	Prt Trq Det 2		
	67*	Torque detection 1 operation setting	0: None		0–8	-
	68*	Torque detection 1 level	100		0–200.0	%
	69*	Torque detection 1 delay time	0.1		0.0–10.0	sec
	70**	Torque detection 2 operation setting	0: None		0–8	-
	71**	Torque detection 2 level	100		0–200.0	%
	72**	Torque detection 2 delay time	0.1		0.0–10.0	sec

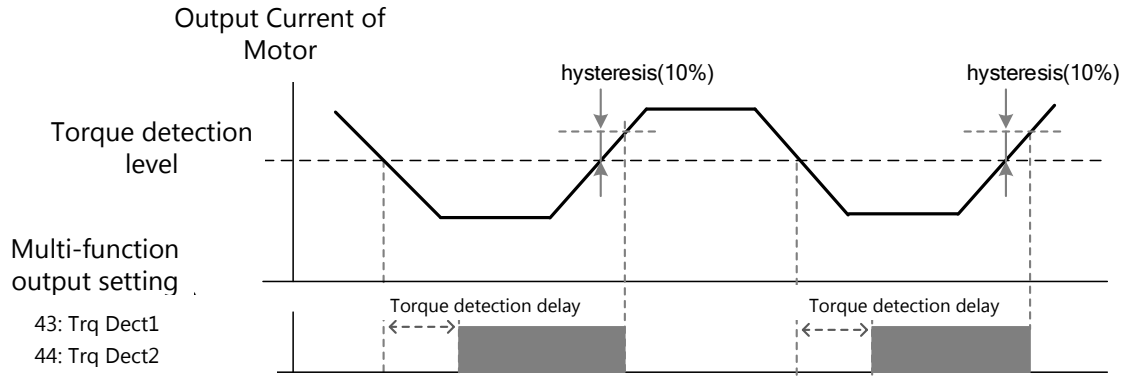
*Visible only when the multi-function (digital) relay (OU.31, 33) is set to 43 (Prt Trq Det 1).
**Visible only when the multi-function (digital) relay (OU.31, 33) is set to 44 (Prt Trq Det 2).

The over and under torque detection action operates as shown in the figure by having a hysteresis level of 10% compared to the motor's rated current. The over and under torque detection level set as OU.68, OU.71 parameters are set as the ratio on motor's rated current.

Over Torque Detection Action



Under Torque Detection Action



Torque Detection Operation Setting Details

Code and Features	Description
OU.67, OU.70 Torque detection operation setting	0: None → Torque detection is not operating. 1: OT CmdSpd Warn → Detects over torque and outputs warning only when the inverter output frequency is the same as the reference frequency. 2: OT Warning → Detects over torque during the operation and outputs warning. 3: OT CmdSpdTrip → Detects over torque and generates a trip only when the inverter output frequency is the same as the reference frequency. 4: OT Trip → Detects over torque during operation and generates a trip. 5: UT CmdSpd Warn → Detects under torque and outputs warning only when the inverter output frequency is the same as the reference frequency. 6: UT Warning → Detects under torque during the operation and outputs warning. 7: UT CmdSpd Trip → Detects under torque and generates a trip only when the inverter output frequency is the same as the reference frequency. 8: UT Trip → Detects under torque during operation and generates a trip.
OU.68, OU.71 Torque detection level	Sets the torque detection level of torque detection 1, 2. The set value is a % of the motor's rated current. The detection level must be higher than Ba.14 no load current value.
OU.69, OU.72 Torque detection delay time	Sets the delay time on torque detection 1, 2. When over or under torque is detected, a warning or trip is output after the torque detection delay time.

7 RS-485 Communication Features

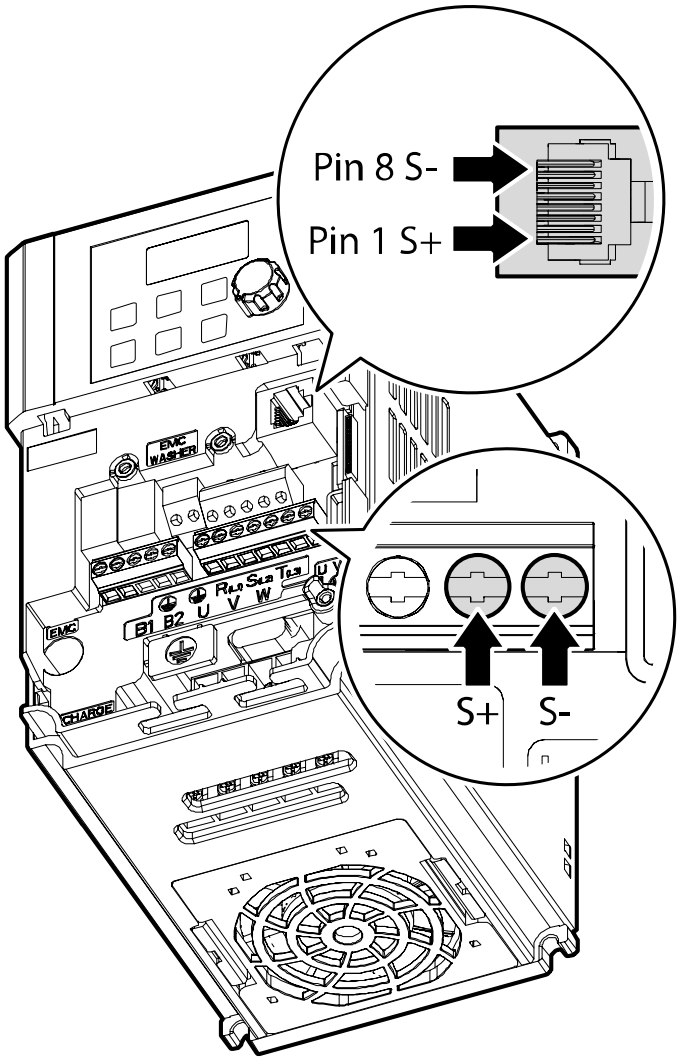
This section explains how to control the inverter with a PLC or a computer over a long distance using the RS-485 communication features. To use the RS-485 communication features, connect the communication cables and set the communication parameters in the inverter. Refer to the communication protocols and parameters to configure and use the RS-485 communication features.

7.1 Communication Standards

Following the RS-485 communication standards, GM2 inverters exchange data with a PLC and computer. The RS-485 communication standards support the Multi-drop Link System and offer an interface that is strongly resistant to noise. Please refer to the following table for details about the communication standards.

Items	Standard
Communication method/ Transmission type	RS-485/Bus type, Multi-drop Link System
Inverter type name	GM2
Number of connected inverters/ Transmission distance	Maximum of 16 inverters / Maximum1,200 m (recommended distance: within 700 m)
Recommended cable size	0.75mm^2, (18AWG), Shielded Type Twisted-Pair (STP) Wire
Installation type	Dedicated terminals (S+/S-) on the control terminal block Connected to the RJ-45 connector (no 1 pin S+, no 8 pin S-)
Power supply	Supplied by the inverter-insulated power source from the inverter's internal circuit
Communication speed	1,200/2,400/4,800/9,600/19,200/38,400/57,600/115,200 bps
Control procedure	Asynchronous communications system
Communication system	Half duplex system
Character system	Modbus-RTU: Binary / LS INV 485: ASCII
Stop bit length	1-bit/2-bit
Frame error check	2 bytes
Parity check	None/Even/Odd

Connect the communication lines by referring to the illustration below.



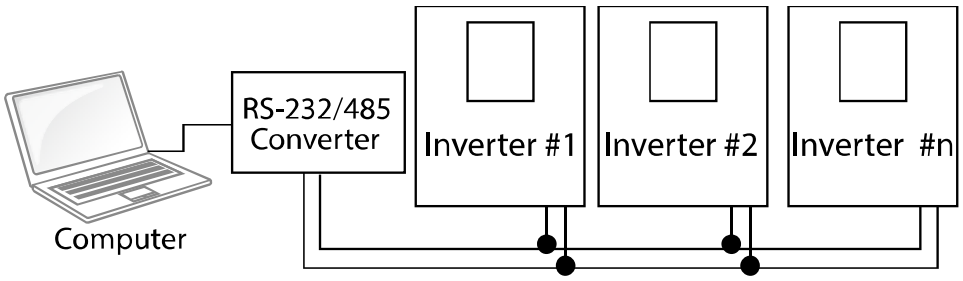
Use 2 Pair STP (Shielded Twisted Pair) cables (using only no.1 pin S+, no.8 pin S-). The no.1 and no.8 pins are twisted types and an RJ45 STP plug. Use an RJ45 coupler for connection between products and cable extension (Y type LAN coupler where STP can be mounted). Use LAN standardized products for cables, plugs, and couplers: CAT5, CAT5e, CAT6.

Note

- Communication cables must be installed by separating from the power cable.
- Use the RS-485 communication by selecting one from S+ or S- of the terminal block and S+ or S- of the RJ45 plug.

7.2 Communication System Configuration

In an RS-485 communication system, the PLC or computer is the master device and the inverter is the slave device. When using a computer as the master, the RS-232 converter must be integrated with the computer, so that it can communicate with the inverter through the RS-232/RS-485 converter. Specifications and performance of converters may vary depending on the manufacturer, but the basic functions are identical. Please refer to the converter manufacturer's user manual for details about features and specifications.
Connect the wires and configure the communication parameters in the inverter by referring to the following illustration of the communication system configuration.



7.2.1 Communication Line Connection

After checking that the power of the inverter is off, connect the RS-485 communication line to S+ or S-terminal of the control terminal or RJ45 connector (no.1 pin S+, no.8 pin S-) of the I/O board. The maximum number of inverters you can connect is 16. For communication lines, use shielded twisted pair (STP) cables.
The maximum length of the communication line is 1,200 meters, but it is recommended to use no more than 700 meters of communication line to ensure stable communication. Please use a repeater to enhance the communication speed when using a communication line longer than 1,200 meters or when using a large number of devices. A repeater is effective when smooth communication is not available due to noise interference.

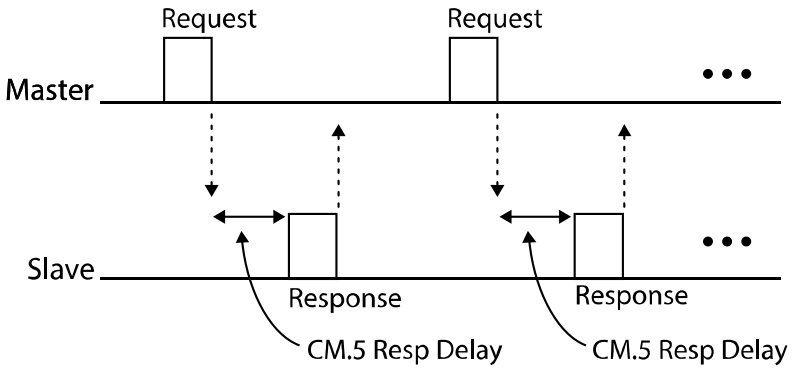
7.2.2 Setting Communication Parameters

Before proceeding with setting communication configurations, make sure that the communication lines are connected properly. Turn on the inverter and set the communication parameters.

Group	Code	Name	Setting		Setting Range	Unit
CM	01	Built-in communication inverter ID	1		1–250	-
	02	Built-in communication protocol	0	ModBus RTU	0, 2	-
	03	Built-in communication speed	3	9600 bps	0–7	-
	04	Built-in communication frame setting	0	D8/PN/S1	0–3	-
	05	Transmission delay after reception	5		0–1000	ms

Communication Parameters Setting Details

Code and Features	Description
CM.01 Int485 St ID	Set the inverter station ID between 1 and 250.
CM.02 Int485 Proto	Select one of the two built-in protocols: Modbus-RTU or LS INV 485. Configuration: 0 – Modbus-RTU – Modbus-RTU compatible protocol Configuration: 2 – LS INV 485 – Dedicated protocol for the LS inverter
CM.03 Int485 BaudR	Set a communication setting speed up to 115,200 bps. Configuration: 0 – Function: 1200bps Configuration: 1 – Function: 2400bps Configuration: 2 – Function: 4800bps Configuration: 3 – Function: 9600bps Configuration: 4 – Function: 19200bps Configuration: 5 – Function: 38400bps Configuration: 6 – Function: 56Kbps Configuration: 7 – Function: 115 Kbps (115,200 bps)
CM.04 Int485 Mode	Set a communication configuration. Set the data length, parity check method, and the number of stop bits. Configuration: 0 – D8/PN/S1 – Function: 8-bit data / no parity check / 1 stop bit Configuration: 1 – D8/PN/S2 – Function: 8-bit data / no parity check / 2 stop bit Configuration: 2 – D8/PE/S1 – Function: 8-bit data / even parity / 1 stop bit Configuration: 3 – D8/PO/S1 – Function: 8-bit data / odd parity / 1 stop bit

Code and Features	Description
CM.05 Resp Delay	Set the response time for the slave (inverter) to react to the request from the master. Response time is used in a system where the slave device response is too fast for the master device to process. Set this code to an appropriate value for smooth master-slave communication. 

7.2.3 Setting Start command and Frequency

Set the drv code of the operation group to 3 (Int 485) and the Frq code of the operation group to 6 (Int 485) in order to set the start command and frequency of the common area parameters via communication.

Group	Code	Name	Setting		Setting Range	Unit
Operation	drv	Command Source	3	Int 485	0–4	-
	Frq	Frequency reference source	6	Int 485	0–8	-

7.2.4 Command Loss Protective Operation

Configure the command loss decision standards and protective operations run when a communication problem lasts for a specified period of time.

Command Loss Protective Operation Setting Details

<table>
<tr><th>Code and Features</th><th>Description</th></tr>
<tr><td>Pr.12 Lost Cmd Mode,
Pr.13 Lost Cmd Time</td><td>Select the operation to (1) Free-Run when a communication error has occurred and has exceeded the time set at Pr.13.
<table>
<tr><th colspan="2">Configuration</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>The reference frequency immediately becomes the operating frequency without any protection function.</td></tr>
<tr><td>1</td><td>Free-Run</td><td>The inverter blocks output. The motor performs in free-run condition.</td></tr>
<tr><td>2</td><td>Dec</td><td>The motor decelerates and then stops.</td></tr>
<tr><td>3</td><td>Hold Input</td><td>The inverter continues in the reference frequency input before the loss of speed.</td></tr>
<tr><td>4</td><td>Hold Output</td><td>The inverter continues in the operating frequency before the loss of speed.</td></tr>
<tr><td>5</td><td>Lost Preset</td><td>The inverter operates at the frequency set at Pr. 14 (Lost Preset F).</td></tr>
</table></td></tr>
</table>

7.2.5 Setting Virtual Multi-function (digital) Input

Multi-function (digital) inputs can be controlled using a communication address (0h0385). Set codes CM.70 ~ 77 to the functions to operate, and then set the BIT relevant to the function to 1 at 0h0322 to operate it. Virtual multi-function (digital) inputs operate independently from In.65–69 digital multi-function (digital) inputs and cannot be set redundantly. Virtual multi-function (digital) inputs can be monitored using CM.86 (Virt DI Status). Before you configure the virtual multi-function (digital) inputs, set the DRV code according to the command source.

Group	Code	Name	Setting		Setting Range	Unit
CM	70–77	Communication multi-function (digital) input x	0	None	0–49	-
	86	Communication multi-function (digital) input monitoring	-	-	-	-

Example: When sending an Fx command by controlling virtual multi-function (digital) input in the common area via Int485, set CM.70 to FX. Then, assign a 0h0001 value to the communication address 0h0322 to operate the forward direction operation (Fx) feature.

NOTE: The following are values and functions that are applied to address 0h0322:

Setting	Function
0h0001	Forward operation (Fx)
0h0003	Reverse operation (Rx)
0h0000	Stop

7.2.6 Saving Parameters Defined by Communication

If you turn off the inverter after setting the common area parameters or keypad parameters via communication, the changes are lost and the values revert to the previous setting.
Set address 0h03E0 to 0 and then set it again to 1 via communication saves the existing parameter settings. However, setting address 0h03E0 to 1 and then setting it to 0 does not carry out the same function.

7.2.7 Total Memory Map for Communication

Communication Area	Memory Map	Description
Communication common compatible area	0h0000–0h00FF	GM2 compatible area
Parameter registration type area	0h0100–0h01FF	Areas registered at CM.31–38 and CM.51–58
GM2 communication common area	0h0300–0h037F	Inverter monitoring area
	0h0380–0h03DF	Inverter control area
	0h03E0–0h03FF	Inverter memory control area
	0h0400–0h0FFF	Reserved
	0h1100	dr Group
	0h1200	bA Group
	0h1300	Ad Group
	0h1400	Cn Group
	0h1500	In Group
	0h1600	OU Group
	0h1700	CM Group
	0h1800	AP Group
	0h1B00	Pr Group
	0h1C00	M2 Group

7.2.8 Parameter Group for Data Transmission

By defining a parameter group for data transmission, the communication addresses registered in the communication function group (CM) can be used in communication. Parameter group for data transmission may be defined to transmit multiple parameters at once, into the communication frame.

Group	Code	Name	Setting	Setting Range	Unit
CM	31–38	Output communication address x	-	0000–FFFF	Hex
	51–58	Input communication address x	-	0000–FFFF	Hex

Currently Registered CM Group Parameter

Comm. Address	Parameter	Assigned Content by Bit
0h0100–0h0107	Status Parameter-1–Status Parameter-8	Parameter communication code value registered at CM.31–38 (Read-only)
0h0110–0h0117	Control Parameter-1–Control Parameter-8	Parameter communication code value registered at CM.51–58 (Read/Write access)

Note

When registering control parameters, register the operation speed (0h0005, 0h0380, 0h0381) and operation command (0h0006, 0h0382) parameters at the end of a parameter control frame. The operation speed and operation command must be registered to the highest number of the parameter control-h (Para Control-h).

For example, when the Para Ctrl Num is 5, register the operation speed to Para Control-4 and the operation command to Para Control-5.

7.3 Communication Protocol

The built-in RS-485 communication supports Modbus-RTU protocol.

7.3.1 Modbus-RTU Protocol

7.3.1.1 Function Code and Protocol (Unit: byte)

In the following section, station ID is the value set at CM.01 (Int485 St ID), and starting address is the communication address. (The starting address size is in bytes).

Function Code #03: Read Holding Register

Query Field Name	Response Field Name	
Station ID	Station ID	
Function(0x03)	Function (0x03)	
Starting Address Hi	Byte Count	
Starting Address Lo	Data Hi	# Number of Points
# of Points Hi	Data Lo	
# of Points Lo	...	
CRC Lo	...	
CRC Hi	Data Hi	
	Data Lo	
	CRC Lo	
	CRC Hi	

Function Code #04: Read Input Register

Query Field Name	Response Field Name	
Station ID	Station ID	
Function(0x04)	Function (0x04)	
Starting Address Hi	Byte Count	
Starting Address Lo	Data Hi	# Number of Points
# of Points Hi	Data Lo	
# of Points Lo	...	
CRC Lo	...	
CRC Hi	Data Hi	
	Data Lo	
	CRC Lo	
	CRC Hi	

Function Code #06: Preset Single Register

Query Field Name	Response Field Name
Station ID	Station ID
Function (0x06)	Function (0x06)
Starting Address Hi	Register Address Hi
Register Address Lo	Register Address Lo
Preset Data Hi	Preset Data Hi
Preset Data Lo	Preset Data Lo
CRC Lo	CRC Lo
CRC Hi	CRC Hi

Function Code #16 (hex 0h10): Preset Multiple Register

Query Field Name	Response Field Name
Station ID	Station ID
Function (0x10)	Function (0x10)
Starting Address Hi	Starting Address Hi
Starting Address Lo	Starting Address Lo
# of Register Hi	# of Register Hi
# of Register Lo	# of Register Lo
Byte Count	CRC Lo
Data Hi	CRC Hi
Data Lo	
…	
…	
Data Hi	
Data Lo	
CRC Lo	
CRC Hi	

Number of Points

Exception Code

Code
01: ILLEGAL FUNCTION
02: ILLEGAL DATA ADRESS
03: ILLEGAL DATA VALUE
06: SLAVE DEVICE BUSY

Response

Field Name
Station ID
Function*
Exception Code
CRC Lo
CRC Hi

* The function value uses the top level bit for all query values.

Example of Modbus-RTU Communication in Use
When the muti-step acceleration time1 (Communication address 0x1246) is changed to 5.0 sec and the Multi-step deceleration time1 (Communication address 0x1247) is changed to 10.0 sec.

Frame Transmission from Master to Slave (Request)

Items	Station ID	Function	Starting Address	# of Register	Byte Count	Data 1	Data 2	CRC
Hex	0x01	0x10	0x1245	0x0002	0x04	0x0032	0x0064	0x4324
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1246-1)	-	-	50 (ACC time 5.0sec)	100 (DEC time 10.0sec)	-

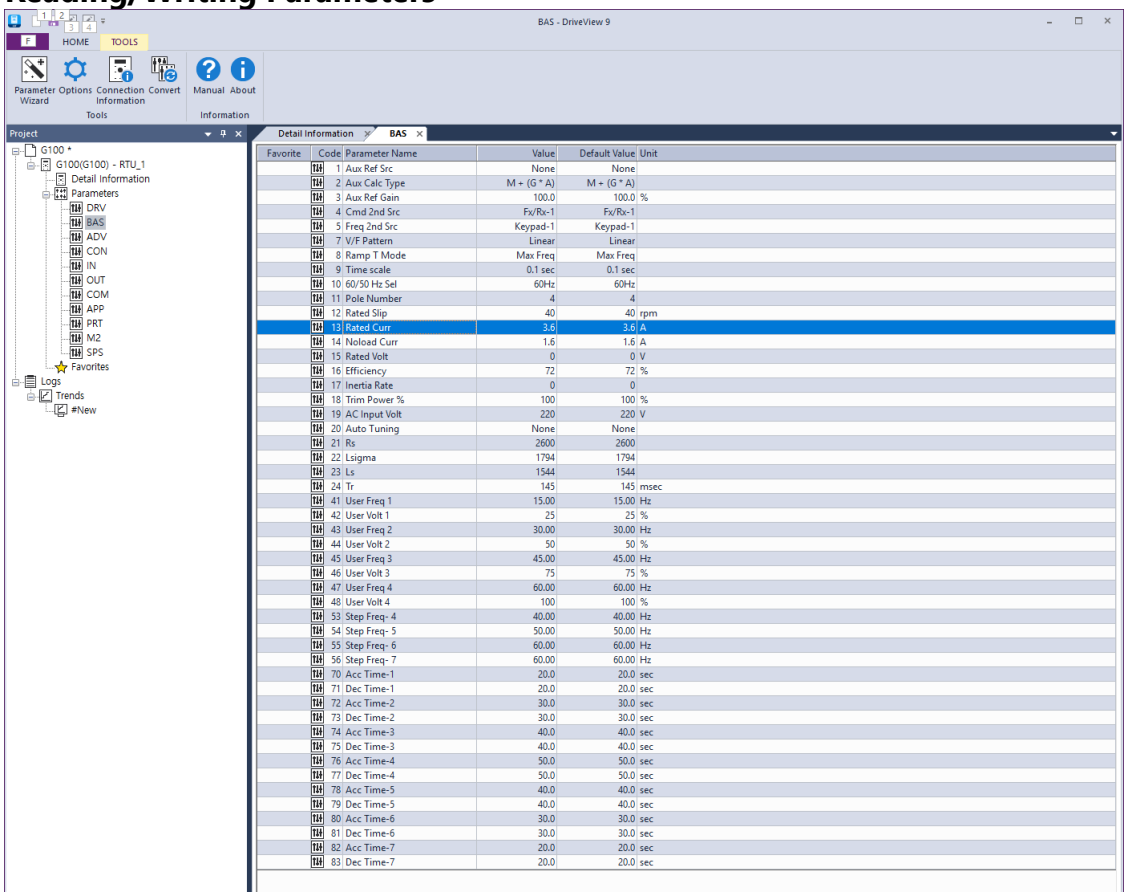
Frame Transmission from Slave to Master (Response)

Items	Station ID	Function	Starting Address	# of Register	CRC
Hex	0x01	0x10	0x1245	0x0002	0x5565
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address - 1 (0x1246-1)	-	-

7.4 **WinDRIVE**

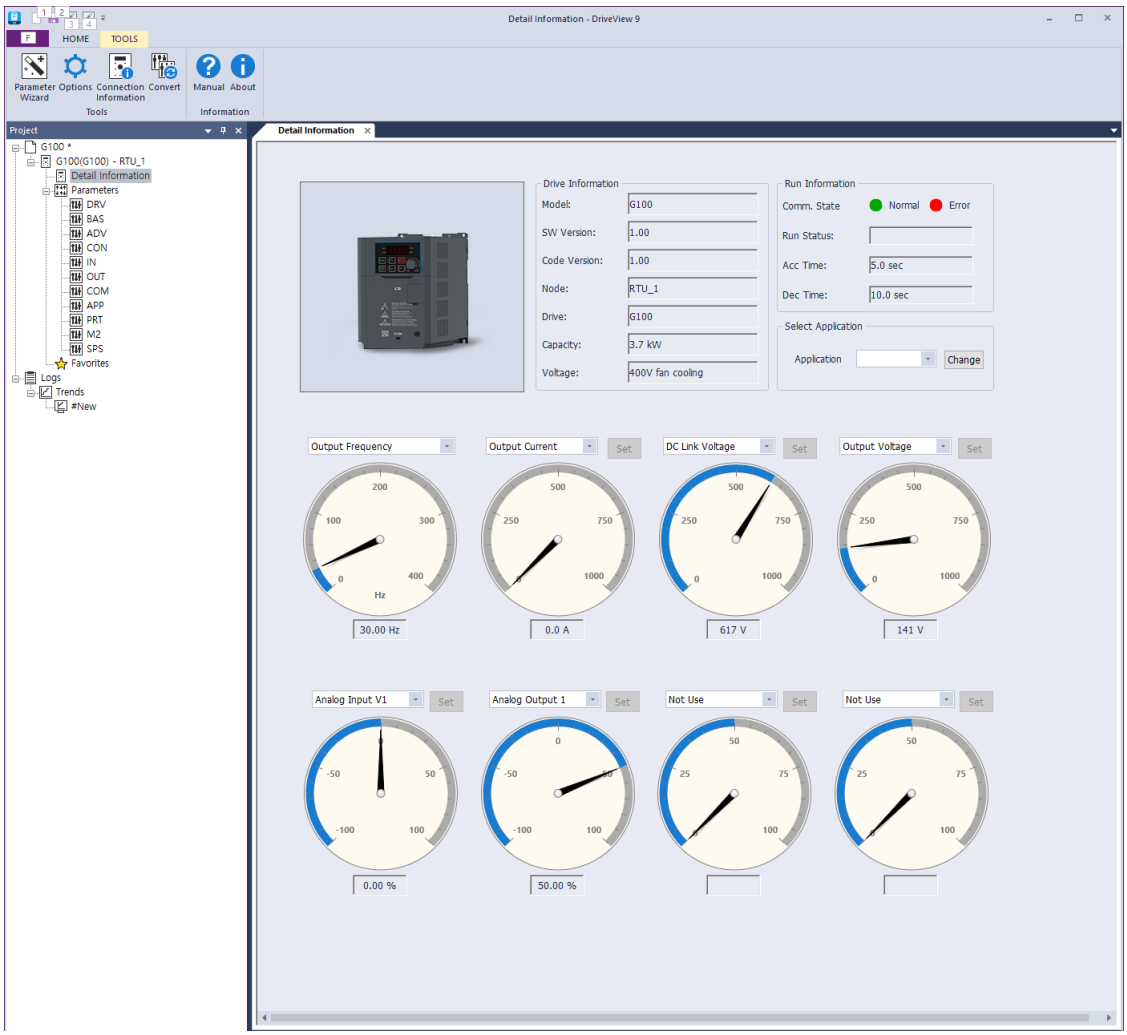
WinDRIVE is a Benshaw PC software program. It is used for changing and saving parameters, monitoring inverter status plus other features. WinDRIVE supports the Modbus-RTU protocol.

Reading/Writing Parameters



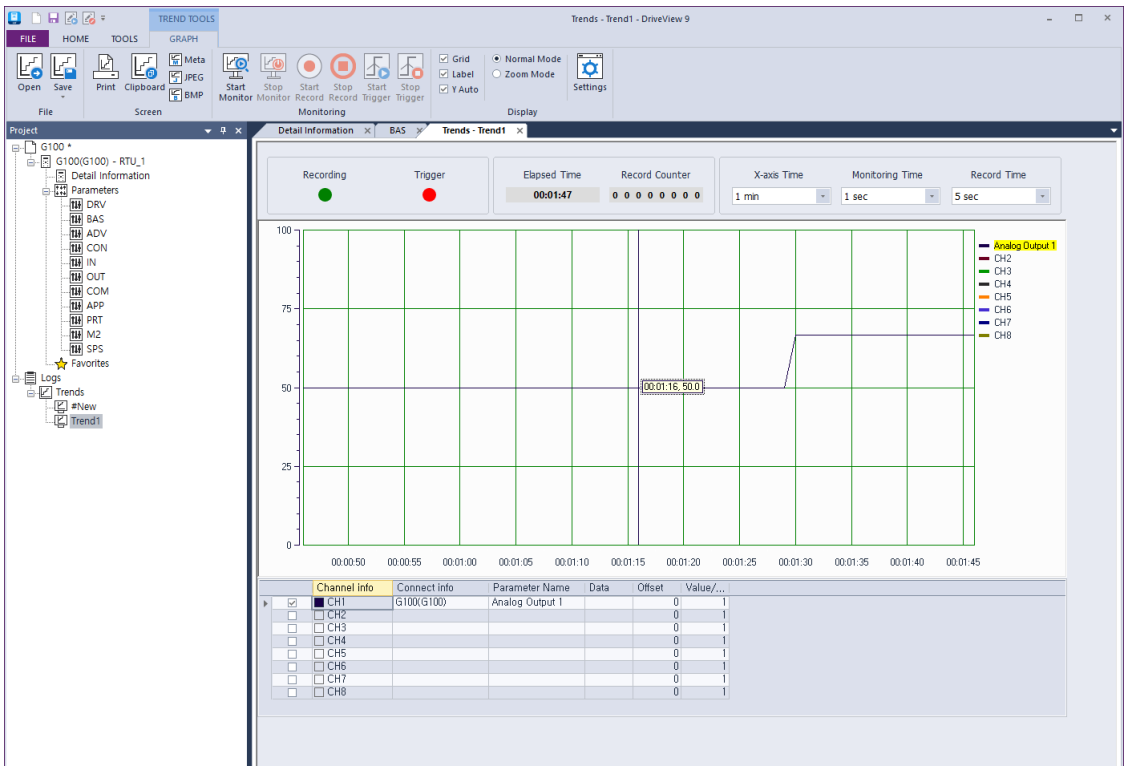
In WinDRIVE, you can read/write individual parameters, groups, and all parameters. In the case of the frequently used parameters, you can add to favorites to manage them separately. For more details, see WinDRIVE user's manual.

Detailed Information



On the WinDRIVE Detailed Information screen , you can see the drive information and the monitoring parameters. One output meter and seven optional meters are provided. On the output meter, you can monitor the output frequency/speed. On the optional meters, the user can select the items that can be monitored, such as the output voltage, output current, or analog input. For more details, see WinDRIVE's user manual.

Trends Feature



On the Trends screen of WinDRIVE, you can monitor the parameters in the graph form. Monitoring graphs provide 8 channels. Trends provide monitoring, recording, and trigger observation features. For more details, see WinDRIVE user's manual.

7.5 Compatible Common Area Parameter

The following are common area parameters compatible with GM2, SG, and GX inverters.

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
0h0000	Inverter model	-	-	R	16: GM2	
0h0001	Inverter capacity	-	-	R	0: 0.75kW, 1: 1.5kW, 2: 2.2kW, 4: 5.5kW, 5: 7.5kW, 6: 11kW, 256 : 0.4kW, 259: 4.0kW	
0h0002	Inverter input voltage	-	-	R	0: 220 V level, 1: 440 V level	
0h0003	Version	-	-	R	(E.g.) 0h0100: Version 1.00	
					(E.g.) 0h0101: Version 1.01	
0h0004	Reserved	-	-	R/W	-	
0h0005	Target frequency	0.01	Hz	R/W	-	
0h0006	Operation command (option)	-	-	R	B15	Reserved
					B14	0: Keypad Freq 1: Keypad Torq 2-16 Terminal block multi-step speed 17: Up, 18: Down 19: STEADY 22: V1, 24: V0, 25: I2 26: Reserved 27: Built-in 485 28: Communication option 30: JOG, 31: PID
					B13	
					B12	
					B11	
					B10	
					B9	
					B8	0: Keypad 1: Fx/Rx-1 2: Fx/Rx-2 3: Built-in 485 4: Communication option
					B7	
					B6	
				R/W	B5	Reserved
					B4	Emergency stop
					B3	W: Trip initialization (0→1) R: Trip status
					B2	Reverse operation (R)
					B1	Forward operation (F)
					B0	Stop (S)
0h0007	Acceleration time	0.1	sec	R/W	-	
0h0008	Deceleration time	0.1	sec	R/W	-	
0h0009	Output current	0.1	A	R	-	
0h000A	Output frequency	0.01	Hz	R	-	
0h000B	Output voltage	1	V	R	-	
0h000C	DC link voltage	1	V	R	-	
0h000D	Output power	0.1	kW	R	-	
0h000E	Operation status	-	-	-	B15	Reserved
					B14	1: Frequency command source by communication (built-in, option)
					B13	1: Start command source by communication (built-in, option)

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
					B12	Reverse start command
					B11	Forward start command
					B10	Brake release signal
					B9	Jog mode
					B8	Drive stopped.
					B7	DC Braking
					B6	Speed reached
					B5	Decelerating
					B4	Accelerating
					B3	Fault - operates according to OU.30 setting
					B2	Operating in reverse direction
					B1	Operating in forward direction
					B0	Stopped
0h000F	Fault information	-	-	R	B15	Reserved
					B14	Reserved
					B13	Reserved
					B12	Reserved
					B11	Reserved
					B10	H/W-Diag
					B9	Reserved
					B8	Reserved
					B7	Reserved
					B6	Reserved
					B5	Reserved
					B4	Reserved
					B3	Level Type trip
					B2	Reserved
					B1	Reserved
					B0	Latch Type trip
0h0010	Input terminal information	-	-	R	B15–B5	Reserved
					B4	P5
					B3	P4
					B2	P3
					B1	P2
					B0	P1
0h0011	Output terminal information	-	-	R	B15	Reserved
					B14	Reserved
					B13	Reserved
					B12	Reserved
					B11	Reserved
					B10	Reserved
					B9	Reserved
					B8	Reserved
					B7	Reserved
					B6	Reserved
					B5	Reserved
					B4	Reserved

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
					B3	Reserved
					B2	Reserved
					B1	Relay 2
					B0	Relay 1
0h0012	V1	0.01	%	R	V1 voltage input	
0h0013	V0	0.01	%	R	Volume voltage input	
0h0014	I2	0.01	%	R	I2 current input	
0h0015	Motor rotation speed	1	Rpm	R	Displays existing motor rotation speed	
0h0016 - 0h0019	Reserved	-	-	-	-	
0h001 A	Select Hz/rpm	-	-	R	0: Hz, 1: Rpm	
0h001B	Display the number of poles for the selected motor	-	-	R	Display the number of poles for the selected motor	

7.6 GM2 Expansion Common Area Parameter

7.6.1 Monitoring Area Parameter (Read Only)

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
0h0300	Inverter model	-	-	16: GM2	
0h0301	Inverter capacity	-	-	0.4kW : 1900h, 0.75kW: 3200h 1.5kW: 4015h, 2.2kW: 4022h 4.0kW: 4040h 5.5kW: 4055h, 7.5kW: 4075h 11kW: 40B0h, 15kW: 40F0h 18.5kW: 4125h, 22kW: 4160h	
0h0302	Inverter input voltage/power (Single phase, 3-phase)/cooling method	-	-	100 V single phase self cooling: 0120h 200 V 3-phase forced cooling: 0231h	
				100 V single phase forced cooling: 0121h 400 V single phase self cooling: 0420h	
				200 V single phase self cooling: 0220h 400 V 3-phase self cooling: 0430h	
				200 V 3-phase self cooling: 0230h 400 V single phase forced cooling: 0421h	
				200 V single phase forced cooling: 0221h 400 V 3-phase forced cooling: 0431h	
0h0303	Inverter S/W version	-	-	(E.g.) 0h0100: Version 1.00	
				(E.g.) 0h0101: Version 1.01	
0h0304	Reserved	-	-	-	
0h0305	Inverter operation state	-	-	B15	0: Normal state 4: Warning occurred 8: Fault occurred (operates according to Pr.30 setting)
				B14	
				B13	
				B12	
				B11	-
				B8	
				B7	1: Speed searching 2: Accelerating 3: At constant speed 4: Decelerating 5: Decelerating to stop 6: H/W OCS 7: S/W OCS 8: Dwell operating
				B6	
				B5	
				B4	
				B3	0: Stopped 1: Operating in forward direction 2: Operating in reverse direction 3: DC operating (0 speed control)
				B2	
				B1	
				B0	
0h0306	Inverter operation, frequency command source	-	-	B15	Start command source 0: Keypad 1: Communication option 2: - 3: Built-in 485 4: Terminal block
				B14	
				B13	
				B12	
				B11	
				B10	
				B9	
				B8	

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
				B7 B6 B5 B4 B3 B2 B1 B0	Frequency command source 0: Keypad speed 1: Keypad torque 2–4: Up/Down operation speed 5: V1, 7: V0, 8: I2 9: - 10: Built-in 485 11: Communication option 12: - 13: Jog, 14: PID 25–39: Multi-step speed frequency
0h0307 –0h30F	Reserved	-	-	-	
0h0310	Output current	0.1	A	-	
0h0311	Output frequency	0.01	Hz	-	
0h0312	Output rpm	0	Rpm	-	
0h0313	Motor feedback speed	0	Rpm	-32768Rpm–32767Rpm(directional)	
0h0314	Output voltage	1	V	-	
0h0315	DC link voltage	1	V	-	
0h0316	Output power	0.1	kW	-	
0h0317	Output torque	0.1	%	-	
0h0318	PID reference	0.1	%	-	
0h0319	PID feedback	0.1	%	-	
0h031 A	Display the number of poles for the 1st motor	-	-	Displays the number of poles for the first motor	
0h031B	Display the number of poles for the 2st motor	-	-	Displays the number of poles for the 2nd motor	
0h031C	Display the number of poles for the selected motor	-	-	Display the number of poles for the selected motor	
0h031D	Select Hz/rpm	-	-	0: Hz, 1: Rpm	
0h031E –0h031F	Reserved	-	-	-	
0h0320	Digital input information	-	-	BI5 - B5 B4 B3 B2 B1 B0	Reserved - Reserved P5 (I/O board) P4 (I/O board) P3 (I/O board) P2 (I/O board) P1 (I/O board)
0h0321	Digital output information	-	-	BI5 - B4 B3 B2 B1 B0	Reserved Reserved Reserved Reserved Reserved Relay 2 Relay 1
0h0322	Virtual digital input information	-	-	B15 - B8 B7 B6 B5	Reserved Reserved Reserved Virtual DI 8 (CM.77) Virtual DI 7 (CM.76) Virtual DI 6 (CM.75)

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
				B4	Virtual DI 5 (CM.74)
				B3	Virtual DI 4 (CM.73)
				B2	Virtual DI 3 (CM.72)
				B1	Virtual DI 2 (CM.71)
				B0	Virtual DI 1 (CM.70)
0h0323	Display the selected motor	-	-	0: 1st motor/1: 2nd motor	
0h0324	AI1	0.01	%	Analog input V1 (I/O board)	
0h0325	Reserved	0.01	%	-	
0h0326	AI3	0.01	%	Volume input (I/O board)	
0h0327	AI4	0.01	%	Analog input I2 (I/O board)	
0h0328	AO1	0.01	%	Analog output 1 (I/O board)	
0h0329	AO2	0.01	%	Analog output 2 (I/O board)	
0h032A	AO3	0.01	%	Reserved	
0h032B	AO4	0.01	%	Reserved	
0h032C	Reserved	-	-	-	
0h032D	Inverter module temperature	1	℃	-	
0h032E	Inverter power consumption	1	kWh	-	
0h032F	Inverter power consumption	1	MWh	-	
0h0330	Latch type trip information - 1	-	-	BI5	Fuse Open Trip
				BI4	Over Heat Trip
				BI3	Arm Short
				BI2	External Trip
				BI1	Overvoltage Trip
				BI0	Overcurrent Trip
				B9	NTC Trip
				B8	Reserved
				B7	Reserved
				B6	In phase open trip
				B5	Out phase open trip
				B4	Ground Fault
				B3	E-Thermal Trip
				B2	Inverter Overload Trip
				B1	Underload Trip
				B0	Overload Trip
0h0331	Latch type trip information - 2	-	-	BI5	Reserved
				BI4	Pre Over Heat Trip
				BI3	Reserved
				BI2	Reserved
				BI1	Reserved
				BI0	Bad option card
				B9	No motor trip
				B8	External brake trip
				B7	Bad contact at basic I/O board
				B6	Pre PID Fail
				B5	Reserved
				B4	Reserved
				B3	FAN Trip
				B2	Reserved
				B1	Reserved
				B0	Reserved

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
0h0332	Level type trip information	-	-	B15	Reserved
				-	-
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Reserved
				B3	Keypad Lost Command
				B2	Lost Command
				B1	LV
				B0	BX
0h0333	H/W Diagnosis Trip information	-	-	B15	Reserved
				-	Reserved
				B6	Reserved
				B5	QueueFull
				B4	Reserved
				B3	Watchdog-2 error
				B2	Watchdog-1 error
				B1	EEPROM error
				B0	ADC error
0h0334	Warning information	-	-	B15	Reserved
				-	Reserved
				B10	Reserved
				B9	Auto Tuning failed
				B8	Keypad lost
				B7	Encoder disconnection
				B6	Wrong installation of encoder
				B5	DB
				B4	FAN running
				B3	Lost command
				B2	Inverter Overload
				B1	Underload
				B0	Overload
0h0335	Latch type trip information - 3	-	-	B3	Under Torque Detection 2
				B2	Over Torque Detection 2
				B1	Under Torque Detection 1
				B0	Over Torque Detection 1
0H03356–0h033F	Reserved	-	-	-	
0h0340	On Time date	0	Day	Total number of days the inverter has been powered on	
0h0341	On Time minute	0	Min	Total number of minutes excluding the total number of On Time days	
0h0342	Run Time date	0	Day	Total number of days the inverter has driven the motor	
0h0343	Run Time minute	0	Min	Total number of minutes excluding the total number of Run Time days	
0h0344	Fan Time date	0	Day	Total number of days the heat sink fan has been running	
0h0345	Fan Time minute	0	Min	Total number of minutes excluding the total number of Fan Time days	

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit
0h0346 –0h0348	Reserved	-	-	-
0h0349	Reserved	-	-	-
0h034A	Option 1	-	-	0: None, 9: CANopen
0h034B	Reserved	-	-	-
0h034C	Reserved	-	-	-

7.6.2 Control Area Parameter (Read/ Write)

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
0h0380	Frequency command	0.01	Hz	Reference frequency setting	
0h0381	RPM command	1	Rpm	Command rpm setting	
0h0382	Start (Run) command	-	-	B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Reserved
				B3	0 → 1: Free-run stop
				B2	0 → 1: Trip initialization
				B1	0: Reverse direction command, 1: Forward direction command
				B0	0: Stop command, 1: Run command
				Example: Forward start command: 0003h, Reverse start command: 0001h	
0h0383	Acceleration time	0.1	sec	Acceleration time setting	
0h0384	Deceleration time	0.1	sec	Deceleration time setting	
0h0385	Virtual digital input control (0: Off, 1: On)	-	-	BI5	Reserved
				-	Reserved
				B8	Reserved
				B7	Virtual DI 8 (CM.77)
				B6	Virtual DI 7 (CM.76)
				B5	Virtual DI 6 (CM.75)
				B4	Virtual DI 5 (CM.74)
				B3	Virtual DI 4 (CM.73)
				B2	Virtual DI 3 (CM.72)
				B1	Virtual DI 2 (CM.71)
				B0	Virtual DI 1 (CM.70)
0h0386	Digital output control (0: Off, 1: On)	-	-	BI5	Reserved
				BI4	Reserved
				BI3	Reserved
				BI2	Reserved
				BI1	Reserved
				BI0	Reserved
				B9	Reserved
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Reserved
				B3	Reserved
				B2	Reserved

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
				B1	Relay 2 (0.4–7.5 kW, OU.33: None)
				B0	Relay 1 (0.4–7.5 kW, OU.31: None)
0h0387	Reserved	-	-	Reserved	
0h0388	PID reference	0.1	%	PID reference command	
0h0389	PID feedback value	0.1	%	PID feedback value	
0h038A	Motor rated current	0.1	A	-	
0h038B	Motor rated voltage	1	V	-	
0h038C–0h038F	Reserved	-	-	Reserved	
0h0390	Torque Ref	0.1	%	Torque command	
0h0391	Fwd Pos Torque Limit	0.1	%	Forward motoring torque limit	
0h0392	Fwd Neg Torque Limit	0.1	%	Positive-direction regeneration torque limit	
0h0393	Rev Pos Torque Limit	0.1	%	Reverse motoring torque limit	
0h0394	Rev Neg Torque Limit	0.1	%	Negative-direction regeneration torque limit	
0h0395	Torque Bias	0.1	%	Torque bias	

NOTE: A frequency set via communication using the common area frequency address (0h0380, 0h0005) is not saved even when used with the parameter save function. To save a changed frequency to use after a power cycle, follow these steps:

1. Set a frequency reference after setting the frequency reference source to 1 (Keypad-1).
2. Set the frequency via communication into the parameter area frequency address (0h1D04).
3. Perform the parameter save (0h03E0: '1') before turning off the power. After the power cycle, the frequency set before turning off the power is displayed.

7.6.3 Memory Control Area Parameter (Read and Write)

Comm. Address	Parameter	Scale	Unit	Changeable During Operation	Function
0h03E0	Save parameters	-	-	X	0: No, 1: Yes
0h03E1	Monitor mode initialization	-	-	O	0: No, 1: Yes
0h03E2	Parameter initialization	-	-	X	0: No, 1: All Grp, 2: Drv Grp 3: bA Grp, 4: Ad Grp, 5: Cn Grp 6: In Grp, 7: OU Grp, 8: CM Grp 9: AP Grp, 12: Pr Grp, 13: M2 Grp, 14: Operation group Setting is prohibited during fault interruptions.
0h03E3	Changed parameter display	-	-	O	0: No, 1: Yes
0h03E4	Reserved	-	-	-	Reserved
0h03E5	Delete all fault history	-	-	O	0: No, 1: Yes
0h03E6	Delete user-registrated codes	-	-	O	0: No, 1: Yes
0h03E7	Hide parameter mode	0	Hex	O	Write: 0–9999

Comm. Address	Parameter	Scale	Unit	Changeable During Operation	Function
					Read: 0: Unlock, 1: Lock
0h03E8	Lock parameter mode	0	Hex	O	Write: 0–9999 Read: 0: Unlock, 1: Lock
0h03E9	Reserved	-	-	-	Reserved
0h03EA	Initializing power consumption	-	-	O	0: No, 1: Yes
0h03EB	Initialize inverter operation accumulative time	-	-	O	0: No, 1: Yes
0h03EC	Initialize cooling fan accumulated operation time	-	-	O	0: No, 1: Yes

Note

When setting parameters in the inverter memory control area, the values are reflected to the inverter operation and saved. Parameters set in other areas via communication are reflected in the inverter operation, but are not saved. All set values are cleared following an inverter power cycle. Therefore, changes made via communications to Common Area parameters must be saved before turning off the inverter. Set parameter dr.92 to 1 (Parameter Save).

- Define the parameter carefully. After setting a parameter to 0 via communication, set it to another value. If a parameter has been set to a value other than 0 and a non-zero value is entered again, an error message is returned. The previously-set value can be identified by reading the parameter when operating the inverter via communication.
- The addresses 0h03E7 and 0h03E8 are parameters for entering the password. When the password is entered, the condition will change from Lock to Unlock, and vice versa. When the same parameter value is entered continuously, the parameter is executed just once. Therefore, if the same value is entered again, change it to another value first and then re-enter the previous value.

  For example, if you want to enter 244 twice, enter it in the following order: 244 → 0 → 244.

Caution

It may take longer to set the parameter values in the inverter memory control area because all data is saved to the inverter. Communication may be lost during parameter setup if parameter setup is continues for an extended period of time.

8 Table of Functions

The following tables list the parameter groups and all the parameters within each group. Program parameters according to your operating requirements.

The following messages may be displayed during programming of parameters when the [ENT] key is pressed.

- **rd: ReDo -** value not allocated.
- **OL: OverLap -** An input is already programmed for the same function.
- **no: Not Allowed -** The set value is not allowed.

Parameters shaded in gray will be displayed when a related parameter has been selected.
The columns labeled **"Property", "V/F", and "SL"** show whether the parameter can be changed while the inverter is running according to the following:.

O: Write enabled during run, **X**: Write Disabled during run, "**-" :** Read only.
Additionally, columns **"V/F"** and **"SL"** refer to parameter dr.09, Control Mode settings.
V/F: Volts/Frequency Mode, **SL**: Sensorless Vector Mode

8.1 Operation Group

Code	Comm. Address	Name	Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
-	0h1D00	Target frequency	0	0–Maximum frequency (Hz)	0	O	O	O	**p.40**
-	0h1D01	Acceleration time	ACC	0.0–600.0 (s)	5	O	O	O	**p.67**
-	0h1D02	Deceleration time	dEC	0.0–600.0 (s)	10	O	O	O	**p.67**
-	0h1D03	Command Source	drv	0 Keypad 1 Fx/Rx-1 2 Fx/Rx-2 3 Int 485 4 Fieldbus[1]	1:Fx/Rx-1	X	O	O	**p.62**
-	0h1D04	Frequency reference source	Frq	0 Keypad-1 1 Keypad-2 2 V1 4 V0, built-in volume (potentiometer) 5 I2 6 Int 485 8 Field Bus[1]	0:Keypad-1	X	O	O	**p.51**
-	0h1D05	Multi-step speed frequency 1	St1	0.00–Maximum frequency (Hz)	10	O	O	O	**p.60**
-	0h1D06	Multi-step speed frequency 2	St2	0.00–Maximum frequency (Hz)	20	O	O	O	**p.60**

Code	Comm. Address	Name	Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
-	0h1D07	Multi-step speed frequency 3	St3	0.00–Maximum frequency (Hz)	30	O	O	O	**p.60**
-	0h1D08	Output current	CUr	-	-	-	O	O	**p.45**
-	0h1D09	Motor revolutions per minute	Rpm	-	-	-	O	O	-
-	0h1D0A	Inverter DC voltage	dCL	-	-	-	O	O	**p.45**
-	0h1D0B	Inverter output voltage	vOL	-	-	-	O	O	**p.45**
-	0h1D0C	Out of order signal (Fault)	nOn	-	-	-	O	O	-
-	0h1D0D	Select rotation direction	drC	F Forward direction operation r Reverse run	F	O	O	O	**p.64**

8.2 Drive Group (PAR→dr)

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
dr.00	-	Jump Code	1–99		9	O	O	O	**p.34**
dr.09	0h1109	Control mode	0	V/F	0: V/F	X	O	O	**p.74**
			2	Slip Compen					**p.107**
			4	IM Sensorless					**p.118**
dr.11	0h110B	Jog Frequency	0.00, Start frequency–Maximum frequency (Hz)		10	O	O	O	**p.98**
dr.12	0h110C	Jog run acceleration time	0.0–600.0 (s)		20	O	O	O	**p.98**
dr.13	0h110D	Jog run deceleration time	0.0–600.0 (s)		30	O	O	O	**p.98**
dr.14	0h110E	Motor capacity	0	0.25 HP (0.2 kW)	Varies by Motor capacity	X	O	O	-
			1	0.5 HP (0.4 kW)					
			2	1 HP (0.75 kW)					
			3	1.5 HP (1.1 kW)					
			4	2 HP (1.5 kW)					
			5	3 HP (2.2 kW)					
			6	4 HP (3.0 kW)					
			7	5 HP (3.7 kW)					
			8	5.5 HP (4.0 kW)					
			9	7.5 HP (5.5 kW)					
			10	10 HP (7.5 kW)					
			11	15 HP (11.0 kW)					
dr.15	0h110F	Torque boost mode	0	Manual	0: Manual	X	O	X	**p.78**
			1	Auto					
dr.16	0h1110	Forward Torque boost	0.0–15.0 (%)		2	X	O	X	**p.78**
dr.17	0h1111	Reverse torque boost	0.0–15.0 (%)		2	X	O	X	**p.78**
dr.18	0h1112	Base frequency	30.00–400.00 (Hz) [V/F, Slip Compen] 40.00–120.00 (Hz) [IM Sensorless]		60	X	O	O	**p.74**
dr.19	0h1113	Start frequency	0.01–10.00 (Hz)		0.5	X	O	O	**p.74**
dr.20	0h1114	Maximum frequency	40.00–400.00 (Hz) [V/F, Slip Compen] 40.00–120.00 (Hz) [IM Sensorless]		60	X	O	O	**p.85**
dr.26[1]	0h111 A	Auto torque boost filter gain	1–1000		2	O	O	X	**p.79**
dr.27[1]	0h111B	Auto torque boost motoring gain	0.0–300.0[%]		50	O	O	X	**p.79**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
dr.28[1]	0h111C	Auto torque boost regeneration gain	0.0–300.0[%]		50	O	O	X	**p.79**
dr.80	0h1150	Select displayed value at power On	0	Operating frequency	0:Operating frequency	O	O	O	
			1	Acceleration time		O	O	O	
			2	Deceleration time		O	O	O	
			3	Command Source		O	O	O	
			4	Frequency reference source		O	O	O	
			5	Multi-step speed frequency 1		O	O	O	
			6	Multi-step speed frequency 2		O	O	O	
			7	Multi-step speed frequency 3		O	O	O	
			8	Output current		O	O	O	
			9	Motor RPM		O	O	O	
			10	Inverter DC voltage		O	O	O	
			11	User select		O	O	O	
				signal (dr.81)		O	O	O	
			12	Currently out of order		O	O	O	
			13	Select run direction		O	O	O	
			14	Output current 2		O	O	O	
			15	Motor RPM 2		O	O	O	
			16	Inverter DC voltage 2		O	O	O	
			17	User select value (dr.81)		O	O	O	
dr.81	0h1151	Select monitor code	Monitors user selected code		0: Output voltage	O	O	O	**p.45**
			0	Output voltage (V)					
			1	Output power (kW)					
			2	Torque(kgf · m)					
			3	PID feedback monitor					
dr.89	0h03E3	Display changed parameter	0	View All	0: View All	O	O	O	**p.139**
			1	View Changed					
dr.91	0h115B	Smart copy	0	None	0: None	X	O	O	-
			1	SmartDownload					
			3	SmartUpLoad					
			4	RemoteUpLoad					

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
			5	RemoteDownload					
dr.92	-	Parameter save	0	None	0:None	X	O	O	**p.137**
			1	Parameter Save					
dr.93	0h115D	Parameter initialization	0	No	0: No	X	O	O	**p.137**
			1	All Grp					
			2	dr Grp					
			3	bA Grp					
			4	Ad Grp					
			5	Cn Grp					
			6	In Grp					
			7	OU Grp					
			8	CM Grp					
			9	AP Grp					
			12	Pr Grp					
			13	M2 Grp					
			14	run Grp					
dr.94	0h115E	Password registration	0–9999		-	O	O	O	**p.138**
dr.95	0h115F	Parameter lock settings	0–9999		-	O	O	O	**p.138**
dr.97	0h1161	Software version	-		-	-	O	O	-
dr.98	0h1162	Display I/O board version	-		-	-	O	O	-

[1] Appears when dr.15 is 1 (automatic torque boost).

8.3 Basic Function Group (PAR→bA)

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
bA.00	-	Jump Code	1–99		20	O	O	O	**p.34**
bA.01	0h1201	Auxiliary reference source	0	None	0: None	X	O	O	**p.94**
			1	V1					
			3	V0					
			4	I2					
bA.02[1]	0h1202	Auxiliary command calculation type	0	M+(G*A)	0: M+(GA)	X	O	O	**p.94**
			1	Mx (G*A)					
			2	M/(G*A)					
			3	M+[M*(G*A)]					
			4	M+G*2 (A–50%)					
			5	Mx[G*2 (A–50%)					
			6	M/[G*2 (A–50%)]					
			7	M+M*G*2 (A–50%)					
bA.03[1]	0h1203	Auxiliary frequency reference gain	-200.0–200.0 (%)		100	O	O	O	**p.94**
bA.04	0h1204	2nd command source	0	Keypad	1:Fx/Rx-1	X	O	O	**p.87**
			1	Fx/Rx-1					
			2	Fx/Rx-2					
			3	Int 485					
			4	FieldBus[2]					
bA.05	0h1205	2nd frequency source	0	Keypad-1	0:Keypad-1	O	O	O	**p.87**
			1	Keypad-2					
			2	V1					
			4	V0					
			5	I2					
			6	Int 485					
			8	FieldBus[2]					
bA.07	0h1207	V/F pattern	0	Linear	0:Linear	X	O	X	**p.74**
			1	Square					
			2	User V/F					
			3	Square 2					
bA.08	0h1208	Acc/Dec reference frequency	0	Max Freq	0: Max Freq	X	O	O	**p.67**
			1	Delta Freq					
bA.09	0h1209	Time scale setting	0	0.01 sec	1: 0.1 sec	X	O	O	**p.67**
			1	0.1 sec					
			2	1 sec					
bA.10	0h120A	Input power frequency	0	60 Hz	0: 60 Hz	X	O	O	**p.136**
			1	50 Hz					

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.
bA.11	0h120B	Number of motor poles	2–48	Dependent on motor setting	X	O	O	p.107 p.115 p.118
bA.12	0h120C	Rated slip speed	0–3000 (Rpm)		X	O	O	p.107 p.115 p.118
bA.13	0h120D	Motor rated current	1.0–1000.0 (A)		X	O	O	p.107 p.115 p.118
bA.14	0h120E	Motor noload current	0.0–1000.0 (A)		X	O	O	p.107 p.115 p.118
bA.15	0h120F	Motor rated voltage	0, 100–480 (V)	0	X	O	O	p.80
bA.16	0h1210	Motor efficiency	64–100 (%)	Dependent on motor setting	X	O	O	p.107 p.115 p.118
bA.17	0h1211	Load inertia rate	0–8	0	X	O	O	p.107 p.115 p.118
bA.18	0h1212	Trim power display	70–130 (%)	100%	O	O	O	-
bA.19	0h1213	Input power voltage	170–480 V	240/480 V	O	O	O	p.136
bA.20	-	Auto tuning	0 None 1 All (Rotation type) 2 All (Static type) 3 Rs+Lsigma (Rotation type) 6 Tr (Static type)	0: None	X	X	O	p.115
bA.21	-	Stator resistance	Dependent on motor setting	Dependent on motor setting	X	X	O	p.115
bA.22	-	Leakage inductance			X	X	O	p.115
bA.23	-	Stator inductance			X	X	O	p.115
bA.24[3]	-	Rotor time constant	25–5000 (ms)	-	X	X	O	p.115
bA.41[4]	0h1229	User Frequency 1	0.00-Maximum frequency (Hz)	15	X	O	X	p.77
bA.42[4]	0h122A	User Voltage 1	0–100 (%)	25	X	O	X	p.77
bA.43[4]	0h122B	User Frequency 2	0.00- Maximum frequency (Hz)	30	X	O	X	p.77
bA.44[4]	0h122C	User Voltage 2	0–100 (%)	50	X	O	X	p.77
bA.45[4]	0h122D	User Frequency 3	0.00-Maximum frequency (Hz)	45	X	O	X	p.77

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.
bA.44[4]	0h122E	User Voltage 3	0–100 (%)	75	X	O	X	**p.77**
bA.47[4]	0h122F	User Frequency 4	0.00–Maximum frequency (Hz)	Maximum frequency	X	O	X	**p.77**
bA.48[4]	0h1230	User Voltage 4	0–100 (%)	100	X	O	X	**p.77**
bA.53[5]	0h1235	Multi-step speed frequency 4	0.00–Maximum frequency (Hz)	40	O	O	O	**p.60**
bA.54[5]	0h1236	Multi-step speed frequency 5	0.00–Maximum frequency (Hz)	50	O	O	O	**p.60**
bA.55[5]	0h1237	Multi-step speed frequency 6	0.00–Maximum frequency (Hz)	Maximum frequency	O	O	O	**p.60**
bA.56[5]	0h1238	Multi-step speed frequency 7	0.00–Maximum frequency (Hz)	Maximum frequency	O	O	O	**p.60**
bA.70	0h1246	Multi-step acceleration time 1	0.0–600.0 (s)	20	O	O	O	**p.69**
bA.71	0h1247	Multi-step deceleration time 1	0.0–600.0 (s)	20	O	O	O	**p.69**
bA.72[6]	0h1248	Multi-step acceleration time 2	0.0–600.0 (s)	30	O	O	O	**p.69**
bA.73[6]	0h1249	Multi-step deceleration time 2	0.0–600.0 (s)	30	O	O	O	**p.69**
bA.74[6]	0h124A	Multi-step acceleration time 3	0.0–600.0 (s)	40	O	O	O	**p.69**
bA.75[6]	0h124B	Multi-step deceleration time 3	0.0–600.0 (s)	40	O	O	O	**p.69**
bA.76[6]	0h124C	Multi-step acceleration time 4	0.0–600.0 (s)	50	O	O	O	**p.69**
bA.77[6]	0h124D	Multi-step deceleration time 4	0.0–600.0 (s)	50	O	O	O	**p.69**
bA.78[6]	0h124E	Multi-step acceleration time 5	0.0–600.0 (s)	40	O	O	O	**p.69**
bA.79[6]	0h124F	Multi-step deceleration time 5	0.0–600.0 (s)	40	O	O	O	**p.69**
bA.80[6]	0h1250	Multi-step acceleration time 6	0.0–600.0 (s)	30	O	O	O	**p.69**

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.
bA.81[6]	0h1251	Multi-step deceleration time 6	0.0–600.0 (s)	30	O	O	O	**p.69**
bA.82[6]	0h1252	Multi-step acceleration time 7	0.0–600.0 (s)	20	O	O	O	**p.69**
bA.83[6]	0h1253	Multi-step deceleration time 7	0.0–600.0 (s)	20	O	O	O	**p.69**

[1] Displayed if bA.01 is not set to 0 (None).
[2] See communications option manual.
[3] Displayed when dr.09 is set to 4 (IM Sensorless).
[4] Displayed if either bA.07 or M2.25 is set to 2 (User V/F).
[5] Displayed if one of In.65-69 is set to Speed–L/M/H.
[6] Displayed one of In.65-69 is set to Xcel–L/M/H.

8.4 Advanced Function Group (PAR→Ad)

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Ad.00	-	Jump Code	1–99		24	O	O	O	**p.34**
Ad.01	0h1301	Acceleration pattern	0	Linear	0: Linear	X	O	O	**p.72**
			1	S-curve					
Ad.02	0h1302	Deceleration pattern	0	Linear	0: Linear	X	O	O	**p.72**
			1	S-curve					
Ad.03[1]	0h1303	S-curve acceleration start point gradient	1–100 (%)		40	X	O	O	**p.72**
Ad.04[1]	0h1304	S-curve acceleration end point gradient	1–100 (%)		40	X	O	O	**p.72**
Ad.05[2]	0h1305	S-curve deceleration start point gradient	1–100 (%)		40	X	O	O	**p.72**
Ad.06[2]	0h1306	S-curve deceleration end point gradient	1–100 (%)		40	X	O	O	**p.72**
Ad.07	0h1307	Start Mode	0	Acc	0: Acc	X	O	O	**p.80**
			1	Dc-Start					
Ad.08	0h1308	Stop Mode	0	Dec	0:Dec	X	O	O	**p.82**
			1	Dc-Brake					
			2	Free-Run					
			4	Power Braking					
Ad.09	0h1309	Run prevention options	0	None	0: None	X	O	O	**p.64**
			1	Forward Prev					
			2	Reverse Prev					
Ad.10	0h130A	Starting with power on	0	No	0: No	O	O	O	**p.65**
			1	Yes					
Ad.12[3]	0h130C	Start DC braking time	0.00–60.00 (s)		0	X	O	X	**p.80**
Ad.13	0h130D	Amount of applied DC	0-Rated Current of Inverter/Rated Current of Motor x 100 (%)		50	X	O	X	**p.83**
Ad.14[4]	0h130E	Output blocking time before DC braking	0.00–60.00 (s)		0.1	X	O	O	**p.83**
Ad.15[4]	0h130F	DC braking time	0.00–60.00 (s)		1	X	O	O	**p.83**

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.
Ad.16[4]	0h1310	DC braking rate	0-Rated Current of Inverter/Rated Current of Motor x 100 (%)	50	X	O	O	**p.83**
Ad.17[4]	0h1311	DC braking frequency	Start frequency–60 Hz	5	X	O	O	**p.83**
Ad.20	0h1314	Dwell frequency on acceleration	Start frequency–Maximum frequency(Hz)	5	X	O	O	**p.105**
Ad.21	0h1315	Dwell operation time on acceleration	0.0–60.0 (s)	0	X	O	O	**p.105**
Ad.22	0h1316	Dwell frequency during deceleration	Start frequency–Maximum frequency(Hz)	5	X	O	O	**p.105**
Ad.23	0h1317	Operation time during deceleration	0.0–60.0 (s)	0	X	O	O	**p.105**
Ad.24	0h1318	Frequency limit	0 No 1 Yes	0: No	X	O	O	**p.85**
Ad.25[5]	0h1319	Frequency lower limit value	0.00–Upper limit frequency(Hz)	0.5	O	O	O	**p.85**
Ad.26[5]	0h131 A	Frequency upper limit value	Lower limit frequency–Maximum frequency(Hz)	Maximum frequency	X	O	O	**p.85**
Ad.27	0h131B	Frequency jump	0 No 1 Yes	0: No	X	O	O	**p.86**
Ad.28[6]	0h131C	Jump frequency lower limit 1	0.00–Jump frequency upper limit1 (Hz)	10	O	O	O	**p.86**
Ad.29[6]	0h131D	Jump frequency upper limit 1	Jump frequency lower limit1–Maximum frequency (Hz)	15	O	O	O	**p.86**
Ad.30[6]	0h131E	Jump frequency lower limit 2	00–Jump frequency upper limit2 (Hz)	20	O	O	O	**p.86**
Ad.31[6]	0h131F	Jump frequency upper limit 2	Jump frequency lower limit2–Maximum frequency (Hz)	25	O	O	O	**p.86**
Ad.32[6]	0h1320	Jump frequency lower limit 3	0.00–Jump frequency upper limit3 (Hz)	30	O	O	O	**p.86**
Ad.33[6]	0h1321	Jump frequency upper limit 3	Jump frequency lower limit3–Maximum frequency (Hz)	35	O	O	O	**p.86**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Ad.41[7]	0h1329	Brake release current	0.0–180.0 (%)		50	O	O	O	**p.140**
Ad.42[7]	0h132A	Brake release delay time	0.00–10.00 (s)		1	X	O	O	**p.140**
Ad.44[7]	0h132C	Brake release Forward frequency	0.00–Maximum frequency (Hz)		1	X	O	O	**p.140**
Ad.45[7]	0h132D	Brake release Reverse frequency	0.00–Maximum frequency (Hz)		1	X	O	O	**p.140**
Ad.46[7]	0h132E	Brake engage delay time	0.00–10.00 (s)		1	X	O	O	**p.140**
Ad.47[7]	0h132F	Brake engage frequency	0.00–Maximum frequency (Hz)		2	X	O	O	**p.140**
Ad.50	0h1332	Energy saving operation	0	None	0: None	X	O	X	**p.127**
			1	Manual					
			2	Auto					
Ad.51[8]	0h1333	Energy saving amount	0–30 (%)		0	O	O	X	**p.127**
Ad.60	0h133C	Acc/Dec time transition frequency	0.00–Maximum frequency (Hz)		0	X	O	O	**p.71**
Ad.61	0h133D	Rotation count speed gain	0.1–6000.0[%]		100	O	O	O	-
Ad.62	0h133E	Rotation count speed scale	0	x 1	0: x 1	O	O	O	-
			1	x 0.1					
			2	x 0.01					
			3	x 0.001					
			4	x 0.0001					
Ad.63	0h133F	Rotation count speed unit	0	Rpm	0: rpm	O	O	O	-
			1	mpm					
Ad.64	0h1340	Cooling fan control	0	During Run	0: During Run	O	O	O	**p.136**
			1	Always ON					
			2	Temp Control					
Ad.65	0h1341	Up/down frequency save	0	No	0: No	O	O	O	**p.100**
			1	Yes					
Ad.66	0h1342	Output contact On/Off control options	0	None	0: None	X	O	O	**p.100**
			1	V1					
			3	V0					
			4	I2					
Ad.67	0h1343	Output contact On level	Output contact off level–100.00%		90	X	O	O	**p.100**
Ad.68	0h1344	Output contact Off level	-100.00–output contact on level (%)		10	X	O	O	**p.100**
Ad.70	0h1346	Safe operation	0	Always Enable	0: Always Enable	X	O	O	**p.103**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		selection	1	DI Dependent					
Ad.71[9]	0h1347	Safe operation stop options	0	Free-Run	0: Free-Run	X	O	O	**p.103**
			1	Q-Stop					
			2	Q-Stop Resume					
Ad.72[9]	0h1348	Safe operation deceleration time	0.0–600.0 (s)		5	O	O	O	**p.103**
Ad.74	0h134A	Selection of regeneration avoidance	0	No	0: No	X	O	O	**p.142**
			1	Yes					
Ad.75	0h134B	Voltage level of regeneration avoidance	200 V: 300–400 V		350	X	O	O	**p.142**
			400 V: 600–800 V		700				
Ad.76[10]	0h134C	Compensation frequency limit of regeneration avoidance	0.00–10.00 Hz		1	X	O	O	**p.142**
Ad.77[10]	0h134D	Regeneration avoidance P gain	0.0–100.0%		50	O	O	O	**p.142**
Ad.78[10]	0h134E	Regeneration avoidance I gain	20–30000 (ms)		500	O	O	O	**p.142**
Ad.79	0h134F	DB Unit turn on voltage level	200 V: Min[11]–400[V]		390[V]	X	O	O	-
			400 V: Min[11]–800[V]		780[V]				
Ad.80	0h1350	Fire Mode selection	0	None	0: None	X	O	O	**p.90**
			1	Fire Mode					
			2	Fire Mode Test					
Ad.81[12]	0h1351	Fire Mode Operating frequency	Start frequency–Maximum frequency [Hz]		60	X	O	O	**p.90**
Ad.82[12]	0h1352	Fire Mode Run direction	0	Forward	0: Forward	X	O	O	**p.90**
			1	Reverse					
Ad.83[12]		Fire Mode operation count	Not configurable		-	-	-	-	**p.90**

[1] Displayed when Ad. 01 is set to 1 (S-curve).
[2] Displayed when the Ad. 02 code is set to 1 (S-curve).
[3] Displayed when Ad. 07 is set to 1 (DC-Start).
[4] Displayed when Ad. 08 is set to 1 (DC-Brake).
[5] Displayed when the Ad.24 code is set to 1 (Yes).
[6] Displayed when the Ad.27 code is set to 1 (Yes).

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.

[7] Displayed if either OU.31 or OU.33 is set to 35 (BR Control).
[8] Displayed if Ad.50 is not set to 0 (None).
[9] Displayed when Ad.70 is set to 1 (DI Dependent).
[10] Displayed when the Ad.74 code is set to 1 (Yes).
[11] The Minimum setting is either the DC Voltage level (converted from bA.19) +20V (for 240V VFD's) or 300V, +40V (for 480V VFD's) or 600V.
[12] Displayed if Ad.80 is not set to 0 (None).

8.5 Control Function Group (PAR→Cn)

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Cn.00	-	Jump Code	1–99		4	O	O	O	**p.34**
Cn.04	0h1404	Carrier frequency[1]	Heavy Duty	V/F: 1.0–15.0 kHz IM: 2.0–15.0 kHz	3	X	O	O	**p.133**
			Normal Duty	V/F: 1.0–5.0 kHz IM: 2.0–5.0 kHz	2				**p.133**
Cn.05	0h1405	Switching mode	0	Normal PWM	0: Normal PWM	X	O	O	-
Cn.09	0h1409	Initial excitation time	0.00–60.00 (s)		1	X	X	O	**p.118**
Cn.10	0h140A	Initial excitation amount	100.0–300.0 (%)		100	X	X	O	**p.118**
Cn.11	0h140B	Continued operation duration	0.00–60.00 (s)		0	X	X	O	**p.118**
Cn.21	0h1415	Low-speed torque compensation gain	50–300 (%)		Varies by Motor capacity	X	X	O	**p.118**
Cn.22	0h1416	Output torque compensation gain	50–300 (%)		Varies by Motor capacity	X	X	O	**p.118**
Cn.23	0h1417	Speed deviation compensation gain	50–300 (%)		Varies by Motor capacity	X	X	O	**p.118**
Cn.24	0h1418	Main compensation of speed deviation	50–300 (%)		Varies by Motor capacity	X	X	O	**p.118**
Cn.29	0h141D	No load speed deviation compensation gain	0.50–2.00		1.06	O	X	O	**p.118**
Cn.30	0h141E	Speed response adjustment gain	2.0–10.0		4	O	X	O	**p.118**
Cn.53	0h1435	Torque limit	0	Keypad-1	0:Keypad-1	X	X	O	**p.118**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		source	1	Keypad-2					
			2	V1					
			4	V0					
			5	I2					
			6	Int 485					
			8	FieldBus					
Cn.54[2]	0h1436	Positive direction +torque limit	0.0–200.0 (%)		180	O	X	O	**p.118**
Cn.55[2]	0h1437	Positive direction regeneration (-) torque limit	0.0–200.0 (%)		180	O	X	O	**p.118**
Cn.56[2]	0h1438	Reverse direction regeneration (-) torque limit	0.0–200.0 (%)		180	O	X	O	**p.118**
Cn.57[2]	0h1439	Reverse direction +torque limit	0.0–200.0 (%)		180	O	X	O	**p.118**
Cn.70	0h 1446	Speed search mode selection	0	Flying Start-1[3]	0	X	O	O	**p.128**
			1	Flying Start-2	Flying Start-1				
Cn.71	0h1447	Speed search operation selection	bit	0000–1111	0000[4]	X	O	O	**p.128**
			1	Selects the speed search function at acceleration.					
			10	Initialization after a fault					
			100	Restart after instantaneous power interruption					
			1000	Starting with power-on					
Cn.72[5]	0h1448	Speed search reference current	80–200 (%)		150	O	O	O	**p.128**
Cn.73[6]	0h1449	Speed search proportional gain	0–9999		Flying Start-1	O	O	O	**p.128**
					: 100				
					Flying Start-2				
					: 600[7]				
Cn.74[6]	0h144A	Speed search integral gain	0–9999		Flying Start-1	O	O	O	**p.128**
					: 200				
					Flying Start-2				
					: 1000				

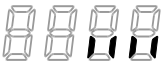
Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Cn.75[6]	0h144B	Output block time before speed search	0.0–60.0 (s)		1	X	O	O	**p.128**
Cn.77	0h144D	Energy buffering selection	0	No	0: No	X	O	O	**p.124**
			1	KEB-1					
			2	KEB-2					
Cn.78[8]	0h144E	Energy buffering start level	110.0–200.0 (%)		125	X	O	O	**p.124**
Cn.79[8]	0h144F	Energy buffering stop level	Cn78–210.0 (%)		130	X	O	O	**p.124**
Cn.80[8]	0h1450	Energy buffering P gain	0–20000		1000	O	O	O	**p.124**
Cn.81[8]	0h1451	Energy buffering I gain	1–20000		500	O	O	O	**p.124**
Cn.82[8]	0h1452	Energy buffering Slip gain	0–2000.0%		30	O	O	O	**p.124**
Cn.83[8]	0h1453	Energy buffering acceleration time	0.0–600.0 (s)		10	O	O	O	**p.124**

[1] Applicable to 5.5 - 7.5 kW products. Refer to 5.15 for information on all capacities.

[2] Displayed when dr.09 is set to 4 (IM Sensorless). This will change the initial value of the parameter at Ad.74 (Torque limit) to 150%.

[3] Will not be displayed if dr.09 is set to 4 (IM Sensorless).

[4] It will be displayed on the keypad as



[5] Displayed when any of the Cn.71 code bits are set to 1 and Cn70 is set to 0 (Flying Start-1).

[6] Displayed when any of the Cn.71 code bits are set to 1.

[7] The initial value is 1200 when the motor-rated capacity is less than 7.5 kW

[8] Displayed when Cn.77 is not set to 0 (No).

8.6 Input Terminal Block Function Group (PAR→In)

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
In.00	-	Jump Code	1–99		65	O	O	O	p.34
In.01	0h1501	Frequency for maximum analog input	Start frequency–Maximum frequency(Hz)		Maximum frequency	O	O	O	p.52 p.55 p.57 p.57
In.02	0h1502	Torque at maximum analog input	0.0–200.0 (%)		100	O	X	X	p.119
In.05	0h1505	V1 input voltage display	-12.00–12.00 (V)		0	-	O	O	p.52
In.06	0h1506	V1 input polarity selection	0	Unipolar	0:Unipolar	X	O	O	p.52
			1	Bipolar					
In.07	0h1507	Time constant of V1 input filter	0–10000 (ms)		100	O	O	O	p.52
In.08	0h1508	V1 Minimum input voltage	0.00–10.00 (V)		0	O	O	O	p.52
In.09	0h1509	V1 output at Minimum voltage (%)	0.00–100.00 (%)		0	O	O	O	p.52
In.10	0h150A	V1 Maximum input voltage	0.00–12.00 (V)		10	O	O	O	p.52
In.11	0h150B	V1 output at Maximum voltage (%)	0.00–100.00 (%)		100	O	O	O	p.52
In.12[1]	0h150C	V1 Minimum input voltage	-10.00–0.00 (V)		0	O	O	O	p.55
In.13[1]	0h150D	V1 output at Minimum voltage (%)	-100.00–0.00 (%)		0	O	O	O	p.55
In.14[1]	0h150E	V1 Maximum input voltage	-12.00–0.00 (V)		-10	O	O	O	p.55
In.15[1]	0h150F	V1 output at Maximum voltage (%)	-100.00–0.00 (%)		-100	O	O	O	p.55
In.16	0h1510	Changing rotation direction of V1	0	No	0: No	O	O	O	p.52
			1	Yes					
In.17	0h1511	V1 quantization level	0.00[2], 0.04–10.00 (%)		0.04	X	O	O	p.52
In.35	0h1523	V0 input voltage display	0.00–5.00 (V)		0	-	O	O	p.57

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
In.37	0h1525	Time constant of V0 input filter	0–10000 (ms)		100	O	O	O	**p.57**
In.38	0h1526	V0 Minimum input voltage	0.00–5.00 (V)		0	O	X	O	**p.57**
In.39	0h1527	V0 output at Minimum voltage (%)	0.00–100.00 (%)		0	O	O	O	**p.57**
In.40	0h1528	V0 Maximum input voltage	0.00–5.00 (V)		5	O	X	O	**p.57**
In.41	0h1529	V0 output at Maximum voltage (%)	0.00–100.00 (%)		100	O	O	O	**p.57**
In.46	0h152E	Changing rotation direction of V0	0	No	0: No	O	O	O	**p.57**
			1	Yes					
In.47	0h152F	V0 quantization level	0.00[2], 0.04–10.00 (%)		0.04	O	O	O	**p.57**
In.50	0h1532	I2 input voltage display	0–24 (mA)		0	-	O	O	**p.57**
In.52	0h1534	I2 input filter time constant	0–10000 (ms)		100	O	O	O	**p.57**
In.53	0h1535	I2 minimum input current	0.00–20.00 (mA)		4	O	O	O	**p.57**
In.54	0h1536	I2 output at Minimum current (%)	0.00–100.00 (%)		0	O	O	O	**p.57**
In.55	0h1537	I2 maximum input current	0.00–20.00 (mA)		20	O	O	O	**p.57**
In.56	0h1538	I2 output at Maximum current (%)	0.00–100.00 (%)		100	O	O	O	**p.57**
In.61	0h153D	Changing rotation direction of I2	0	No	0: No	O	O		**p.57**
			1	Yes					
In.62	0h153E	I2 quantization level	0.00[2]- 0.04–10.00 (%)		0.04	O	O	O	**p.57**
In.65	0h1541	P1 terminal function setting	0	None	1: Fx	X	O	O	**p.62**
			1	Fx					
In.66	0h1542	P2 terminal function setting	2	Rx	2: Rx	X	O	O	**p.62**
			3	RST					**p.173**
In.67	0h1543	P3 terminal	4	External Trip	5: BX	X	O	O	**p.163**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		function setting	5	BX					p.172
In.68	0h1544	P4 terminal function setting	6	JOG	3: RST	X	O	O	p.98
			7	Speed-L					p.60
In.69	0h1545	P5 terminal function setting	8	Speed-M	7: Sp-L	X	O	O	p.60
			9	Speed-H					p.60
			11	XCEL-L					p.69
			12	XCEL-M					p.69
			13	RUN Enable					p.103
			14	3-Wire					p.102
			15	2nd Source					p.87
			16	Exchange					p.135
			17	Up					p.100
			18	Down					p.100
			20	U/D Clear					p.100
			21	Analog Hold					p.59
			22	I-Term Clear					p.108
			23	PID Openloop					p.108
			24	P Gain2					p.108
			25	XCEL Stop					p.74
			26	2nd Motor					p.134
			27	U/D Enable					p.100
			33	Baseblock					p.153
			34	Pre Excite					p.82
			38	Timer In					p.139
			40	dis Aux Ref					p.94
			46	FWD JOG					p.99
			47	REV JOG					p. 99
			49	XCEL-H					p.69
			51	Fire Mode					p.90
			52	KEB-1 Select					p.124
In.84	0h1554	Multi-function (digital) input terminal On filter selection	P5–P1		1 1111[3]	O	O	O	p.88
			0	Disable(Off)					
			1	Enable(On)					
In.85	0h1555	Multi-function (digital) input terminal On filter	0–10000 (ms)		10	O	O	O	p.88

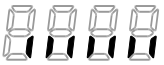
Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
In.86	0h1556	Multi-function (digital) input terminal Off filter	0–10000 (ms)		3	O	O	O	**p.88**
In.87	0h1557	Multi-function (digital) input terminal selection	P5 – P1		0 0000[4]	X	O	O	**p.88**
			0	A contact (NO)					
			1	B contact (NC)					
In.88	0h1558	Selects the NO/NC start command	0	NO	0	X	O	O	**p.88**
			1	NO/NC					
In.89	0h1559	Multi-step command delay time	1–5000 (ms)		1	X	O	O	**p.60**
In.90	0h155A	Multi-function (digital) input terminal status	P5–P1		0 0000	-	O	O	**p.88**
			0	Open (Off)					
			1	Closed (On)					
In.99	0h1563	SW1 (NPN/PNP), status	Bit	0–1	0	-	O	O	-

[1] Displayed when In.06 is set to 1 (Bipolar).

[2] Quantizing is not used when set to 0.

[3] It will be displayed on the keypad as

[4] It will be displayed on the keypad as



8.7 Output Terminal Block Function Group (PAR→OU)

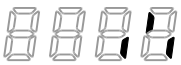
Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
OU.00	-	Jump Code	1–99		30	O	O	O	**p.34**
OU.01	0h1601	Analog output 1 item	0	Frequency	0: Frequency	O	O	O	**p.143**
			1	Output Current					
			2	Output Voltage					
			3	DCLink Voltage					
			4	Torque					
			5	Output Power					
			6	Idse					
			7	Iqse					
			8	Target Freq					
			9	Ramp Freq					
			10	Speed Fdb					
			12	PID Ref Value					
			13	PID Fdb Value					
			14	PID Output					
			15	Constant					
OU.02	0h1602	Analog output 1 gain	-1000.0–1000.0 (%)		100	O	O	O	**p.143**
OU.03	0h1603	Analog output 1 bias	-100–100 (%)		0	O	O	O	**p.143**
OU.04	0h1604	Analog output 1 filter	0–10000 (ms)		5	O	O	O	**p.143**
OU.05	0h1606	Analog constant output1	0.0–100.0 (%)		0	O	O	O	**p.143**
OU.06	0h1606	Analog output1 monitor	0.0–1000.0 (%)		0	-	O	O	**p.143**
OU.30	0h161E	Fault output item	bit	000–111	10[1]	O	O	O	**p.151**
			1	Low voltage					
			2	Any faults other than low voltage					
			3	Final failure of automatic restart					
OU.31	0h161F	Multi-function (digital) relay1 item	0	None	29: Trip	O	O	O	**p.151**
			1	FDT-1					
			2	FDT-2					
			3	FDT-3					
			4	FDT-4					
			5	Over Load					
			6	IOL					
			7	Under Load					
			8	Fan Warning					
			9	Stall					

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
			10	Over Voltage					
			11	Low Voltage					
			12	Over Heat					
			13	Lost Command					
			14	Run					
			15	Stop					
			16	Steady					
			17	Inverter Line					
			18	Comm Line					
			19	Speed Search					
			21	Regeneration					
			22	Ready					
			23	Zero Speed					
			28	Timer Out					
			29	Trip					
			31	DB Warn%ED					
			34	On/Off Control					
			35	BR Control					
			36	Reserved					
			37	FAN Exchange					
			38	Fire Mode					
			40	KEB Operating					
			41	Pre Overheat					
			42	Minor fault					
			43	Torque Detect1					
			44	Torque Detect2					
OU.33	0h1621	Multi-function (digital) relay2 item	0	None	14: Run	O	O	O	**p.151**
			1	FDT-1					
			2	FDT-2					
			3	FDT-3					
			4	FDT-4					
			5	Over Load					
			6	IOL					
			7	Under Load					
			8	Fan Warning					
			9	Stall					
			10	Over Voltage					
			11	Low Voltage					
			12	Over Heat					
			13	Lost Command					
			14	Run					
			15	Stop					
			16	Steady					
			17	Inverter Line					
			18	Comm Line					
			19	Speed Search					

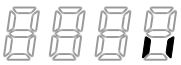
Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
			21	Regeneration					
			22	Ready					
			23	Zero Speed					
			28	Timer Out					
			29	Trip					
			31	DB Warn%ED					
			34	On/Off Control					
			35	BR Control					
			36	Reserved					
			37	FAN Exchange					
			38	Fire Mode					
			40	KEB Operating					
			41	Pre Overheat					
			42	Minor fault					
			43	Torque Detect1					
			44	Torque Detect2					
OU.41	0h1629	Multi-function (digital) relay monitor	-		0	-	-	-	**p.146**
OU.50	0h1632	Multi-function (digital) relay On delay	0.00–100.00 (s)		0	O	O	O	**p.152**
OU.51	0h1633	Multi-function (digital) relay Off delay	0.00–100.00 (s)		0	O	O	O	**p.152**
OU.52	0h1634	Multi-function (digital) relay contact selection	Relay2, Relay1		00[2]	X	O	O	**p.152**
			0	A type (NO)					
			1	B type (NC)					
OU.53	0h1635	Fault output On delay	0.00–100.00 (s)		0	O	O	O	**p.151**
OU.54	0h1636	Fault output Off delay	0.00–100.00 (s)		0	O	O	O	**p.151**
OU.55	h1637	Timer On delay	0.00–100.00 (s)		0	O	O	O	**p.139**
OU.56	0h1638	Timer Off delay	0.00–100.00 (s)		0	O	O	O	**p.139**
OU.57	0h1639	Detection frequency	0.00–Maximum frequency (Hz)		30	O	O	O	**p.146**
OU.58	0h163A	Detection frequency band	0.00–Maximum frequency (Hz)		10	O	O	O	**p.146**
OU.67	0h1643	Torque	0	None	0	X	O	O	**p.176**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		detection 1 operation setting[3]	1	OT CmdSpd Warn					
			2	OT Warning					
			3	OT CmdSpdTrip					
			4	OT Trip					
			5	UT CmdSpd Warn					
			6	UT Warning					
			7	UT CmdSpdTrip					
			8	UT Trip					
OU.68	0h1644	Torque detection 1 level[3]	0.0~200.0		100	O	O	O	**p.176**
OU.69	0h1645	Torque detection 1 delay time[3]	0~100		1	O	O	O	**p.176**
OU.70	0h1646	Torque detection 2 operation setting[4]	0	None	0	X	O	O	**p.176**
			1	OT CmdSpd Warn					
			2	OT Warning					
			3	OT CmdSpdTrip					
			4	OT Trip					
			5	UT CmdSpd Warn					
			6	UT Warning					
			7	UT CmdSpdTrip					
			8	UT Trip					
OU.71	0h1647	Torque detection 2 level[4]	0.0~200.0		100	O	O	O	**p.176**
OU.72	0h1648	Torque detection 2 delay time[4]	0~100		1	O	O	O	**p.176**

[1] It will be displayed on the keypad as



[2] It will be displayed on the keypad as



[3] Visible only when the multi-function (digital) relay (OU.31, 33) is set to 43 (Prt Trq Det 1).

[4] Visible only when the multi-function (digital) relay (OU.31, 33) is set to 44 (Prt Trq Det 2).

8.8 Communication Function Group (PAR→CM)

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
CM.00	-	Jump Code	1–99		20	O	O	O	**p.34**
CM.01	0h1701	Built-in comms. inverter ID	1–250		1	O	O	O	**p.182**
CM.02	0h1702	Built-in comms. protocol	0	ModBus RTU	0: ModBus RTU	O	O	O	**p.182**
			2	LS INV 485					
CM.03	0h1703	Built-in comms. speed	0	1200 bps	3:9600 bps	O	O	O	**p.182**
			1	2400 bps					
			2	4800 bps					
			3	9600 bps					
			4	19200 bps					
			5	38400 bps					
			6	56 Kbps					
			7	115 Kbps[1]					
CM.04	0h1704	Built-in comms. frame setting	0	D8/PN/S1	0:D8/PN/S1	O	O	O	**p.182**
			1	D8/PN/S2					
			2	D8/PE/S1					
			3	D8/PO/S1					
CM.05	0h1705	Transmission delay after reception	0–1000 (ms)		5ms	O	O	O	**p.182**
CM.06[2]	0h1706	Communication option S/W version	-		0	O	O	O	-
CM.07[2]	0h1707	Communication option inverter ID	0–255		1	O	O	O	-
CM.08[2]	0h1708	FIELD BUS communication speed	-		12Mbps	-	O	O	-
CM.09[2]	0h1709	Communication option LED status	-		-	O	O	O	-
CM.30	0h171E	Number of output parameters	0–8		3	O	O	O	**p.185**
CM.31	0h171F	Output communication address 1	0000–FFFF Hex		000A	O	O	O	**p.185**
CM.32	0h1720	Output communication address 2	0000–FFFF Hex		000E	O	O	O	**p.185**
CM.33	0h1721	Output communication address 3	0000–FFFF Hex		000F	O	O	O	**p.185**
CM.34	0h1722	Output communication address 4	0000–FFFF Hex		0	O	O	O	**p.185**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
CM.35	0h1723	Output communication address 5	0000–FFFF Hex		0	O	O	O	**p.185**
CM.36	0h1724	Output communication address 6	0000–FFFF Hex		0	O	O	O	**p.185**
CM.37	0h1725	Output communication address 7	0000–FFFF Hex		0	O	O	O	**p.185**
CM.38	0h1726	Output communication address 8	0000–FFFF Hex		0	O	O	O	**p.185**
CM.50	0h1732	Number of input parameters	0–8		2	O	O	O	**p.185**
CM.51	0h1733	Input communication address 1	0000–FFFF Hex		5	X	O	O	**p.185**
CM.52	0h1734	Input communication address 2	0000–FFFF Hex		6	X	O	O	**p.185**
CM.53	0h1735	Input communication address 3	0000–FFFF Hex		0	X	O	O	**p.185**
CM.54	0h1736	Input communication address 4	0000–FFFF Hex		0	X	O	O	**p.185**
CM.55	0h1737	Input communication address 5	0000–FFFF Hex		0	X	O	O	**p.185**
CM.56	0h1738	Input communication address 6	0000–FFFF Hex		0	X	O	O	**p.185**
CM.57	0h1739	Input communication address 7	0000–FFFF Hex		0	X	O	O	**p.185**
CM.58	0h173A	Input communication address 8	0000–FFFF Hex		0	X	O	O	**p.185**
CM.68	0h1744	Field bus data swap	0	No	0	X	O	O	-
			1	Yes					
CM.70	0h1746	Communication multi-function (digital) input 1	0	None	0: None	O	O	O	**p.184**
CM.71	0h1747	Communication multi-function (digital) input 2	1	Fx	0: None	O	O	O	**p.184**
CM.72	0h1748	Communication multi-function (digital) input 3	2	Rx	0: None	O	O	O	**p.184**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
CM.73	0h1749	Communication multi-function (digital) input 4	3	RST	0: None	O	O	O	**p.184**
CM.74	0h174A	Communication multi-function (digital) input 5	4	External Trip	0: None	O	O	O	**p.184**
CM.75	0h174B	Communication multi-function (digital) input 6	5	BX	0: None	O	O	O	**p.184**
CM.76	0h174C	Communication multi-function (digital) input 7	6	JOG	0: None	O	O	O	**p.184**
CM.77	0h174D	Communication multi-function (digital) input 8	7	Speed-L	0: None	O	O	O	**p.184**
			8	Speed-M					
			9	Speed-H					
			11	XCEL-L					
			12	XCEL-M					
			13	RUN Enable					
			14	3-Wire					
			15	2nd Source					
			16	Exchange					
			17	Up					
			18	Down					
			20	U/D Clear					
			21	Analog Hold					
			22	I-Term Clear					
			23	PID Openloop					
			24	P Gain2					
			25	XCEL Stop					
			26	2nd Motor					
			27	U/D Enable					
			33	Baseblock					
			34	Pre Excite					
			38	Timer In					
			40	dis Aux Ref					
			46	FWD JOG					
			47	REV JOG					
			49	XCEL-H					
			51	Fire Mode					
			52	KEB-1 Select					
CM.86	0h1756	Communication multi-function (digital) input monitoring	-		0	X	O	O	**p.184**
CM.90	0h175A	Selection of data frame comms. monitor	0	Int485	0	O	O	O	-
			1	KeyPad					

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
CM.91	0h175B	Rev Data frame count	0–65535		-	X	O	O	-
CM.92	0h175C	Err Data frame count	0–65535		-	X	O	O	-
CM.93	0h175D	NAK Data frame count	0–65535		-	X	O	O	-
CM.94[3]	-	Communication data upload	0	No	0: No	X	O	O	-

[1] 115200 bps

[2] Displayed only when a communication option card is installed.

[3] Displayed only when a communication option card is installed.

8.9 Application Function Group (PAR→AP)

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.
AP.00	-	Jump Code	1–99	20	O	O	O	**p.34**
AP.01	0h1801	Application function selection	0 None 1 - 2 Proc PID	0:None	X	O	O	**p.108**
AP.16[1]	0h1810	PID output monitor	(%)	0	-	O	O	**p.108**
AP.17[1]	0h1811	PID reference monitor	(%)	50	-	O	O	**p.108**
AP.18[1]	0h1812	PID feedback monitor	(%)	0	-	O	O	**p.108**
AP.19[1]	0h1813	PID reference setting	-100.00–100.00 (%)	50	O	O	O	**p.108**
AP.20[1]	0h1814	PID reference source	0 Keypad 1 V1 3 V0 4 I2 5 Int 485 7 FieldBus	0:Keypad	X	O	O	**p.108**
AP.21[1]	0h1815	PID feedback source	0 V1 2 V0 3 I2 4 Int 485 6 FieldBus	0: V1	X	O	O	**p.108**
AP.22[1]	0h1816	PID controller proportional gain	0.0–1000.0 (%)	50	O	O	O	**p.108**
AP.23[1]	0h1817	PID controller integral time	0.0–200.0 (s)	10	O	O	O	**p.108**
AP.24[1]	0h1818	PID controller differentiation time	0–1000 (ms)	0	O	O	O	**p.108**
AP.25[1]	0h1819	PID controller feed-forward compensation gain	0.0–1000.0 (%)	0	O	O	O	**p.108**
AP.26[1]	0h181 A	Proportional gain scale	0.0–100.0 (%)	100	X	O	O	**p.108**
AP.27[1]	0h181B	PID output filter	0–10000 (ms)	0	O	O	O	**p.108**
AP.28[1]	0h181C	PID Mode	0 Process PID 1 Normal PID	0	X	O	O	**p.108**
AP.29[1]	0h181D	PID upper limit frequency	PID lower limit frequency–300.00 (Hz)	60	O	O	O	**p.108**
AP.30[1]	0h181E	PID lower limit frequency	-300.00 –PID upper limit frequency(Hz)	-60.00	O	O	O	**p.108**

Code	Comm. Address	Name	Setting Range	Initial Value	Property*	V/F	SL	Ref.
AP.32[1]	0h1820	PID output scale	0.1–1000.0 (%)	100	X	O	O	**p.108**
AP.33[1]	0h181F	PID output inverse	0 No 1 Yes	0: No	X	O	O	**p.108**
AP.34[1]	0h1822	Pre-PID Frequency	0.00–Maximum frequency (Hz)	0	X	O	O	**p.108**
AP.35[1]	0h1823	Pre-PID Exit Level	0.0–100.0 (%)	0	X	O	O	**p.108**
AP.36[1]	0h1824	Pre-PID delay time	0–9999 (s)	600	O	O	O	**p.108**
AP.37[1]	0h1825	PID sleep mode delay time	0.0–999.9 (s)	60	O	O	O	**p.108**
AP.38[1]	0h1826	PID sleep mode frequency	0.00–Maximum frequency (Hz)	0	O	O	O	**p.108**
AP.39[1]	0h1827	PID wake-up level	0–100 (%)	35	O	O	O	**p.108**
AP.40[1]	0h1828	PID wake-up mode setting	0 Below Level 1 Above Level 2 Beyond Level	0: Below Level	O	O	O	**p.108**
AP.43[1]	0h182B	PID unit gain	0.00–300.00 (%)	100	O	O	O	**p.108**
AP.44[1]	0h182C	PID unit scale	0 x100 1 x10 2 x 1 3 x 0.1 4 x 0.01	2: x 1	O	O	O	**p.108**
AP.45[1]	0h182D	PID 2nd proportional gain	0.0–1000.0 (%)	100	X	O	O	**p.108**

[1] Displayed when AP.01 is set to 2 (Proc PID).

8.10 **Protection Function Group (PAR→Pr)**

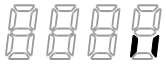
Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Pr.00	-	Jump Code	1–99		40	O	O	O	**p.34**
Pr.04	0h1B04	Load level setting	0	Normal Duty	0:Normal Duty	X	O	O	**p.156** **p.169**
			1	Heavy Duty					
Pr.05	0h1B05	Input/output open-phase protection	bit	00–11	00[1]	X	O	O	**p.162**
			1	Output open phase					
			10	Input open phase					
Pr.06	0h1B06	Input voltage range during open-phase	1–100 (V)		15	X	O	O	**p.162**
Pr.07	0h1B07	Deceleration time at fault	0.0–600.0 (s)		3	O	O	O	**p.164**
Pr.08	0h1B08	Selection of startup on trip reset	0	No	0: No	O	O	O	**p.66** **p.128** **p.131**
			1	Yes					
Pr.09	0h1B09	Number of automatic restarts	0–10		0	O	O	O	**p.66** **p.131**
Pr.10[2]	0h1B0A	Automatic restart delay time	0.0–60.0 (s)		1	O	O	O	**p.66** **p.90** **p.131**
Pr.12	0h1B0C	Motion at reference frequency loss	0	None	0: None	O	O	O	**p.164** **p.184**
			1	Free-Run					
			2	Dec					
			3	Hold Input					
			4	Hold Output					
			5	Lost Preset					
Pr.13[3]	0h1B0D	Time to determine reference frequency loss	0.0–120.0 (s)		1	O	O	O	**p.164** **p.184**
Pr.14[3]	0h1B0E	Operating frequency at reference frequency loss	0, Start frequency–Maximum frequency(Hz)		0	O	O	O	**p.164** **p.184**
Pr.15[3]	0h1B0F	Analog input loss decision level	0	Half of x1	0: Half of x1	O	O	O	**p.164** **p.184**
			1	Below x1					
Pr.17	0h1B11	Overload warning selection	0	No	0: No	O	O	O	**p.156**
			1	Yes					
Pr.18	0h1B12	Overload warning level	30–180 (%)		110	O	O	O	**p.156**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Pr.19	0h1B13	Overload warning time	0.0–30.0 (s)		10	O	O	O	**p.156**
Pr.20	0h1B14	Motion at overload fault	0	None	1: Free-Run	O	O	O	**p.156**
			1	Free-Run					
			2	Dec					
Pr.21	0h1B15	Overload fault level	30–200 (%)		150	O	O	O	**p.156**
Pr.22	0h1B16	Overload fault time	0.0–60.0 (s)		60	O	O	O	**p.156**
Pr.25	0h1B19	Under load warning selection	0	No	0: No	O	O	O	**p.169**
			1	Yes					
Pr.26	0h1B1 A	Under load warning time	0.0–600.0 (s)		10	O	O	O	**p.169**
Pr.27	0h1B1B	Under load fault selection	0	None	0: None	O	O	O	**p.169**
			1	Free-Run					
			2	Dec					
Pr.28	0h1B1C	Under load fault time	0.0–600.0 (s)		30	O	O	O	**p.169**
Pr.29	0h1B1D	Under load lower limit level	10–100 (%)		30	O	O	O	**p.169**
Pr.30	0h1B1E	Under load upper limit level	10–100 (%)		30	O	O	O	**p.169**
Pr.31	0h1B1F	No motor motion at detection	0	None	0: None	O	O	O	**p.174**
			1	Free-Run					
Pr.32	0h1B20	No motor detection current level	1–100 (%)		5	O	O	O	**p.174**
Pr.33	0h1B21	No motor detection time	0.1–10.0 (s)		3	O	O	O	**p.174**
Pr.40	0h1B28	Electronic thermal fault selection	0	None	1: Free-Run	O	O	O	**p.154**
			1	Free-Run					
			2	Dec					
Pr.41	0h1B29	Motor cooling fan type	0	Self-cool	0: Self-cool	O	O	O	**p.154**
			1	Forced-cool					
Pr.42	0h1B2A	Electronic thermal 1 minute rating	120–200 (%)		150	O	O	O	**p.154**
Pr.43	0h1B2B	Electronic thermal continuous rating	50–150 (%)		115	O	O	O	**p.154**
Pr.45	0h1B2D	BX trip mode	0	Free-Run	0	X	O	O	**p.172**
			1	Dec					
Pr.50	0h1B32	Stall	bit	0000–1111	0	X	O	X	**p.158**

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		prevention motion and flux braking	1	Accelerating					
			10	At constant speed					
			100	Decelerating					
			1000	FluxBraking					
Pr.51	0h1B33	Stall frequency 1	Start frequency–Stall frequency2 (Hz)		60	O	O	X	**p.158**
Pr.52	0h1B34	Stall level 1	30–250 (%)		180	X	O	X	**p.158**
Pr.53	0h1B35	Stall frequency 2	Start frequency1–Stall frequency3 (Hz)		60	O	O	X	**p.158**
Pr.54	0h1B36	Stall level 2	30–250 (%)		180	X	O	X	**p.158**
Pr.55	0h1B37	Stall frequency 3	Start frequency2–Stall frequency4 (Hz)		60	O	O	X	**p.158**
Pr.56	0h1B38	Stall level 3	30–250 (%)		180	X	O	X	**p.158**
Pr.57	0h1B39	Stall frequency 4	Stall frequency3–Maximum frequency(Hz)		60	O	O	X	**p.158**
Pr.58	0h1B3A	Stall level 4	30–250 (%)		180	X	O	X	**p.158**
Pr.66	0h1B42	DB resistor warning level	0–30 (%)		10	O	O	O	**p.167** **p.262**
Pr.77	0h1B4D	Pre-overheat warning temperature	90–110		90	O	O	O	**p.175**
Pr.78	0h1B4E	Pre-overheat warning operation selection	0	NONE	0	O	O	O	**p.175**
			1	Warning					
			2	Freerun					
			3	Dec					
Pr.79	0h1B4F	Cooling fan fault selection	0	Trip	1: Warning	O	O	O	**p.170**
			1	Warning					
Pr.80	0h1B50	Motion selection at option trip	0	None	1: Free-Run	O	O	O	**p.173**
			1	Free-Run					
			2	Dec					
Pr.81	0h1B51	Low voltage fault decision delay time	0.0–60.0 (s)		0	X	O	O	**p.172**
Pr.82	0h1B52	LV2 Selection	0	No	0	X	O	O	**p.174**
			1	Yes					
Pr.86	0h1B56	Accumulated percent of fan usage	0.0–100.0[%]		0	-	O	O	**p.171**
Pr.87	0h1B57	Fan exchange warning level	0.0–100.0[%]		90	O	O	O	**p.171**
Pr.88	0h1B58	Fan reset time	0	No	0	X	O	O	**p.171**
			1	Yes					
Pr.89	0h1B59	FAN Status	Bit	00–01	0	-	O	O	**p.171**
			0	-					
			1	FAN Exchange					

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
Pr.90	0h1B5A	Warning Message	-		-	X	O	O	**p.239**
Pr.91	0h1B5B	Fault history 1	-		-	-	O	O	**p.239**
Pr.92	0h1B5C	Fault history 2	-		-	-	O	O	**p.239**
Pr.93	0h1B5D	Fault history 3	-		-	-	O	O	**p.239**
Pr.94	0h1B5E	Fault history 4	-		-	-	O	O	**p.239**
Pr.95	0h1B5F	Fault history 5	-		-	-	O	O	**p.239**
Pr.96	0h1B60	Fault history deletion	0	No	0: No	O	O	O	**p.239**
			1	Yes					

[1] It will be displayed on the keypad as



[2] Displayed when Pr.09 is set higher than 0.

[3] Displayed when Pr.12 is not set to 0 (NONE).

8.11 2nd Motor Function Group (PAR→M2)

The 2nd Motor function group will be displayed if any one of In.65–69 is set to 26 (2nd MOTOR).

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
M2.00	-	Jump Code	1–99		14	O	O	O	**p.34**
M2.04	0h1C04	Acceleration time	0.0–600.0 (s)		20	O	O	O	**p.134**
M2.05	0h1C05	Deceleration time	0.0–600.0 (s)		30	O	O	O	**p.134**
M2.06	0h1C06	Motor capacity	0	0.25 HP (0.2 kW)	Dependent on inverter rating	X	O	O	**p.134**
			1	0.5 HP (0.4 kW)					
			2	1 HP (0.75 kW)					
			3	1.5 HP (1.1 kW)					
			4	2 HP (1.5 kW)					
			5	3 HP (2.2 kW)					
			6	4 HP (3.0 kW)					
			7	5 HP (3.7 kW)					
			8	5.5 HP (4.0 kW)					
			9	7.5 HP (5.5 kW)					
			10	10 HP (7.5 kW)					
			11	15 HP (11.0 kW)					
M2.07	0h1C07	Base frequency	30.00–400.00 (Hz.)		60	X	O	O	**p.134**
M2.08	0h1C08	Control mode	0	V/F	0: V/F	X	O	O	**p.134**
			2	Slip Compen					
			4	IM Sensorless					
M2.10	0h1C0A	Number of motor poles	2–48		Dependent on motor setting	X	O	O	**p.134**
M2.11	0h1C0B	Rated slip speed	0–3000 (Rpm)			X	O	O	**p.134**
M2.12	0h1C0C	Motor rated current	1.0–1000.0 (A)			X	O	O	**p.134**
M2.13	0h1C0D	Motor noload current	0.5–1000.0 (A)			X	O	O	**p.134**
M2.14	0h1C0E	Motor rated voltage	170–480 (V)			X	O	O	**p.134**
M2.15	0h1C0F	Motor efficiency	64–100 (%)			X	O	O	**p.134**
M2.16	0h1C10	Load inertia rate	0–8			X	O	O	**p.134**
M2.17	-	Stator resistance	Dependent on motor setting			X	O	O	**p.134**
M2.18	-	Leakage inductance				X	O	O	**p.134**
M2.19	-	Stator inductance				X	O	O	**p.134**
M2.20[1]	-	Rotor time constant	25–5000 (ms)			X	O	O	**p.134**
M2.25	0h1C19	V/F pattern	0	Linear	0: Linear	X	O	O	**p.134**
			1	Square					

Code	Comm. Address	Name	Setting Range		Initial Value	Property*	V/F	SL	Ref.
			2	User V/F					
M2.26	0h1C1 A	Forward Torque boost	0.0–15.0 (%)		2	X	O	O	**p.134**
M2.27	0h1C1B	Reverse torque boost	0.0–15.0 (%)			X	O	O	**p.134**
M2.28	0h1C1C	Stall prevention level	30–150 (%)		150	X	O	O	**p.134**
M2.29	0h1C1D	Electronic thermal 1 minute rating	100–200 (%)		150	X	O	O	**p.134**
M2.30	0h1C1E	Electronic thermal continuous rating	50–Electronic thermal 1 minute rating		100	X	O	O	**p.134**
M2.31	0h1C1F	Low-speed torque compensation gain	50–300 (%)		Varies by Motor capacity	X	X	O	-
M2.32	0h1C20	Stator leakage inductance scale	50–300 (%)		Varies by Motor capacity	X	X	O	-
M2.33	0h1C21	Stator inductance scale	50–300 (%)		Varies by Motor capacity	X	X	O	-
M2.34	0h1C12	Rotor time constant scale	50–300 (%)		Varies by Motor capacity	X	X	O	-
M2.40	0h1C28	Rotation count speed gain	0.1–6000.0[%]		100	O	O	O	-
M2.41	0h1C29	Rotation count speed scale	0	x 1	0: x 1	O	O	O	-
			1	x 0.1					
			2	x 0.01					
			3	x 0.001					
			4	x 0.0001					
M2.42	0h1C2A	Rotation count speed unit	0	Rpm	0: rpm	O	O	O	-
			1	mpm					

[1] Displayed when M2.08 is set to 4 (IM Sensorless).

9 Troubleshooting

This chapter explains how to troubleshoot problems when the inverter protective functions are activated (faults and warnings). If the inverter does not work normally after following the suggested troubleshooting steps, please contact the Benshaw customer service center.

9.1 Trip and Warning

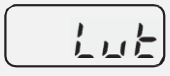
When the inverter detects a fault, it stops operating (trips) and displays a fault message at parameter nOn in the Operations Group and/or sends out a warning signal. When a fault or warning occurs, the keypad displays the information briefly. The fault/warning message can be viewed at parameter Pr.90. When more than two trips occur at the same time, the keypad display shows the higher priority fault code. The fault history can be viewed at parameters Pr.91 ~ Pr.95 The fault history can be cleared by setting parameter Pr.96 to (1) Yes.

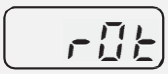
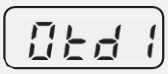
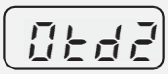
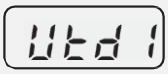
The fault conditions are categorized as follows:

- Level: When the fault is corrected, the fault or warning signal disappears and the fault is not saved in the fault history.
- Latch: When the fault is corrected and a reset is performed (keypad or external), the fault or warning signal disappears. The fault is saved in the Fault History.
- Fatal: When the fault is corrected, the fault or warning signal disappears only after the inverter power is cycled. When powered off, wait until the charge indicator light goes off then turn the inverter on again. If the inverter is still in a faulted condition after powering it on again, please contact the supplier or the customer service center.

9.1.1 Faults

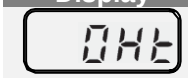
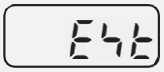
Protection Functions related to Output Current and Input Voltage

Keypad Display	Name	Type	Description
	Over Load	Latch	Motor overload trip is activated. The load level exceeded the level set in Pr.21 for the time set in Pr.22.
	Under Load	Latch	Motor underload trip is activated. The load level is less than the level set in Pr.29 and Pr.30 for the time set in Pr.28.
	Over Current1	Latch	Inverter output current exceeded 200% of the rated current.
	Over Voltage	Latch	Internal DC link voltage exceeded the OV trip level.
	Low Voltage	Level	Internal DC link voltage is less than the LV trip level.
	Low Voltage2	Latch	Internal DC link voltage is less than the LV trip level during inverter operation. Operates when Pr.82 is set to 1.
	Ground Trip*	Latch	Ground fault on the output of the inverter. Ground current has exceeded the GF trip level. The level varies depending on inverter capacity.
	E-Thermal	Latch	The inverters Eth function (inverse time-limit thermal characteristics) has determined the motor is overheating. Operates based on Pr.42 and Pr.43 settings.

Keypad Display	Name	Type	Description
	Out Phase Open	Latch	Inverter output has one or more phases in an open circuit condition. Operates when bit 1 of Pr.05 is set to 1.
	In Phase Open	Latch	Inverter input has one or more phases in an open circuit condition. Operates only when bit 2 of Pr.05 is set to 1.
	Inverter OLT	Latch	Inverter has protected itself from overload/overheating based on inverse time-limit thermal characteristics. Allowable overload rates for the inverter are 120% or 150% for 1 min based on application and 200% for 4 sec.
	No Motor Trip	Latch	Motor is not connected during inverter operation. Operates based on Pr.32 and Pr.33 settings.
	Relay Open Trip	Latch	Occurs when the DC voltage relay is not operating when power is applied. The Pr.90 code must be reset to operate. Detected only in 2 HP, 3 HP and 5 HP, 480V models.
	Over torque trip1	Latch	Occurs when the output current is higher than the level set in Ou-68. Operates when OU.67 is set to 3, 4.
	Over torque trip2	Latch	Occurs when the output current is higher than the level set in OU.71. Operates when OU.70 is set to 3, 4.
	Under torque trip1	Latch	Occurs when the output current is lower than the level set in OU.68. Operates when OU.67 is set to 7, 8.
	Under torque trip2	Latch	Occurs when the output current is lower than the level set in OU.71. Operates when OU.70 is set to 7, 8.

* The Ground Trip (GFT) feature is not provided in products under 5 HP (4.0 kW) except for 3 HP and 5 HP, 200V. An over current trip (OCT) or over voltage trip (OVT) may occur during low resistance grounding.

Protection Functions Related to Inverter Internal Circuits and External Signals

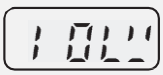
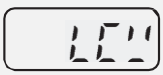
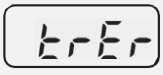
Keypad Display	Name	Type	Description
	Over Heat	Latch	Temperature of the inverter heat sink exceeded the trip level.
	Over Current2	Latch	The DC Link in the inverter detected excessive short circuit current.
	External Trip	Latch	An external fault signal is activated at the digital input terminal. Related parameter In.65–69 to 4 (External Trip) to enable external trip.
	BX	Level	Inverter Output Disable. An external sgnal is activated at the digital input terminal. Related parameter In.65–69 to 5 (BX) to enable inverter output disable function.
	H/W-Diag	Fatal	Displayed when an error is detected in the memory (EEPRom), analog-digital converter output (ADC Off Set), or CPU watchdog (Watch Dog-1, Watch Dog-2).
			• **EEP Err:** An error in reading/writing parameters due to keypad or memory (EEPRom) fault.
			• **ADC Off Set:** An error in the current sensing circuit (U/V/W terminal, current sensor, etc.).
	NTC Open	Latch	Error is detected in the temperature sensor of the Insulated Gate Bipolar Transistor (IGBT).

Keypad Display	Name	Type	Description
FAn	Fan Trip	Latch	Error is detected in the cooling fan with Pr.79 set to 0.
PId	Pre-PID Fail	Latch	The pre-PID functions set with AP.34 ~ AP.36 remain out of range (% and time) based on the PID feedback signal. It is treated as a load fault.
ebr	Ext-Brake	Latch	When controlling an external (electro-mechanical) brake, the inverter output current (Brake Release Current) remained below the value set at Ad.41. Related parameter OU.31 or OU.33 set to 35 (BR Control) to control the relay.
OH	Overheat Pre Alarm	Latch	Inverter Overheat. The inverter temperature exceeded the temperature set in Pr.77. Related parameters Pr.78 set to 2: Free-Run or 3: Dec. OU.31 or OU.33 set to 41 (Pre Overheat).

Protection Functions Related to Communication Options

Keypad Display	Name	Type	Description
LOr	Lost Command	Level	Lost analog or communications frequency reference. Based on Pr.12 ~ Pr.15 settings. Related parameters OU.31 or OU.33 set to 13 (Lost Command).
IOt	IO Board Trip	Latch	Displayed when the I/O board or external communication card is not connected to the inverter or there is a bad connection.
HOLd			Displayed when the hold error code continues for more than 5 sec.
ErrC			(‘Errc’ -> ’-rrc’ -> ‘E-rc’ -> ’Er-c’ -> ‘Err-‘ -> ’- -rc’ -> ‘Er- -‘ -> ’- - - -‘ -> ’Errc’ -> …)
OPt	Option Trip-1	Latch	Communication error is detected between the inverter and the installed communication board.

9.1.2 **Warning Messages**

Keypad Display	Name	Description
	Over Load	Motor overload warning. Operates based on Pr.17 ~ Pr.19 settings. Related parameter OU.31 or OU.33 set to 5 (Over Load).
	Under Load	Motor underload warning. Operates based on Pr.25 ~ Pr.30 settings..The under load level (% current) is based on the motor rated current. Related parameters OU.31 or OU.33) set to 7 (Under Load).
	INV Over Load	Inverter over load warning. Operates when 60% (36 secs.) of the inverter overload protection time has accumulated. Related parameter OU.31 or OU.33 set to 6 (IOL).
	Lost Command	Lost frequency reference warning (analog or communications). The warning occurs based on the conditions set at Pr.13~15. Occurs even if Pr.12 is set to 0. Related parameter OU.31 or OU.33 set to 13 (Lost Command). If the communication settings and status are not suitable for P2P, a Lost Command alarm also occurs.
	Fan Exchange	Fan Exchange warning occurs when the value set at Pr.86 exceeds the value set at Pr.87. Related parameters OU.31 or OU.33 set to 37 (Fan Exchange).
	Fan Warning	Error is detected with the cooling fan with Pr.79 is set to 1. OU.31 or OU.33 to 8 (Fan Warning).
	DB Warn%ED	DB resistor usage rate warning occurs when the duty cycle exceeds the value set in Pr.66.
	Retry Tr Tune	During Auto Tuning, the warning occurs when the motor's rotor time constant (Tr) is either too low or too high. Related parameter dr.09 is set to 4 (IM Sensorless).
	Overheat Pre Alarm	Inverter Overheat warning occurs when inverter temperature exceeds the temperature set in Pr.77 and Pr.78 is set to 1 (Warning)

9.2 Troubleshooting Faults

When a fault or warning occurs, refer to the following table for possible causes and remedies.

Items	Cause	Remedy
OLt	The load is greater than the motor's rated capacity.	Replace the motor and/or inverter with larger models.
	Pr.21 value for the overload trip level is too low.	Increase the value for the overload trip level.
ULt	There is a motor-load connection problem.	Check connections, measure amps to motor.
		Inverter/motor too large for application. Replace the motor and/or inverter with models with lower capacity.
	Pr.29, Pr.30 underload level is less than the system's minimum load.	Reduce the value for the underload levels.
OCt	Acc/Dec time is too short, compared to load inertia (GD2).	Increase Acc/Dec time.
	The load is greater than the inverter rated capacity.	Replace the inverter with a larger model.
	The inverter supplied an output while the motor was tuning.	Operate the inverter after the motor has stopped or use the speed search function (Cn.70).
	The mechanical brake of the motor is operating too fast.	Check the mechanical brake.
	A ground fault has occurred in the inverter output wiring.	Check the output wiring.
	The motor insulation is damaged.	Check/Replace the motor.
Out	Deceleration time is too short for the load inertia (GD2).	Increase the deceleration time.
	Load is regenerative.	Use dynamic braking.
	The input voltage is too high.	Check supply voltage. Check DC Link voltage.
	Ground fault in the output wiring.	Check the output wiring.
	The motor insulation is damaged.	Check/Replace the motor.
Lut	The input voltage is too low.	Check supply voltage. Check DC Link voltage.
	Other equipment connected to the same power source (e.g., a welder, direct motor connection, etc.).	Increase source power capacity.
	The input contactor connecting the power source has a faulty connection.	Check/Replace the contactor.
Lu2	The input voltage has decreased during operation.	Determine if the input voltage is lower than the specified value.
	An input open-phase has occurred.	Check the input wiring.
	The input contactor connecting the power source has a faulty connection.	Check/Replace the contactor.
GFt	A ground fault has occurred in the inverter output wiring.	Check output wiring.
	The motor insulation is damaged.	Check/Replace the motor.

Items	Cause	Remedy
EtH	The motor has overheated.	Reduce the load or operating frequency.
	The load is greater than the inverter rated capacity.	Replace the inverter with a larger model.
	Pr.42 and/or Pr.43 (Eth) are set too low.	Check Eth levels.
	The inverter has been operated at low speed for an extended duration.	Verify motor cooling is adequate at low speed operation. Add supplemental cooling to motor.
POt	The output contactor connecting the motor has a faulty connection.	Check/Replace the contactor on the output side.
	The output wiring is faulty.	Check the output wiring.
IPO	The input contactor connecting the power source has a faulty connection.	Check/Replace the contactor on the input side.
	The input wiring is faulty.	Check the input wiring.
	The DC link capacitors need to be replaced.	Replace the DC link capacitors. Contact the Benshaw technial support center.
IOL	The load is greater than the rated motor capacity.	Replace the motor and inverter with models that have increased capacity.
	The torque boost level is too high.	Reduce the torque boost levels (dr.15 ~ dr.17).
	The torque boost level is too low.	Increase the torque boost levels (dr.15 ~ dr.17).
OHt	There is a problem with the cooling system.	Check for obstructions of air flow (inlet, outlet, or vents).
	The inverter cooling fan has failed.	Replace the cooling fan.
	The ambient temperature is too high.	Keep the ambient temperature below 50℃.
OC2	Output wiring is short-circuited.	Check the output wiring.
	There is a short in the output transistors (IGBT's).	Check IGBT for short circuits. If shorted, do not operate the inverter. Contact the Benshaw technial support center.
	A ground fault has occurred in the inverter output wiring.	Check the output wiring.
	The motor insulation is damaged.	Check/Replace the motor.
ntC	There is a fault with the internal temperature sensor.	Contact the Benshaw technial support center.
	The ambient temperature is too low.	Keep the ambient temperature above –10℃.
FAn	There is an obstruction in the fan or air vent.	Remove the obstruction from the air inlet or outlet.
	The cooling fan needs to be replaced.	Replace the cooling fan.

9.3 Other Faults

When a fault other than those identified as faults or warnings occurs, refer to the following table for possible causes and remedies.

Items	Cause	Remedy
Parameters cannot be set.	The inverter is in operation (run mode).	Stop the inverter to change to program mode.
	The parameter access is incorrect.	Check the correct parameter access level.
	The password is incorrect.	Check the password, disable the parameter lock.
	Low voltage is detected.	Check the power input to resolve the low voltage.
The motor does not rotate.	The frequency command source is set incorrectly.	Check the frequency command source setting.
	The operation command (start) source is set incorrectly.	Check the start command source setting.
	Power is not supplied to the terminal R/S/T.	Check the terminal connections R/S/T and U/V/W.
	The charge lamp is turned off.	Turn on the inverter.
	The start command (Run) is off.	Apply the start command (Run).
	The motor is locked.	Unlock the motor or lower the load level.
	The load is too high.	Operate the motor independently (no load).
	An emergency stop signal is input.	Reset the emergency stop signal.
	The wiring for the control circuit terminal is incorrect.	Check the wiring for the control circuit terminal.
	The selection for the frequency reference source is incorrect.	Check the selected frequency reference source.
	The input voltage or current for the frequency reference is incorrect.	Check the input voltage or current for the frequency reference.
	The PNP/NPN mode is selected incorrectly.	Check the PNP/NPN mode setting.
	The frequency reference value is too low.	Check the frequency reference and input a value above the minimum frequency.
	Motor torque is too low.	Change the operation modes (V/F, IMSensorless). If the fault remains, replace the inverter and/or motor with larger models.
The motor rotates in the opposite direction to the command.	VFD output or motor wiring is incorrect.	Determine if the VFD output wiring is wired correctly to the phases (U/V/W) of the motor.
	The control circuit wiring to Fx and Rx terminals is incorrect.	Check the forward/reverse control wiring.
The motor only rotates in one direction.	Reverse rotation prevention is selected.	Remove the reverse rotation prevention.
	3-wire control - The control circuit wiring to Rx or 3-wire terminals not provided.	Check the control wiring of the signal associated with the 3-wire operation.
The motor is overheating.	The load is too high.	Reduce the load. Increase Acc/Dec time.
		Check the motor parameters and set the correct values.
		Replace the motor and/or the inverter with larger models.

Items	Cause	Remedy
	The ambient temperature of the motor is too high.	Lower the ambient temperature of the motor.
	The phase-to-phase voltage of the motor is insufficient.	Use a motor that can withstand phase-to-phase voltages greater than the maximum voltage.
		Only use motors suitable for applications with inverters.
		Connect the AC reactor to the inverter output (lower the carrier frequency).
	The motor fan has stopped or the fan is obstructed with debris.	Check the motor fan and remove any foreign objects.
The motor stops during acceleration or when connected to load.	The load is too high.	Reduce the load.
		Replace the motor and/or the inverter with larger models.
The motor does not accelerate.	The frequency reference value is low.	Set an appropriate value.
	The load is too high.	Reduce the load. Increase the acceleration time.
		Check the mechanical brake status.
	The acceleration time is too long.	Change the acceleration time.
	The combined values of the motor properties and the inverter parameter are incorrect.	Change the motor related parameters.
	The stall prevention level during acceleration is low.	Change the stall prevention level.
	The stall prevention level during operation is low.	Change the stall prevention level.
	Starting torque is insufficient.	Change to vector control operation mode. If the fault remains, replace the inverter with a larger model.
Motor speed varies during operation.	There is a high variance in load.	Replace the motor and/or the inverter with larger models.
	The input voltage varies.	Correct the input voltage variation.
	Motor speed variations occur at a specific frequency.	Adjust the output frequency to avoid a resonance area.
The motor rotation is different from the setting.	The V/F pattern is set incorrectly.	Set a V/F pattern that is suitable for the motor specification.
The motor deceleration time is too long even with Dynamic Braking (DB) resistor connected.	The deceleration time is set too long.	Change the setting accordingly.
	The motor negative torque is excessive.	Check DB Resistor circuit operation. Investigate alternate braking methods.
		Replace the motor and/or the inverter with larger models.
Operation is difficult during light load conditions.	The carrier frequency is too high.	Reduce the carrier frequency.
	Over-excitation has occurred due to an inaccurate V/F setting at low speed.	Reduce the torque boost value to avoid over-excitation.
While the inverter is in operation, a control unit malfunctions or noise occurs.	Noise occurs due to switching inside the inverter.	Change the carrier frequency to the minimum value.
		Install a micro surge filter in the inverter output.

Items	Cause	Remedy
When the inverter is operating, the earth leakage breaker is activated.	An earth leakage breaker will interrupt the supply if current flows to ground during inverter operation.	Connect the inverter to a ground terminal.
		Check that the ground resistance is less than 100Ω for 240 V inverters and less than 10Ω for 480 V inverters.
		Check the capacity of the earth leakage breaker, base on the rated input current of the inverter.
		Reduce the carrier frequency.
		Make the cable length between the inverter and the motor as short as possible.
The motor vibrates severely and does not rotate normally.	The voltage between phases is not balanced.	Check the input voltage and balance the voltage.
		Check and test the motor’s insulation.
		Check motor for mechanical issues.
The motor makes humming, or loud noises.	Resonance occurs between the motor's natural frequency and the carrier frequency.	Slightly increase or decrease the carreir frequency.
	Resonance occurs between the motor's natural frequency and the inverter’s output frequency.	Slightly increase or decrease the operating frequency.
		Use the frequency jump function to avoid the frequency band where resonance occurs.
The motor vibrates/hunts.	The analog frequency reference contains induced noise.	Check the routing, grounding and shielding of the analog signal cable. Add filtering to the analog cable. Increase the analog input filter time constant (In.07).
	The wiring length between the inverter and the motor is too long.	Ensure that the cable length between the inverter and the motor is less than 665 ft. (200 m). For smaller inverters (≤ 5 HP), less than 165 ft. (50 m).
The motor does not come to a complete stop when the inverter output stops.	It is difficult to decelerate sufficiently, because DC braking is not operating normally.	Adjust the DC braking parameters Brake Current and Brake Time. Caution: Avoid excessive Motor heating.
The output frequency does not increase to the frequency reference.	The frequency reference is within the jump frequency range.	Set the frequency reference higher than the jump frequency range.
	The frequency reference is above the upper limit frequency.	Check Frequency Limit settings.
	The analog frequency reference is lower (due to losses) at the inverter terminals.	Check scaling of the analog frequency reference.
	Because the load is too heavy, the stall prevention function is working.	Replace the motor and/or the inverter with larger models.
The cooling fan does not rotate.	The control parameter for the cooling fan is set incorrectly.	Check the control parameter setting for the cooling fan.

10 Maintenance

This chapter explains:

- **Periodic Inspections**
- **Storage and Disposal**

The Benshaw model GM2 series VFD's are an industrial electronic product with advanced semiconductor components. A reasonable life expectancy of 8 to 10 years can be expected however, there are factors that may affect their continued long term operation. Environmental issues (temperature and humidity) and mechanical issues (vibration and connections) are the most common reasons for premature failure of drives. To avoid problems, it is recommended to perform periodic inspections of the drive.

 **Caution**

- Be sure to remove the drive's power input while performing maintenance. Lock out all sources of power.
- Be sure to perform maintenance only after checking that the DC bus voltage has discharged. The voltage between terminal P1-N (or P2-N) should be less than 30VDC. The DC bus capacitors can still be charged even after the power is turned off. The DC bus LED (if equipped) is not a definitive indication of the absence of DC voltage.
- Preventive maintenance should always be performed by a trained technician.
- Clean with a dry cloth. Do not use water, solvents or detergents.
-

10.1 Periodic Inspection Summary

Refer to the attached Table for specific frequency of inspection.

The conditions of the installed location

- Observe any physical damage to enclosure or enclosure degradation.
- Any signs of liquid leakage into the enclosure.
- Any signs of corrosion or rust resulting from leakage into the enclosure.

The conditions of the drive cooling. Causes for abnormal heating are:

- Check for any deposits or dirt inside the enclosure, in the cooling fans/filters and the drive fan(s). Remove with compressed air.
- Check the rotating condition of the cooling fan(s).

Abnormal vibration

- Are there any loose nuts or bolts as a result of the vibration?
- Loose connections will show signs of heated connectors and wires. Tighten or replace.

10.2 **Periodic Inspection Items**

	Inspection Item	Inspection	Period			Inspection Method	Criterion	Customer use
			Monthly	1 year	2 year			Check/Initial /Date
Environment	Ambient Temperature/ Humidity	Is the ambient temperature and humidity within the design range?	X			Measure/ Monitor (Thermometer, Hygrometer, Recorder)	Temperature: -10°C~+40°C	
							Humidity: Under 90% non-condensing	
Physical Inspection	Physical	Any signs of physical damage to the enclosure of the VFD?		X		Visual	Yes/No	
		Any signs of liquid leaking into enclosure of the VFD?		X				
		Are there any signs of rust inside the VFD enclosure?		X				
		Are there any signs of rust inside the panel where the VFD is housed.?		X				
		Are there any abnormal vibrations or oscillations of the VFD/Panel?		X				
	Physical (Cables and Connections)	Are there any signs of overheated connections (discolored lugs, insulation melted)?		X		Visual	Yes/No	
		Are there any signs of rusted or coroded connections?		X				
		Are there any signs of cracked terminal blocks?		X				
		Is there any damage to cable insulation?		X				
	Physical (Fans)	Inspect fans and filters for debris and dust accumulation.	X					
		Inspect fans for free rotation.	X					

Periodic Inspection Items (con't)

	Inspection Item	Inspection	Period			Inspection Method	Criterion	Customer use
			Monthly	1 Year	2 Year			Check/Initial /Date
Non-Powered VFD Checks/Measurements	IGBT Module	Check the resistance between each of the terminals.			X	Disconnect the VFD three phase input and measure the resistance between R, S, T and P, N.	Refer to "How to Check Power Components" using Digital or Analog meter.	
	Input Diode/SCR Modules					Disconnect the VFD three phase output and measure the resistance between U, V, W and P, N.		
	DC Bus Capacitors	Is there any visible leakage coming out?			X	Visual check	Yes/No	
		Inspect the pressure relief vent (or pin). Is there any swelling or rupture?			X			
	Motor (Note 1)			X		Megger Test	500 MΩ	
Powered VFD - Not Running Checks/Measurements	Input Voltages	Is the input voltage from the main within spec of the VFD?		X		Measure the voltage between the terminals R, S, T.	VFD rating +/-15%	
		Is the input voltage from the main balanced within spec of the VFD?			X		2%	
	DC Bus Voltage	Is the DC Bus Higher or Lower than normal?			X	Measure the DC Voltage between the Pos. and Neg. terminals of the VFD.	Input Voltage x SQRT2 (+/- 10%)	
	Cooling Fan	Is there any abnormal oscillations or noise?		X		Turn OFF the power and turn the fan by hand.	Must rotate smoothly.	
	Trip Circuit (Input to VFD)	Is VFD trip circuit funciotnal?		X		Identify the VFD input trip circuit. Open or Close external trip mechanism.	VFD must trip.	

Periodic Inspection Items (con't)

	Inspection Item	Inspection	Period			Inspection Method	Criterion	Customer Use
			Monthly	1 Year	2 Year			Check/Initial /Date
Powered VFD - Running Checks/Measurements	Output Voltages	Is there any voltage imbalance between phases of the output?			X	Measure the voltage between the output terminals U, V and W.	Tol. +/-2% 230V (5V) 460V (10V).	
		Does the displayed Output Voltage agree with measurement?			X	Display parameter for Output Voltage, compare to measured value.	Tol. -10% + 20% Note 2	
	Output Curent	Is there any current imbalance between phases of the output?			X	Measure the current out of each phase U, V, W.	Tol. +/-3% Note 2	
		Does the displayed Output Current agree with measurement?			X	Display parameter for Output Current, compare to measured value.	Tol. +/-5% Note 2	
	Motor	Are there any abnormal vibrations or noise?		X		Auditory, sensory, visual check.	Mounting and Coupling	
		Is there any unusual odor?		X		Check for overheat and damage.		
Note 1	Do not run an insulation resistance test (Megger) on the VFD or with VFD connected to supply and motor, damage will occur.							
Note 2	Multimeter measurements of VFD output could vary depending on the type of meter.							

Caution

ESD (Electrostatic discharge) To prevent damage to the PCB from ESD, touch a metal object with your hands to discharge any electricity before working on the PCB, or wear an anti-static wrist strap and ground it on a metal object.

10.3 **Storage**

If you are not using the product for an extended period, adhere to the following guidelines:

- Store the product in the same environmental conditions as specified for operation (Refer to Technical Specifications).
- When storing the product for a period longer than 3 months, store it between 14°F (-10 ˚C)
- and 86°F (30 ˚C), to prevent depletion of the electrolytic capacitor.
- If the inverter has not been operated for a long time, capacitors lose their charging characteristics and are depleted. To prevent depletion, turn on the product once a year and allow the device to operate for 30-60 min. Run the device under no-load conditions.
- Do not expose the inverter to snow, rain, fog, or dust.
- Package the inverter in a way that prevents contact with moisture. Keep the moisture level below 70% in the package by including a desiccant, such as silica gel.
- Do not allow the inverter to be exposed to dusty or humid environments. If the inverter is installed in such environments (for example, a construction site) and the inverter will be unused for an extended period, remove the inverter and store it in a safe place.

10.4 **Disposal**

When disposing of the product, categorize it as general industrial waste. Recyclable materials are included in the product, so recycle them whenever possible. The packing materials and all metal parts can be recycled. The plastic can also be recycled.

11 Technical Specification

11.1 Input and Output Specification

240 V, 1 HP ~15 HP (0.75 kW –11 kW)

RSI-XXX-GM2.2C			001	002	003	005	007	010	015
240V, 3ϕ Input	Normal Duty, 120% OL	HP	1	2	3	5	7.5	10	15
		kW	0.75	1.5	2.2	4	5.5	7.5	11
		Amps	3.1	6	9.6	12	18	30	40
		KVA	1.2	2.3	3.8	4.6	6.9	11.4	15.2
	Heavy Duty, 150% OL	HP	0.5	1	2	3	5	7.5	10
		kW	0.4	0.75	1.5	2.2	4	5.5	7.5
		Amps	2.5	5	8	11	17	24	32
		KVA	1	1.9	3	4.2	6.5	9.1	12.2
240V, 1ϕ Input	Normal Duty	HP	-	0.75	1.5	2	3	5	7.5
		Amps	2	3.6	5.9	6.7	9.8	16.3	22
	Heavy Duty	HP	-	0.5	1	1.5	3	3	5
		Amps	1.5	2.8	4.6	6.1	9.3	12.8	17.4
	Output frequency		0–400 Hz. (IM Sensorless: 0–120 Hz)						
	Output voltage (V)		3-phase 200–240 V						
Rated input	Voltage (V)		3-phase 200–240 VAC (-15% to +10%)						
			1-phase 240VAC (-5% to +10%)						
	Input frequency		3-phase 50–60 Hz (±5%)						
			1-phase 60Hz (±5%)) only.						
	Rated current (A)	Normal Duty	3	6.3	10.8	13.1	19.4	32.7	44.2
		Heavy Duty	2.2	4.9	8.4	11.8	18.5	25.8	34.9
Weight (lb /kg)		lbs	2.3	2.3	3	3	4.2	6.8	7.1
		kg	1.04	1.06	1.36	1.4	1.89	3.08	3.21
Heat Dissipation (W)			22	45	79	117	208	281	382
Degree of Protection			IP20, UL Open (UL Type 1 achieved with optional conduit box)						

- The standard motor capacity is based on a standard 4-pole motor.
- The KVA rating is based on a 220V supply voltage for 240V inverters.
- The rated output current is limited based on the carrier frequency set at Cn.04.
- The output voltage is reducued 20%~40% during no-load operations to protect the inverter from faults, 1 HP ~ 7.5 HP (0.4 ~ 4.0 kW) only.

480 V, 1 HP ~ 15 HP (0.75 kW ~ 11 kW)

RSI-XXX-GM2.4C			001	002	003	005	007	010	015
480V, 3ϕ Input	Normal Duty, 120% OL	HP	1	2	3	5	7.5	10	15
		kW	0.75	1.5	2.2	4	5.5	7.5	11
		Amps	2	3.1	5.1	6.9	10	16	23
		KVA	1.5	2.4	3.9	5.3	7.6	12.2	17.5
	Heavy Duty, 150% OL	HP	0.5	1	2	3	5	7.5	10
		kW	0.4	0.75	1.5	2.2	4	5.5	7.5
		Amps	1.3	2.5	4	5.5	9	12	16
		KVA	1	1.9	3	4.2	6.5	9.1	12.2
480V, 1ϕ Input	Normal Duty	HP	0.5	0.75	1~1.5	2	3	5	7.5
		Amps	1.3	1.9	2.8	3.6	5.4	8.7	12.6
	Heavy Duty	HP	-	0.5	1	1.5	3	3	5
		Amps	0.7	1.4	2.1	2.8	4.9	6.4	8.7
	Output frequency		0–400 Hz. (IM Sensorless: 0–120 Hz)						
	Output voltage (V)		3-phase 380–480 V						
Rated input	Voltage (V)		3-phase 380–480 VAC (-15% to +10%)						
			1-phase 480VAC (-5% to +10%)						
	Input frequency		3-phase 50–60 Hz (±5%)						
			1-phase 60Hz (±5%)) only.						
	Rated current (A)	Normal Duty	2	3.3	5.5	7.5	10.8	17.5	25.4
		Heavy Duty	1.1	2.4	4.2	5.9	9.8	12.9	17.5
Weight (lb /kg)		lbs	2.3	2.4	3.2	3.2	4.4	7.1	7.2
		kg	1.04	1.08	1.44	1.46	1.98	3.24	3.28
Heat Dissipation (W)			24	42	71	99	176	231	315
Degree of Protection			IP20, UL Open (UL Type 1 achieved with optional conduit box)						

- The standard motor capacity is based on a standard 4-pole motor.
- The KVA rating is based on a 440V supply voltage for 480V inverters.
- The rated output current is limited based on the carrier frequency set at Cn.04.
- The output voltage is reducued 20%~40% during no-load operations to protect the inverter from faults, 1 HP ~ 7.5 HP (0.4 ~ 4.0 kW) only.

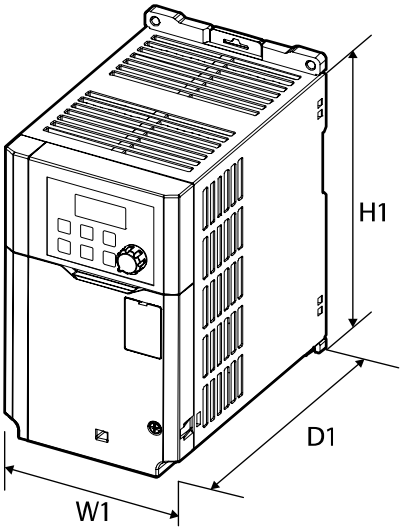
11.2 **Product Specification Details**

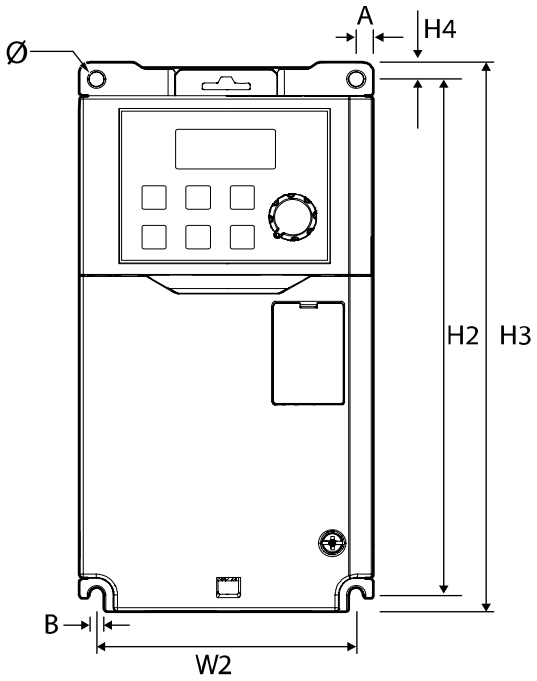
Items			Description	
Control	Control method		V/F control, Sensorless Vector, Slip Compensation	
	Frequency settings resolution		Digital command: 0.01 Hz	
			Analog command: 0.06 Hz (60 Hz standard)	
	Frequency accuracy		1% of maximum output frequency	
	V/F pattern		Linear, Square Reduction, User V/F	
	Overload capacity		Normal Duty: 120%, 1minute	
			Heavy Duty: 150%, 1 minute	
	Torque boost		Manual torque boost, Automatic torque boost	
Operation	Operation Type			
	Start/Stop		Keypad, terminal strip, or communication operation	
	Frequency settings		Analog type: -10–10 V (bipolar), 0–10 V, 4–20 mA	
			Digital type: keypad	
	Operation functions		**Basic**	**Advanced**
			Start/Stop Operation	Auto Tuning
			Frequency Reference Sources	Sensorless Vector Control
			Accel/Decel Times	Torque Limits
			2nd Source (HOA)	Slip Compensation
			Multi-Step Speeds	PID Control
			Jog	Auxiliary Frequency Reference
			Auto Start	Multi-Step Accel/Decel Times
			Auto Reset/Restart	User V/Hz.
			Accel/Decel Patterns	Dwell Frequency Operation
			V/Hz. Control	Regen Avoidance
			Liniear, Squared	Stall Prevention
			Motor Rotation Prohibit	Speed Search
			Torque Boost	VFD Fan Control
			Start Modes	**Loss of Power**
			Stop Modes	Ride Through (KEB)
			Frequency Limits	Safe Stop
			Jump Frequencies	**Braking**
			3-Wire Control	DC Injection, Power Braking
			Fire Mode	Flux Brakinig, External Brake
	Input	(5) Multi-function terminals (P1 - P5)	Select PNP (Source) or NPN (Sink) mode.	
			Functions of the digital inputs are set with parameters In.65– In.69.	
			• Forward/Reverse	• Run Enable (Interlock)
			• Reset	• External trip
			• Emergency stop	• Jog operation (FWD/REV)
			• Multi-Step frequencies	• Multi step acc/dec
			• DC braking during stop	• Second motor selection
			• Frequency increase	• Up/Down Frequency
			• 3-wire	• Analog Hold (frequency)

Items			Description	
			• acc/dec/stop	• Exit PID Operation
	Output	Multi-function relays	Programmable Output Relays	AC 250 V, 1 A DC 30V, 1A
			Relay 1 (A1-C1-B1)	
			Relay 2 (A2-C2)	
		Analog output	0–12 VDC: Programmable Analog Output	
Protection	Trip		• Motor Overload	• Under Torque
			• Motor Under Load	• Inverter Over Heat
			• Over Current (OC1)	• Short Circuit (OC2)
			• Over Voltage	• External Trip
			• Low Voltage	• Hardware Fault
			• Ground Fault	• Temperature Sensor (NTC)
			• Motor Over Heat (Eth)	• Fan Fault
			• Phase Open (In/Out)	• Pre-PID Operation Failure
			• Inverter Overload	• External Brake Trip
			• No Motor Trip	• Reference Loss
			• Over Torque	• Option Board trip
	Alarm		**Warnings:** Reference Loss, Motor Overload, Motor Under Load, Inverter Overload, Fan, Dynamic Braking Rate Warning, Auto Tuning Error, Inverter Overheat	
	Instantaneous Power Outage		Normal Duty: Less the 8ms (~1/2 cycle)	
			Heavy Duty: Less than 15 ms (~ 1 cycle)	
			For longer outages use KEB operation and/or Auto Restart operation	
Structure / Working Environment	Cooling type		Forced fan cooling structure	
	Protection structure		IP 20, UL Open Type	
			UL Enclosed Type 1 is achieved with conduit box installation (option)*	
	Ambient Operating temperature		14°F ~ +104°F (-10°C ~ +40℃)	
			Derating: 2% output amps for every degree above 104°F (40°C), maximum 122°F (50°C)	
			No ice or frost should be present	
	Ambient humidity		Less than 95% RH (avoid condensation forming)	
	Storage temperature		-4°F ~ +149°F (-20℃ ~ +65℃)	
	Environmental factors		Prevent contact with corrosive gases, inflammable gases, oil stains, dust, and other pollutants (Pollution Degree 2 Environment).	
	Operation altitude/vibration		3280 ft (1,000 m).	
			Apply derating of 1% voltage/output current for every 100 m above 1,000 m, maximum of 4,000 m	
			Less than 9.8 m/sec^2 (1G).	
	Air pressure		15 PSI (70 ~106 kPa)	

11.3 **External dimensions**

1.0 HP ~ 2.0 HP, 240V/480V
0.75–kW ~ 1.5 kW

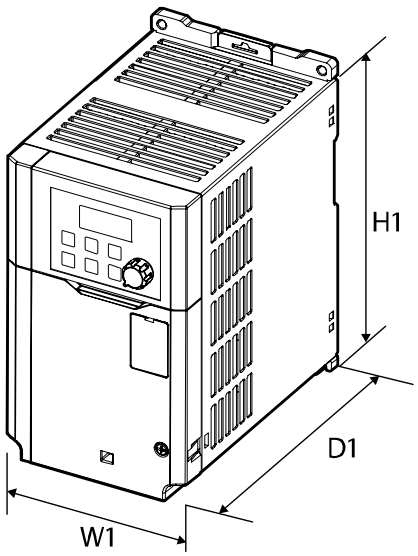


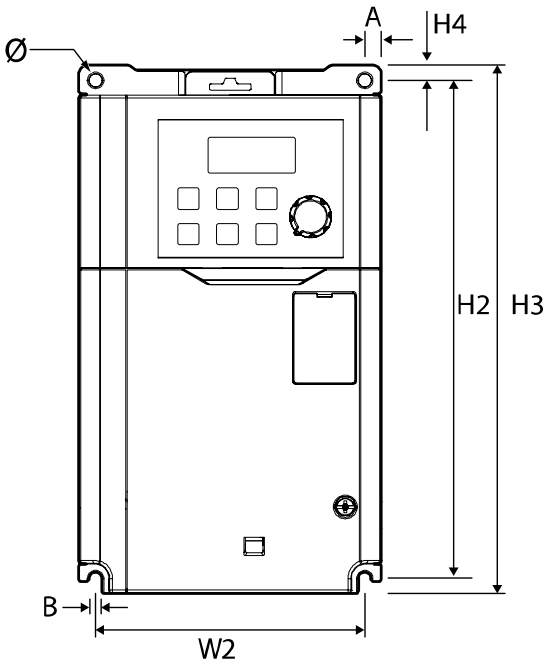


Model	W1	W2	H1	H2	H3	H4	D1	A	B	Ø
RSI-001-GM2-2C	3.39 (86.2)	3.00 (76.2)	6.06 (154)	6.06 (154)	6.46 (164)	0.2 (5)	5.18 (131.5)	0.2 (5)	0.18 (4.5)	0.18 (4.5)
RSI-002-GM2-2C										
RSI-001-GM2-4C										
RSI-002-GM2-4C										

Units: inches (mm)

3.0 HP ~ 5.0 HP, 240V/480V
2.2 kW ~ 4.0 kW

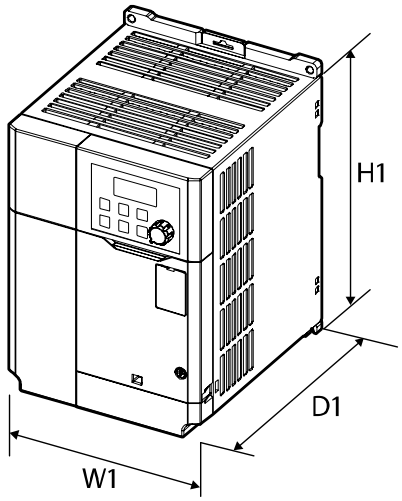


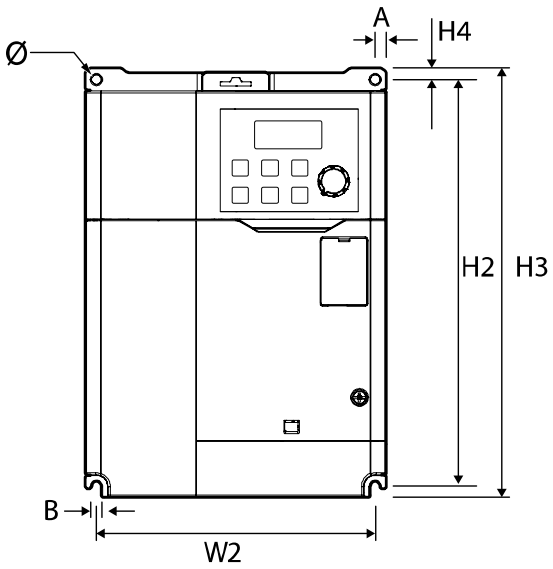


Model	W1	W2	H1	H2	H3	H4	D1	A	B	Ø
RSI-003-GM2-2C	3.98 (101	3.54 (90)	6.57 (167)	6.57 (167)	6.97 (177)	0.2 (5)	5.93 150.5)	0.22 (5.5)	0.18 (4.5)	0.18 (4.5)
RSI-005-GM2-2C										
RSI-003-GM2-4C										
RSI-005-GM2-4C										

Units: inches (mm)

7.5 HP, 240V/480V
5.5 kW

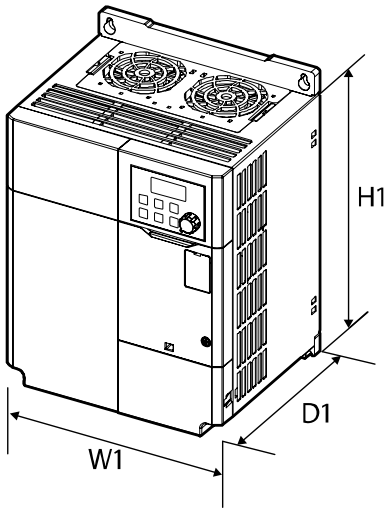


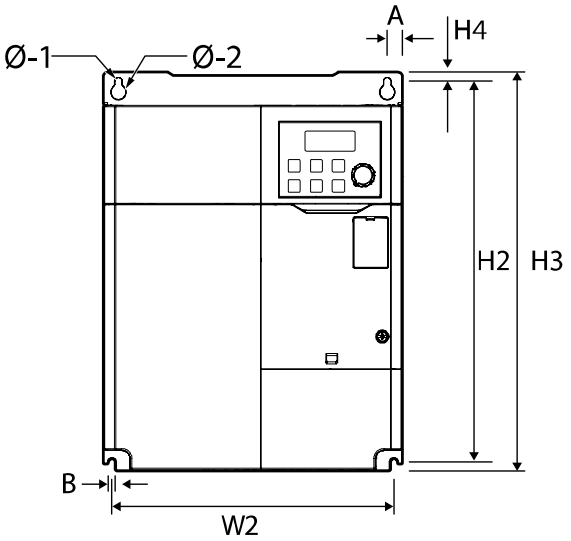


Model	W1	W2	H1	H2	H3	H4	D1	A	B	Ø
RSI-007-GM2-2C	5.31 (135)	4.92 (125)	7.2 (183)	7.2 (183)	7.6 (193)	0.2 (5)	5.93 (150.5)	0.2 (5)	0.18 (4.5)	0.18 (4.5)
RSI-007-GM2-4C										

Units: inches (mm)

10.0 HP ~ 15.0 HP, 240V/480V
7.5 kW ~ 11.0 kW





Model	W1	W2	H1	H2	H3	H4	D1	A	B	Ø
RSI-010-GM2-2C	7.09 (180)	Top: 6.38 (162)	8.66 (220)	9.04 (229.5)	9.45 (240)	0.22 (5.5)	5.67 (144)	Top: 0.35 (9)	0.18 (4.5)	Ø -1: 0.1 (4.5)
RSI-015-GM2-2C										
RSI-010-GM2-4C		Bottom: 6.70 (170)						Bottom: 0.20 (5)		Ø -2: 0.24 (6)
RSI-015-GM2-4C										

Units: inches (mm)

11.4 **Terminal Screw Specification**

Input/output Terminal Screw Specification

	Capacity				R/S/T, U/V/W Screw Size	Torque (lbf-in)
	Normal Duty		Heavy Duty			
	kW	HP	kW	HP		
3-phase 240V	0.75	1	0.4	0.5	M3	4.4
	1.5	2	0.75	1		
	2.2	3	1.5	2	M4	10.5
	4	5	2.2	3		
	5.5	7.5	4	5	M4	16
	7.5	10	5.5	7.5	M4	R/S/T : 12.1
	11	15	7.5	10		U/V/W : 13
3-phase 480V	0.75	1	0.4	0.5	M3.5	8.9
	1.5	2	0.75	1		
	2.2	3	1.5	2		
	4	5	2.2	3		
	5.5	7.5	4	5	M4	16
	7.5	10	5.5	7.5	M4	R/S/T : 12.1
	11	15	7.5	10		U/V/W : 13

Control Circuit Terminal Screw Specification

Terminals	Screw Size	Torque (lbf-in)
P1-P5/CM/VR/V1/I2/AO/24/S+/S-	M2	2.1
A1/B1/C1, A2/C2	M2.6	3.5

Caution

Apply rated torques to the terminal screws. Loose screws may cause short circuits and malfunctions. Tightening the screw too much may damage the terminals and cause short circuits and malfunctions. Use copper wires only with 600 V, 75℃ rating for the power terminal wiring, and 300 V, 75℃ rating for the control terminal wiring.

11.5 **Braking Resistor Specification**

	Inverter Capacity					
	Normal Duty		Heavy Duty			
	kW	HP	kW	HP	Resistance (Ω)	Rated Capacity (W)
3-phase 240V	0.75	1	0.4	0.5	300	100
	1.5	2	0.75	1	150	150
	2.2	3	1.5	2	60	300
	4	5	2.2	3	50	400
	5.5	7.5	4	5	33	600
	7.5	10	5.5	7.5	20	800
	11	15	7.5	10	15	1,200
3-phase 480V	0.75	1	0.4	0.5	1,200	100
	1.5	2	0.75	1	600	150
	2.2	3	1.5	2	300	300
	4	5	2.2	3	200	400
	5.5	7.5	4	5	130	600
	7.5	10	5.5	7.5	85	1,000
	11	15	7.5	10	60	1,200

The standard for braking torque is 150% at a working rate of 5% (%ED or duty cycle). If the ED% is increased to 10%, the rated capacity (W) of the brake resistor must be doubled.	
Related parameter Pr.66 (ED%)	Range 0 - 30%
Relay outputs OU.31 or OU.33 can be set to (31): DBWarn%ED which toggles the relay when duty cycle is exceeded.	

11.6 **Continuous Current Derating**

Derating based on Single Phase Input

A Single-phase power source can be safely applied to three-phase rated inverter's provided that care is taken to properly oversize the inverter. NOTE: The output is always three phase. Below is a summary of operating conditions that occur in the inverter when powered with a single-phase power source compared to a three-phase source. For more detail, see Benshaw Application Note - Sizing inverters for use with a Single-Phase Power Source.

Frequency - The DC bus ripple becomes 120 Hz vs. the normal 360 Hz. from a three-phase power source. The result is the DC bus ripple voltage is higher and the DC Bus circuit is subject to higher stress in order for the inverter to deliver equivalent power. Output current ratings are valid for a 60 Hz single-phase power source only.

Input Current - The input current through the two phases of the diode bridge converter will approximately double.

Harmonics - Input current harmonics increase resulting in current distortion levels of 90% THDi and greater compared to approximately 40% with a three-phase power source. The result is lower input power factor. A line reactor is always required. Size the reactor based on inverter rating.

Voltage - A stricter input voltage tolerance of –5% applies compared to -15% when powering the inverter with a three-phase power source. The average bus voltage will be lower than the equivalent from a three-phase power source. The minimum input voltage must be no less than 228Vac for 240 volt models and 456Vac for 480 volt models. It will be necessary to maintain a rigid incoming line voltage so that adequate motor voltage can be produced. To minimize the effect of voltage deprivation at the motor, consider operating the motor at reduced speed (reduced power) or using a motor with a base voltage that is lower than the incoming AC power source rating (EX: 480V source, 415V motor).

The result of all the above is that derating of the inverter's output current and horsepower is required. Improper selection of the inverter will result in poor performance and premature failure. Refer to the ratings table in the Technical Specifications Chapter. Identify the inverter's rated output current with single phase input conditions. This rating must meet or exceed the motor current rating.

Precautions

- Add a line reactor matched to the inverter rating. A three phase reactor can be wired as single phase. Connect single-phase power source to R(L1) and T(L3).
- Output current ratings are valid for a 60Hz power source only.
- Verify minimum input voltage.
- If an input phase open fault occurs, turn off the input phase open protection (Pr.05).
- Set Motor Data and Protections - Set the parameters that are related to motor
- information (dr.14, bA.11 ~ bA.16), overload trip (Pr.20 ~ Pr.22) and E-thermal functions (Pr.40 ~ Pr.43).

Derating based on Carrier Frequency

The continuous rated current of the inverter is limited based on the carrier frequency setting. Parameter Cn.04 allows for adjustment of the carrier frequency. The default setting is 2 kHz or 3 kHz depending on Load type (Normal or Heavy). Refer to the following table for derating of output current for carrier frequency settings above 4 kHz.

	Inverter Capacity				Current Derating %				
	Normal Duty		Heavy Duty		Carrier Frequency (kHz.)				
	kW	HP	kW	HP	1~4	5~6	9	12	15
3-phase 240V	0.75	1	0.4	0.5	100	100	91	81	72
	1.5	2	0.75	1	100	100	91	81	72
	2.2	3	1.5	2	100	100	91	81	72
	4	5	2.2	3	100	100	91	81	72
	5.5	7.5	4	5	100	93	83	73	62
	7.5	10	5.5	7.5	100	93	83	73	62
	11	15	7.5	10	100	91	79	69	58
3-phase 480V	0.75	1	0.4	0.5	100	100	91	81	72
	1.5	2	0.75	1	100	100	91	81	72
	2.2	3	1.5	2	100	100	91	81	72
	4	5	2.2	3	100	100	91	81	72
	5.5	7.5	4	5	100	100	85	70	58
	7.5	10	5.5	7.5	100	93	83	73	62
	11	15	7.5	10	100	89	72	59	48

Derating based on Input Voltage

The continuous rated current of the inverter can be limited when higher than normal input voltages are applied. Parameter bA.19, Input Voltage settings are 240V and 480V maximum. For input voltages higher than the 240V and 480V ratings, up to a maximum of +10%, refer to the following table for current derating percentages.

	Inverter Capacity				Current Derating (%)
	Normal Duty		Heavy Duty		
	kW	HP	kW	HP	
3-phase 240V	0.75	1	0.4	0.5	88
	1.5	2	0.75	1	88
	2.2	3	1.5	2	88
	4	5	2.2	3	94
	5.5	7.5	4	5	96
	7.5	10	5.5	7.5	85
	11	15	7.5	10	85
3-phase 480V	0.75	1	0.4	0.5	74
	1.5	2	0.75	1	86
	2.2	3	1.5	2	84
	4	5	2.2	3	85
	5.5	7.5	4	5	93
	7.5	10	5.5	7.5	81
	11	15	7.5	10	77

Derating based on Ambient Temperature

The continuous rated output current of the inverter is limited when installed in an environment with higher than normal ambient temperatures. The operating temperature rating of the inverters is 104°F (40°C). The required derating is 2% output amps for every degree above 104°F (40°C), up to a maximum of 122°F (50°C).

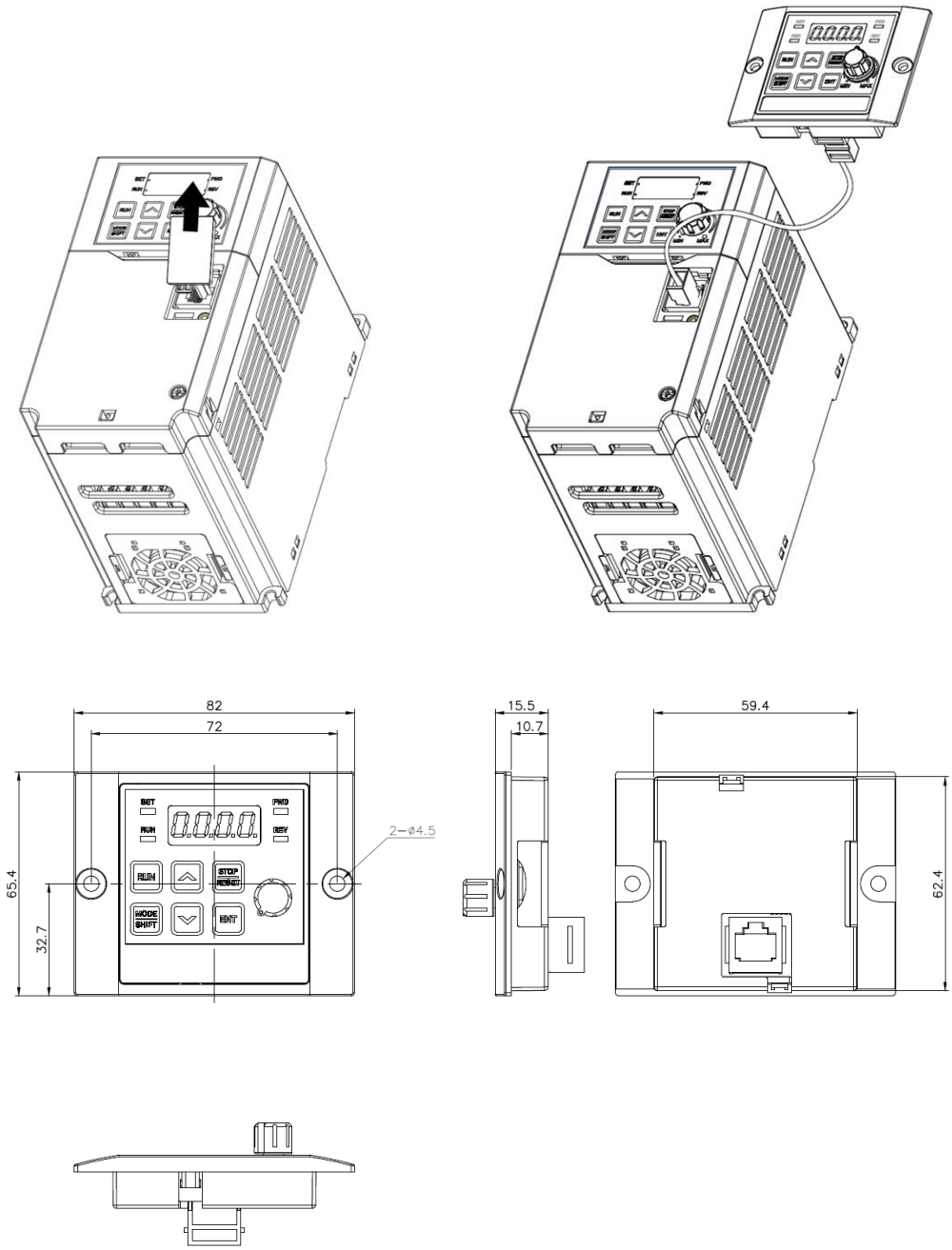
11.7 **Heat Emission**

The following table provides data on the heat generated by the inverters. Heat emissions are based on operation at room temperature and the carrier frequency set at default.

	Inverter Capacity						Efficiency (%)	Total Losses (W)	Internal Losses (W)	External Losses (W)
	Normal Duty			Heavy Duty						
	kW	HP	Amps	kW	HP	Amps				
3-phase 240V	0.75	1	3.1	0.4	0.5	2.5	96.40	22	17	6
	1.5	2	6	0.75	1	5	96.40	45	17	28
	2.2	3	9.6	1.5	2	8	96.70	79	17	62
	4	5	12	2.2	3	11	96.70	117	17	99
	5.5	7.5	18	4	5	17	96.80	208	18	190
	7.5	10	30	5.5	7.5	24	96.90	281	19	262
	11	15	40	7.5	10	32	96.90	382	19	364
3-phase 480V	0.75	1	2	0.4	0.5	1.3	96.00	24	17	7
	1.5	2	3.1	0.75	1	2.5	96.80	42	17	24
	2.2	3	5.1	1.5	2	4	97.30	71	18	53
	4	5	6.9	2.2	3	5.5	97.50	99	18	81
	5.5	7.5	10	4	5	9	97.60	176	19	157
	7.5	10	16	5.5	7.5	12	97.80	231	20	211
	11	15	23	7.5	10	16	97.80	315	20	295

11.8 **Remote Keypad Option**

The remote keypad kit includes the keypad and choice of cable lengths of 1 m, 2 m, 3 m, or 5 m.



Units: mm

Installation

1. Remove the RJ45 terminal cover on the inverter I/O cover. Connect the remote keypad cable to the I/O RJ45 connector.
2. Connect the other end of the cable to the remote keypad.

Enable

1. When the remote keypad is connected and power applied to the inverter, the inverter keypad buttons and potentiometer are disabled. These functions are replaced by the buttons and potentiometer on the remote keypad.
   - Within 2 seconds of attaching the remote keypad, operation is now from the remote keypad.
   - NOTE: If the frequency reference source (parameter Frq) is set to (4) V0 potentiometer, the frequency reference will instantly switch between the inverter keypad and the remote keypad when attaching (and detaching). Be cautious of the potentiometer setting to prevent the motor from running at an undesireable frequency.
   - If communication is not linked between the inverter and the remote keypad, "E.vEr" is displayed on the 7-Seg of the remote keypad.
2. **Up Loading parameters**: Set dr.91 parameter to 4 (Remote UpLoad) to copy the parameter settings saved in the inverter to the remote keypad.
   - “r-UL” is displayed on the inverter 7-Seg display while upload is in progress. “d” is displayed on the remote 7-Seg display. When complete, the message disappears and the default screen is displayed.
   - If there is a communication error while uploading, a warning message saying "Fail" is displayed for 3 seconds, and saving the parameters to the remote keypad failed.
3. **Down Loading parameters**: After connecting the remote keypad with saved parameters, set dr.91 parameter to 5 (Remote DownLoad) to copy the parameter settings saved in the remote keypad to the inverter.
   - While saving, a message saying “W-dL” is displayed on the inverter 7-Seg display. "U" is displayed on the 7-Seg display of the remote keypad. When complete, the message disappears and the default screen is displayed. If parameter data was not previously saved in the remote keypad, you cannot set the dr.91 parameter to 5 for down loading.
   - If there is a communication error with the remote keypad, a warning message saying "Fail" is displayed for 3 seconds, and saving the parameters to the inverter failed.
   - If the parameter code version (dr.97, dr.98) or the inverter model is different (copying parameters between 200V ⇄ 400V products), the WErr warning is displayed for 5 seconds and saving parameters to the inverter fails.

UL mark

The UL mark applies to products in the United States and Canada. This mark indicates that UL has tested and evaluated the products and determined that the products satisfy the UL standards for product safety. If a product received UL certification, this means that all components inside the product had been certified for UL standards as well.

Suitable for Installation in a compartment Handing Conditioned Air

CE mark

The CE mark indicates that the products carrying this mark comply with European safety and environmental regulations. European standards include the Machinery Directive for machine manufacturers, the Low Voltage Directive for electronics manufacturers and the EMC guidelines for safe noise control.

Low Voltage Directive
We have confirmed that our products comply with the Low Voltage Directive (EN 61800-5-1).

EMC Directive
The Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3) covers requirements stated for drives.

EAC mark

The EAC (EurAsian Conformity) mark is applied to the products before they are placed on the market of the Eurasian Customs Union member states.
It indicates the compliance of the products with the following technical regulations and requirements of the Eurasian Customs Union:
Technical Regulations of the Customs Union 004/2011 “On safety of low voltage equipment”
Technical Regulations of the Customs Union 020/2011 “On electromagnetic compatibility of technical products”

Manual Revision History

Revision History

No	Date	Edition	Changes
0	8/30/2020	Initial Release	Software Ver. 21.10

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