Rsi S Series

Low Voltage
Variable Frequency Drive

Instruction Manual

890049-00-00

BENSHAW®
ADVANCED CONTROLS & DRIVES

Safety Information

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

Safety symbols in this manual

Danger

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

Warning

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

Caution

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

Safety information

Danger

- Do not open the cover of the equipment while it is on or operating. Likewise, do not operate the inverter while the cover is open. Exposure of high voltage terminals or charging area to the external environment may result in an electric shock. Do not remove any covers or touch the internal circuit boards (PCBs) or electrical contacts on the product when the power is on or during operation. Doing so may result in serious injury, death, or serious property damage.
- Do not open the cover of the equipment even when the power supply to the inverter has been turned off unless it is necessary for maintenance or regular inspection. Opening the cover may result in an electric shock even when the power supply is off.
- The equipment may hold charge long after the power supply has been turned off. Use a multi-meter to make sure that there is no voltage before working on the inverter, motor or motor cable.

Warning

- This equipment must be grounded for safe and proper operation.
- Do not supply power to a faulty inverter. If you find that the inverter is faulty, disconnect the power supply and have the inverter professionally repaired.
- The inverter becomes hot during operation. 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 inverter with wet hands. Doing so may result in electric shock.
- Check the information about the protection level for the circuits and devices.

  The following connection terminals and devices are the Electrical Protection level 0 per IEC -61140. This means that the circuit protection level depends on the basic insulation. If there is no basic insulation this may cause electric shock. When installing or wiring the connection terminals and devices, take the same protective action as with the power wire.

  - Multi-function Input: P1-P5, CM
  - Analog Frequency Input: VR, V1, I2, TI
  - Safety Function: SA, SB, SC
  - Analog Output: AO, TO
  - Contact: Q1, EG, 24, A1, B1, C1, S+, S-, SG
  - Fan

- The protection level of this equipment (inverter) is the Electrical Protection level I.

Caution

- Do not modify the interior workings of the inverter. Doing so will void the warranty.
- The inverter is designed for 3-phase motor operation. Do not use the inverter to operate a single phase motor.
- Do not place heavy objects on top of electric cables. Doing so may damage the cable and result in an electric shock.

Note – Short Circuit Current Rating, SCCR
Maximum allowed prospective short-circuit current at the input power connection is defined in IEC 60439-1 as 100 kA. Depending on the selected MCCB, the “S” Series inverter is suitable for use in circuits capable of delivering a maximum of 100 kA RMS symmetrical amperes when protected by a 100 kaic rated breaker or fuses.

Quick Reference Table

The following table contains situations frequently encountered while working with inverters. Refer to the situations in the table to quickly and easily locate answers to your questions.

Situation	Reference
I want to run a slightly higher rated motor than the inverter's rated capacity.	p.348
I want to configure the inverter to start operating as soon as the power source is applied.	p. 81
I want to configure the motor's parameters.	p.143
I want to set up sensorless vector control.	p.146
Something seems to be wrong with the inverter or the motor.	p.336
What is auto tuning?	p.143
What are the recommended wiring lengths?	p. 24
The motor is too noisy.	p. 176
I want to apply PID control on my system.	p. 135
What are the factory default settingss for P1–P5 multi-function terminals?	p. 27
I want to view all of the parameters I have modified.	p. 186
I want to review recent fault and warning histories.	p. 302
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I want to install a frequency meter using an analog terminal.	p. 29
I want to display the supply current to motor.	p. 55
I want to operate the inverter using a multi-step speed configuration.	p. 75
The motor runs too hot.	p. 213
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1 Preparing the Installation

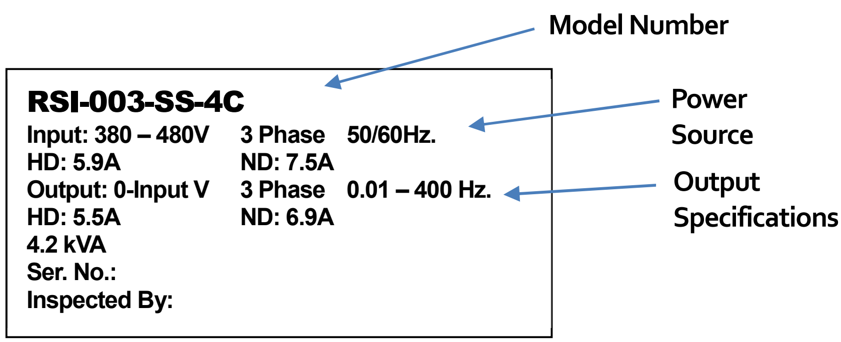
This chapter provides details on product identification, part names, correct installation and cable specifications. To install the inverter correctly and safely, carefully read and follow the instructions.

1.1 Product Identification

Product name and specifications are detailed on the nameplate (label). The illustration below shows the nameplate. Check the nameplate before installing the product and make sure that the product meets your requirements. For more detailed product specifications, refer to 11.1 *Drive Ratings*.

Note

Check the product name, open the packaging, and then confirm that the product is free from defects. Contact your supplier if you have any issues or questions about your product.



RSI – 003 – SS – 4 – C

<u>RSI</u> – Benshaw **R**edi **S**tart **I**nverter

<u>003</u> – HP
001 – 1 HP
002 – 2 HP
003 – 3 HP
005 – 5 HP
007 – 7.5 HP
010 – 10 HP

<u>SS</u> – Benshaw "S" Series

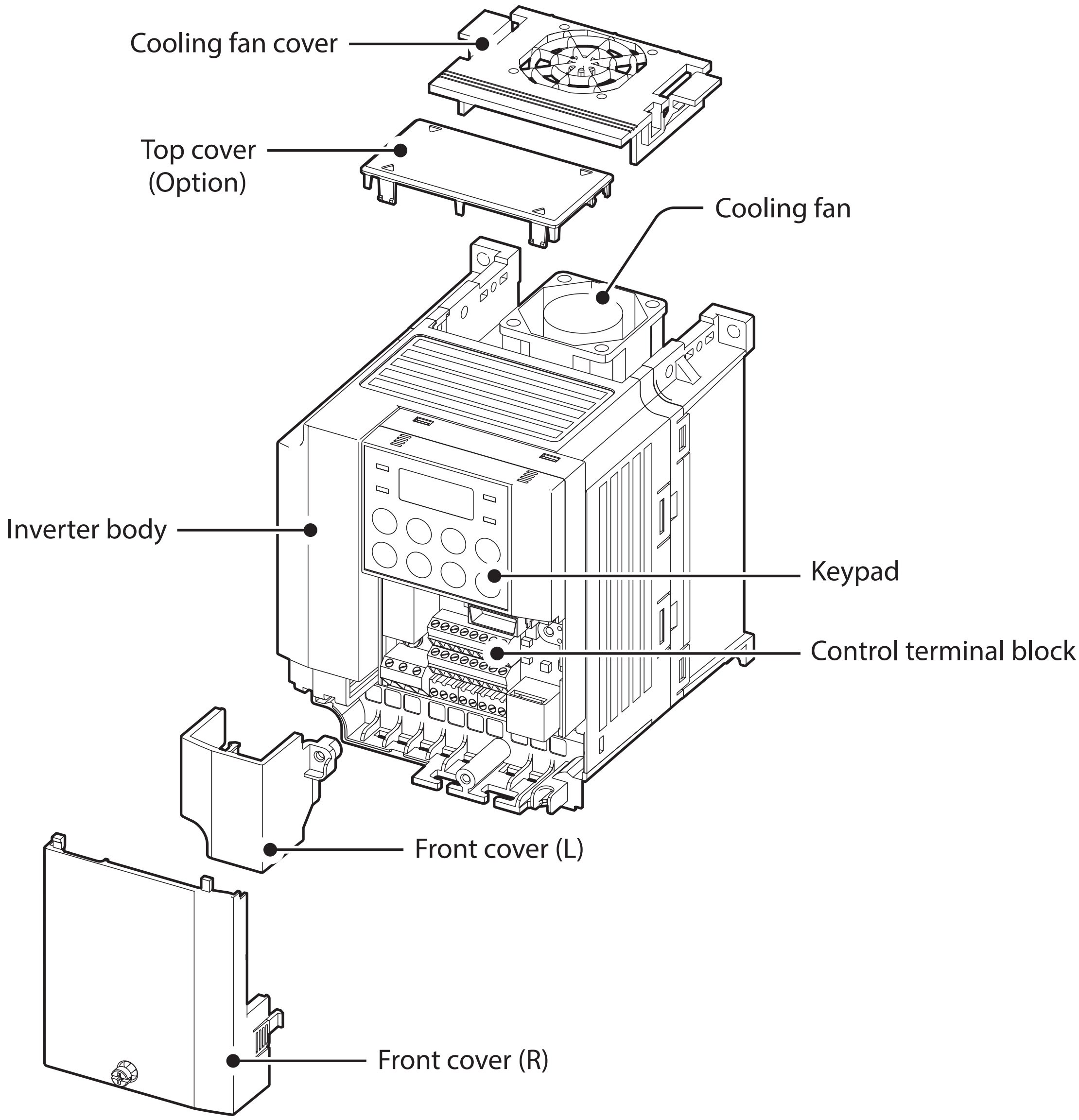
<u>4</u> – Voltage Class: 2 – 240V
4 – 480V

<u>C</u> – Open Chassis (Nema/UL Open type, IP-00)

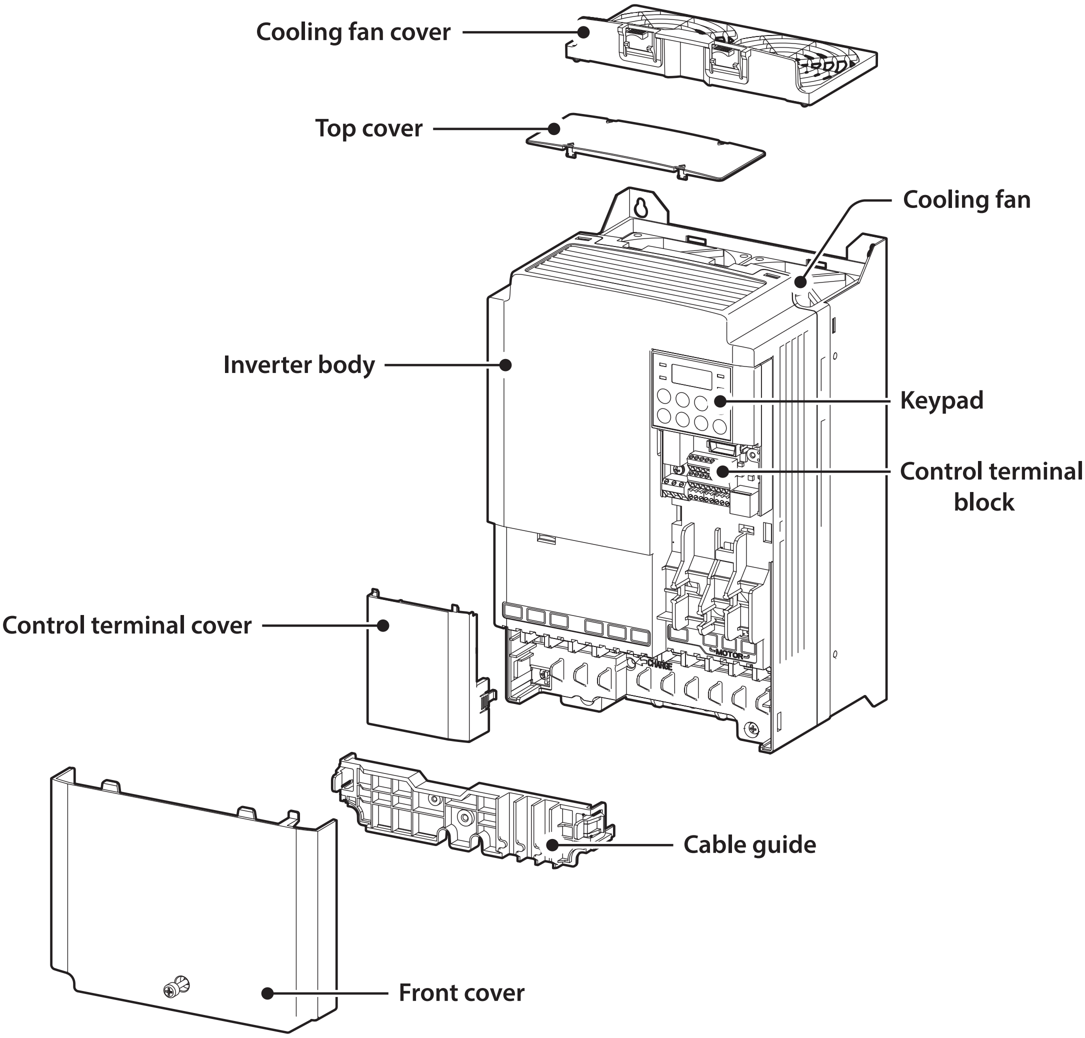
1.2 Part Names

The illustration below displays part names. Details may vary between product groups.

Three Phase 230V / 460V
0.5 HP~5 HP (0.4~3.7kW)



Three Phase 230V / 460V
7.5 HP~ 10 HP (5.5–7.5kW)

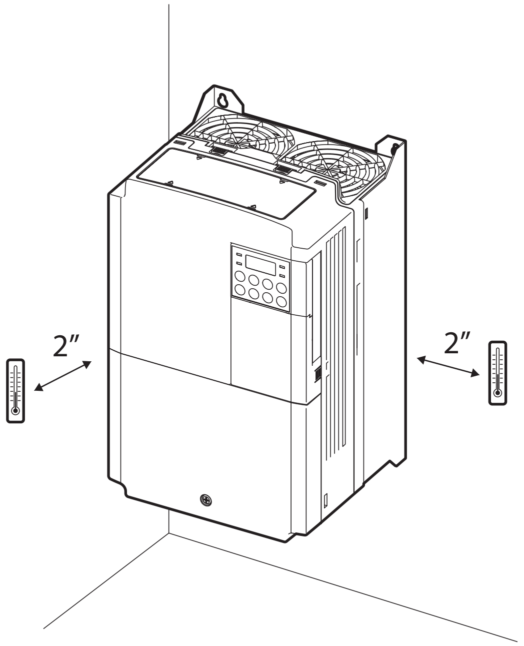


1.3 Installation Considerations

The environment can significantly impact the lifespan and reliability of the product. The table below details the ideal operation and installation conditions for the inverter.

Items	Description
Ambient Temperature*	Heavy Duty: 14–104°F (-10–40℃) Normal Duty: 14–122°F (-10–50℃)
Ambient Humidity	90% relative humidity (no condensation)
Storage Temperature	- 4–149°F (-20–65℃)
Environmental Factors	An environment free from corrosive or flammable gases, oil residue or dust
Altitude/Vibration	Lower than 3,280 ft (1,000 m) above sea level/less than 1G (9.8m/sec^2)
Air Pressure	20.7 – 31.3 inHg (10 – 15 PSI, 70 –106kPa)

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



See side by side installation on pages 7 and 8.

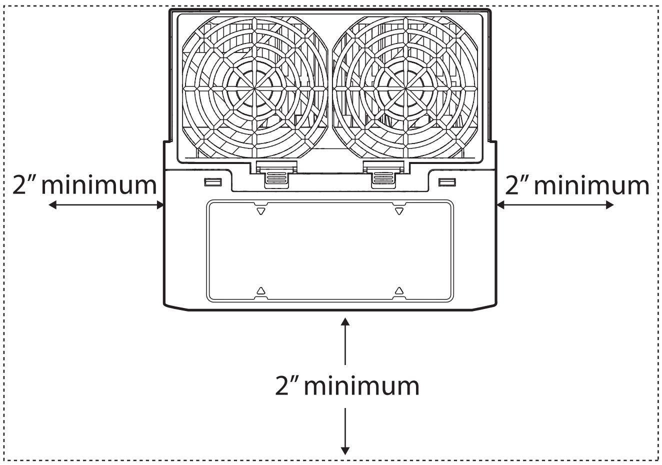
Caution

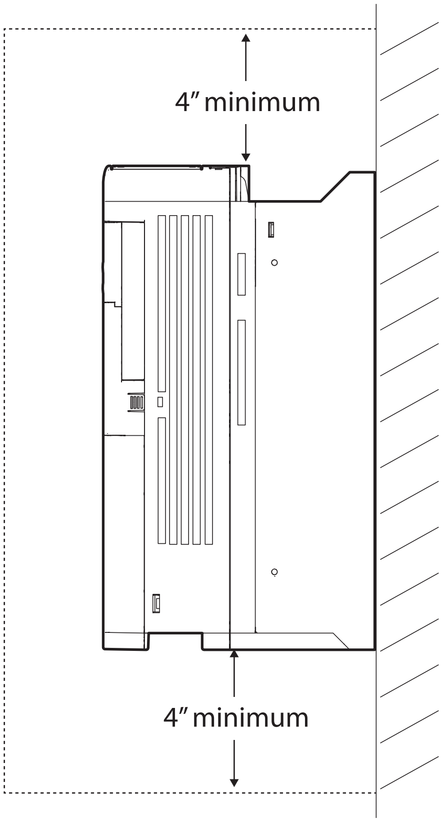
Do not allow the ambient temperature to exceed the allowable range while operating the inverter.

1.4 Selecting and Preparing a Site for Installation

When selecting an installation location consider the following points:

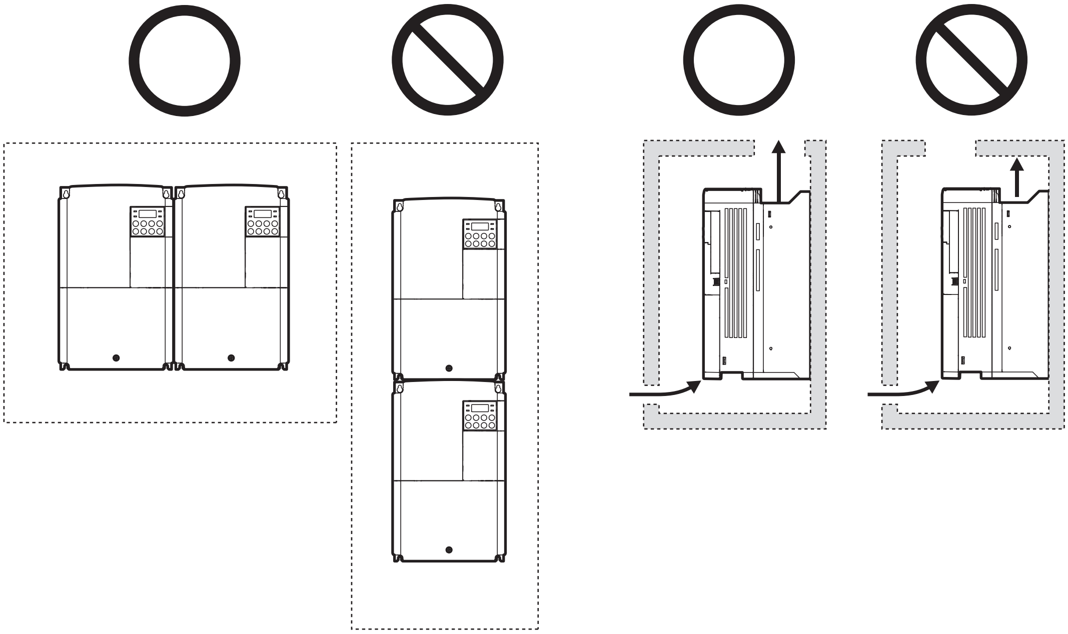
- The inverter must be installed on a wall that can support the inverter's weight.
- The location must be free from vibration. Vibration can adversely affect the long term operation of the inverter.
- The inverter can become very hot during operation. Install the inverter on a surface that is fire-resistant or flame-retardant and with sufficient clearance around the inverter to allow air to circulate. The illustrations below detail the required installation clearances.





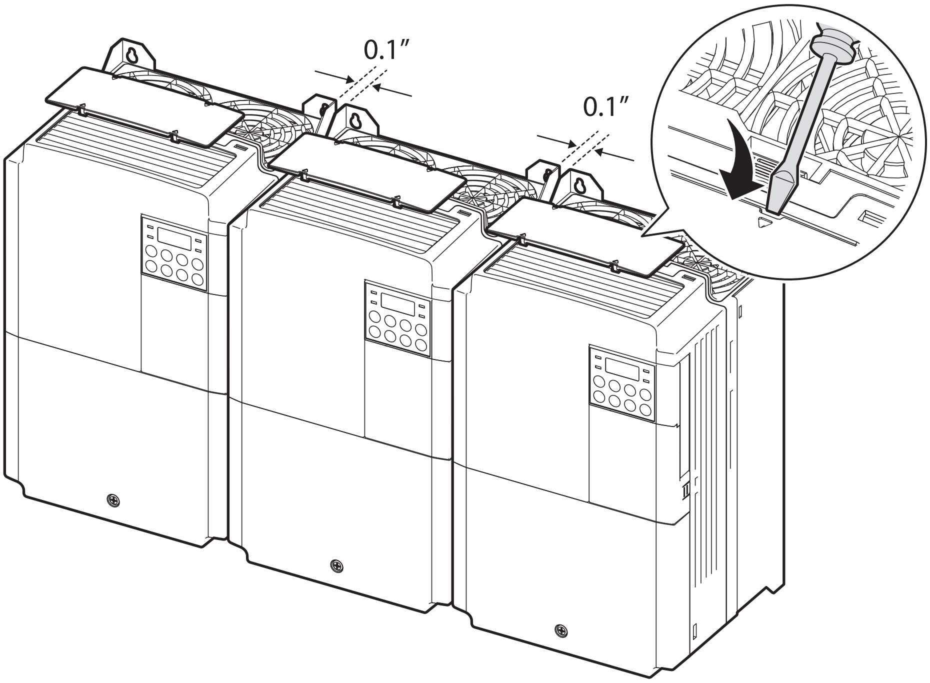
See side by side installation on pages 7 and 8.

- Ensure sufficient air circulation is provided around the inverter when it is installed. If the inverter is to be installed inside a panel, enclosure, or cabinet rack, carefully consider the position of the inverter's cooling fan and the ventilation louver. The cooling fan must be positioned to efficiently transfer the heat generated by the operation of the inverter.

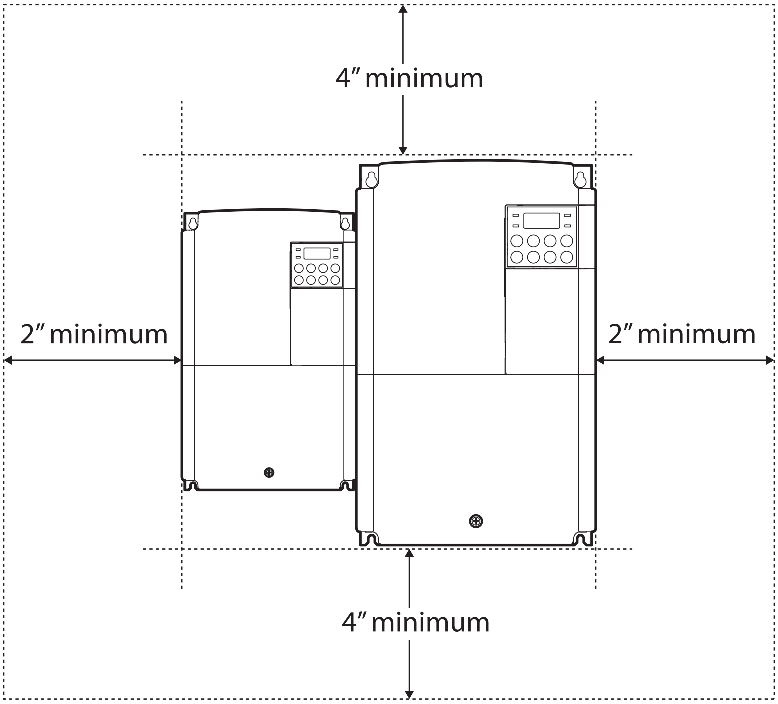


See side by side installation on pages 7 and 8.

- If you are installing multiple inverters in one location, arrange them side-by-side and remove the top covers. The top covers MUST be removed for side-by-side installations. Use a flat head screwdriver to remove the top covers.



- If you are installing multiple inverters, of different ratings, provide sufficient clearance 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 600V, 75℃ for power terminal wiring.
- Use copper cables rated for 300V, 75℃ for control terminal wiring.

Ground Cable and Power Cable Specifications

<table>
<tr><th colspan="3">Load</th><th colspan="2">Ground</th><th colspan="4">Power I/O</th></tr>
<tr><th colspan="3"></th><th rowspan="2">mm²</th><th rowspan="2">AWG</th><th colspan="2">mm²</th><th colspan="2">AWG</th></tr>
<tr><th></th><th>HP</th><th>kW</th><th>R/S/T</th><th>U/V/W</th><th>R/S/T</th><th>U/V/W</th></tr>
<tr><td rowspan="8">3–Phase 200V</td><td>0.5</td><td>0.4</td><td rowspan="6">4</td><td rowspan="6">12</td><td rowspan="4">2</td><td rowspan="4">2</td><td rowspan="4">14</td><td rowspan="4">14</td></tr>
<tr><td>1</td><td>0.75</td></tr>
<tr><td>2</td><td>1.5</td></tr>
<tr><td>3</td><td>2.2</td></tr>
<tr><td>5</td><td>3.7</td><td rowspan="2">3.5</td><td rowspan="2">3.5</td><td rowspan="2">12</td><td rowspan="2">12</td></tr>
<tr><td>5.4</td><td>4</td></tr>
<tr><td>7.5</td><td>5.5</td><td rowspan="2">5.5</td><td rowspan="2">10</td><td rowspan="2">6</td><td rowspan="2">6</td><td rowspan="2">10</td><td rowspan="2">10</td></tr>
<tr><td>10</td><td>7.5</td></tr>
<tr><td rowspan="9">3–Phase 400V</td><td>0.5</td><td>0.4</td><td rowspan="6">4</td><td rowspan="6">12</td><td rowspan="6">2</td><td rowspan="6">2</td><td rowspan="6">14</td><td rowspan="6">14</td></tr>
<tr><td>1</td><td>0.75</td></tr>
<tr><td>2</td><td>1.5</td></tr>
<tr><td>3</td><td>2.2</td></tr>
<tr><td>5</td><td>3.7</td></tr>
<tr><td></td><td></td></tr>
<tr><td>7.5</td><td>5.5</td><td rowspan="3">4</td><td rowspan="3">12</td><td>2.5</td><td>2.5</td><td>14</td><td>14</td></tr>
<tr><td>10</td><td>7.5</td><td rowspan="2">4</td><td rowspan="2">4</td><td rowspan="2">12</td><td rowspan="2">12</td></tr>
<tr><td></td><td></td></tr>
</table>

Signal (Control) Cable Specifications

<table>
<tr><th rowspan="3">Terminals</th><th colspan="4">Signal Cable</th></tr>
<tr><th colspan="2">Without Crimp Terminal Connectors (Bare wire)</th><th colspan="2">With Crimp Terminal Connectors (Bootlace Ferrule)</th></tr>
<tr><th>mm²</th><th>AWG</th><th>mm²</th><th>AWG</th></tr>
<tr><td>P1~P5*/CM/VR/V1/I2 /AO/Q1/EG/24/TI/TO* /SA,SB,SC/S+,S-,SG</td><td>0.75</td><td>18</td><td>0.5</td><td>20</td></tr>
<tr><td>A1/B1/C1</td><td>1.0</td><td>17</td><td>1.5</td><td>15</td></tr>
</table>

* Refer to *Step 4 Control Terminal Wiring.*

2 Installing the Inverter

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

Installation Flowchart

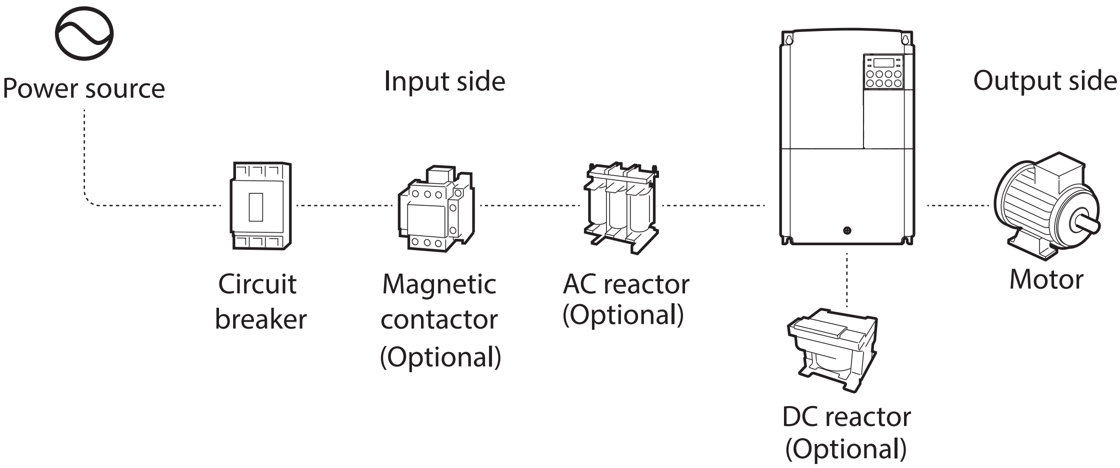
The flowchart lists the sequence to be followed during installation. The steps cover equipment installation and testing of the product. More information on each step is referenced in the steps.

* Product Identification (p.1)
↓
Select the Installation Location (p.4)
↓
Mounting the Inverter (p.13)
↓
Wiring the Ground Connection (p.21)
↓
Power and Signal Wiring (p.22)
↓
Post-Installation Checks (p.35)
↓
Turning on the Inverter
↓
Parameter Configuration (p.47)
↓
Testing (p.37)

Basic Configuration Diagram

The reference diagram below shows a typical system configuration showing the inverter and peripheral devices.

Prior to installing the inverter, ensure that the product is suitable for the application (power rating, capacity, etc). Ensure that all of the required peripheral devices (breakers, contactors, etc.) and optional devices (filters, brake resistors, etc.) are sized correctly. For more details on peripheral devices, refer to *11.4 Fuse and Reactor Specifications*.



Caution

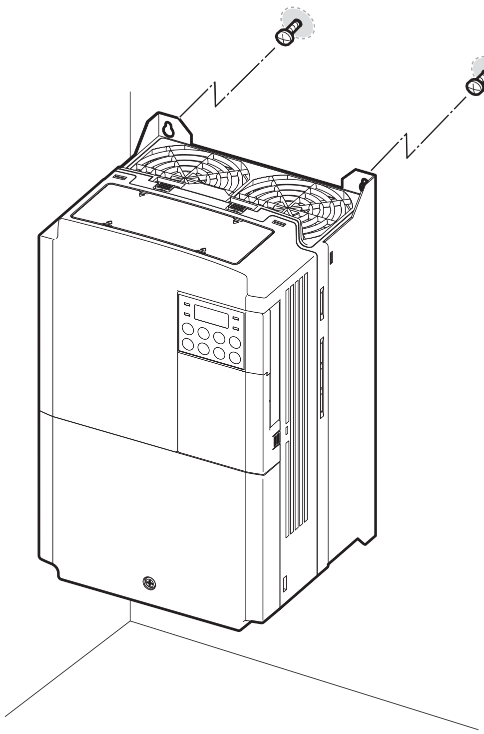
- Figures in this manual are shown with covers or circuit breakers removed to show a more detailed view of the installation arrangements. Install covers and circuit breakers before operating the inverter. Operate the product according to the instructions in this manual.
- Do not start or stop the inverter using a magnetic contactor installed on the input power supply.
- 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. Note that reactors may be installed within 30 ft (9.14 m) from the power source if the input power exceeds 10 times of inverter capacity. Refer to 11.4 *Fuse and Reactor* Specification and carefully select a reactor that meets the requirements.

2.1 Mounting the Inverter

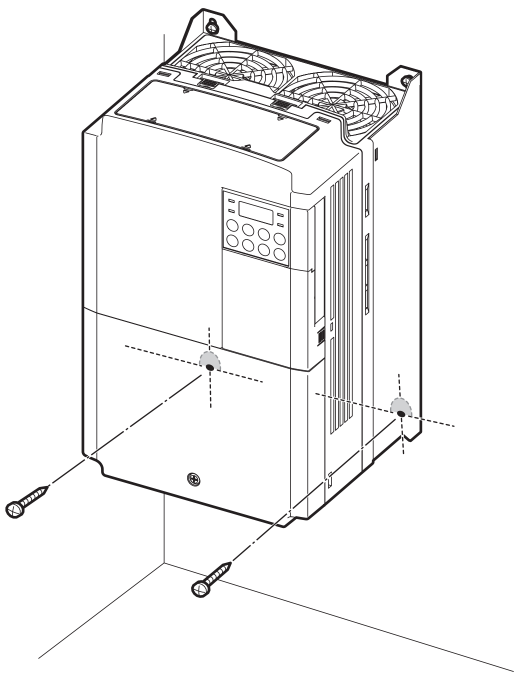
Mount the inverter on a wall or inside a panel following the procedures provided below. Before installation, ensure that there is sufficient space to meet the clearance specifications, and that there are no obstacles impeding the cooling fan's air flow.
Select a wall or panel suitable to support the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

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



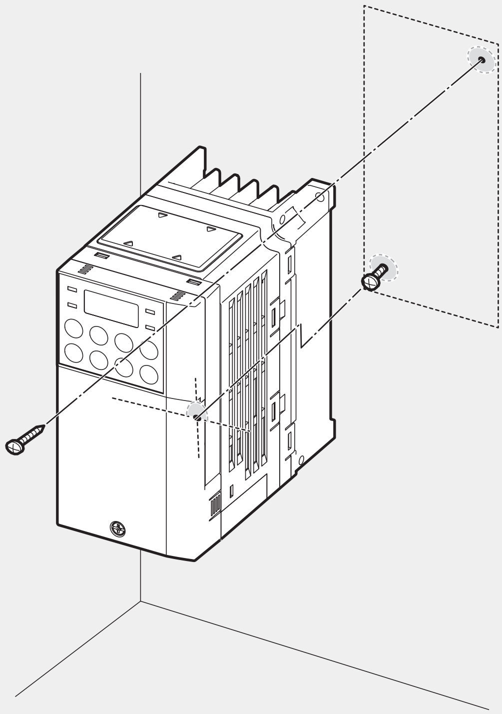
3 Mount the inverter on the wall or inside a panel using the two upper bolts, and then fully tighten the mounting bolts. Ensure that the inverter is placed flat on the mounting surface, and that the installation surface can securely support the weight of the inverter.



Note

The quantity and dimensions of the mounting brackets vary based on frame size. Refer to o_

External Dimensions for detailed information about your model.

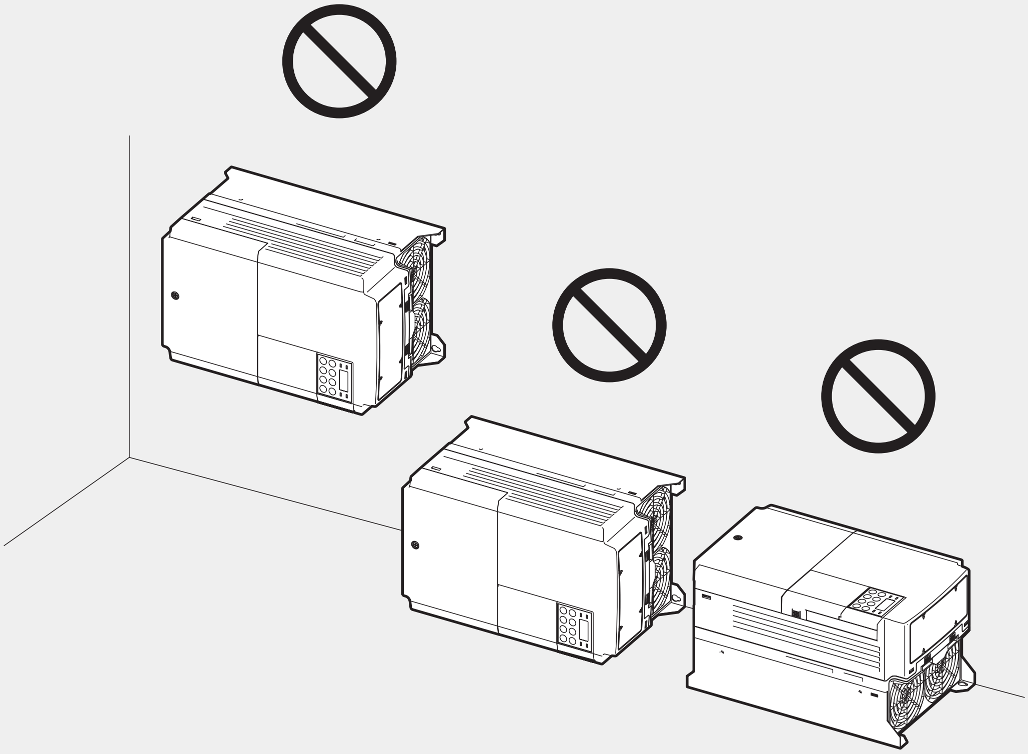


Inverters with small frames (0.4–0.8kW) have only two mounting brackets. Inverters with large frames have 4 mounting brackets.

ⓘ Caution

- Do not transport the inverter by lifting with the inverter's covers or plastic surfaces. The inverter may tip over if covers break, causing injuries or damage to the product. Always support the inverter using the metal frames when moving it.
- Hi-capacity inverters are very heavy and bulky. Use an appropriate transport method that is suitable for the weight.

- Do not install the inverter on the floor or mount it sideways against 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 Cable Wiring

Open the front cover, remove the cable guides and control terminal cover, and then install the ground connection as specified. Complete the cable connections by connecting an appropriately rated cable to the terminals on the 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

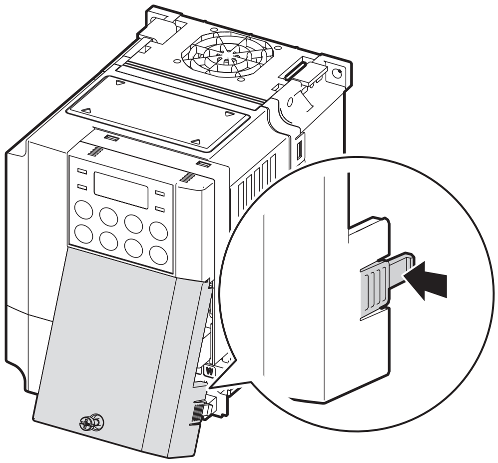
- Install the inverter before carrying out wiring connections.
- Ensure that no small metal debris, such as wire cut-offs, remain inside the inverter. Metal debris in the inverter may cause inverter failure.
- Tighten terminal screws to their specified torque. Loose terminal block screws may allow the cables to disconnect and cause short circuit or inverter failure. Refer to *11.5 Terminal Screw S* for torque specifications.
- Do not place heavy objects on top of electric cables. Heavy objects may damage the cable and result in electric shock.
- The power supply system for this equipment (inverter) is a grounded system. Only use a grounded power supply system for this equipment (inverter). Do not use a TT, TN, IT, or corner grounded system with the inverter.
- 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 600V, 75℃ for power terminal wiring.
- Use copper cables rated at 300V, 75℃ for control terminal wiring.
- Separate control circuit wires from the main circuits and other high voltage circuits.
- Check for short circuits or wiring failure in the control circuit. They could cause system failure or device malfunction.
- Use shielded cables when wiring the control circuit. Failure to do so may cause malfunction due to interference. If a ground is needed, use STP (Shielded Twisted Pair) 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.

Step 1 Front Cover, Control Terminal Cover and Cable Guide

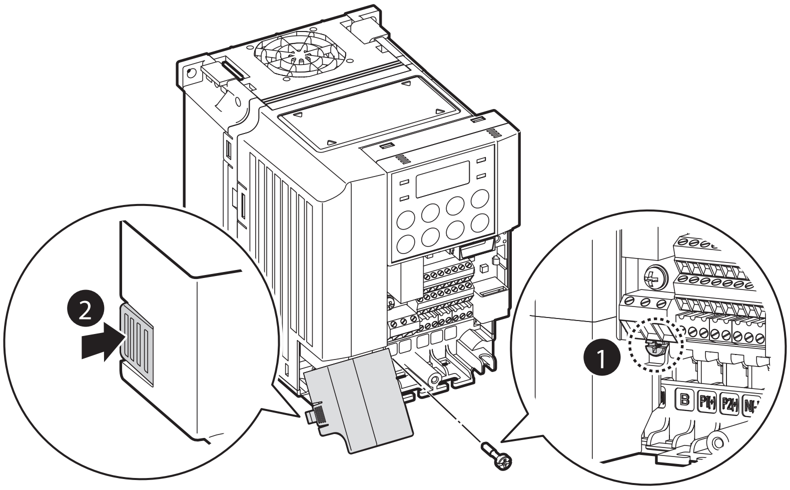
The front cover, control terminal cover and cable guide must be removed to install cables. Refer to the following procedures to remove the covers and cable guide. The steps to remove these parts may vary depending on the inverter model.

<u>**0.5HP~3HP (0.4–2.2kW) 3-phase**</u>

1 Loosen the bolt that secures the front cover (right side). 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.



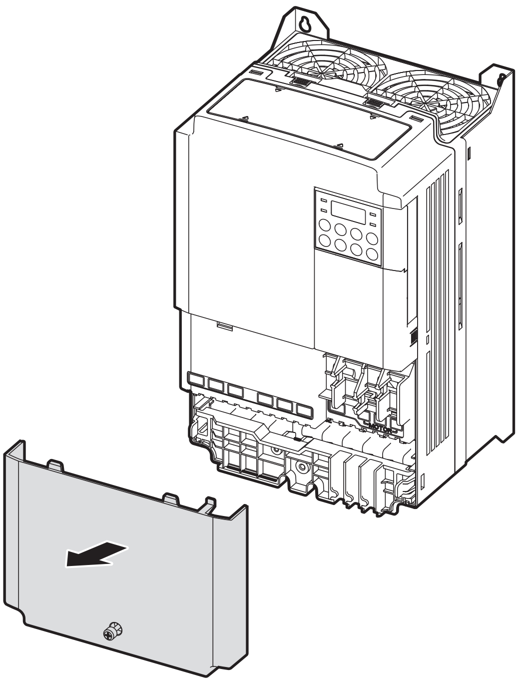
2 Remove the bolt that secures the front cover (left side) (❶). Push and hold the latch on the left side of the cover. Then remove the cover by lifting it from the bottom and moving it away from the front of the inverter (❷).



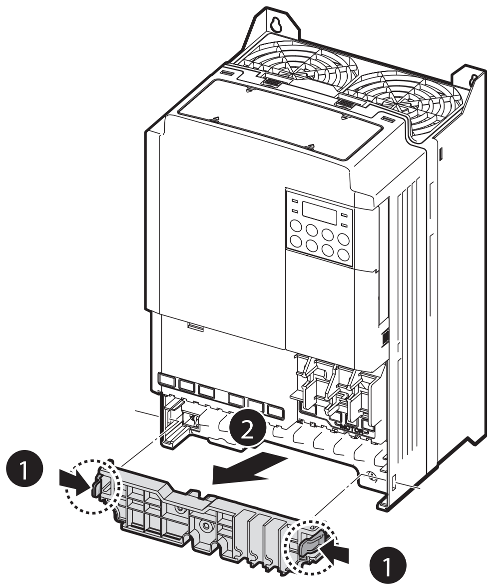
3 Connect the cables to the power terminals and the control terminals. For cable specifications, refer to 1.5 *Cable Selection*.

5HP~10HP (3.7–7.5kW) 3-phase

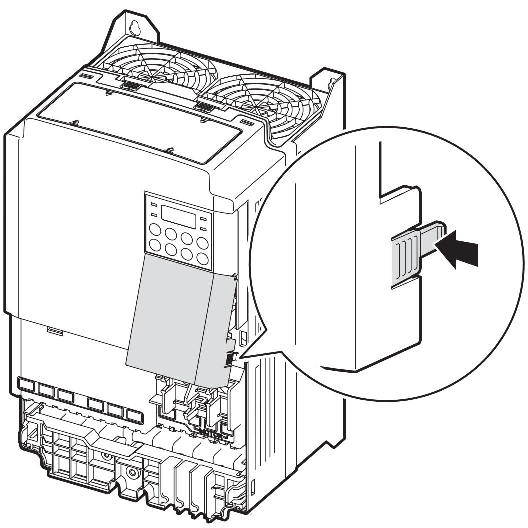
1 Loosen the bolt that secures the front cover. Then remove the cover by lifting it from the bottom and away from the front.



2 Push and hold the levers on both sides of the cable guide (❶) and then remove the cable guide by pulling it directly away from the front of the inverter (❷). In some models where the cable guide is secured by a bolt, remove the bolt first.



3 Push and hold the tab on the right side of the control terminal cover. Then remove the cover by lifting it from the bottom and moving it away from the front of the inverter.



4 Connect the cables to the power terminals and the control terminals. For cable specifications, refer to 1.5 *Cable Selection*.

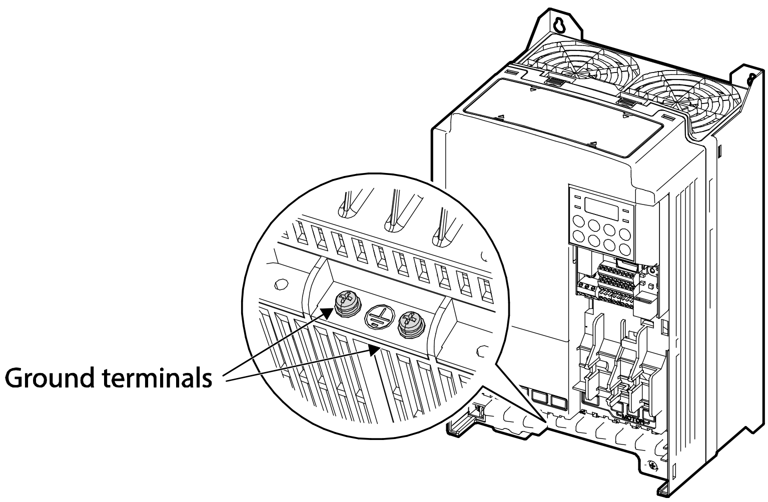
Step 2 Ground Connection

Remove the front cover(s), cable guide, and the control terminal cover. Then follow the instructions below to install the ground connection for the inverter.

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

Note

To connect an LCD keypad, remove the plastic knock-out from the bottom of the front cover (right side) or from the control terminal cover. Then connect the signal cable to the RJ-45 port on the control board.



2 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 < 10Ω.

⚠ Warning

Install ground connections for the inverter and the motor by following the correct specifications to ensure safe and accurate operation. Using the inverter and the motor without the specified grounding connections may result in electric shock.

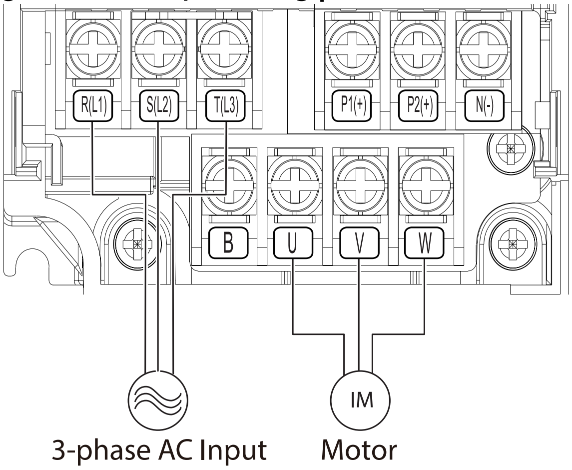
Step 3 Power Terminal Wiring

The following illustration shows the terminal layout on the power terminal block. Refer to the detailed 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* before installing them.

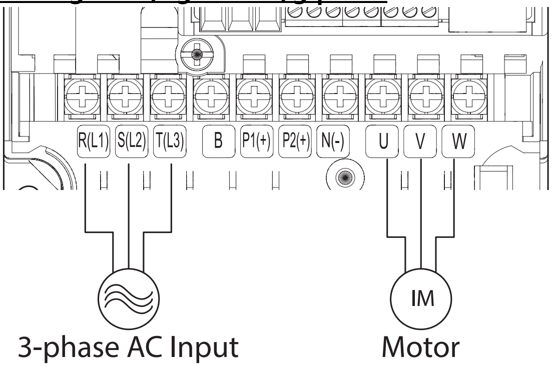
Caution

- 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 malfuctions.
- Use copper wires only with 600V, 75℃ rating for the power terminal wiring, and 300V, 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. Connecting them to the output (U, V, W terminals) will cause damage to the inverter. Arrangement of the input phase sequence is not critical.
- Motor must be connected to the U, V, and W Terminals.

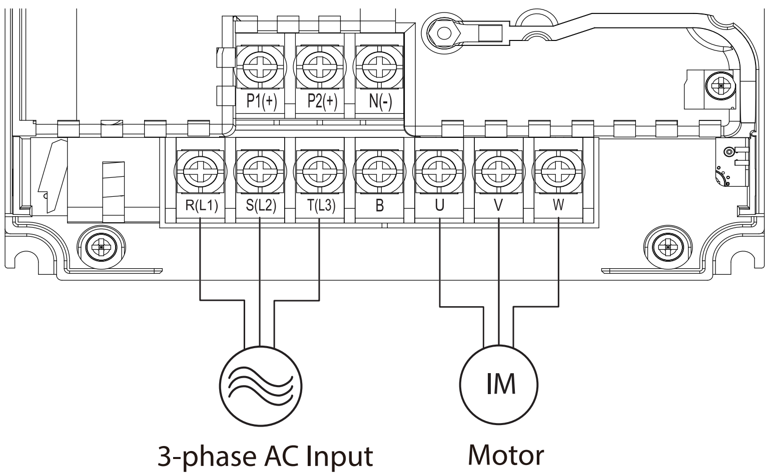
0.5HP~1.0HP (0.4~0.8kW) 3-phase



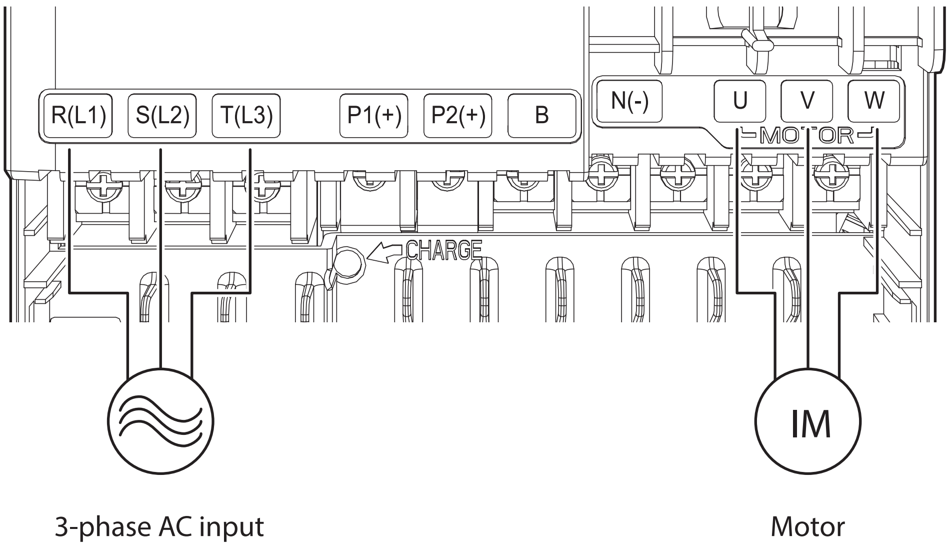
2.0HP~3.0HP (1.5–2.2kW) 3-phase



5.0HP (3.7kW) 3-phase



7.5HP~ 10HP (5.5–7.5kW) 3-phase



Power Terminal Labels and Descriptions

Terminal Labels	Name	Description
R(L1)/S(L2)/T(L3)	AC power input terminal	Main supply AC power connections.
P2(+)/N(-)	DC link terminal	DC voltage terminals.
P1(+)/P2(+)	DC reactor terminal	DC reactor wiring connection. (When you use the DC reactor, must remove short-bar)
P2(+)/B	Brake resistor terminals	Brake resistor wiring connection.
U/V/W	Motor output terminals	3-phase induction motor wiring connections.

- Do not use 3 core cables to connect a remotely located motor to the inverter.
- When you operating Brake resistor, the motor may vibrate under the Flux braking operation. In this case, turn off the Flux braking(Pr.50).
- Make sure that the total cable length does not exceed 665ft (202m). For inverters < = 4.0kW capacity, ensure that the total cable length does not exceed 165ft (50m).
- 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 (m*Ω*/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.

Allowed Carrier Frequency	< 15 kHz	< 5 kHz	< 2.5 kHz

⚠ Warning

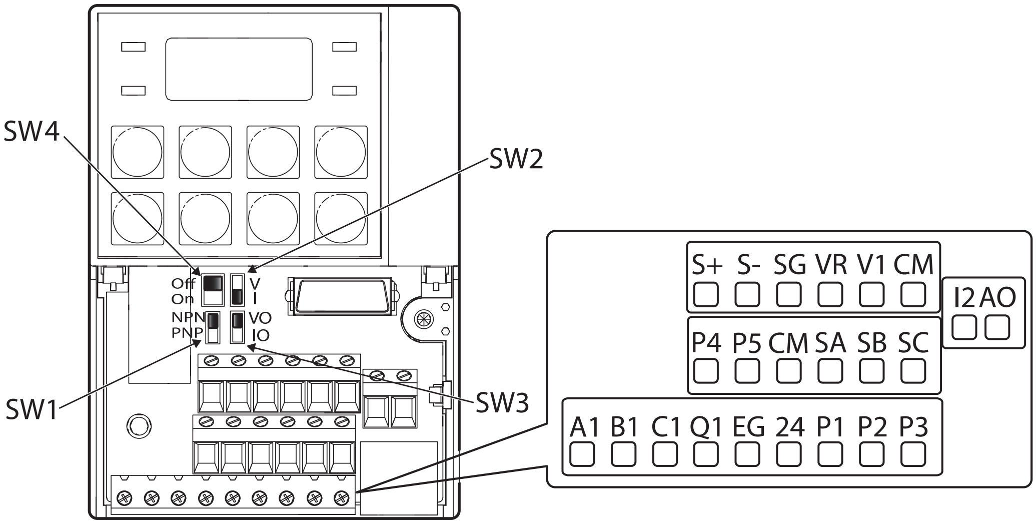
Do not connect power to the inverter until installation has been fully completed and the inverter is ready to be operated. Doing so may result in electric shock.

Caution

- Power supply cables must be connected to the R, S, and T terminals. Connecting power cables to other terminals will damage the inverter.
- Use insulated ring lugs when connecting cables to R/S/T and U/V/W terminals.
- 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.
- To avoid circuit interruption or damaging connected equipment, do not install power factor correction capacitors, surge protection, or electronic noise filters on the output side of the inverter.

Step 4 Control Terminal Wiring

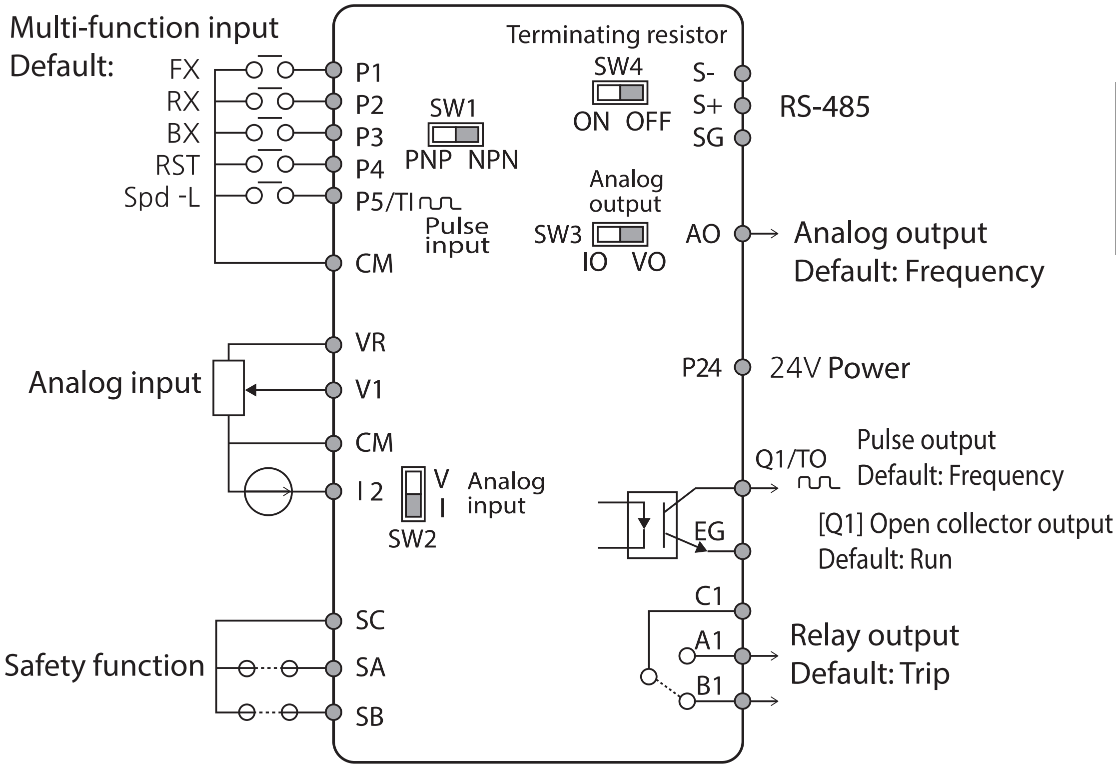
The illustrations below show the detailed layout of control wiring terminals, and control board switches. Refer to the detailed information provided below and 1.5 *Cable Selection* before installing control terminal wiring and ensure that the cables used meet the required specifications.



<Standard I/O>

Control Board Switches

Switch	Description
SW1	NPN/PNP mode selection switch
SW2	analog voltage/current input terminal selection switch
SW3	analog voltage/current output terminal selection switch
SW4	Terminating Resistor selection switch



<Standard I/O>

Input Terminal Labels and Descriptions

Function	Label	Name	Description
Multi-function terminal configuration	P1–P5	Multi-function Input 1-7	Configurable for multi-function input terminals. Factory default terminals and setup are as follows: • P1: Fx • P2: Rx • P3: BX • P4: RST • P5: Speed-L Standard I/O includes up to P5 only.
	CM	Common Sequence	Common terminal for analog terminal inputs and outputs.
Analog input configuration	VR	Potentiometer frequency reference input	Used to setup or modify a frequency reference via analog voltage or current input.

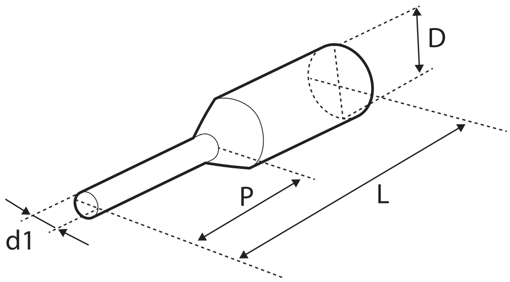
Function	Label	Name	Description
			• Maximum Voltage Output: 12V • Maximum Current Output: 100mA, • Potentiometer: 1–5kΩ
	V1	Voltage input for frequency reference input	Used to setup or modify a frequency reference via analog voltage input terminal. • Unipolar: 0–10V (12V Max.) • Bipolar: -10–10V (±12V Max.)
	I2	Voltage/current input for frequency reference input	Used to setup or modify a frequency reference via analog voltage or current input terminals. Switch between voltage (V2) and current (I2) modes using a control board switch (SW2). V2 Mode: • Unipolar: 0–10V (12V Max.) I2 Mode • Input current: 4–20mA • Maximum Input current: 24mA • Input resistance: 249Ω
	TI	Pulse input for frequency reference input (pulse train)	Setup or modify frequency references using pulse inputs from 0 to 32kHz. • Low Level: 0–2.5V • High Level: 3.5–12V (For Standard I/O, Pulse input TI and Multi-function terminal P5 share the same terminal. Set the In.69 P5 Define to 54(TI).).
Safety functionality configuration	SA	Safety input A	Used to block the output from the inverter in an emergency. Conditions: • Normal Operation: Both the SA and SB terminals are connected to the SC terminal. • Output Block: One or both of the SA and SB terminals lose connection with the SC terminal.
	SB	Safety input B	
	SC	Safety input power source	DC 24V, < 25mA

Output/Communication Terminal Labels and Descriptions

Function	Label	Name	Description
Analog output	AO	Voltage/Current Output	Used to send inverter output information to external devices: output frequency, output current, output voltage, or a DC voltage. Operate switch (SW3) to select the signal output type (voltage or current) at the AO terminal. Output Signal Specifications: • Output voltage: 0–10V • Maximum output voltage/current: 12V/10mA • Output current: 0–20mA • Maximum output current: 24mA • Factory default output: Frequency
	TO	Pulse Output	Sends pulse signals to external devices to provide a single output value from the inverter of either: output frequency, output current, output voltage, or DC voltage. Output Signal Specifications: • Output frequency: 0–32kHz • Output voltage: 0–12V • Factory default output: Frequency For Standard I/O, Pulse output TO and Multi-function output Q1 share the same terminal. Set the OU.33Q1 Define to 38(TO).) When connecting to a pulse between the inverters, • Multiple I/O< -> Multiple I/O : Connect to TO -> TI, CM -> CM • Standard I/O <-> Standard I/O : Connect to Q1 -> P5, EG -> CM • Multiple I/O <-> Standard I/O : Do not support.
Digital output	Q1	Multi-functional (open collector)	DC 26V, 100mA or less Factory default output: Run
	EG	Common	Common ground contact for an open collector (with external power source)
	24	External 24V power source	Maximum output current: 150mA
	A1/C1/B1	Fault signal output	Sends out alarm signals when the inverter's safety features are activated (AC 250V <1A, DC 30V < 1A). • Fault condition: A1 and C1 contacts are connected (B1 and C1 open connection) • Normal operation: B1 and C1 contacts are connected (A1 and C1 open connection)
Communication	S+/S-/SG	RS-485 signal line	Used to send or receive RS-485 signals. Refer to 7 *RS-485 Communication* Ffor more details.

Preinsulated Crimp Terminal Connectors (Bootlace Ferrule) .

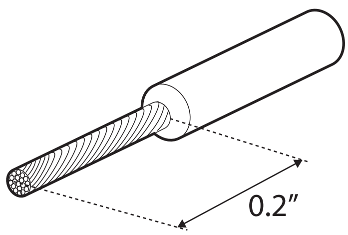
Use preinsulated crimp terminal connectors to increase reliability of the control terminal wiring. Refer to the specifications below to determine the crimp terminals to fit various cable sizes.



Cable Spec.		Dimensions (inches/mm)			
AWG	mm²	L*	P	d1	D
26	0.25	10.4	0.4 / 6.0	0.04 / 1.1	0.1 / 2.5
		12.4	0.5 / 8.0		
22	0.50	12.0	0.45 / 6.0	0.05 / 1.3	0.125 / 3.2
20	0.75	12.0	0.45 / 6.0	0.06 / 1.5	0.13 / 3.4

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

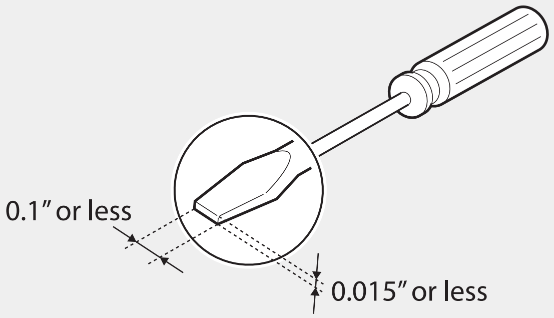
To connect cables to the control terminals without using crimp terminals, refer to the following illustration detailing the correct length of exposed conductor at the end of the control cable.



Note

- While making wiring connections at the control terminals, ensure that the total cable length does not exceed 165ft (50m).
- Ensure that the length of any safety related wiring does not exceed 100ft (30m).
- Ensure that the cable length between an LCD keypad and the inverter does not exceed 10ft

(3.04m). Cable connections longer than 10ft (3.04m) may cause signal errors.
- 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 (0.1in wide (2.5mm) and 0.015in thick (0.4mm) at the tip).



⚠ Warning

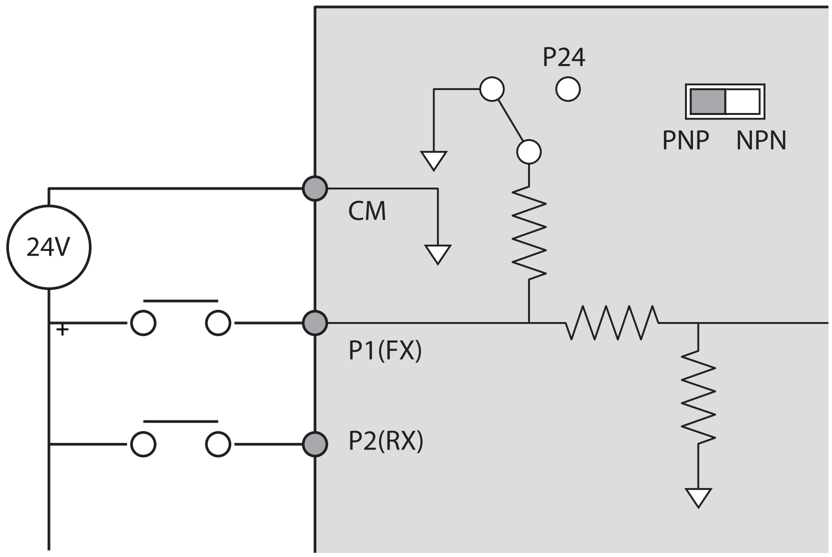
SA,SB, SC, they are shorted, have 24V voltage. Do not connect power to the inverter until installation has been fully completed and the inverter is ready to be operated. Doing so may result in electric shock.

Step 5 PNP/NPN Mode Selection

The "S" Series inverter supports both PNP (Source) and NPN (Sink) modes for digital inputs at the terminals. Select an appropriate mode to suit requirements using the PNP/NPN selection switch (SW1) on the control board. Refer to the following information for detailed applications.

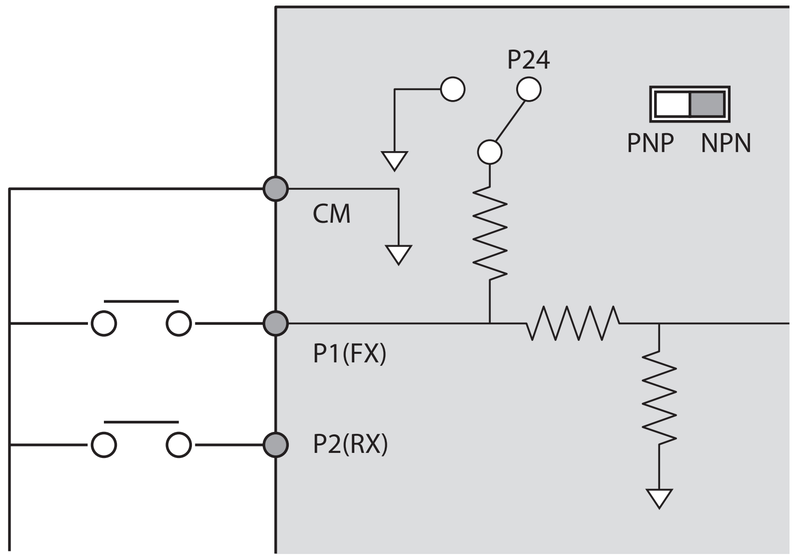
PNP Mode (Source)

Select PNP using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is is the common ground terminal for all analog inputs at the terminal, and P24 is 24V internal source. If you are using an external 24V source, build a circuit that connects the external source (-) and the CM terminal.



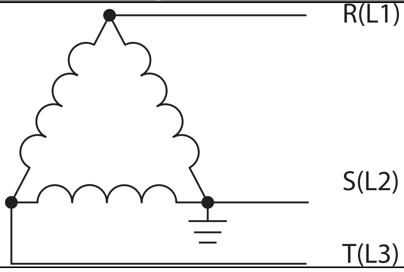
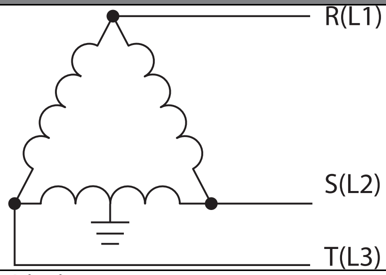
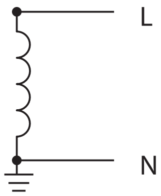
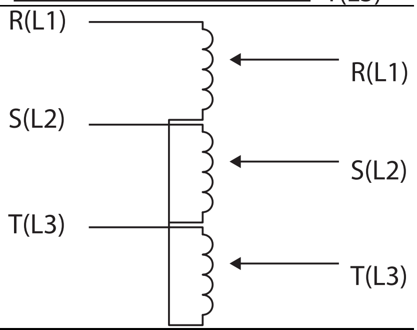
NPN Mode (Sink)

Select NPN using the PNP/NPN selection switch (SW1). Note that the factory default setting is NPN mode. CM is is the common ground terminal for all analog inputs at the terminal, and P24 is 24V internal source.



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

An EMC filter prevents electromagnetic interference by reducing radio emissions from the inverter. EMC filter use is not always recommended, as it increases leakage current. If an inverter uses a power source with an asymmetrical grounding connection, the EMC filter MUST be disconnected.

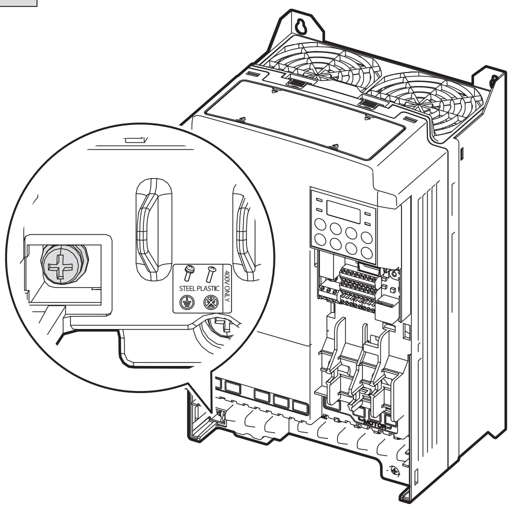
Asymmetrical Grounding Connection			
One phase of a delta connection is grounded		Intermediate grounding point on one phase of a delta connection	
The end of a single phase is grounded		A 3-phase connection without grounding	

⚠ Danger

- Do not use the EMC filter if the inverter uses a power source with an asymmetrical grounding structure, for example a grounded delta connection. Personal injury or death by electric shock may result.
- 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. Personal injury or death by electric shock may result.

Before using the inverter, confirm the power supply's grounding system. Disable the EMC filter if the power source has an asymmetrical grounding connection. Refer to the figures below to locate the EMC filter on/off terminal and replace the metal bolt with the plastic bolt. If the EMC filter is required in the future, reverse the steps and replace the plastic bolt with the metal bolt to reconnect the EMC filter.

Steel bolt	Plastic bolt
	
EMC ON	EMC OFF



Step 7 Re-assembling the Covers and Routing Bracket

Re-assemble the cable routing bracket and the covers after completing the wiring and basic configurations. 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	Check Point	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.351	
	Is the inverter's rated output sufficient to supply the equipment? (Degraded performance will result in certain circumstances. Refer to 11.7_ *Continuous Rated Current D* for details.	p.351	
Power Terminal Wiring	Is a circuit breaker installed on the input side of the inverter?	p.12	
	Is the circuit breaker correctly rated?	p.351	
	Are the power source cables correctly connected to the R/S/T terminals of the inverter? (Caution: connecting the power source to the U/V/W terminals will damage the inverter.)	p.22	
	Are the motor output cables connected in the correct phase rotation (U/V/W)? (Caution: motors will rotate in reverse direction if three phase cables are not wired in the correct rotation.)	p.22	
	Are the cables used in the power terminal connections correctly rated?	p.9	
	Is the inverter grounded correctly?	p.21	
	Are the power terminal screws and the ground terminal screws tightened to their specified torques?	p. 22	
	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	p.12	

Items	Check Point	Ref.	Result
	use)?		
	Are power factor correction capacitors, surge protection and electromagnetic interference filters installed correctly? (These devices MUST not be installed on the output side of the inverter.)	p.22	
Control Terminal Wiring	Are STP (shielded twisted pair) cables used for control terminal wiring?	-	
	Is the shielding of the STP wiring properly grounded?	-	
	If 3-wire operation is required, are the multi-function input terminals defined prior to the installation of the control wiring connections?	p.26	
	Are the control cables properly wired?	p26	
	Are the control terminal screws tightened to their specified torques?	p.17	
	Is the total cable length of all control wiring < 165ft (100m)?	p.24	
	Is the total length of safety wiring < 100ft (30m)?	p.24	
Miscellaneous	Are optional cards connected correctly?	-	
	Is there any debris left inside the inverter?	p.17	
	Are any cables contacting adjacent terminals, creating a potential short circuit risk?	-	
	Are the control terminal connections separated from the power terminal connections?	-	
	Have the capacitors been replaced if they have been in use for > 2 years?	-	
	Have the fans been replaced if they have been in use for > 3 years?	-	
	Has a fuse been installed for the power source?	p.363	
	Are the connections to the motor separated from other connections?	-	

Note

STP (Shielded Twisted Pair) 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.
2. Select the command source.
3. Set a frequency reference, and then check the following:
   - If V1 is selected as the frequency reference source, does the reference change according to the input voltage at VR?
   - If V2 is selected as the frequency reference source, is the voltage/current selector switch (SW2) set to voltage, and does the reference change according to the input voltage?
   - If I2 is selected as the frequency reference source, is the voltage/current selector switch (SW2) set to current, and does the reference change according to the input current?
4. Set the acceleration and deceleration time.
5. Start the motor and check the following:
   - Ensure that the motor rotates in the correct direction (refer to the note below).
   - Ensure that the motor accelerates and decelerates according to the set times, and that the motor speed reaches the frequency reference.

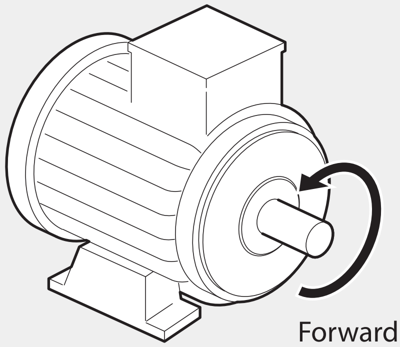
Note

If the forward command (Fx) is on, the motor should rotate counterclockwise when viewed from the load side of the motor. If the motor rotates in the reverse direction, switch the cables at the U and V terminals.

Verifying the Motor Rotation

1. On the keypad, set the drv (Frequency reference source) code in the Operation group to 0 (Keypad).
2. Set a frequency reference.
3. Press the [RUN] key. Motor starts forward operation.
4. Observe the motor's rotation from the load side and ensure that the motor rotates counterclockwise (forward).

If the motor rotates in the reverse direction, two of the U/V/W terminals need to be switched.



Forward operation

Caution

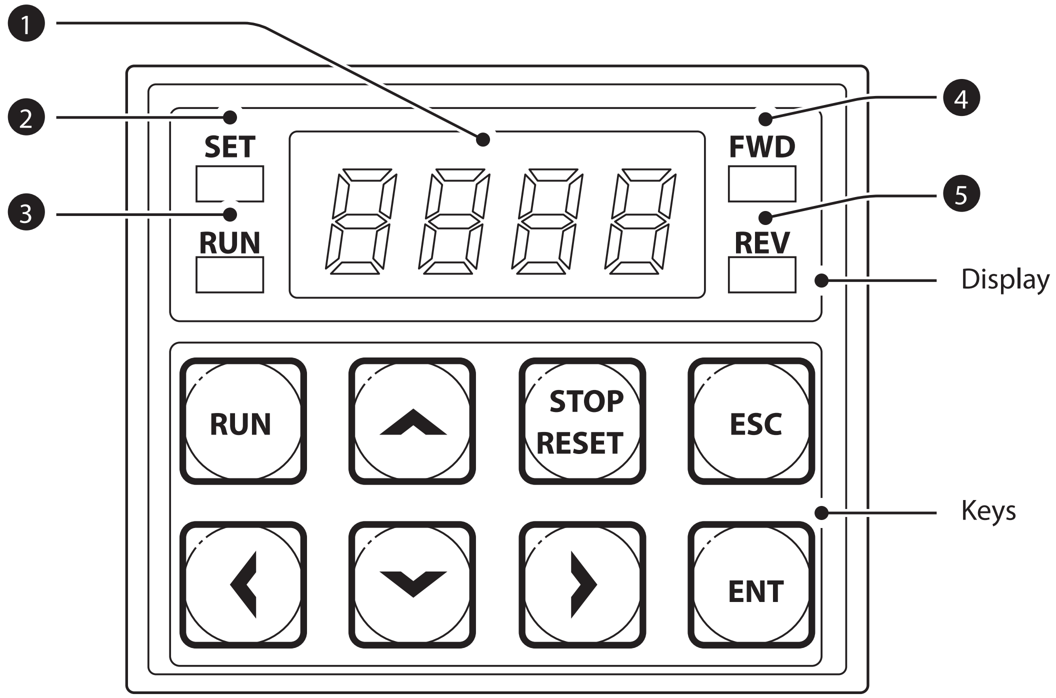
- Check the parameter settings before running the inverter. Parameter settings may have to be adjusted depending on the load.
- To avoid damaging the inverter, do not supply the inverter with an input voltage that exceeds the rated voltage for the equipment.
- Before running the motor at maximum speed, confirm the motor's rated capacity. The "S" Series inverters can be used to easily increase motor speed, use caution to ensure that motor speeds do not accidently exceed the motor's rated capacity.

3 Learning to Perform Basic Operations

This chapter describes the keypad layout and functions. It also introduces parameter groups and codes required to perform basic operations. The chapter also outlines the correct operation of the inverter before advancing to more complex applications. Examples are provided to demonstrate how the inverter actually operates.

3.1 About the Keypad

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



3.1.1 About the Display

The following table lists display part names and their functions.

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 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 lists the way that the keypad displays characters (letters and numbers).

0	0	a	A	k	K	u	U
1	1	b	B	l	L	v	V
2	2	c	C	m	M	w	W
3	3	d	D	n	N	x	X
4	4	e	E	o	O	y	Y
5	5	f	F	p	P	z	Z
6	6	g	G	q	Q	-	-
7	7	h	H	r	R	-	-
8	8	i	I	s	S	-	-
9	9	j	J	t	T	-	-

3.1.2 Operation Keys

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

Key	Name	Description
RUN	[RUN] key	Used to run the inverter (inputs a RUN command).
STOP RESET	[STOP/RESET] key	STOP: stops the inverter. RESET: resets the inverter following fault or failure condition.
,	[▲] key, [▼] key	Switch between codes, or to increase or decrease parameter values.
,	[◀] key, [▶] key	Switch between groups, or to move the cursor during parameter setup or modification.
ENT	[ENT] key	Used to select, confirm, or save a parameter value.
ESC	[ESC] key	A multi-function key used to configure different functions, such as: • Jog operation • Remote/Local mode switching • Cancellation of an input during parameter setup

ⓘ 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 an input from the keypad.

3.1.3 Control Menu

The "S" Series inverter control menu uses the following groups.

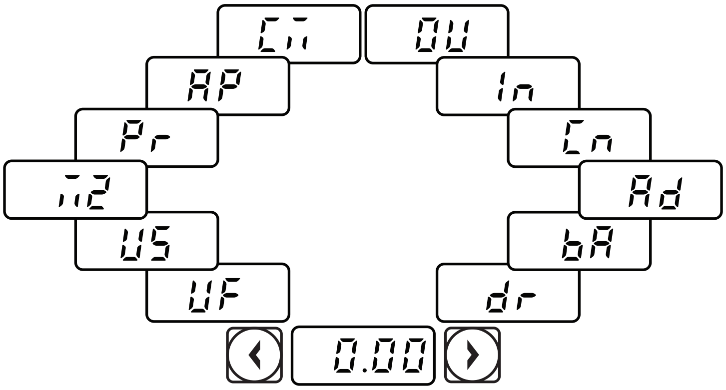
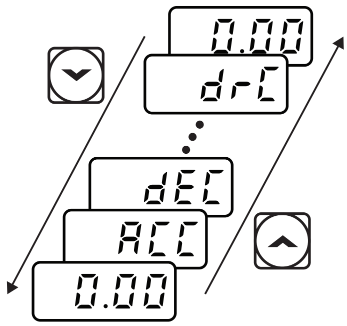
Group	Display	Description
Operation	-	Configures basic parameters for inverter operation. These include reference source , control source, acceleration/deceleration times, etc. The actual speed (frequencies) during acceration and deceleration will not be displayed on the 7-segment (LED) display, only if an LCD keypad is in use.
Drive	dr	Configures parameters for basic operations. These include jog operation, motor capacity evaluation, torque boost, and other keypad related parameters.
Basic	ba	Configures basic parameters, including motor-related parameters and multi-step frequencies.
Advanced	ad	Configure acceleration or deceleration patterns and to setup frequency limits.
Control	cn	Configures sensorless vector - related features.
Input Terminal	in	Configures input terminal–related features, including digital multi–functional inputs and analog inputs.
Output Terminal	ou	Configures output terminal–related features such as relays and analog outputs.
Communication	cm	Configures communication features for RS-485 or other communication options.
Application	ap	Configures PID control–related sequences and operations.
Protection	pr	Configures motor or inverter protection features.
Motor 2 (Secondary Motor)	m2	Configures secondary motor related features. The secondary motor (M2) group appears on the keypad only when one of the multi-function input terminals (In.65–In.71) has been set to 26 (Secondary motor).
User Sequence	us	Used to implement simple sequences with various function blocks.
User Sequence Function	uf	

3.2 Learning to Use the Keypad

The keypad enables movement between groups of parameters and the parameters within each group. At code level, you can set parameter values and turn on or off specific functions. Refer to 8_ on page 255 to find the functions you need.
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 Code Selection

Follow the examples below to switch between groups and codes.

Step	Instruction	Keypad Display
1	Move to the group you want using the [◀] and [▶] keys.	
2	Move up and down through the codes using the [▲] and [▼] keys until you locate the code that you require.	

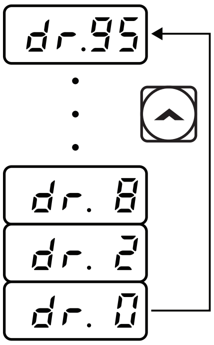
Note

For some settings, pressing the [▲] or [▼] key may skip choices . This is because certain code numbers have been intentionally left blank (or reserved) for new functions to be added in the future. Also some features may have been hidden (disabled) because a certain code has been set to disable the functions for relevant codes.

As an example, if Ad.24 (Frequency Limit) is set to 0 (No), the next codes, Ad.25 (Freq Limit Lo) and Ad.26 (Freq Limit Hi), will not be displayed. If you set code Ad.24 to 1 (Yes), this enables the frequency limit features, codes Ad.25 and 26 will appear to allow the maximum and minimum frequency limitations to be set up.

3.2.2 Navigating Directly to Different Codes

The following example details navigating to code dr. 95, from the initial code in the Drive group (dr. 0). This example applies to all groups whenever you would like to navigate to a specific code number.



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. (default setting)	'9'
3	Press the [▼] key to display '5,' in the ones position.	'5'
4	Press the [◀] key to move to the tens position. The cursor will move to the left and '05' will be displayed. This time the number '0' will be flashing.	'0'5
5	Press the [▲] key to increase the number from '0' to '9,' in the tens position .	'9'5
6	Press the [ENT] key. Code dr.95 is displayed.	dr.95

3.2.3 Setting Parameter Values

Follow the instructions below to set or modify parameter values.

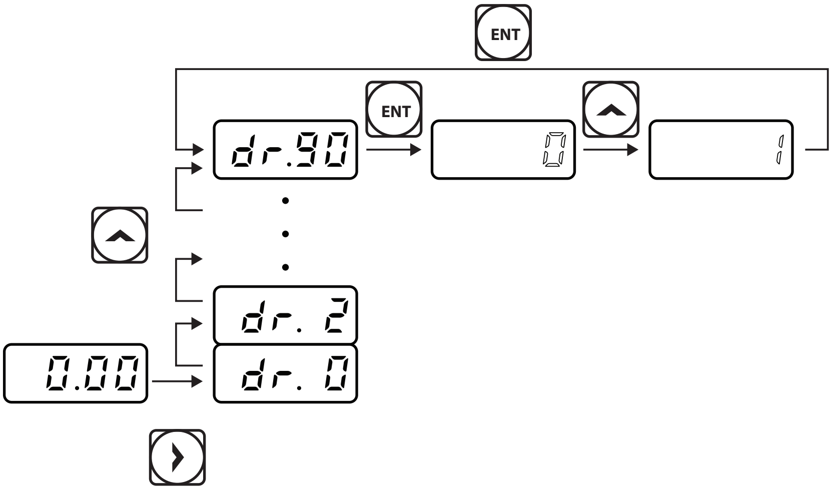
Step	Instruction	Keypad Display
1	Select the group and code to setup or modify. Press the [ENT] key (The SET LED will flash indicating Program mode). The first number on the right side of the display will flash.	5.'0'
2	Press the [◀] or [▶] key to move the cursor to the number that you would like to modify.	05.0 5.0 5.0
3	Press the [▲] or [▼] key to adjust the value, and then press the [ENT] key to confirm it. The selected value will flash on the display.	6.0 5.0 4.0
4	Press the [ENT] key again to save the change.	-

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 code's parameter values have default features and ranges specified. Refer to 8_ on page 255 for information about the features and ranges before setting or modifying parameter values.

3.2.4 Configuring the [ESC] Key

The [ESC] key is a multi-functional key that can be configured to carry out a number of different functions. Refer to 4.6 *Local/Remote Mode Switch* for more information about the other functions of the [ESC] key. The following example shows how to configure the [ESC] key to perform a jog operation.



Step	Instruction	Keypad Display
1	Ensure that you are currently at the first code of the Operation group, and that code 0.00 (Command Frequency) is displayed.	0.00
2	Press the [▶] key. You have moved to the initial code of the Drive group (dr.0).	dr.0
3	Press the [▲] or [▼] key to select code dr.90 (ESC key configuration), and then press the [ENT] key. Code dr.90 currently has an initial parameter value of 0.	dr.90 0
4	Press the [▲] key to modify the value to 1 (Jog key) and then press the [ENT] key. The new parameter value will flash.	'1'
5	Press the [ENT] key again to save changes.	-

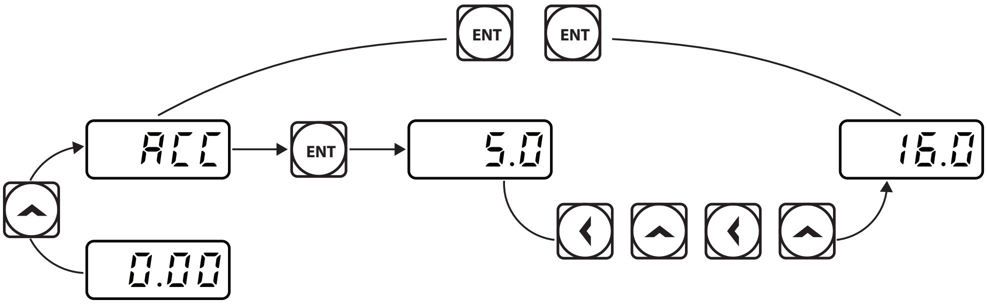
Note

- If the code dr. 90 (ESC key configuration) is set to 1 (JOG Key) or 2 (Local/Remote), the SET indicator will flash when the [ESC] key is pressed.
- The factory default setting for code dr. 90 is 0 (move to the initial position). You can navigate back to the initial position (code 0.00 of the Operation group) immediately, by pressing the [ESC] key while configuring any codes in any groups.

3.3 Application Examples

3.3.1 Acceleration Time Configuration

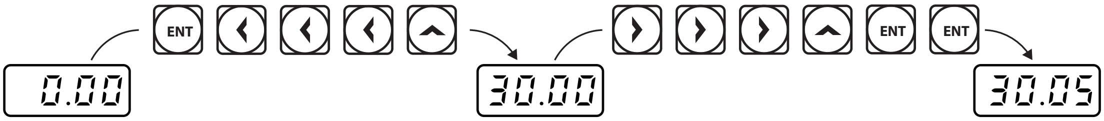
The following is an example demonstrating how to modify the ACC (Acceleration time) code value (from 5.0 to 16.0) from the Operation group.



Step	Instruction	Keypad Display
1	Ensure that the first code of the Operation group is displayed and code 0.00 (Command Frequency) is displayed.	0.00
2	Press the [▲] key. The display will change to the second code in the Operation group, the ACC (Acceleration Time) code.	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 [◀] key to move to the left. '5' will be flashing now. This indicates the flashing value, '5' is ready to be modified.	'5'.0
5	Press the [▲] key to change the number '5' to '6', in the one's place.	'6'.0
6	Press the [◀] key to move to the tens place. The number in the tens position, '0' in '06' will start to flash	'0'6.0
7	Press the [▲] key to change the number from '0' to '1', to match the tens place and then press the [ENT] key. Both digits will flash on the display.	'16'.0
8	Press the [ENT] key once again to save changes. 'ACC' will be displayed. The change to the acceleration time setup has been completed.	acc

3.3.2 Frequency Reference Configuration

The following is an example to demonstrate configuring a frequency reference of 30.05 (Hz) from the first code in the Operation group (0.00).



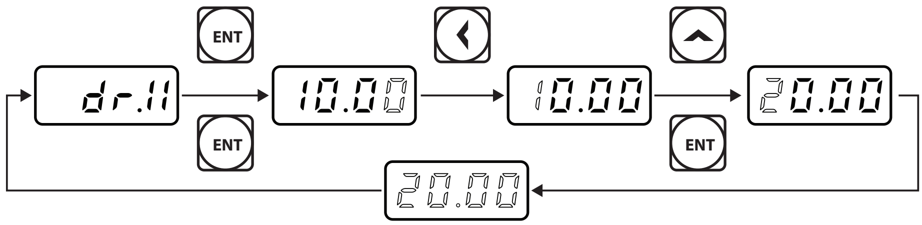
Step	Instruction	Keypad Display
1	Ensure that the first code of the Operation group is selected, and the code 0.00 (Command Frequency) is displayed.	0.00
2	Press the [ENT] key. The value, 0.00 will be displayed with the '0' in the hundredths place value flashing.	0.0'0'
3	Press the [◀] key 3 times to move to the tens place. The '0' at the tens place will start to flash.	'0'0.00
4	Press the [▲] key to change it to '3'.	30.00
5	Press the [▶] key 3 times. The '0' at the hundredths place position will flash.	30.0'0'
6	Press the [▲] key to change it to '5'. The parameter value will flash on the display.	30.0'5'
7	Press the [ENT] key to save 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 input from the user. Changes are saved when the [ENT] key is pressed while the value is flashing. Changes will be canceled if any other key is pressed.
- The "S" Series inverter keypad display can display up to 4 digits. However, 5-digit figures can be used and are accessed by pressing the [◀] or [▶] key, to allow keypad input.

3.3.3 Jog Frequency Configuration

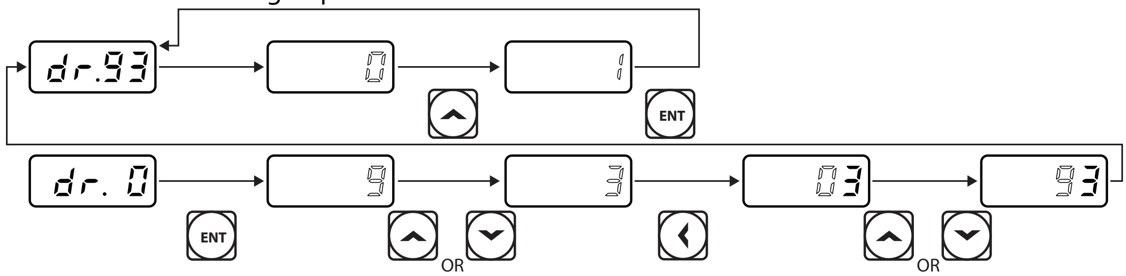
The following example demonstrates how to configure Jog Frequency by modifying code dr.11 in the Drive group (Jog Frequency) from 10.00(Hz) to 20.00(Hz). You can configure the parameters for different codes in any other group in exactly the same way.



Step	Instruction	Keypad Display
1	Go to code 11(Jog Frequency) in the Drive group.	dr.11
2	Press the [ENT] key. The current Jog Frequency value (10.00) for code dr.11 is displayed.	10.00
3	Press the [◀] key 3 times to move to the tens place. Number '1' at the tens place will flash.	'1'0.00
4	Press the [▲] key to change the value to '2,' in the tens place and then press the [ENT] key. All parameter digits will flash on the display.	'20.00'
5	Press the [ENT] key once again to save the changes. Code dr.11 will be displayed. The parameter change has been completed.	dr.11

3.3.4 Initializing All Parameters

The following example demonstrates parameter initialization using code dr.93 (Parameter Initialization) in the Drive group. Once executed, parameter initialization will delete all modified values for all codes and groups.

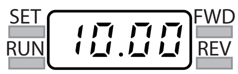


Step	Instruction	Keypad Display
1	Go to code 0 (Jog Frequency) in the Drive group.	dr.0
2	Press the [ENT] key. The current parameter value (9) will be displayed. (default setting)	9
3	Press the [▼] key to change the ones place to '3' of the target code, '93.'	3
4	Press the [◀] key to move to the tens place. '03' will be displayed.	03
5	Press the [▲] or [▼] key to change the '0' to '9' of the target code, '93.'	93
6	Press the [ENT] key. Code dr.93 will be displayed.	dr.93
7	Press the [ENT] key once again. The current parameter value for code dr.93 is set to 0 (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 again after an initialization.

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

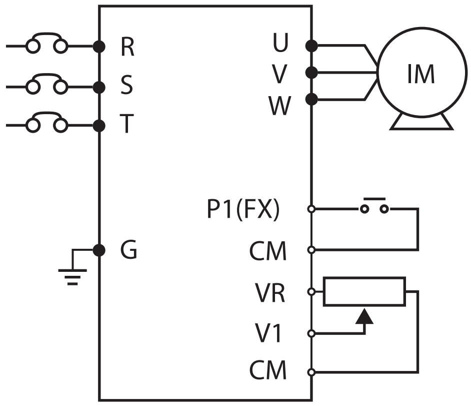
Step	Instruction	Keypad Display
1	Turn on the inverter.	-
2	Ensure that the first code of the Operation group is selected, and code 0.00 (Command Frequency) is displayed, then press the [ENT] key. The first digit on the right will flash.	0.0'0'
3	Press the [◀] key 3 times to go to the tens place. The number 'o' at the tens place will flash.	'0'0.00
4	Press the [▲] key to change it to 1, and then press the [ENT] key. The parameter value (10.00) will flash.	'10.00'
5	Press the [ENT] key once again to save changes. A change of reference frequency to 10.00 Hz has been completed.	10.00
6	Refer to the wiring diagram at the bottom of the table, and close the switch between the P1 (FX) and CM terminals. The FWD indicator light comes on steady. The RUN indicator light flashes as the drive accelerates from 0 Hz. to 10 Hz. When the drive frequency of 10 Hz. is reached, the RUN indicator light becomes steady (not flashing).	
7	When the frequency reference is reached (10Hz), 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 0Hz, the RUN and FWD indicator lights turn off, and the frequency reference (10.00Hz) is displayed again.	

Note

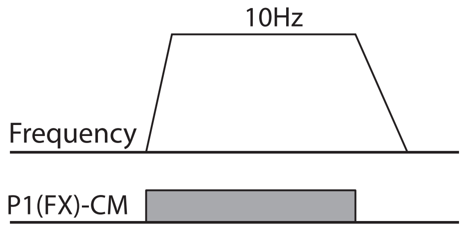
The instructions in the table are based on the factory default parameter settings. The inverter may not work correctly if the default parameter settings are changed after the inverter is purchased. In such cases, initialize all parameters to reset the values to factory default parameter settings before following the instructions in the table (refer to 5.23).

3.3.5 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 the code 0.00 (Command Frequency) is displayed.	0.00
3	Press the [▲] key 4 times to go to the Frq (Frequency reference source) code.	Frq
4	Press the [ENT] key. The Frq code in the Operation group is currently set to 0 (keypad).	0
5	Press the [▲] key to change the parameter value to 2 (Potentiometer), and then press the [ENT] key. The new parameter value will flash.	‘2’
6	Press the [ENT] key once again. The Frq code will be displayed again. The frequency input has been configured for the potentiometer.	Frq
7	Press the [▼] key 4 times. Returns to the first code of the Operation group (0.00).From here frequency setting values can be monitored.	0.00
8	Adjust the potentiometer to verify the frequency reference changes. The frequency reference will change eventhough the drive is not running yet.	-
9	Refer to the wiring diagram at the bottom of the table, and close the switch between the P1 (FX) and CM terminals. The FWD indicator light comes on steady. The RUN indicator light flashes as the drive accelerates from 0 Hz. to the frequency reference. When the drive frequency is reached, the RUN indicator light becomes steady (not flashing).	SET RUN 10.00 FWD REV
10	When the frequency reference is reached (10Hz), 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 0Hz, the RUN and FWD indicators turn off, and the frequency reference is displayed again.	SET RUN 10.00 FWD REV



[Wiring Diagram]



[Operation Pattern]

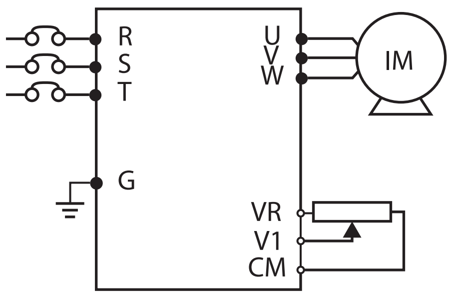
Note

The instructions in the table are based on the factory default parameter settings. The inverter may not work correctly if the default parameter settings are changed after the inverter is purchased. In such cases, initialize all parameters to reset the factory default parameter settings before following the instructions in the table (refer to 5.23_ on page 183).

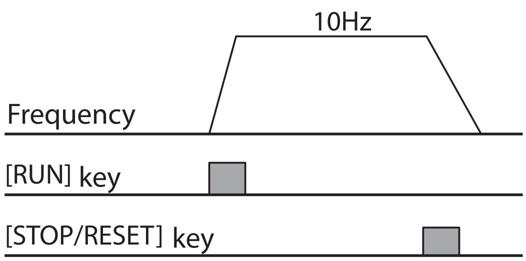
3.3.6 Frequency Setting (Potentiometer) and Operation (Keypad)

Step	Instruction	Keypad Display
1	Turn on the inverter.	-
2	Ensure that the first code of the Operation group is selected, and the code 0.00 (Command Frequency) is displayed.	0.00
3	Press the [▲] key 4 times to go to the drv code.	drv
4	Press the [ENT] key. The drv code in the Operation group is currently set to 1 (Analog Terminal).	1
5	Press the [▼] key to change the parameter value to 0 (Keypad), and then press the [ENT] key. The new parameter value will flash.	'0'
6	Press the [ENT] key once again. The drv code is displayed again. The frequency input has been configured for the keypad.	drv

Step	Instruction	Keypad Display
7	Press the [▲] key. To move to the Frq (Frequency reference source) code.	frq
8	Press the [ENT] key. The Frq code in the Operation group is set to 0 (Keypad).	0
9	Press the [▲] key to change it to 2 (Potentiometer), and then press the [ENT] key. The new parameter value will flash.	'2'
10	Press the [ENT] key once again. The Frq code is displayed again. The frequency input has been configured for potentiometer.	frq
11	Press the [▼] key 4 times. Returns to the first code of the Operation group (0.00). From here frequency setting values can be monitored.	0.00
12	Adjust the potentiometer to verify the frequency reference changes. The frequency reference will change eventhough the drive is not running yet.	-
13	Press the [RUN] key on the keypad. The FWD indicator light comes on steady. The RUN indicator light flashes as the drive accelerates from 0 Hz. to the frequency reference. When the drive frequency is reached, the RUN indicator light becomes steady (not flashing).	SET RUN 10.00 FWD REV
14	When the frequency reaches the reference (10Hz), press the [STOP/RESET] key on the keypad. The RUN indicator light flashes again and the decelerating frequency is displayed. When the frequency reaches 0Hz, the RUN and FWD indicator lights turn off, and the frequency reference is displayed again.	SET RUN 10.00 FWD REV



[Wiring Diagram]



[Operation Pattern]

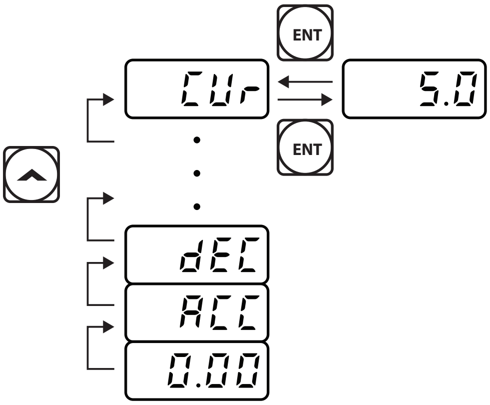
Note

The instructions in the table are based on the factory default parameter settings. The inverter may not work correctly if the default parameter settings are changed after the inverter is purchased. In such cases, initialize all parameters to reset the factory default parameter settings before following the instructions in the table (refer to 5.23_ on page 183).

3.4 Monitoring the Operation

3.4.1 Output Current Monitoring

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



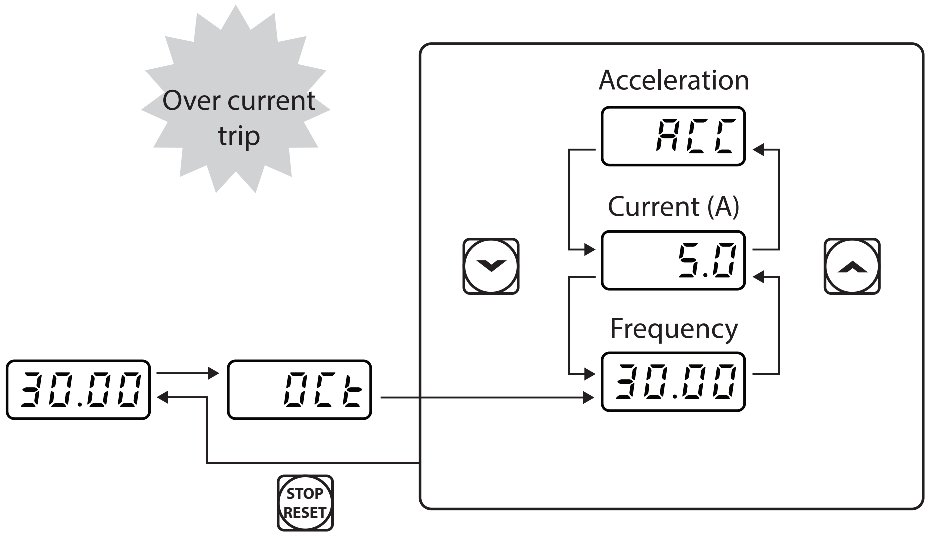
Step	Instruction	Keypad Display
1	Ensure that the first code of the Operation group is selected, and the code 0.00 (Command Frequency) is displayed.	0.00
2	Press the [▲] or [▼] key to move to the Cur code.	cur
3	Press the [ENT] key. The output current (5.0A) is displayed.	5.0
4	Press the [ENT] key again.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

Note

You can use the dCL (DC link voltage monitor) and vOL (output voltage monitor) codes in the Operation group in exactly the same way as shown in the example above, to monitor each function's relevant values.

3.4.2 Fault Trip Monitoring

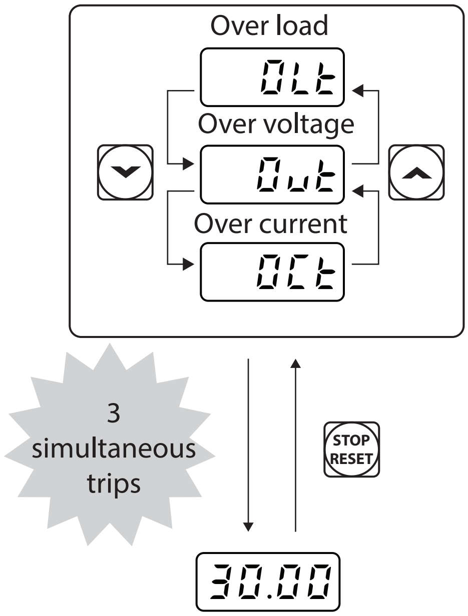
The following example demonstrates how to monitor fault conditions in the Operation group using the keypad.



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 operation frequency at the time of the fault (30.00Hz) is displayed.	30.00
3	Press the [▲] key. The output current at the time of the fault (5.0A) 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.	30.00

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 condition occurs while running at a specified frequency, the current frequency and the warn signal will be displayed alternately, at 1 second intervals. Refer to 6.3 for more details.



4 Learning Basic Features

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

Basic Tasks	Description	Ref.
Frequency reference source configuration for the keypad	Configures the inverter to allow you to setup or modify frequency reference using the Keypad.	p.62
Frequency reference source configuration using V1 or V2	Configures the inverter to allow input voltages at terminals V1 or V2 to control the frequency reference.	p.63, p.70
Frequency reference source configuration using I2	Configures the inverter to allow input currents at terminal I2 to control the frequency reference.	p.68
Frequency reference source configuration using TI terminal (pulse input)	Configures the inverter to allow an input pulse at the terminal TI to control the frequency reference.	p.71
Frequency reference source configuration using RS-485 communication	Configures the inverter to allow communication signals from controllers, such as PLCs or PCs, to setup or modify a frequency reference.	p.73
Frequency hold control when using analog inputs	Enables the user to hold a frequency steady with a digital input when using analog inputs at terminals.	p.74
Motor speed display options	Motor speed is displayed either in frequency (Hz) or speed (rpm).	p.74
Multi-step speed (frequency) configuration	Configures multi-step frequencies using digital inputs at the terminals defined for each step frequency.	p.75
Command source configuration for keypad buttons	Configures inverter operation using the [FWD], [REV] and [Stop] keys on the keypad.	p.77
Command source (Start/Stop) configuration for terminal inputs	Configures inverter start/stop operation using digital inputs at the FX/RX terminals.	p.77
Command source configuration for RS-485 communication	Configures inverter operation from communication signals from controllers, such as PLCs or PCs.	p.79
Local/remote switching via the [ESC] key	Configures the inverter to switch between local and remote operation modes when the [ESC] key is pressed. When the inverter is operated using remote inputs (any input other than from the keypad), this configuration can be used to control the inverter from the keypad without altering saved parameter settings. It overrides the remote settings to control the inverter from the keypad in emergency situations.	p.79
Motor rotation (direction) control	Configures the inverter to prevent operating the motor in a specific direction.	p.81
Automatic start-up at power-on	Configures the inverter to start operating at power-on. With this configuration, the inverter begins to run and the	p.81

Basic Tasks	Description	Ref.
	motor accelerates as soon as power is supplied to the inverter. The start command must be maintained at the Fx/Rx terminals.	
Automatic restart after reset of a fault condition	Configures the inverter to start operating when the inverter is reset after a fault. In this configuration, the inverter starts to run and the motor accelerates as soon as the inverter is reset. The start command must be maintained at the Fx/Rx terminals.	p.82
Acc/Dec time configuration based on the Max. Frequency	Configures the acceleration and deceleration times for the motor. The time scale is based on starting from a stopped state (0 Hz.) to the maximum frequency.	p.84
Acc/Dec time configuration based on the frequency reference	Configures acceleration and deceleration times for the motor based on the existing operating frequency to the next frequency reference.	p.85
Multi-stage Acc/Dec time configuration using the multi-function terminal	Configures multi-stage acceleration and deceleration times for the motor based on defined parameters using the digital input terminals.	p.86
Acc/Dec time using a switch frequency.	Enables two independent acceleration and deceleration times below and above a set switch frequency.	p.88
Acc/Dec pattern configuration	Enables modification of the acceleration and deceleration gradient patterns. Basic patterns to choose from include linear and S-curve patterns.	p.88
Acc/Dec stop command	Stops the current acceleration or deceleration and controls motor operation at a constant speed. A digital input terminal must be configured for this command.	p.91
Linear V/F pattern operation	Configures the inverter to run a motor at a constant torque. To maintain the required torque, the operating frequency may vary during operation.	p.91
Square reduction V/F pattern operation	Configures the inverter to run the motor at a square reduction V/F pattern. Fans and pumps are appropriate loads for square reduction V/F operation.	p.92
User V/F pattern configuration	Enables the user to configure a V/F pattern to match the characteristics of a motor and load. This configuration is for special-purpose motor applications to achieve optimal performance.	p.92
Manual torque boost	Manual configuration of the inverter's output voltage during starting and low speed operation to produce a torque boost. This configuration is for loads that require a large amount of starting torque.	p.94
Automatic torque boost	Automatic configuration of the inverter's output voltage to produce a momentary torque boost. This configuration is for loads that require a large amount of starting torque.	p.94
Output voltage adjustment	Adjusts the output voltage to the motor when the input voltage to the inverter differs from the motor's rated	p.95

Basic Tasks	Description	Ref.
	voltage.	
Accelerating start	Accelerating start is the typical method to start motor operation. The typical application configures the motor to accelerate to a target frequency in response to a run command. There may be other start or acceleration conditions defined.	p.96
Start after DC braking	Configures the inverter to perform DC braking before the motor starts rotating. This configuration is used when the motor will be rotating before the start command is supplied to the inverter.	p.96
Deceleration stop	Deceleration stop is the typical method used to stop a motor. The motor decelerates to 0Hz and stops on a stop command. There may be other stop or deceleration conditions defined.	p.97
Stopping by DC braking	Configures the inverter to apply DC braking during motor deceleration. The frequency at which DC braking occurs must be defined. When the motor reaches the defined frequency, DC braking is applied.	p.97
Free-run stop	Configures the inverter to turn off output to the motor using a stop command. The motor will free-run until it slows down and stops.	p.98
Power braking	Configures the inverter to provide optimal motor deceleration without tripping the over-voltage protection.	p.99
Start/maximum frequency configuration	Configures the frequency reference limits by defining a start frequency and a maximum frequency.	p.100
Upper/lower frequency limit configuration	Configures the frequency reference limits by defining an upper limit and a lower limit.	p.100
Frequency jump	Configures the inverter to avoid running a motor in mechanically resonating frequencies.	p.101
2nd Operation Configuration	Used to configure a second set of control and speed reference sources (i.e. local/remote) and switch between them using a digital input terminal.	p.102
Multi-function input terminal control configuration	Configure the digital input terminals. Add time delays (On/Off delay),logic (NO/NC operation) and view status.	p.103
P2P communication configuration	Configures the inverter to share input and output devices with other inverters.	p.105
Multi-keypad configuration	Enables the user to monitor multiple inverters with one monitoring device.	p.106
User sequence configuration	Enables the user to implement simple sequences using various function blocks.	p.108

4.1 Setting Frequency Reference

The "S" Series inverter provides several methods to setup and modify a frequency reference for operation. These include:

- The keypad
- Analog inputs, V1 and V2 (voltage inputs), I2 (current input)
- Pulse input, TI
- Digital input, RS-485 signals from PLC and
- If UserSeqLink is selected, the common area can be linked with user sequence output and can be used as frequency reference.

The **Frq** parameter code (Frequency reference source) in the Operation group includes the following choices.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Ref Freq Src	0	KeyPad-1	0–12	-
				1	KeyPad-2		
				2	V1		
				4	V2		
				5	I2		
				6	Int 485		
				8	Field Bus		
				9	UserSeqLink		
				12	Pulse		

4.1.1 Keypad as the Source (KeyPad-1 setting)

To use the keypad as a frequency reference input source, go to the Frq code in the Operation group and change the parameter value to 0 (Keypad-1). Program the frequency reference at the Command Frequency code (0.00) in the Operation group.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	0	KeyPad-1	0–12	
	0.00	Frequency reference		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 Keypad as the Source (KeyPad-2 setting)

The KeyPad-2 setting uses the [▲] and [▼] keys to modify a frequency reference. Go to the Frq code in the Operation group and change the parameter value to 1 (Keypad-2). This allows frequency reference values to be increased or decreased by pressing the [▲] and [▼] keys.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	1	KeyPad-2	0–12	-
	0.00	Frequency reference		0.00		Min to Max Frq*	Hz

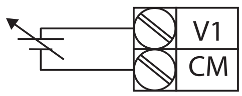
* You cannot set a frequency reference that exceeds the Max. Frequency, as configured with dr.20.

4.1.3 V1 Terminal as the Source

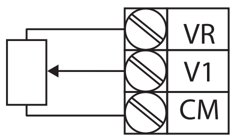
Set and modify the frequency reference using voltage inputs at the V1 terminal. Use voltage inputs ranging from 0 to 10V (unipolar) for forward only operation. Use voltage inputs ranging from -10 to +10V (bipolar) for both directions, where negative voltage inputs are used for reverse operation.

4.1.3.1 Setting a Frequency Reference for 0–10V Input

Set code In.06 (V1 Polarity) to 0 (unipolar) in the Input Terminal group (IN). The input to the V1 terminal can be from an external 0-10V source or use the voltage output from the VR terminal when connecting a potentiometer. Refer to the diagrams below for wiring connections to the V1 terminal.



[External source]



[Potentiometer using internal source (VR)]

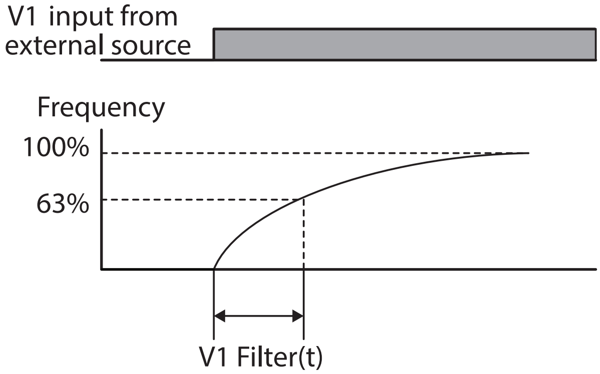
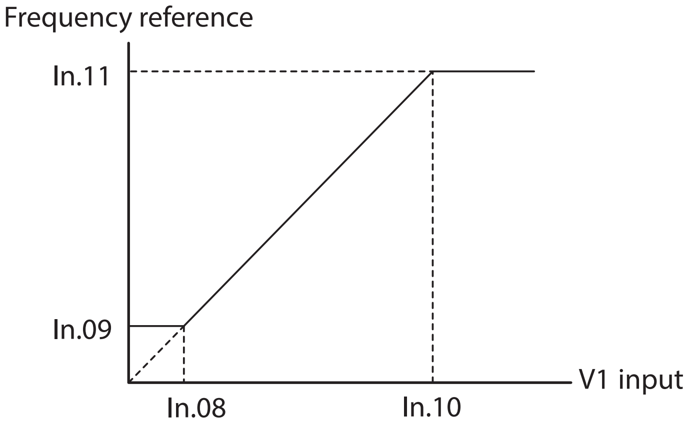
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	2	V1	0–12	-
In	01	Frequency at maximum analog input	Freq at 100%	Maximum frequency		0.00– Max. Frequency	Hz
	05	V1 input monitor	V1 Monitor [V]	0.00		0.00–12.00	V
	06	V1 polarity options	V1 Polarity	0	Unipolar	0–1	-
	07	V1 input filter	V1 Filter	10		0–10000	ms

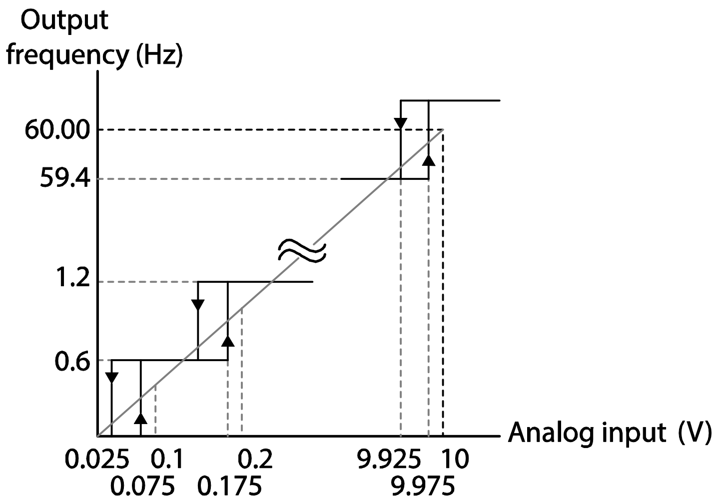
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		time constant					
	08	V1 minimum input voltage	V1 volt x1	0.00		0.00–10.00	V
	09	V1 output at minimum voltage (%)	V1 Perc y1	0.00		0.00–100.00	%
	10	V1 maximum input voltage	V1 Volt x2	10.00		0 .00– 12.00	V
	11	V1 output at maximum voltage (%)	V1 Perc y2	100.00		0–100	%
	16	Rotation direction options	V1 Inverting	0	No	0–1	-
	17	V1 Quantizing level	V1 Quantizing	0.04		0.00*, 0.04–10.00	%

* Quantizing is disabled if '0' is selected.

0–10V Input Voltage Setting Details

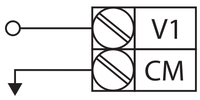
Code	Description
In.01 Freq at 100%	Configures the frequency reference at the maximum input voltage when a potentiometer is connected to the control terminal block. A frequency set with code In.01 becomes the maximum frequency only if the value set in code In.11 (or In.15) is 100(%). • Set code In.01 to 60.00 and use default values for codes In.02–In.16. Motor will run at 60.00Hz when a 10V input is provided at V1. • Set code In.11 to 50.00 (%) and use default values for codes In.01–In.16. Motor will run at 30.00Hz (50% of the default maximum frequency–60Hz) when a 10V input is provided at V1.
In.05 V1 Monitor[V]	Configures the inverter to monitor the input voltage at V1.
In.07 V1 Filter	V1 Filter may be used when there are variations to the applied reference frequency (i.e.noise filter). Variations can be mitigated by increasing the time constant, but this will delay the response time when changing the reference frequency. The value t (time) indicates the time required for the frequency to reach 63% of the reference, when external input voltages are provided in multiple steps.

Code	Description
	 [V1 Filter]
In.08 V1 Volt x1 In.09 V1 Perc y1 In.10 V1 Volt x2 In.11 V1 Perc y2	These parameters are used to configure the gradient level and offset values of the Output Frequency, based on the Input Voltage.  [In.08 Volt x1 (min. volts), In.09 V1 Perc Y1, (min. % speed)] [In.10 Volt y1, (max. volts), In.11 V1 Perc y2 (max. % speed)]
In.16 V1 Inverting	Inverts the direction of rotation. Set this code to 1 (Yes) if you need the motor to run in the opposite direction from the existing rotation.
In.17.V1 Quantizing	Quantizing may be used when the noise level is high in the analog input (V1 terminal) signal. Quantizing is useful when you are operating a noise-sensitive system, because it suppresses any signal noise. However, quantizing will diminish system sensitivity (resultant power of the output frequency will decrease based on the analog input). You can also turn on the low-pass filter using code In.07 to reduce the noise, but increasing the value will reduce responsiveness and may cause pulsations (ripples) in the output frequency.

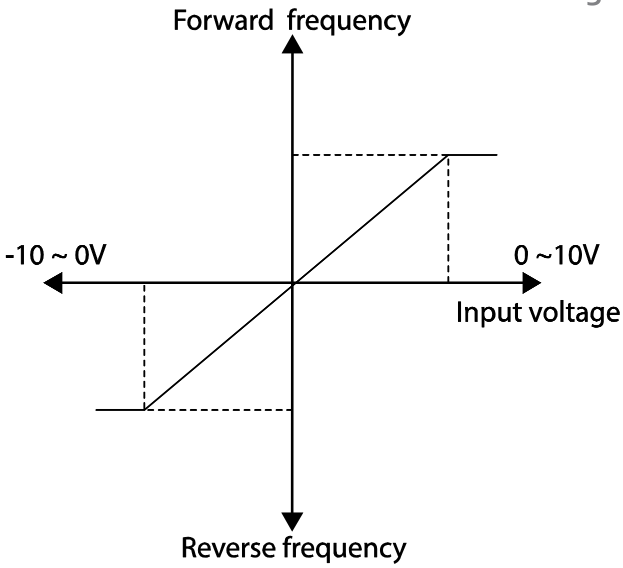
Code	Description
	Parameter values for quantizing refer to a percentage based on the maximum input. Therefore, if the value is set to 1% of the analog maximum input (60Hz), the output frequency will increase or decrease by 0.6Hz per 0.1V difference. When the analog input is increased, an increase to the input equal to 75% of the set value will change the output frequency, and then the frequency will increase according to the set value. Likewise, when the analog input decreases, a decrease in the input equal to 75% of the set value will make an initial change to the output frequency. As a result, the output frequency will be different at acceleration and deceleration, mitigating the effect of analog input changes over the output frequency.  [V1 Quantizing]

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

Set the Frq (Frequency reference source) code in the Operation group to 2 (V1), and then set code In.06 (V1 Polarity) to 1 (bipolar) in the Input Terminal group (IN). Use the output voltage from an external source to provide input to V1.



[V1 terminal wiring]



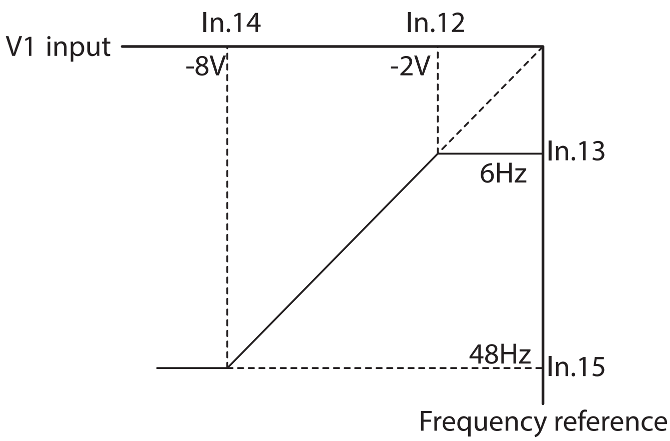
[Bipolar input voltage and output frequency]

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	2	V1	0–12	-
In	01	Frequency at maximum analog input	Freq at 100%	60.00		0– Max Frequency	Hz
	05	V1 input monitor	V1 Monitor	0.00		0.00–12.00V	V
	06	V1 polarity options	V1 Polarity	1	Bipolar	0–1	-
	12	V1 minimum input voltage	V1- volt x1	0.00		10.00–0.00V	V
	13	V1 output at minimum voltage (%)	V1- Perc y1	0.00		-100.00–0.00%	%
	14	V1maximum input voltage	V1- Volt x2	-10.00		-12.00 – 0.00V	V
	15	V1 output at maximum voltage (%)	V1- Perc y2	-100.00		-100.00–0.00%	%

Rotational Directions for Different Voltage Inputs

Command / Voltage Input	Input voltage	
	0–10V	-10–0V
FWD	Forward	Reverse
REV	Reverse	Forward

-10–10V Voltage Input Setting Details

Code	Description
In.12 V1 - volt x1 In.13 V1-Perc y1 In.14 V1-Volt x2 In.15 V1- Perc y2	Sets the gradient level and offset value of the output frequency in relation to the input voltage. These codes are displayed only when In.06 is set to 1 (bipolar). As an example, if the minimum input voltage (at V1) is set to -2 (V) with 10% output ratio, and the maximum voltage is set to -8 (V) with 80% output ratio respectively, the output frequency will vary within the range of 6 - 48 Hz.  [In.12 V1-volt X1 (min. volts), In.13 V1 Perc y1 (min. % speed)] [In.14 V1 volt x2 (max. volts), In.15 V1 Perc y (max. % speed)] For details about the 0–+10V analog inputs, refer to the code descriptions In.08 V1 volt x1–In.11 V1 Perc y2 on page 65.

4.1.3.3 Setting a Reference Frequency using Input Current (I2)

You can set and modify a frequency reference using input current at the I2 terminal after selecting current input at SW 2 (Switch 2). Set the Frq (Frequency reference source) code in the Operation group to 5 (I2) and apply 4–20mA input current to I2.

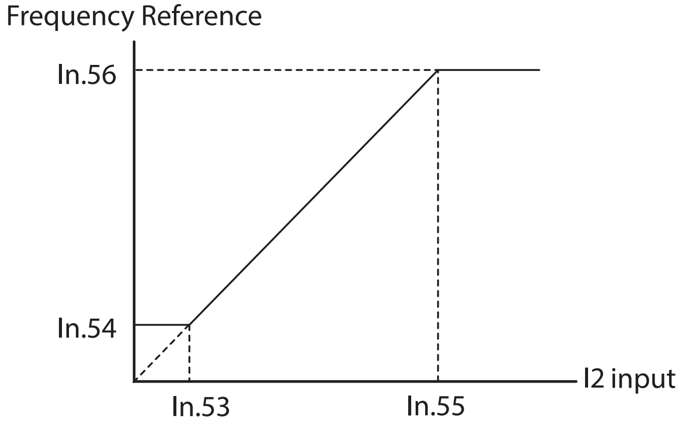
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	5	I2	0–12	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	01	Frequency at maximum analog input	Freq at 100%	60.00		0–Maximum Frequency	Hz
	50	I2 input monitor	I2 Monitor	0.00		0.00–24.00	mA
	52	I2 input filter time constant	I2 Filter	10		0–10000	ms
	53	I2 minimum input current	I2 Curr x1	4.00		0.00–20.00	mA
	54	I2 output at minimum current (%)	I2 Perc y1	0.00		0–100	%
	55	I2 maximum input current	I2 Curr x2	20.00		0.00–24.00	mA
	56	I2 output at maximum current (%)	I2 Perc y2	100.00		0.00–100.00	%
	61	I2 rotation direction options	I2 Inverting	0	No	0–1	-
	62	I2 Quantizing level	I2 Quantizing	0.04		0*, 0.04–10.00	%

* Quantizing is disabled if '0' is selected.

Input Current (I2) Setting Details

Code	Description
In.01 Freq at 100%	Configures the frequency reference for operation at the maximum current (when In.56 is set to 100%). • If In.01 is set to 60.00Hz, and default settings are used for In.53–56, 20mA input current (max) to I2 will produce a frequency reference of 60.00Hz. • If In.56 is set to 50.00 (%), and default settings are used for In.01 (60Hz) and In.53–55, 20mA input current (max) to I2 will produce a frequency reference of 30.00Hz (50% of 60Hz).
In.50 I2 Monitor	Used to monitor input current at I2.
In.52 I2 Filter	Configures the time for the operation frequency to reach 63% of target frequency based on the input current at I2.

Code	Description
In.53 I2 Curr x1 In.54 I2 Perc y1 In.55 I2 Curr x2 In.56 I2 Perc y2	Configures the gradient level and offset value of the output frequency.  [Gradient and off-set configuration based on output frequency] [In.53 I2 Curr x1 (min. current), In.54 I2 Perc y1 (min. % speed)] [In.55 I2 Curr x2 (max. current), In.56 i2 Perc y2 (max. % speed)]

4.1.4 Setting a Frequency Reference with Input Voltage (Terminal I2)

Set and modify a frequency reference using input voltage at I2 (V2) terminal by setting SW2 (switch 2) to V2. Set the Frq (Frequency reference source) code in the Operation group to 4 (V2) and apply 0–12V input voltage to I2 (=V2, Analog current/voltage input terminal). Codes In.35–47 will only be displayed when I2 is set to receive voltage input (Frq code parameter is set to 4).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	4	V2	0–12	-
In	35	V2 input display	V2 Monitor	0.00		0.00–12.00	V
	37	V2 input filter time constant	V2 Filter	10		0–10000	ms
	38	Minimum V2 input voltage	V2 Volt x1	0.00		0.00–10.00	V
	39	Output% at minimum V2 voltage	V2 Perc y1	0.00		0.00–100.00	%
	40	Maximum V2 input voltage	V2 Volt x2	10.00		0.00–10.00	V
	41	Output% at maximum V2 voltage	V2 Perc y2	100.00		0.00–100.00	%
	46	Invert V2 rotational direction	V2 Inverting	0	No	0–1	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	47	V2 quantizing level	V2 Quantizing	0.04	0.00*, 0.04–10.00	%

* Quantizing is disabled if '0' is selected.

4.1.5 Setting a Frequency with TI Pulse Input

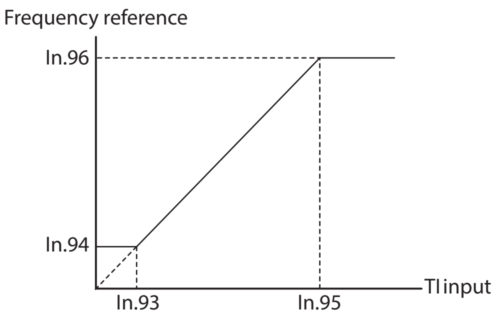
Set a frequency reference by setting the Frq (Frequency reference source) code in Operation group to 12 (Pulse). When using the Standard I/O board, set parameter In.69 (P5 Define) to 54 (TI) and provide a 0–32.00kHz pulse frequency to P5.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	12	Pulse	0–12	-
In	69	P5 terminal function setting	P5 Define	54	TI	0-54	-
	01	Frequency at maximum analog input	Freq at 100%	60.00		0.00–Maximum frequency	Hz
	91	Pulse input display	Pulse Monitor	0.00		0.00–50.00	kHz
	92	TI input filter time constant	TI Filter	10		0–9999	ms
	93	TI input minimum pulse	TI Pls x1	0.00		0.00–32.00	kHz
	94	Output% at TI minimum pulse	TI Perc y1	0.00		0.00–100.00	%
	95	TI Input maximum pulse	TI Pls x2	32.00		0.00–32.00	kHz
	96	Output% at TI maximum pulse	TI Perc y2	100.00		0.00–100.00	%
	97	Invert TI direction of rotation	TI Inverting	0	No	0–1	-
	98	TI quantizing level	TI Quantizing	0.04		0.00*, 0.04–10.00	%

* Data shaded in grey applies to the Standard I/O board only.

*Quantizing is disabled if '0' is selected.

TI Pulse Input Setting Details

Code	Description
In.69 P5 Define	For Standard I/O, Pulse input TI and Multi-function terminal P5 share the same terminal. Set the In.69 (P5 Define) to 54(TI).
In.01 Freq at 100%	Configures the frequency reference at the maximum pulse input. The frequency reference is based on 100% of the value set with In.96. • If In.01 is set to 60.00 and codes In.93–96 are set at default, 32kHz input to TI yields a frequency reference of 60.00Hz. • If In.96 is set to 50.00 and codes In.01, In.93–95 are set at default, 32kHz input to the TI terminal yields a frequency reference of 30.00Hz.
In.91 Pulse Monitor	Displays the pulse frequency supplied at TI.
In.92 TI Filter	Sets the time for the pulse input at TI to reach 63% of its nominal frequency (when the pulse frequency is supplied in multiple steps).
In.93 TI Pls x1 In.94 TI Perc y1 In.95 TI Pls x2 In.96 TI Perc y2	Configures the gradient level and offset values for the output frequency.  [In.93 TI Pls x1 (min. pulse freq.), In.94 TI Perc y1 (min. % speed)] In.95 TI Pls x2 (max. pulse freq.), In.96 TI Perc y2 (max. % speed)]
In.97 TI Inverting– In.98 TI Quantizing	Identical to In.16–17 (refer to In.16 V1 Inverting/In.17.V1 Quantizing on page 65).

4.1.6 Setting a Frequency Reference via RS-485 Communication

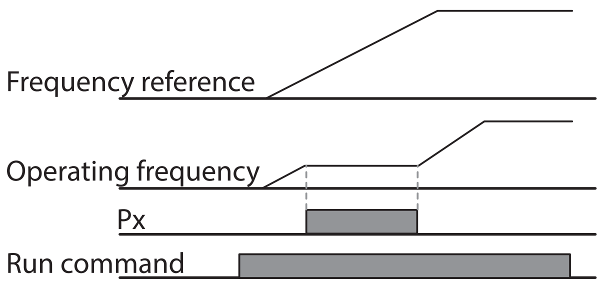
Control the inverter with advanced controllers such as PLC's or PC's via RS-485 communication. Set the Frq (Frequency reference source) code in the Operation group to 6 (Int 485) and use the RS-485 signal input terminals (S+/S-/SG) for communication. Refer to 7 *RS-485 Communication F* on page *231*.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	6	Int 485	0–12	-
In	01	Inverter ID Integrated RS-485 communication	Int485 St ID	-	1	1–250	-
	02	Protocol Integrated RS-485 communication	Int485 Proto	0	ModBus RTU	0–2	-
				1	Reserved		
				2	LS Inv 485		
	03	Integrated communication speed	Int485 BaudR	3	9600 bps	0–7	-
	04	Integrated communication frame configuration	Int485 Mode	0	D8/PN/S1	0–3	-
				1	D8/PN/S2		
				2	D8/PE/S1		
				3	D8/PO/S1		

4.2 Frequency Hold by Analog Input

When the frequency reference is via an analog input, you can hold the operation frequency by assigning a digital input as "analog hold". The operation frequency will be fixed at the existing analog input signal when the digital input terminal is activated.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	0	Keypad-1	0–12	-
				1	Keypad-2		
				2	V1		
				4	V2		
				5	I2		
				6	Int 485		
				8	Field Bus		
				12	Pulse		
In	65–69	Px terminal configuration	Px Define(Px : P1–P5)	21	Analog Hold	0–54	-



4.3 Changing the Displayed Units (Hz↔Rpm)

You can change the units used to display the operational speed of the inverter by setting Dr. 21 (Speed unit selection) to 0 (Hz) or 1 (Rpm). This function is available only with the LCD keypad.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	21	Speed unit selection	Hz/Rpm Sel	0	Hz Display	0–1	-
				1	Rpm Display		

4.4 Setting Multi-step Frequency

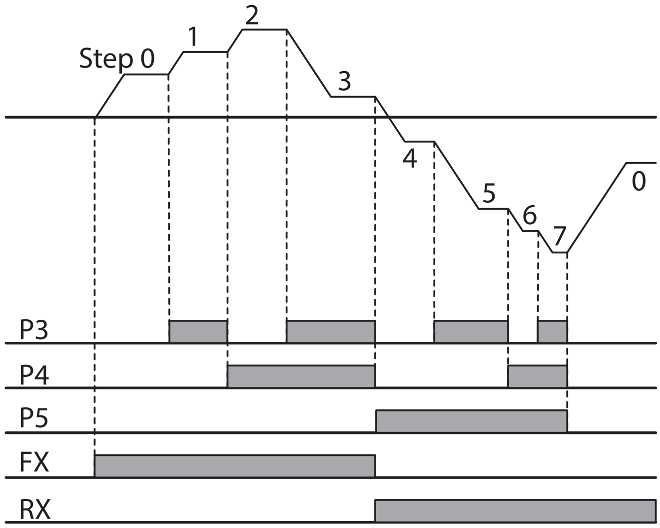
Multi-step operations can be carried out by assigning different speeds (or frequencies) to the Px terminals. Step 0 uses the frequency reference source set with the Frq code in the Operation group. The digital input terminals can be programmed to provide fixed speed inputs (multi-step frequencies). Parameters in the Input Group, In.65 through In.71 can be assigned 7 (Speed-L), 8 (Speed-M) and 9 (Speed-H). The step frequencies are set using parameters St1 through St3 (multi-step frequencies 1 through 3) in the Operations Group. The digital inputs are recognized as a 3 bit binary input. Additional speeds are set with parameters bA.53–56 (multi-step frequencies 4–7).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	St1–St3	Multi-step frequency 1–3	Step Freq - 1–3	-		0–Maximum frequency	Hz
bA	53–56	Multi-step frequency 4–7	Step Freq - 4–7	-		0–Maximum frequency	Hz
In	65–71	Px terminal configuration	Px Define (Px: P1–P5)	7	Speed-L	0–54	-
				8	Speed-M		-
				9	Speed-H		-
	89	Multi-step command delay time	InCheck Time	1		1–5000	ms

Multi-step Frequency Setting Details

Code	Description
Operation group St 1–St3 Step Freq - 1–3	Configure multi-step frequency1–3. If an LCD keypad is in use, bA.50–52 is used instead of St1–St3 (multi-step frequency 1–3).
bA.53–56 Step Freq - 4–7	Configure multi-step frequency 4–7.
In.65–69 Px Define	Choose the terminals to setup as multi-step inputs, and then set the relevant codes (In.65–69) to 7(Speed-L), 8(Speed-M), or 9(Speed-H). EX: Using terminals P3, P4 and P5 set to Speed-L, Speed-M and Speed-H respectively, the following multi-step operation will be available.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>



[An example of a 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>

</td></tr>
<tr><td></td><td>The parameters for the eight (8) speeds in the above example are:
Ref. Freq.=30Hz., St1=45Hz., St2=60Hz., St3=15Hz., bA.53=15Hz., bA.54=50Hz, bA.55=55Hz., bA.56-60Hz.</td></tr>
<tr><td>In.89 InCheck Time</td><td>Set a time interval for the inverter to check for additional terminal block inputs after receiving an input signal.

After adjusting In.89 to 100ms and an input signal is received at P5, the inverter will search for inputs at other terminals for 100ms, before proceeding to accelerate or decelerate based on P5's configuration.</td></tr>
</table>

4.5 Command Source Configuration

The start and stop commands can come from various sources. Input devices available to select include keypad, digital input terminals (Px), RS-485 communication and field bus adapter. If UserSeqLink is selected, the common area can be linked with user sequence output and can be used as command.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command Source	Cmd Source*	0	Keypad	0–5	-
				1	Fx/Rx-1		
				2	Fx/Rx-2		
				3	Int 485		
				4	Field Bus		
				5	UserSeqLink		

* Displayed under DRV-06 on the LCD keypad.

4.5.1 The Keypad as a Command Input Device

The keypad can be selected as the start/stop source for the inverter. This is configured by setting the drv (command source) code to 0 (Keypad). Pressing the [RUN] key on the keypad starts the inverter and the [STOP/RESET] key stops it.

group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	0	KeyPad	0–5	-

* Displayed under DRV-06 on the LCD keypad.

4.5.2 Terminal Block as a Command Input Device (Fwd/Rev Run Commands)

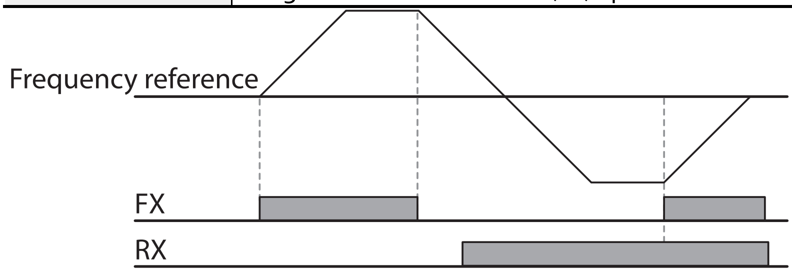
The digital input terminals can be selected as the start/stop command source. This is configured by setting the drv (command source) code in the Operation group to 1(Fx/Rx). Select 2 terminals for the forward and reverse operations, codes In.65–69 for P1–P5 to 1(Fx) and 2(Rx) respectively. This application also enables both terminals to be turned on or off at the same time, constituting a stop command that will cause the inverter to stop operation.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1	Fx/Rx-1	0–5	-
In	65–71	Px terminal configuration	Px Define(Px: P1– P5)	1	Fx	0–54	-
				2	Rx		

* Displayed under DRV-06 on the LCD keypad.

Fwd/Rev Command by Multi-function Terminal – Setting Details

Code	Description
Operation group drv– Cmd Source	Set to 1(Fx/Rx-1).
In.65–71 Px Define	Assign a terminal for forward (Fx) operation. Assign a terminal for reverse (Rx) operation.



4.5.3 Terminal Block as a Command Input Device (Run and Rotation Direction Commands)

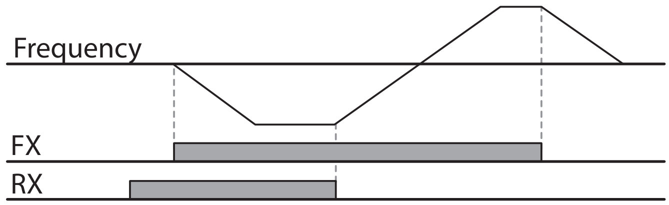
The digital inputs can be selected to operate as the start/stop source along with direction of rotation. This is configured by setting the drv (command source) code in the Operation group to 2(Fx/Rx-2). Select 2 terminals for run and rotation direction commands, codes In.65–69 for P1–P5 to 1(Fx) and 2(Rx) respectively. This application uses the Fx input as a run command while the Rx input determines the motor's rotation direction.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Drv	Command source	Cmd Source*	2	Fx/Rx-2	0–5	-
In	65–69	Px terminal configuration	Px Define (Px: P1 – P5)	1	Fx	0–54	-
				2	Rx		

* Displayed under DRV-06 on the LCD keypad.

Run Command and Fwd/Rev Change Command Using Multi-function Terminal – Setting Details

Code	Description
Operation group drv Cmd Source	Set to 2(Fx/Rx-2).
In.65–71 Px Define	Assign a terminal for run command (Fx). Assign a terminal for changing rotation direction (Rx).



4.5.4 RS-485 Communication as a Command Input Device

Internal RS-485 communication can be selected as a command input device by setting the drv (command source) code in the Operation group to 3(Int 485). This configuration uses advanced controllers such as PCs or PLCs to control the inverter by transmitting and receiving signals via the S+, S-, and Sg terminals at the terminal block. For more details, refer to 7 *RS-485 Communication F* on page *231*.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	3	Int 485	0–5	-
CM	01	Inverter ID Integrated communication	Int485 St ID	1		1–250	-
	02	Protocol Integrated communication	Int485 Proto	0	ModBus RTU	0–2	-
	03	Integrated communication speed	Int485 BaudR	3	9600 bps	0–7	-
	04	Integrated communication frame setup	Int485 Mode	0	D8 / PN / S1	0–3	-

* Displayed under DRV-06 on the LCD keypad.

4.6 Local/Remote Mode Switching

Local/remote switching with the [ESC] key is used to override control and operate the system manually using the keypad. The [ESC] key is programmable to many other functions. For other functions, refer to 3.2.4 *Configuring the [ESC] K* on page *46*.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	90	[ESC] key functions	-	2	Local/Remote	0–2	-
Operation	drv	Command source	Cmd Source*	1	Fx/Rx-1	0–5	-

* Displayed under DRV-06 on the LCD keypad.

Local/Remote Mode Switching Setting Details

Code	Description
dr.90 [ESC] key functions	Set dr.90 to 2(Local/Remote) to perform local/remote switching using the [ESC] key. Once the value is set, the inverter will automatically begin operating in remote mode. Changing from local to remote will not alter any previously configured parameter values and the operation of the inverter will not change. Press the [ESC] key to switch the operation mode back to "local." The SET light will flash, and the inverter will operate using the [RUN] key on the keypad. Press the [ESC] key again to switch the operation mode back to "remote." The SET light will turn off and the inverter will operate according to the previous drv code configuration.

Note

Local/Remote Operation

- Full control of the inverter is available with the keypad during local operation.
- During local operation, jog commands will only work if one of the P1–P5 multi-function terminals (codes In.65–69) is set to 13(RUN Enable) and the relevant terminal is turned on.
- During remote operation (remote operation), the inverter will operate according to the previously set frequency reference source and the command received from the input device.
- If Ad.10 (power-on run) is set to 0(No), the inverter will NOT operate on power-on even when the following terminals are turned on:
  - Fwd/Rev run (Fx/Rx) terminal
  - Fwd/Rev jog terminal (Fwd jog/Rev Jog)
  - Pre-Excitation terminal

  To operate the inverter manually with the keypad, switch to local mode. Use caution when switching back to remote operation mode as the inverter will stop operating. If Ad.10 (power-on run) is set to 0(No), a command through the input terminals will work ONLY AFTER all the terminals listed above have been turned off and then turned on again.

- If the inverter has been reset to clear a fault during an operation, the inverter will switch to local operation mode at power-on, and full control of the inverter will be with the keypad. The inverter will stop operating when operation mode is switched from "local" to "remote". In this case, a run command through an input terminal will work ONLY AFTER all the input terminals have been turned off.

Inverter Operation During Local/Remote Switching

Switching operation mode from "remote" to "local" while the inverter is running will cause the inverter to stop operating. Switching operation mode from "local" to "remote" however, will cause the inverter to operate based on the command source:

- Analog commands via terminal input: the inverter will continue to run without interruption based on the command at the terminal block. If a reverse operation (Rx) signal is ON at the terminal block at startup, the inverter will operate in the reverse direction even if it was running in the forward direction in local operation mode before the reset.

- Digital source commands: all command sources except terminal block command sources (which are analog sources) are digital command sources that include the keypad, LCD keypad, and communication sources. The inverter stops operation when switching to remote operation mode, and then starts operation when the next command is given.

Caution

Use local/remote operation mode switching only when it is necessary. Improper mode switching will result in interruption of the inverter's operation.

4.7 Forward or Reverse Run Prevention

The rotation direction of motors can be configured to prevent motors from running in either direction. If Ad.09 is set to 2 Reverse Prev, pressing the [REV] key on the LCD keypad will cause the motor to decelerate to 0Hz and stop. The inverter will remain on.

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

Forward/Reverse Run Prevention Setting Details

Code	Description		
Ad.09 Run Prevent	Choose a direction to prevent.		
	Setting		Description
	0	None	Do not set run prevention.
	1	Forward Prev	Set forward run prevention.
	2	Reverse Prev	Set reverse run prevention.

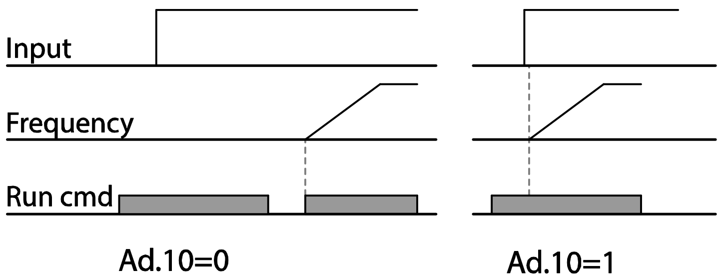
4.8 Power-on Run

The power-on Run command can be set to start inverter operation after powering up. To enable power-on run set the drv (command source) code to 1(Fx/Rx-1) or 2 (Fx/Rx-2) in the Operation group. The digital input must be active (closed) during power up.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1, 2	Fx/Rx-1 or Fx/Rx-2	0–5	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	10	Power-on run	Power-on Run	1	Yes	0–1	-

* Displayed under DRV-06 on the LCD keypad.



Note

- A fault may be triggered if the inverter starts operation while a motor's load (fan-type load) is in free-run state. To prevent this from happening, set bit4 to 1 in Cn. 71 (speed search options) of the Control group. The inverter will perform a speed search at the beginning of the operation.
- If the speed search is not enabled, the inverter will begin its operation in a normal V/F pattern and accelerate the motor. If the inverter has been turned on without power-on run enabled, the terminal block command must first be turned off, and then turned on again to begin the inverter's operation.

Caution

Use caution when operating the inverter with Power-on Run enabled as the motor will begin rotating when the inverter starts up.

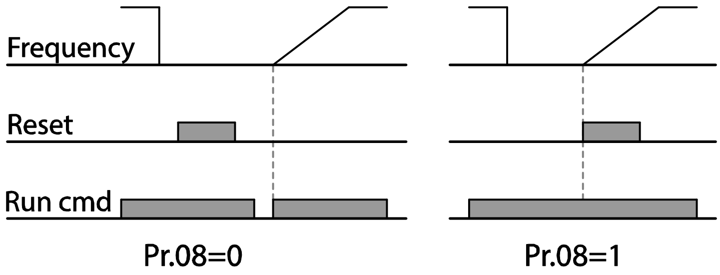
4.9 Reset and Restart

Automatic restart after a fault reset can be setup with parameter Pr.08 set to 1 (Yes). The number of reset attempts and the time delay between reset attempts are set with parameters Pr.09 and Pr.10. The digital input for the run command (Fx/Rx-1) must remain closed to allow the inverter to run after a successful reset. When a fault occurs, the inverter cuts off the output and the motor will free-run. Another fault may occur if the inverter begins its operation while motor load is in a free-run state.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1 2	Fx/Rx-1 or Fx/Rx-2	0–5	-
Pr	08	Reset restart setup	RST Restart	1	Yes	0–1	
	09	No. of auto	Retry	0		0–10	

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		restart	Number				
	10	Auto restart delay time	Retry Delay	1.0		0–60	sec

* Displayed under DRV-06 in an LCD keypad.



Note

- To prevent a repeat fault from occurring, set Cn.71 (speed search options) bit 2 equal to 1. The inverter will perform a speed search at the beginning of the operation.
- If the speed search is not enabled, the inverter will start its operation in a normal V/F pattern and accelerate the motor.
- With parameter Pr.08 set to 0 (No), when the inverter is powered up with the run command made, the inverter will not start. The run command (digital input) must be first turned off, and then turned on again to begin the inverter's operation.

Caution

Use caution when operating the inverter with Power-on Run enabled as the motor will begin rotating when the inverter starts up.

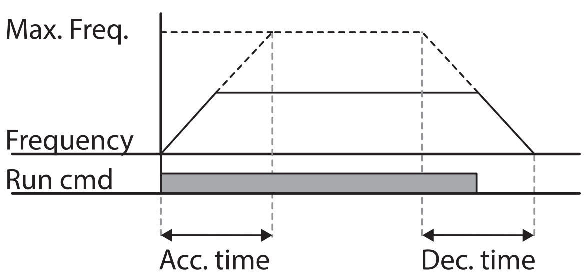
4.10 Setting Acceleration and Deceleration Times

4.10.1 Acc/Dec Time Based on Maximum Frequency

Acceleration time set at the ACC (Acceleration time) code in the Operation group (dr.03 in an LCD keypad) refers to the time required for the inverter to reach the maximum frequency from a stopped (0Hz) state. The Acc/Dec time values are based on maximum frequency when parameter bA. 08 (Acc/Dec reference) in the Basic group is set to 0 (Max Freq, default setting). Likewise, the value set at the dEC (deceleration time) code in the Operation group (dr.04 in an LCD keypad) refers to the time required to return to a stopped state (0Hz) from the maximum frequency.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	20.0		0.0–600.0	sec
	dEC	Deceleration time	Dec Time	30.0		0.0–600.0	sec
	20	Maximum frequency	Max Freq	60.00		40.00–400.00	Hz
bA	08	Acc/Dec reference frequency	Ramp T Mode	0	Max Freq	0–1	-
	09	Time scale	Time scale	1	0.1sec	0–2	-

Acc/Dec Time Based on Maximum Frequency – Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>bA.08
Ramp T Mode</td><td>
Set the parameter value to 0 (Max Freq) to setup Acc/Dec time based on maximum frequency.
<table>
<tr><td colspan="2">Configuration</td><td>Description</td></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>
If, for example, maximum frequency is 60.00Hz, the Acc/Dec times are set to 5 seconds, and the frequency reference for operation is set at 30Hz (half of 60Hz), the time required to reach 30Hz therefore is 2.5 seconds (half of 5 seconds).


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

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>bA.09 Time scale</td><td>Use the time scale for all time-related values. It is particularly useful when a more accurate Acc/Dec times are required because of load characteristics, or when the maximum time range needs to be extended.

<table><tr><td colspan="2">Configuration</td><td>Description</td></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 range of maximum time values may change automatically when the units are changed. If for example, the acceleration time is set at 6000 seconds, a time scale change from 1 second to 0.01 second will result in a modified acceleration time of 60.00 seconds.

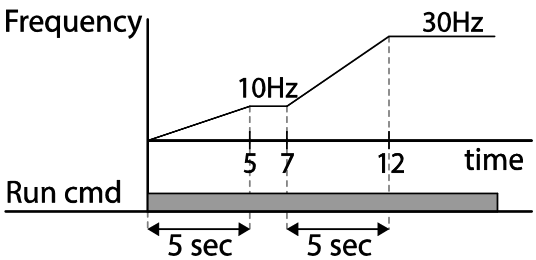
4.10.2 Acc/Dec Time Based on Operation Frequency

Acc/Dec times can be set based on the time required to reach the next step frequency from the existing operation frequency. To set the Acc/Dec time values based on the existing operation frequency, set bA. 08 (acc/dec reference) in the Basic group to 1 (Delta Freq).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	20.0		0.0–600.0	sec
	dEC	Deceleration time	Dec Time	30.0		0.0–600.0	sec
bA	08	Acc/Dec reference	Ramp T Mode	1	Delta Freq	0–1	-

Acc/Dec Time Based on Operation Frequency – Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>bA.08
Ramp T Mode</td><td>Set the parameter value to 1 (Delta Freq) to set Acc/Dec times based on Maximum frequency.

<table><tr><td colspan="2">Configuration</td><td>Description</td></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 Operation frequency.</td></tr></table>
If Acc/Dec times are set to 5 seconds, and multiple frequency references are used in the operation in 2 steps, at 10Hz and 30 Hz, each acceleration stage will take 5 seconds (refer to the graph below).
</td></tr>
</table>

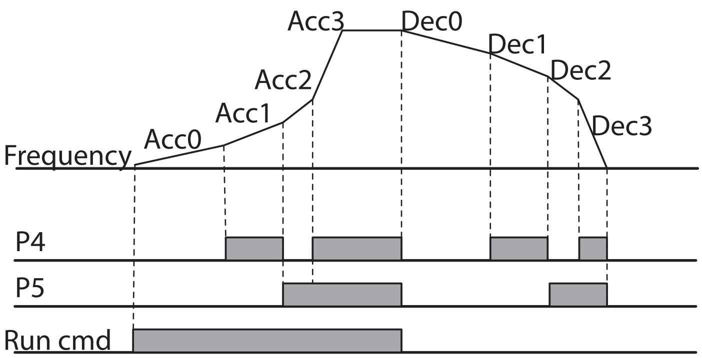
4.10.3 Multi-step Acc/Dec Time Configuration

Acc/Dec times can be configured via digital input terminals by setting the ACC (acceleration time) and dEC (deceleration time) codes in the Operation group.

<table>
<tr><th>Group</th><th>Code</th><th>Name</th><th>LCD Display</th><th colspan="2">Parameter Setting</th><th>Setting Range</th><th>Unit</th></tr>
<tr><td rowspan="2">Operation</td><td>ACC</td><td>Acceleration time</td><td>Acc Time</td><td colspan="2">20.0</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td>dEC</td><td>Deceleration time</td><td>Dec Time</td><td colspan="2">30.0</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td rowspan="2">bA</td><td>70–82</td><td>Multi-step acceleration time1–7</td><td>Acc Time 1–7</td><td colspan="2">x.xx</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td>71–83</td><td>Multi-step deceleration time1–7</td><td>Dec Time 1–7</td><td colspan="2">x.xx</td><td>0.0–600.0</td><td>sec</td></tr>
<tr><td rowspan="4">In</td><td rowspan="3">65–69</td><td rowspan="3">Px terminal configuration</td><td rowspan="3">Px Define
(Px: P1–P5)</td><td>11</td><td>XCEL-L</td><td rowspan="3">0–54</td><td rowspan="3">-</td></tr>
<tr><td>12</td><td>XCEL-M</td></tr>
<tr><td>49</td><td>XCEL-H</td></tr>
<tr><td>89</td><td>Multi-step command delay time</td><td>In Check Time</td><td colspan="2">1</td><td>1–5000</td><td>ms</td></tr>
</table>

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

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>bA. 70–82 Acc Time 1–7</td><td>Set multi-step acceleration time1–7.</td></tr>
<tr><td>bA.71–83 Dec Time 1–7</td><td>Set multi-step deceleration time1–7.</td></tr>
<tr><td>In.65–69
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>Description</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.83.
If, for example, the P4 and P5 terminals are set as XCEL-L and XCEL 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>
</td></tr>
<tr><td>In.89 In Check Time</td><td>Set the time for the inverter to check for other terminal block inputs. If In.89 is set to 100ms and a signal is supplied to the P4 terminal, the inverter searches for other inputs over the next 100ms. When the time expires, the Acc/Dec time will be set based on the input received at P4.</td></tr>
</table>

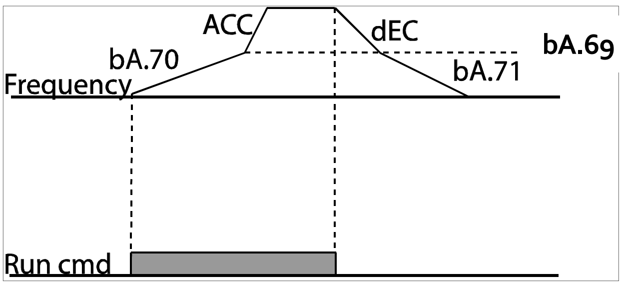
4.10.4 Configuring Acc/Dec Time Switch Frequency

You can switch between two different sets of Acc/Dec times (Acc/Dec gradients) by configuring the switch frequency without configuring the multi-function terminals.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Operation	ACC	Acceleration time	Acc Time	10.0	0.0–600.0	sec
	dEC	Deceleration time	Dec Time	10.0	0.0–600.0	sec
bA	70	Multi-step acceleration time1	Acc Time-1	20.0	0.0–600.0	sec
	71	Multi-step deceleration time1	Dec Time-1	20.0	0.0–600.0	sec
bA	69	Acc/Dec switch frequency	Xcel Change Frq	30.00	0–Maximum frequency	Hz

Acc/Dec Time Switch Frequency Setting Details

Code	Description
bA.69 Xcel Change Fr	When the Acc/Dec switch frequency (bA.69, Xcel Change Fr) is set and the inverter operation is at or below the set frequency, it will use the accel and decel times set in parameters bA.70 and 71. If the operation frequency is above the switch frequency, it will use the accel and decal times set in parameters ACC and dEC codes. If you configure the P1–P5 multi-function input terminals for multi-step Acc/Dec gradients (XCEL-L, XCEL-M, XCEL-H), the inverter will operate based on the Acc/Dec inputs at the terminals instead of the Acc/Dec switch frequency configurations.



4.11 Acc/Dec Pattern Configuration

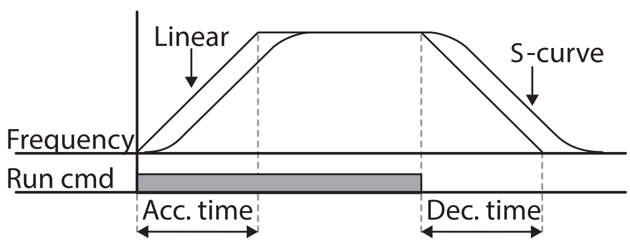
Acc/Dec gradient level patterns can be configured to enhance and smooth the inverter's acceleration and deceleration curves. The linear pattern features a linear increase or decrease to the output frequency, at a fixed rate. With an S-curve pattern, a smoother and more gradual increase or decrease of output frequency is performed. S-curve gradient level can be adjusted using codes Ad. 03–06 in the Advanced group.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	08	Acc/Dec reference	Ramp T mode	0	Max Freq	0–1	-

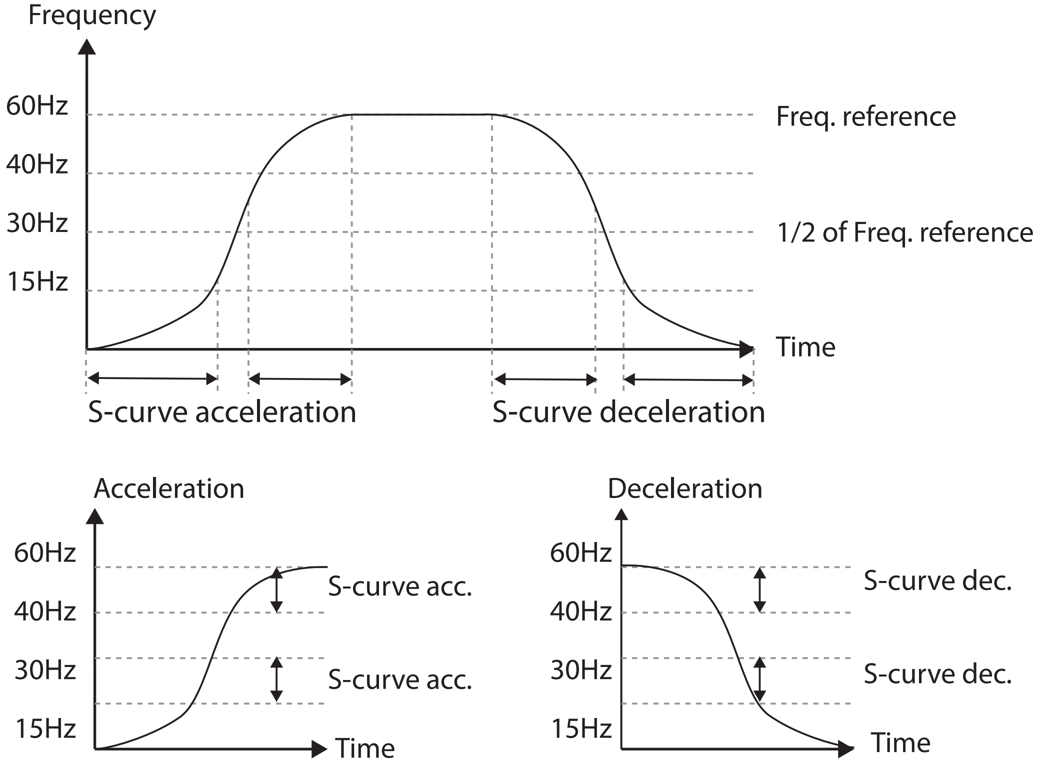
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	01	Acceleration pattern	Acc Pattern	0	Linear	0–1	-
	02	Deceleration pattern	Dec Pattern	1	S-curve		-
	03	S-curve Acc start gradient	Acc S Start	40		1–100	%
	04	S-curve Acc end gradient	Acc S End	40		1–100	%
	05	S-curve Dec start gradient	Dec S Start	40		1–100	%
	06	S-curve Dec end gradient	Dec S End	40		1–100	%

Acc/Dec Pattern Setting Details

Code	Description
Ad.03 Acc S Start	Sets the gradient level as acceleration starts when using an S-curve Acc/Dec pattern. Ad. 03 defines S-curve gradient level as a percentage, up to half of total acceleration. If the frequency reference and maximum frequency are set at 60Hz and Ad.03 is set to 50%, Ad. 03 configures acceleration up to 30Hz (half of 60Hz).The inverter will operate S-curve acceleration in the 0-15Hz frequency range (50% of 30Hz). Linear acceleration will be applied to the remaining acceleration within the 15–30Hz frequency range.
Ad.04 Acc S End	Sets the gradient level as acceleration ends when using an S-curve Acc/Dec pattern. Ad. 03 defines S-curve gradient level as a percentage, above half of total acceleration. If the frequency reference and the maximum frequency are set at 60Hz and Ad.04 is set to 50%, setting Ad. 04 configures acceleration to increase from 30Hz (half of 60Hz) to 60Hz (end of acceleration). Linear acceleration will be applied within the 30-45Hz frequency range. The inverter will perform an S-curve acceleration for the remaining acceleration in the 45–60Hz frequency range.
Ad.05 Dec S Start – Ad.06 Dec S End	Sets the rate of S-curve deceleration. Configuration for codes Ad.05 and Ad.06 may be performed the same way as configuring codes Ad.03 and Ad.04.



[Acceleration / deceleration pattern configuration]



[Acceleration / deceleration S-curve pattern configuration]

Note

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

Actual acceleration time = user-configured acceleration time + user-configured acceleration time x starting gradient level/2 + user-configured acceleration time x ending gradient level/2.

Actual deceleration time = user-configured deceleration time + user-configured deceleration time x starting gradient level/2 + user-configured deceleration time x ending gradient level/2.

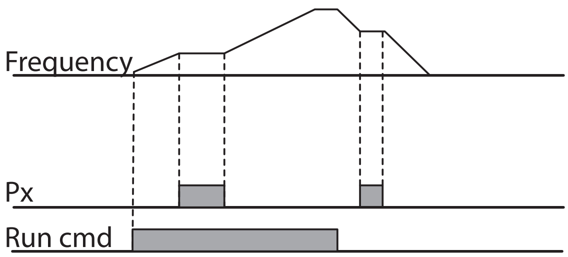
① Caution

Note that actual Acc/Dec times become greater than user defined Acc/Dec times when S-curve Acc/Dec patterns are in use.

4.12 Stopping the Acc/Dec Operation

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

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65–69	Px terminal configuration	Px Define(Px: P1– P5)	25	XCEL Stop	0–54	-



4.13 V/F(Voltage/Frequency) 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 of torque boost used during low frequency operations can also be adjusted.

4.13.1 Linear V/F Pattern Operation

A linear V/F pattern configures the inverter to increase or decrease the output voltage at a fixed rate for different operation frequencies based on V/F characteristics. A linear V/F pattern is partcularly useful when a constant torque load is applied.

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

Linear V/F Pattern Setting Details

Code	Description
dr.18 Base Freq	Sets the base frequency. A base frequency is the inverter's output frequency when running at its rated voltage. Refer to the motor's name plate to set this parameter value.

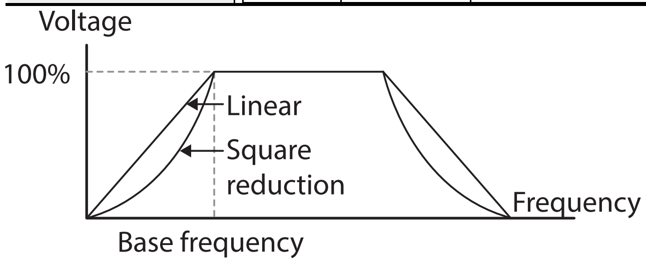
4.13.2 Square Reduction V/F pattern Operation

Square reduction V/F pattern is ideal for loads such as fans and pumps that do not require constant torque. It provides non-linear acceleration and deceleration patterns (squared V/F ratio) to sustain torque throughout the whole frequency range.

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

Square Reduction V/F pattern Operation - Setting Details

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



4.13.3 User V/F Pattern Operation

The "S" Series inverter allows configuration of a user-defined V/F pattern for special applications with unique load characteristics.

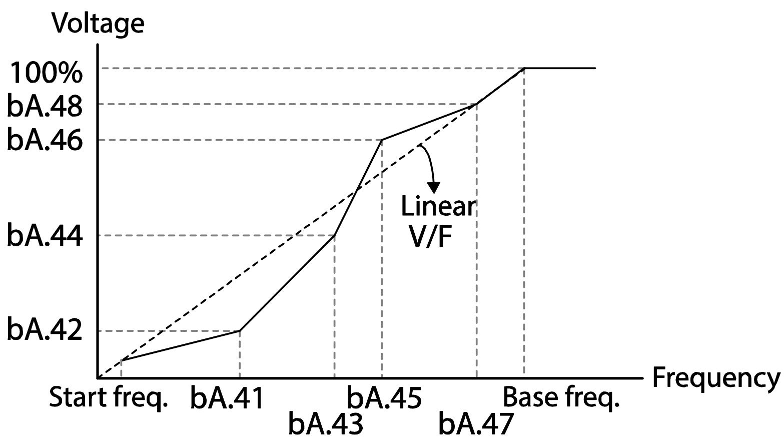
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	07	V/F pattern	V/F Pattern	2	User V/F	0–3	-
	41	User Frequency1	User Freq 1	15.00		0–Maximum frequency	Hz
	42	User Voltage1	User Volt 1	25		0–100	%
	43	User Frequency2	User Freq 2	30.00		0–Maximum frequency	Hz
	44	User Voltage2	User Volt 2	50		0–100	%
	45	User Frequency3	User Freq 3	45.00		0–Maximum frequency	Hz
	46	User Voltage3	User Volt 3	75		0–100	%
	47	User Frequency4	User Freq 4	Maximum frequency		0–Maximum frequency	Hz

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	48	User Voltage4	User Volt 4	100	0–100%	%

User V/F pattern Setting Details

Code	Description
bA.41 User Freq 1–bA.48 User Volt 4	Set the parameter values, both frequency and voltage for up to four points to create a custom V/F curve. Frequencies are set to correspond with each voltage. The defined points are between the start frequency and the base frequenciy.

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.
- When a user V/F pattern is in use, forward torque boost (dr.16) and reverse torque boost (dr.17) do not operate.

4.14 Torque Boost

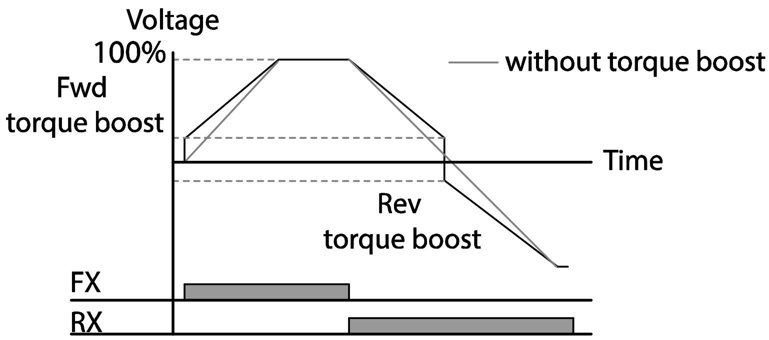
4.14.1 Manual Torque Boost

Manual torque boost increases the output voltage during motor starting and low speed operation. Increase the boost percentage to improve motor starting properties for loads that require high starting torque.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Dr	15	Torque boost options	Torque Boost	0	Manual	0–1	-
	16	Forward torque boost	Fwd Boost	2.0		0.0–15.0	%
	17	Reverse torque boost	Rev Boost	2.0		0.0–15.0	%

Manual Torque Boost Setting Details

Code	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, motor overheating and possible over current faults .

4.14.2 Auto Torque Boost-1

Auto torque boost enables the inverter to automatically calculate the amount of output voltage required for torque boost based on the entered motor parameters. Because auto torque boost requires motor-related parameters such as stator resistance, inductance, and no-load current, auto tuning (bA.20) has to be performed before auto torque boost can be configured [Refer to 5.9_ on page 143]. Configure auto torque boost for loads that require high starting torque.

Group		Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Dr		15	torque boost	Torque Boost	1	Auto1	0–2	-

Group		Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
			mode					
bA		20	auto tuning	Auto Tuning	3	Rs+Lsigma	0–6	-

4.14.3 Auto Torque Boost-2

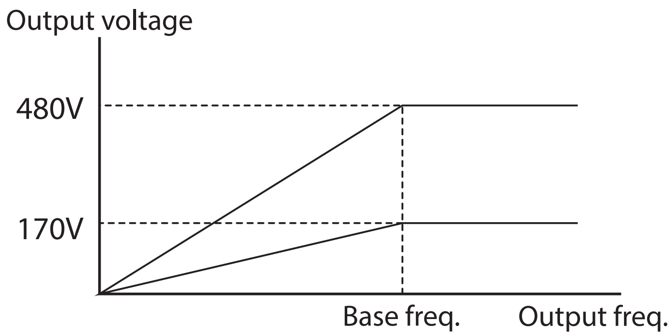
In V/F operation, this adjusts the output voltage during starting if motor does not rotate due to a low output voltage and due to a lack of starting torque.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Dr	15	torque boost mode	Torque Boost	2	Auto2	0–2	-

4.15 Output Voltage Setting

Output voltage adjustment is required when a motor's rated voltage differs from the input voltage to the inverter. Set bA.15 to configure the motor's rated operating voltage. The set voltage becomes the output voltage at the inverter's base frequency. When the motor's voltage rating is lower than the input voltage at the inverter, the inverter adjusts the voltage and supplies the motor with the voltage set at bA.15 (motor rated voltage). When the inverter operates above the base frequency or if the motor's rated voltage is higher than the input voltage at the inverter, the maximum output voltage will be equal to the input voltage.
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. When the input voltage is lower than the parameter setting, the input voltage will be the inverter output voltage.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
bA	15	Motor rated voltage	Motor Volt	230 or 460 model dependant	0, 170–480	V



4.16 Start Mode Setting

Select the start mode to use when a start command is applied to the inverter.

4.16.1 Acceleration Start

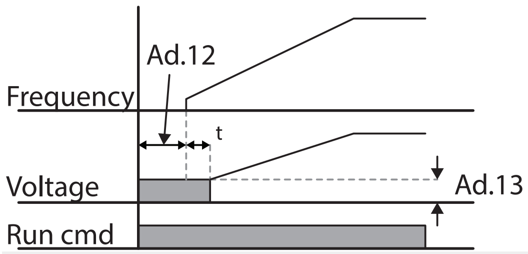
Acceleration start is the general acceleration mode used when starting a motor from a stopped condition. If there are no other settings applied, the motor accelerates to the frequency reference when the start command is applied.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	07	Start mode	Start mode	0	Acc	0–1	-

4.16.2 Start After DC Braking

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. If the motor is rotating before a start command 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 with a mechanical brake connected to a motor shaft if a constant torque is required after the the mechanical brake is released.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	07	Start mode	Start Mode	1	DC-Start	0–1	-
	12	Start DC braking time	DC-Start Time	0.00		0.00–60.00	sec
	13	DC Injection Level	DC Inj Level	50		0–200	%



Caution

The amount of DC braking required [Ad.13 percent] is based on the motor's rated current. Do not use DC braking levels that can cause current draw to exceed the rated current of the inverter. If the DC braking level is too high or brake time is too long, the motor may overheat or be damaged.

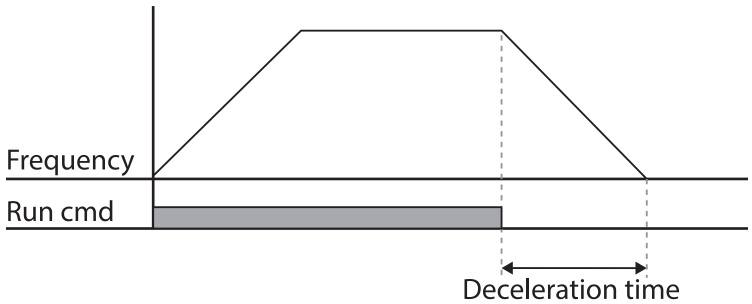
4.17 Stop Mode Setting

Select a stop mode to stop the inverter operation.

4.17.1 Deceleration Stop

Deceleration stop is the general stop mode used when stopping a motor. If there are no other settings applied, the motor decelerates down to 0Hz and stops, as shown in the figure below.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop mode	Stop Mode	0	Dec	0–4	-



4.17.2 Stop with DC Braking

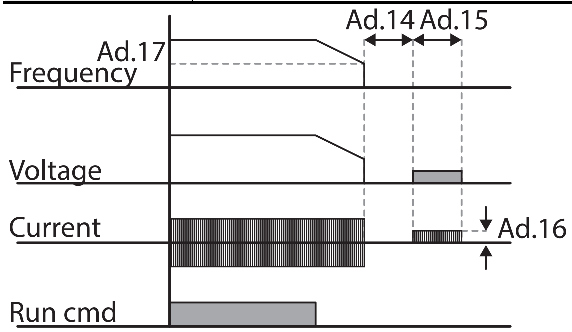
During deceleration. when the output frequency reaches the DC Brake frequency [Ad.17, DC braking frequency], the inverter stops the motor by supplying DC power to the motor.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop mode	Stop Mode	1	DC Brake	0–4	-
	14	Output block time before braking	DC-Block Time	0.10		0.00–60.00	sec
	15	DC braking time	DC-Brake Time	1.00		0–60	sec
	16	DC braking amount	DC-Brake Level	50		0–200	%
	17	DC braking frequency	DC-Brake Freq	5.00		0.00–60.00	Hz

Stop with DC Braking Setting Details

Code	Description
Ad.14 DC-Block Time	Set the time delay between stopping the inverter output and before applying DC braking. If the inertia of the load is great, or if DC braking frequency (Ad.17) is set too high, a fault may occur due to overcurrent conditions when the inverter supplies DC voltage to the motor. To prevent overcurrent faults, increase the delay time before DC braking is applied.
Ad.15 DC-Brake Time	Set the time duration of the applied DC voltage 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.
Ad.17 DC-Brake	Set the frequency to start DC braking. When the frequency is reached, the

Code	Description
Freq	inverter output is cut off. After the block time [Ad.14], the inverter applies DC power to the motor for the time set in Ad.15. If there is a dwell frequency set [Ad.22, Ad.23] lower than the DC braking frequency, dwell operation will be ignored and DC braking will start instead.



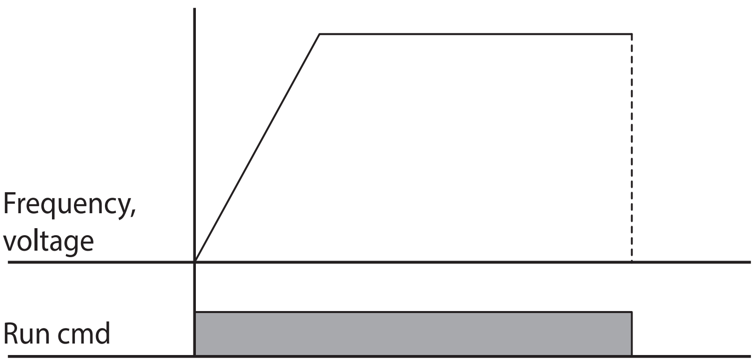
ⓘ Caution

- Note that the motor can overheat or be damaged if excessive amount of DC braking is applied to the motor, or DC braking time is set too long.
- DC braking is configured based on the motor's rated current. To prevent overheating or damaging motors, do not set the current value higher than the inverter's rated current.

4.17.3 Free Run Stop

When the run command is turned off, the inverter output turns off and the motor/load coasts to a stop due to residual inertia.

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



> ⓘ Caution
>
> Note that when the load has a high inertia and the motor is operating at high speed, the load's inertia can cause the motor to continue rotating for a period of time after inverter output has been turned off.

4.17.4 Power Braking

During deceleration, when the inverter's DC voltage rises above a specified level due to motor regenerated energy, a inverter adjusts the deceleration gradient level and can accelerate the motor in order to reduce the regenerated energy. 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	LCD Display	Parameter Setting		Setting Range	Unit
Ad	08	Stop mode	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, and power braking takes priority over stall prevention. In other words, when both Pr.50 (stall prevention and flux braking) and Ad.08 (power braking) are set, power braking will take precedence.
> - Note that if deceleration time is too short or inertia of the load is too great, an overvoltage fault may occur.
> - Note that when power braking stop is used, the actual deceleration time can be longer than the pre-set deceleration time.

4.18 Frequency Limit

Operation frequency can be limited by setting the start frequency, maximum frequency, upper limit frequency and lower limit frequency.

4.18.1 Frequency Limit Using Maximum Frequency and Start Frequency

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

Frequency Limit Using Maximum Frequency and Start Frequency - Setting Details

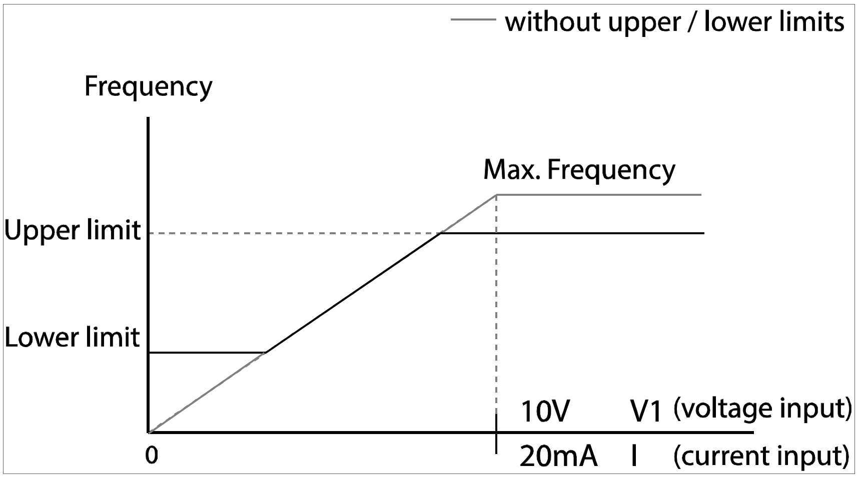
Code	Description
dr.19 Start Freq	Set the lower limit value for speed unit parameters that are expressed in Hz or rpm. If an input frequency is lower than the start frequency, the displayed value will be 0.00.
dr.20 Max Freq	Set a maximum frequency for all speed unit parameters that are expressed in Hz or rpm, except for the base frequency (dr.18). Frequency cannot be set higher than the maximum frequency.

4.18.2 Frequency Limit Using Upper and Lower Limit Frequency Values

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	24	Frequency limit	Freq Limit	0	No	0–1	-
				1	Yes		
	25	Frequency lower limit value	Freq Limit Lo	0.50		0.0–maximum frequency	Hz
	26	Frequency upper limit value	Freq Limit Hi	Maximum frequency		minimum–maximum frequency	Hz

Frequency Limit Using Upper and Lower Limit Frequencies - Setting Details

Code	Description
Ad.24 Freq Limit	The initial setting is 0(No). Changing the setting to 1(Yes) allows the setting of frequencies between the lower limit frequency (Ad.25) and the upper limit frequency (Ad.26). When the setting is 0(No), codes Ad.25 and Ad.26 are not visible.
Ad.25 Freq Limit Lo, Ad.26 Freq Limit Hi	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.

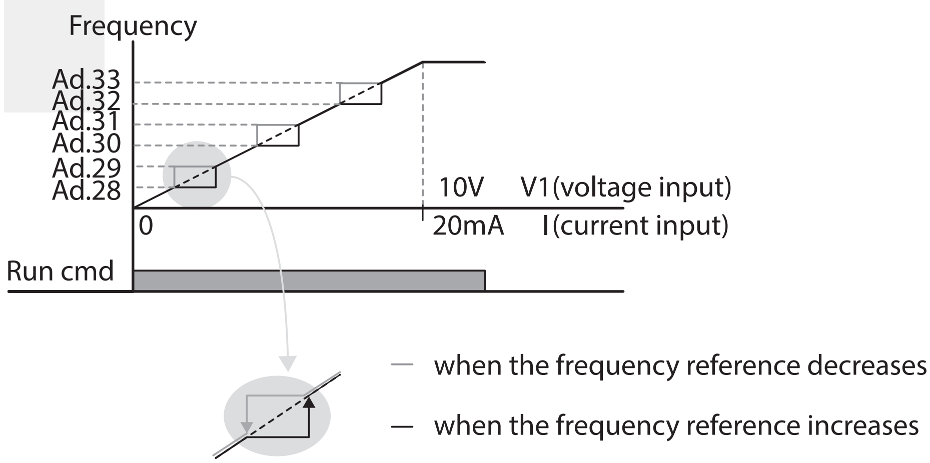


4.18.3 Frequency Jump

Use frequency jump to avoid mechanical resonance frequencies during acceleration and deceleration. Operation frequencies cannot be set within the pre-set frequency jump band. When the frequency reference value (voltage, current, RS-485 communication, keypad setting, etc.) is within a jump frequency band , the frequency will be maintained at the lower limit value of the frequency band. When the frequency reference increases to a speed above the frequency jump band, the inverter will accelerate to the corresponding speed based on the existing frequency reference.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	27	Frequency jump	Jump Freq	0	No	0–1	-
				1	Yes		
	28	Jump frequency lower limit1	Jump Lo 1	10.00		0.00–Jump frequency upper limit 1	Hz
	29	Jump frequency upper limit1	Jump Hi 1	15.00		Jump frequency lower limit 1–Maximum frequency	Hz
	30	Jump frequency lower limit 2	Jump Lo 2	20.00		0.00–Jump frequency upper limit 2	Hz

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	31	Jump frequency upper limit 2	Jump Hi 2	25.00	Jump frequency lower limit 2–Maximum frequency	Hz
	32	Jump frequency lower limit 3	Jump Lo 3	30.00	0.00–Jump frequency upper limit 3	Hz
	33	Jump frequency upper limit 3	Jump Hi 3	35.00	Jump frequency lower limit 3–Maximum frequency	Hz



4.19 2nd Operation Mode Setting

Allows to select between two different start/stop sources and speed reference sources. This can be used be for switching between local and remote operation. (See also ESC Key programming for Local/Remote Operation in 4.6). A digital input must be programmed to 2nd source. The primary (or local) operating mode is defined by parameters drv and Frq. The second (or remote) operating mode is defined by parameters bA.01 and bA.02. Set one of the digital input terminals from codes In. 65–71 and set the parameter value to 15 (2nd Source).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1	Fx/Rx-1	0–5	-
	Frq	Frequency reference source	Freq Ref Src	2	V1	0–12	-
bA	01	2nd Command source	Cmd 2nd Src	0	Keypad	0–4	-
	02	2nd Frequency reference source	Freq 2nd Src	0	KeyPad-1	0–12	-
In	65–69	Px terminal configuration	Px Define (Px: P1–P5)	15	2nd Source	0–54	-

* Displayed under DRV-06 in an LCD keypad.

2nd Operation Mode Setting Details

Code	Description
bA.01 Cmd 2nd Src bA.02 Freq 2nd Src	When the digital input set to 2nd source is activated, the operating mode is performed using the set values from bA.01 and BA.02 instead of the set values from the drv and Frq codes in the Operation group. The 2nd command source settings cannot be changed while operating with the 1st command source (Main Source).

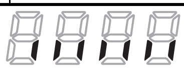
Caution

- When setting the digital input terminal to the 2nd command source (2nd Source), if the digital input is active (On), operation will be from the 2nd command. Before closing the input to the digital input terminal, ensure that the 2nd command is correctly set. Note that if the deceleration time is too short or inertia of the load is too high, an overvoltage fault may occur.
- Depending on the parameter settings, the inverter may stop operating when you switch the command modes.

4.20 Multi-function Input Terminal Control

The functioning of the digital inputs can be configured to add filter time constants (time delays) and NO or NC activation to each terminal individually.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
In	84	Multi-function input terminal On filter Selection	DI Delay Sel	0 0000*	0 0000 ~ 1 1111	
	85	Multi-function input terminal On filter	DI On Delay	10	0~10000	ms
	86	Multi-function input terminal Off filter	DI Off Delay	3	0~10000	ms
	87	Multi-function input terminal selection	DI NC/NO Sel	0 0000*	-	-
	90	Multi-function input terminal status	DI Status	0 0000*	-	-

* Displayed as  on the keypad.

Multi-function Input Terminal Control Setting Details

Code	Description
In.84 DI Delay Sel	Select whether or not to activate the time values set at In.85 and In.86. If not activated (0 0000), the time values are set to the default values at In.85 and In.86. If activated, the set time values at

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>In.85 and In.86 are applied to the corresponding terminals.
<table>
<tr><td>Type</td><td>B terminal status (Normally Closed)</td><td>A terminal status (Normally Open)</td></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
<tr><td>LCD keypad</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>In.85 DI On Delay, In.86 DI Off Delay</td><td>When the terminal receives an input, it is recognized after the filter time has elapsed.</td></tr>
<tr><td>In.87 DI NC/NO Sel</td><td>Select terminal contact types (NO or NC) for each input terminal. The position of the indicator light corresponds to the segment that is on as shown in the table below. With the bottom segment on, it indicates that the terminal is configured as a 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 P1–P5, from right to left.
<table>
<tr><td>Type</td><td>B terminal status (Normally Closed)</td><td>A terminal status (Normally Open)</td></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
<tr><td>LCD keypad</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>In.90 DI Status</td><td>Displays the status of each terminal. When a segment is configured as A terminal using In.87, the On condition is indicated by the top segment turning on. The Off condition is indicated when the bottom segment is turned on. When contacts are configured as B terminals, the segment lights behave conversely. Terminals are numbered P1–P5, from right to left.
<table>
<tr><td>Type</td><td>A terminal setting (On)</td><td>A terminal setting (Off)</td></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
</table></td></tr>
</table>

Code	Description		
	LCD keypad		

4.21 P2P Setting

The P2P function is used to share input and output devices between multiple inverters. To enable P2P setting, RS-485 communication must be turned on .

Inverters connected through P2P communication are designated as either a master or slaves . The Master inverter controls the input and output of slave inverters. Slave inverters provide input and output actions. When using the multi-function output, a slave inverter can select to use either the master inverter's output or its own output. When using P2P communication, first designate the slave inverter and then the master inverter. If the master inverter is designated first, connected inverters may interpret the condition as a loss of communication.

Master Parameter

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	95	P2P Communication selection	Int 485 Func	1	P2P Master	0–3	-
US	80	Analog input1	P2P In V1	0		0–12,000	%
	81	Analog input2	P2P In I2	0		-12,000–12,000	%
	82	Digital input	P2P In DI	0		0–0x7F	bit
	85	Analog output	P2P Out AO1	0		0–10,000	%
	88	Digital output	P2P Out DO	0		0–0x03	bit

Slave Parameter

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	95	P2P Communication selection	Int 485 Func	2	P2P Slave	0–3	-
	96	P2P DO setting selection	P2P OUT Sel	0	No	0–2	bit

P2P Setting Details

Code	Description
CM.95 Int 485 Func	Set master inverter to 1(P2P Master), slave inverter to 2(P2P Slave).
US.80–82 P2P Input Data	Input data sent from the slave inverter.

Code	Description
US.85, 88 P2P Output Data	Output data transmitted to the slave inverter.

Caution

- P2P features work only with code version 1.00, IO S/W version 0.11, and keypad S/W version 1.07 or higher versions.
- Set the user sequence functions to use P2P features..

4.22 Multi-keypad Setting

Use multi-keypad settings to control more than one inverter with one keypad. To use this function, first configure RS-485 communication.
The group of inverters to be controlled by the keypad will include a master inverter. The master inverter monitors the other inverters, and slave inverter responds to the master inverter's input. When using multi-function output, a slave inverter can select to use either the master inverter's output or its own output. When using the multi keypad, first designate the slave inverter and then the master inverter. If the master inverter is designated first, connected inverters may interpret the condition as a loss of communication.

Master Parameter

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	95	P2P Communication selection	Int 485 Func	3	KPD-Ready	0–3	-
CNF	03	Multi-keypad ID	Multi KPD ID	3		3–99	-
	42	Multi-function key selection	Multi Key Sel	4	Multi KPD	0–4	-

Slave Parameter

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CM	01	Station ID	Int485 St ID	3		3–99	-
	95	P2P communication options	Int 485 Func	3	KPD-Ready	0–3	-

Multi-keypad Setting Details

Code	Description
CM.01 Int485 St ID	Prevents conflict by designating a unique identification value to an inverter. Values can be selected from numbers between 3–99.
CM.95 Int 485 Func	Set the value to 3(KPD-Ready) for both master and slave inverter
CNF-03 Multi KPD ID	Select an inverter to monitor from the group of inverters.
CNF-42 Multi key Sel	Select a multi-function key type 4(Multi KPD) .

Caution

- Multi-keypad (Multi-KPD) features work only with code version 1.00, IO S/W version 0.11, and keypad S/W version 1.07 or higher versions.

- The multi-keypad feature will not work when the multi-keypad ID (CNF-03 Multi-KPD ID) setting is identical to the RS-485 communication station ID (CM-01 Int485 st ID) setting.
- The master/slave setting cannot be changed while the inverter is operating in slave mode.

4.23 User Sequence Setting

User Sequence creates a simple sequence from a combination of different function blocks. The sequence can comprise of a maximum of 18 steps using 29 function blocks and 30 void parameters. 1 Loop refers to a single execution of a user configured sequence that contains a maximum of 18 steps. Users can select a Loop Time of between 10-1,000ms.
The codes for user sequences configuration can be found in the US group (for user sequence settings) and the UF group (for function block settings).

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP	02	User sequence activation	User Seq En	0	0–1	-
US	01	User sequence operation command	User Seq Con	0	0–2	-
	02	User sequence operation time	User Loop Time	0	0–5	-
	11–28	Output address link1–18	Link UserOut1–18	0	0–0xFFFF	-
	31–60	Input value setting1–30	Void Para1–30	0	-9999–9999	-
	80	Analog input 1	P2P In V1(-10–10 V)	0	0–12,000	%
	81	Analog input 2	P2P In I2	0	-12,000	%
	82	Digital input	P2P In D	0	–12,000	bit
	85	Analog output	P2P Out AO1	0	0–0x7F	%
	88	Digital output	P2P Out DO	0	0–0x03	bit
UF	01	User function 1	User Func1	0	0–28	-
	02	User function input 1-A	User Input 1-A	0	0–0xFFFF	-
	03	User function input 1-B	User Input 1-B	0	0–0xFFFF	-
	04	User function input 1-C	User Input 1-C	0	0–0xFFFF	-
	05	User function output 1	User Output 1	0	-32767–32767	-
	06	User function 2	User Func2	0	0–28	-
	07	User function input 2-A	User Input 2-A	0	0–0xFFFF	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	08	User function input 2-B	User Input 2-B	0	0–0xFFFF	-
	09	User function input 2-C	User Input 2-C	0	0–0xFFFF	-
	10	User function output 2	User Output 2	0	-32767–32767	-
	11	User function 3	User Func3	0	0–28	-
	12	User function input 3-A	User Input 3-A	0	0–0xFFFF	-
	13	User function input 3-B	User Input 3-B	0	0–0xFFFF	-
	14	User function input 3-C	User Input 3-C	0	0–0xFFFF	-
	15	User function output 3	User Output 3	0	-32767–32767	-
	16	Uer function 4	User Func4	0	0–28	-
	17	User function input 4-A	User Input 4-A	0	0–0xFFFF	-
	18	User function input 4-B	User Input 4-B	0	0–0xFFFF	-
	19	User function input 4-C	User Input 4-C	0	0–0xFFFF	-
	20	User function output 4	User Output 4	0	-32767–32767	-
	21	User function 5	User Func5	0	0–28	-
	22	User function input 5-A	User Input 5-A	0	0–0xFFFF	-
	23	User function input 5-B	User Input 5-B	0	0–0xFFFF	-
	24	User function input 5-C	User Input 5-C	0	0–0xFFFF	-
	25	User function output 5	User Output 5	0	-32767–32767	-
	26	User function 6	User Func6	0	0–28	-
	27	User function input 6-A	User Input 6-A	0	0–0xFFFF	-
	28	User function input 6-B	User Input 6-B	0	0–0xFFFF	-
	29	User function input 6-C	User Input 6-C	0	0–0xFFFF	-
	30	User function output 6	User Output 6	0	-32767–32767	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	31	User function 7	User Func7	0	0–28	-
	32	User function input 7-A	User Input 7-A	0	0–0xFFFF	-
	33	User function input 7-B	User Input 7-B	0	0–0xFFFF	-
	34	User function input 7-C	User Input 7-C	0	0–0xFFFF	-
	35	User function output 7	User Output 7	0	-32767–32767	-
	36	User function 8	User Func8	0	0–28	-
	37	User function input 8-A	User Input 8-A	0	0–0xFFFF	-
	38	User function input8-B	User Input 8-B	0	0–0xFFFF	-
	39	User function input 8-C	User Input 8-C	0	0–0xFFFF	-
	40	User function output 8	User Output 8	0	-32767–32767	-
	41	User function 9	User Func9	0	0–28	-
	42	User function input 9-A	User Input 9-A	0	0–0xFFFF	-
	43	User function input 9-B	User Input 9-B	0	0–0xFFFF	-
	44	User function input 9-C	User Input 9-C	0	0–0xFFFF	-
	45	User function output 9	User Output 9	0	-32767–32767	-
	46	User function 10	User Func10	0	0–28	-
	47	User function input 10-A	User Input 10-A	0	0–0xFFFF	-
	48	User function input 10-B	User Input 10-B	0	0–0xFFFF	-
	49	User function input 10-C	User Input 10-C	0	0–0xFFFF	-
	50	User function output 10	User Output 10	0	-32767–32767	-
	51	User function 11	User Func11	0	0–28	-
	52	User function input 11-A	User Input 11-A	0	0–0xFFFF	-
	53	User function input 11-B	User Input 11-B	0	0–0xFFFF	-
	54	User function	User Input 11-	0	0–0xFFFF	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		input 11-C	C			
	55	User function output 11	User Output 11	0	-32767–32767	-
	56	User function 12	User Func12	0	0–28	-
	57	User function input 12-A	User Input 12-A	0	0–0xFFFF	-
	58	User function input 12-B	User Input 12-B	0	0–0xFFFF	-
	59	User function input 12-C	User Input 12-C	0	0–0xFFFF	-
	60	User function output 12	User Output 12	0	-32767–32767	-
	61	User function 13	User Func13	0	0–28	-
	62	User function input 13-A	User Input 13-A	0	0–0xFFFF	-
	63	User function input 13-B	User Input 13-B	0	0–0xFFFF	-
	64	User function input 13-C	User Input 13-C	0	0–0xFFFF	-
	65	User function output 13	User Output 13	0	-32767–32767	-
	66	User function 14	User Func14	0	0–28	-
	67	User function input 14-A	User Input 14-A	0	0–0xFFFF	-
	68	User function input14-B	User Input 14-B	0	0–0xFFFF	-
	69	User function input 14-C	User Input 14-C	0	0–0xFFFF	-
	70	User function output14	User Output 14	0	-32767–32767	-
	71	User function 15	User Func15	0	0–28	-
	72	User function input 15-A	User Input 15-A	0	0–0xFFFF	-
	73	User function input 15-B	User Input 15-B	0	0–0xFFFF	-
	74	User function input 15-C	User Input 15-C	0	0–0xFFFF	-
	75	User function output 15	User Output 15	0	-32767–32767	-
	76	User function 16	User Func16	0	0–28	-
	77	User function input 16-A	User Input 16-A	0	0–0xFFFF	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	78	User function input 16-B	User Input 16-B	0	0–0xFFFF	-
	79	User function input 16-C	User Input 16-C	0	0–0xFFFF	-
	80	User function output 16	User Output 16	0	-32767–32767	-
	81	User function 17	User Func17	0	0–28	-
	82	User function input 17-A	User Input 17-A	0	0–0xFFFF	-
	83	User function input 17-B	User Input 17-B	0	0–0xFFFF	-
	84	User function input 17-C	User Input 17-C	0	0–0xFFFF	-
	85	User function output 17	User Output 17	0	-32767–32767	-
	86	User function 18	User Func18	0	0–28	-
	87	User function input 18-A	User Input 18-A	0	0–0xFFFF	-
	88	User function input 18-B	User Input 18-B	0	0–0xFFFF	-
	89	User function input 18-C	User Input 18-C	0	0–0xFFFF	-
	90	User function output 18	User Output 18	0	-32767–32767	-

User Sequence Setting Details

Code	Description
AP.02 User Seq En	Display the parameter groups related to a user sequence.
US.01 User Seq Con	Set Sequence Run and Sequence Stop with the keypad. Parameters cannot be adjusted during an operation. To adjust parameters, the operation must be stopped.
US.02 User Loop Time	Set the user sequence Loop Time. User sequence loop time can be set to 0.01s/0.02s/ 0.05s/0.1s/0.5s/1s.
US.11–28 Link UserOut1–18	Set parameters to connect 18 Function Blocks. If the input value is 0x0000, an output value cannot be used. To use the output value in step 1 for the frequency reference (Cmd Frequency), input the communication address(0x1101) of the Cmd frequency as the Link UserOut1 parameter.
US.31–60 Void Para1–30	Set 30 void parameters. Use when constant (Const) parameter input is needed in the user function block.
UF.01–90	Set user defined functions for the 18 function blocks. If the function block setting is invalid, the output of the User Output@ is -1.

Code	Description
	All the outputs from the User Output@ are read only, and can be used with the user output link@ (Link UserOut@) of the US group.

Function Block Parameter Structure

Type	Description
User Func @*	Choose the function to perform in the function block.
User Input @-A	Communication address of the function's first input parameter.
User Input @-B	Communication address of the function's second input parameter.
User Input @-C	Communication address of the function's third input parameter.
User Output @	Output value (Read Only) after performing the function block.

* @ is the step number (1-18).

User Function Operation Condition

Number	Type	Description
0	NOP	No Operation.
1	ADD	Addition operation, (A + B) + C If the C parameter is 0x0000, it will be recognized as 0.
2	SUB	Subtraction operation, (A - B) – C If the C parameter is 0x0000, it will be recognized as 0.
3	ADDSUB	Addition andsubtraction compound operation, (A + B) – C If the C parameter is 0x0000, it will be recognized as 0.
4	MIN	Output the smallest value of the input values, MIN(A, B, C). If the C parameter is 0x0000, operate only with A, B.
5	MAX	Output the largest value of the input values, MAX(A, B, C). If the C parameter is 0x0000, operate only with A, B.
6	ABS	Output the absolute value of the A parameter, | A |. This operation does not use the B, or C parameter.
7	NEGATE	Output the negative value of the A parameter, -(A).

Number	Type	Description
		This operation does not use the B, or C parameter.
8	REMAINDER	Remainder operation of A and B, A % B This operation does not use the C parameter.
9	MPYDIV	Multiplication, division compound operation, (A x B)/C. If the C parameter is 0x0000, output the multiplication operation of (A x B).
10	COMPARE-GT (greater than)	Comparison operation: if (A > B) the output is C; if (A </=B) the output is 0. If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).
11	COMPARE-GTEQ (great than or equal to)	Comparison operation; if (A >/= B) output is C; if (A<B) the output is 0. If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).
12	COMPARE-EQUAL	Comparison operation, if(A == B) then the output is C. For all other values the output is 0. If the condition is met, the output parameter is C. if the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).
13	COMPARE-NEQUAL	Comparison operation, if(A != B) then the output is C. For all other values the output is 0. If the condition is met, the output parameter is C. If the condition is not met, the output is 0(False). If the C parameter is 0x0000 and if the condition is met, the output is 1(True).
14	TIMER	Adds 1 each time a user sequence completes a loop. A: Max Loop, B: Timer Run/Stop, C: Choose output mode. If input of B is 1, timer stops (output is 0). If input is 0, timer runs. If input of C is 1, output the current timer value. If input of C is 0, output 1 when timer value exceeds A(Max) value. If the C parameter is 0x0000, C will be recognized as 0. Timer overflow Initializes the timer value to 0.

Number	Type	Description
15	LIMIT	Sets a limit for the A parameter. If input to A is between B and C, output the input to A. If input to A is larger than B, output B. If input of A is smaller than C, output C. B parameter must be greater than or equal to the C parameter.
16	AND	Output the AND operation, (A and B) and C. If the C parameter is 0x0000, operate only with A, B.
17	OR	Output the OR operation, (A | B) | C. If the C parameter is 0x0000, operate only with A, B.
18	XOR	Output the XOR operation, (A ^ B) ^ C. If the C parameter is 0x0000, operate only with A, B.
19	AND/OR	Output the AND/OR operation, (A andB) | C. If the C parameter is 0x0000, operate only with A, B.
20	SWITCH	Output a value after selecting one of two inputs, if (A) then B otherwise C. If the input at A is 1, the output will be B. If the input at A is 0, the output parameter will be C.
21	BITTEST	Test the B bit of the A parameter, BITTEST(A, B). If the B bit of the A input is 1, the output is 1. If it is 0, then the output is 0. The input value of B must be between 0–16. If the value is higher than 16, it will be recognized as 16. If input at B is 0, the output is always 0.
22	BITSET	Set the B bit of the A parameter, BITSET(A, B). Output the changed value after setting the B bit to input at A. The input value of B must be between 0–16. If the value is higher than 16, it will be recognized as 16. If the input at B is 0, the output is always 0. This operation does not use the C parameter.
23	BITCLEAR	Clear the B bit of the A parameter, BITCLEAR(A, B). Output the changed value after clearing the B bit to input at A.

Number	Type	Description
		The input value of B must be between 0–16. If the value is higher than 16, it will be recognized as 16. If the input at B is 0, the output is always 0. This operation does not use the C parameter.
24	LOWPASSFILTER	Output the input at A as the B filter gains time constant, B x US-02 (US Loop Time. In the above formula, set the time when the output of A reaches 63.3% C stands for the filter operation. If it is 0, the operation is started.
25	PI_CONTROL	P, I gain = A, B parameter input, then output as C. Conditions for PI_PROCESS output: C = 0: Const PI, C = 1: PI_PROCESS-B >= PI_PROCESS-OUT >= 0, C = 2: PI_PROCESS-B >= PI_PROCESS-OUT >= -(PI_PROCESS-B), P gain = A/100, I gain = 1/(Bx Loop Time), If there is an error with PI settings, output -1.
26	PI_PROCESS	A is an input error, B is an output limit, C is the value of Const PI output. Range of C is 0–32,767.
27	UPCOUNT	Upcounts the pulses and then output the value- UPCOUNT(A, B, C). After receiving a trigger input (A), outputs are upcounted by C conditions. If the B inputs is 1, do not operate and display 0. If the B inputs is 0, operate. If the C parameter is 0, upcount when the input at A changes from 0 to 1. If the C parameter is 1, upcount when the input at A is changed from 1 to 0. If the C parameter is 2, upcount whenever the input at A changes. Output range is: 0–32767
28	DOWNCOUNT	Downcounts the pulses and then output the value- DOWNCOUNT(A, B, C). After receiving a trigger input (A), outputs are downcounted by C conditions. If the B input is 1, do not operate and display the

Number	Type	Description
		initial value of C. If the B input is 0, operate. Downcounts when the A parameter changes from 0 to 1.

Note

The PI process block (PI_PROCESS Block) must be used after the PI control block (PI_CONTROL Block) for proper PI control operation. PI control operation cannot be performed if there is another block between the two blocks, or if the blocks are placed in an incorrect order.

Caution

User sequence features work only with code version 1.00, IO S/W version 0.11, and keypad S/W version 1.07 or higher versions.

4.24 Fire Mode Operation

This function is used to allow the inverter to ignore minor faults during emergency situations, such as fire, and provides continuous operation to fire pumps.
When turned on, Fire mode forces the inverter to ignore all minor faults. For major faults, the inverter repeats a Reset and Restart regardless of the restart count limit. The retry delay time set at PR. 10 (Retry Delay) still applies while the inverter performs a Reset and Restart.

Fire Mode Parameter Settings

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	80	Fire Mode selection	Fire Mode Sel	1	Fire Mode	0–2	-
	81	Fire Mode frequency	Fire Mode Freq	0-60		0–60	
	82	Fire Mode run direction	Fire Mode Dir	0–1		0–1	
	83	Fire Mode operation count	Fire Mode Cnt	Not configurable		-	-
In	65–69	Px terminal configuration	Px Define (Px: P1– P5)	51	Fire Mode	0–54	-

The inverter runs in Fire mode when Ad. 80 (Fire Mode Sel) is set to '1 (Fire Mode)', and a digital input terminal (P1~P5) is configured (In. 65-71) for Fire mode (51: Fire Mode) is turned on. The Fire mode count increases by 1 at Ad. 83 (Fire Mode Count) each time a Fire mode operation is run.

Caution

Fire mode operation may result in inverter malfunction. Note that Fire mode operation voids the product warranty – the inverter is covered by the product warranty only when the Fire mode count is '0.'

Fire Mode Function Setting Details

Code	Description	Details
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.
Dr.03 Acc Time / Dr.04 Dec Time	Fire mode Acc/Dec times	When Fire mode operation is turned on, the inverter accelerates for the time set at Dr.03 (Acc Time), and then decelerates based on the deceleration time set at Dr.04 (Dec Time). It stops when the Px terminal input is turned off (Fire mode operation is turned off).
PR.10 Retry Delay	Fault process	Some faults are ignored during Fire mode operation. The fault history is saved, but trip outputs are disabled even when they are configured at the multi-function output terminals. **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 and Restart until the trip conditions are released. The retry delay time set at PR. 10 (Retry Delay) applies while the inverter performs a Reset and 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 (Arms-Short)

5 Learning Advanced Features

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

Advanced Tasks	Description	Ref.
Auxiliary frequency operation	Use the main and auxiliary frequencies in the predefined formulas to create various operating conditions. Auxiliary frequency operation is ideal for Draw Operation* as this feature enables fine-tuning of operation speeds.	p.120
Jog operation	Jog operation is a manual operation. The inverter operates to a set of parameter settings predefined for Jog operation when the Jog command button is applied.	p.125
Up-down operation	Uses the upper and lower limit value switch output signals (i.e. signals from a flow meter) as Acc/Dec commands to motors.	p.128
3-wire operation	3-wire operation is used to latch an input signal. This configuration is used to operate the inverter by a push button.	p.129
Safety operation mode	This safety feature allows the inverter's operation only after a signal is input to the multi-function terminal designated for the safety operation mode. This feature is useful when extra care is needed in operating the inverter using the multi-purpose terminals.	p.130
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.132
Slip compensation	This feature ensures that the motor rotates at a constant speed, by compensating for the motor slip as a load increases.	p.133
PID control	PID control provides constant automated control of flow, pressure, and temperature by adjusting the output frequency of the inverter.	p.135
Auto-tuning	Used to automatically measure the motor control parameters to optimize the inverter's control mode performance.	p.143
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.146
Energy buffering operation	Used to maintain the DC link voltage for as long as possible by controlling the inverter output frequency during power interruptions, thus to delay a low voltage fault.	p.154
Energy saving operation	Used to save energy by reducing the voltage supplied to	p.168

Advanced Tasks	Description	Ref.
	motors during low-load and no-load conditions.	
Speed search operation	Used to prevent faults when the inverter voltage is output while the motor is idling or free-running.	p.172
Auto restart operation	Auto restart configuration is used to automatically restart the inverter when a trip condition is released, after the inverter stops operating due to activation of protective devices (faults).	p.176
Second motor operation	Used to switch equipment operation by connecting two motors to one inverter. Configure and operate the second motor using the terminal input defined for the second motor operation.	p.179
Commercial power source switch operation	Used to switch the power source to the motor from the inverter output to a commercial power source, or vice versa.	p.181
Cooling fan control	Used to control the cooling fan of the inverter.	p.182
Timer settings	Set the timer value and control the On/Off state of the multi-function output and relay.	p.190
Brake control	Used to control the On/Off operation of the load's electronic braking system.	p.190
Multi-function output On/Off control	Set standard values and turn On/Off the output relays or multi-function output terminals according to the analog input value.	p.192
Regeneration prevention for press operation.	Used during a press operation to avoid motor regeneration, by increasing the motor operation speed.	p.193

* Draw operation is an openloop 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 operation 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 is used as the operating frequency, while the auxiliary reference is used to modify and fine-tune the main reference. The auxiliary reference can also be disabled using a digial input.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	Frq	Frequency reference source	Freq Ref Src	0	Keypad-1	0–12	-
bA	03	Auxiliary frequency reference source	Aux Ref Src	1	V1	0–4	-
	04	Auxiliary	Aux Calc	0	M+(G*A)	0–7	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		frequency reference calculation type	Type				
	05	Auxiliary frequency reference gain	Aux Ref Gain	0.0		-200.0–200.0	%
In	65–71	Px terminal configuration	Px Define	40	dis Aux Ref	0~54	-

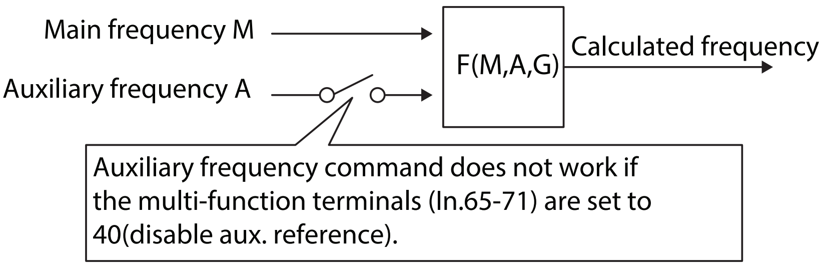
The tables below show the signals available for the auxiliary frequency reference source along with the calculations applied to the main frequency reference source. Example settings are also provided.

Auxiliary Reference Setting Details

Code	Description
bA.03 Aux Ref Src	Set the input type to be used for the auxiliary frequency reference. Configuration | Description 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 V2 | Sets the V2 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference (SW2 must be set to "voltage"). 4 I2 | Sets the I2 (current) terminal at the control terminal block as the source of auxiliary frequency reference (SW2 must be set to "current"). 5 Pulse | Sets the TI (pulse) terminal at the control terminal block as the source of auxiliary frequency reference.
bA.02 Aux Calc Type	Set the auxiliary reference gain with bA.05 (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. Configuration | Formula for frequency reference 0 M+(G*A) | Main reference+(bA.05xbA.03xIn.01) 1 M*(G*A) | x(bA.05xbA.03) 2 M/(G*A) | Main reference/(bA.05xbA.03) 3 M+{M*(G*A)} | Main reference+{Main reference x(bA.05xbA.03)} 4 M+G*2*(A-50) | Main reference+bA.05x2x(bA.03–50)x In.01

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>5</td><td>M*{G*2*(A-50)}</td><td>Main reference x{bA.05x2x(bA.03–50)}</td></tr>
<tr><td>6</td><td>M/{G*2*(A-50)}</td><td>Main reference/{bA.05x2x(bA.03–50)}</td></tr>
<tr><td>7</td><td>M+M*G*2*(A-50)</td><td>Main reference+Main reference x bA.05x2x(bA.03–50)</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.05
Aux Ref
Gain</td><td>Adjust the size of the input (bA.03 Aux Ref Src) configured for auxiliary frequency.</td></tr>
<tr><td>In.65–71
Px
Define</td><td>Set one of the multi-function input terminals to 40(dis Aux Ref) and turn it on to disable the auxiliary frequency reference. The inverter will operate using the main frequency reference only.</td></tr>
</table>



Auxiliary Reference Operation Ex #1

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

- Main frequency: Keypad (operation frequency 30Hz)
- Maximum frequency setting (dr.20): 400Hz
- Auxiliary frequency setting (bA.03): V1[Display by percentage(%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain setting (bA.05): 50%
- In.01–32: Factory default

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

Setting*		Calculating final command frequency**
0	M[Hz]+(G[%]*A[Hz])	30Hz(M)+(50%(G)x36Hz(A))=48Hz
1	M[Hz]*(G[%]*A[%])	30Hz(M)x(50%(G)x60%(A))=9Hz
2	M[Hz]/(G[%]*A[%])	30Hz(M)/(50%(G)x60%(A))=100Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30Hz(M)+{30[Hz]x(50%(G)x60%(A))}=39Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30Hz(M)+50%(G)x2x(60%(A)–50%)x60Hz=36Hz

5	M[HZ]*{G[%]*2*(A[%]-50[%])}	30Hz(M)x{50%(G)x2x(60%(A)–50%)}=3Hz
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30Hz(M)/{50%(G)x2x(60%–50%)}=300Hz
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30Hz(M)+30Hz(M)x50%(G)x2x(60%(A)–50%)=33Hz

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

**If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.

Auxiliary Reference Operation Ex #2

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

- Main frequency: Keypad (Operation frequency 30Hz)
- Maximum frequency setting (dr.20): 400Hz
- Auxiliary frequency setting (bA.03): I2 [Display by percentage(%) or auxiliary frequency(Hz) depending on the operation setting condition]
- Auxiliary reference gain setting (bA.05): 50%
- In.01–32: Factory default

Example: an input current of 10.4mA is applied to I2, with the frequency corresponding to 20mA of 60Hz. The table below shows auxiliary frequency A as 24Hz(=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 command frequency**
0	M[Hz]+(G[%]*A[Hz])	30Hz(M)+(50%(G)x24Hz(A))=42Hz
1	M[Hz]*(G[%]*A[%])	30Hz(M)x(50%(G)x40%(A))=6Hz
2	M[Hz]/(G[%]*A[%])	30Hz(M)/(50%(G)x40%(A))=150Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30Hz(M)+50%(G)x2x(40%(A)–50%)x60Hz=24Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])	30Hz(M)x{50%(G)x2x(40%(A)–50%)} = -3Hz(Reverse)
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30Hz(M)/{50%(G)x2x(60%–40%)} = -300Hz(Reverse)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30Hz(M)+30Hz(M)x50%(G)x2x (40%(A)–50%)=27Hz

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

**If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.

Auxiliary Reference Operation Ex #3

V1 is Main Frequency and I2 is Auxiliary Frequency

- Main frequency: V1 (frequency command setting to 5V and is set to 30Hz)
- Maximum frequency setting (dr.20): 400Hz
- Auxiliary frequency (bA.03): I2[Display by percentage (%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain (bA.05): 50%
- In.01–32: Factory default

Example: an input current of 10.4mA is applied to I2, with the frequency corresponding to 20mA of 60Hz. The table below shows auxiliary frequency A as 24Hz(=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 command frequency**
0	M[Hz]+(G[%]*A[Hz])	30Hz(M)+(50%(G)x24Hz(A))=42Hz
1	M[Hz]*(G[%]*A[%])	30Hz(M)x(50%(G)x40%(A))=6Hz
2	M[Hz]/(G[%]*A[%])	30Hz(M)/(50%(G)x40%(A))=150Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30Hz(M)+50%(G)x2x(40%(A)–50%)x60Hz=24Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])}	30Hz(M)x{50%(G)x2x(40%(A)–50%)}=-3Hz(Reverse)
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30Hz(M)/{50%(G)x2x(60%–40%)}=-300Hz(Reverse)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30Hz(M)+30Hz(M)x50%(G)x2x(40%(A)–50%)=27Hz

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

**If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.

Note

When the maximum frequency value is high, output frequency deviation may result due to analog input variation and deviations in the calculations.

5.2 Jog operation

There are three different ways to put the inverter in the jog mode.

- Jog-1 using a digital input terminal set to JOG along with a run command (Fx or Rx).
- Jog-2 using only a single digital input set to FWD JOG or REV JOG.
- using the [ESC] key on the keypad (see also programming of the ESC key, Section 4.6).

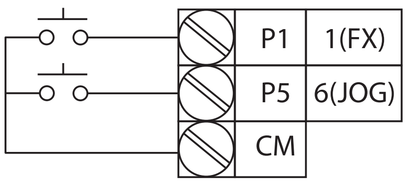
The jog operation overrides all other operation modes, except the dwell operation. The jog operation is the second highest priority operation. If a jog operation is requested while operating the multi-step, up-down, or 3-wire operation modes, the jog operation takes precedence.

5.2.1 Jog Operation 1-Forward Jog by Multi-function Terminal

The jog operation is available in either forward or reverse direction using the digital input terminals. The table below lists parameter setting for a forward jog operation.

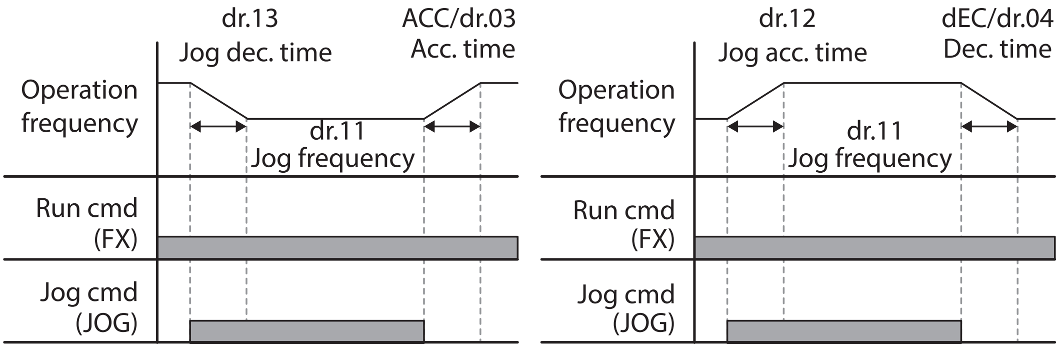
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	11	Jog frequency	JOG Frequency	10.00		0.50-Maximum frequency	Hz
	12	Jog operation acceleration time	JOG Acc Time	20.00		0.00-600.00	sec
	13	Jog operation deceleration time	JOG Dec Time	30.00		0.00-600.00	sec
In	65-69	Px terminal configuration	Px Define(Px: P1–P5)	6	JOG	-	-
OP	Drv	Px terminal configuration	Px Define(Px: P1–P5)	1	Fx/Rx-1	-	-

Forward Jog Description Details

Code	Description
In.65–71 Px Define	Select a digital input from P1- P5 and program to 6. Jog from In.65-69.  [Terminal settings for jog operation]
dr.11 JOG Frequency	Set the operation frequency.
dr.12 JOG Acc Time	Set the acceleration speed.

Code	Description
dr.13 JOG Dec Time	Set the deceleration speed.

When the drive is running (FX command applied) and a digital input is applied to the jog terminal, the operation frequency changes to the jog frequency and the jog operation begins.

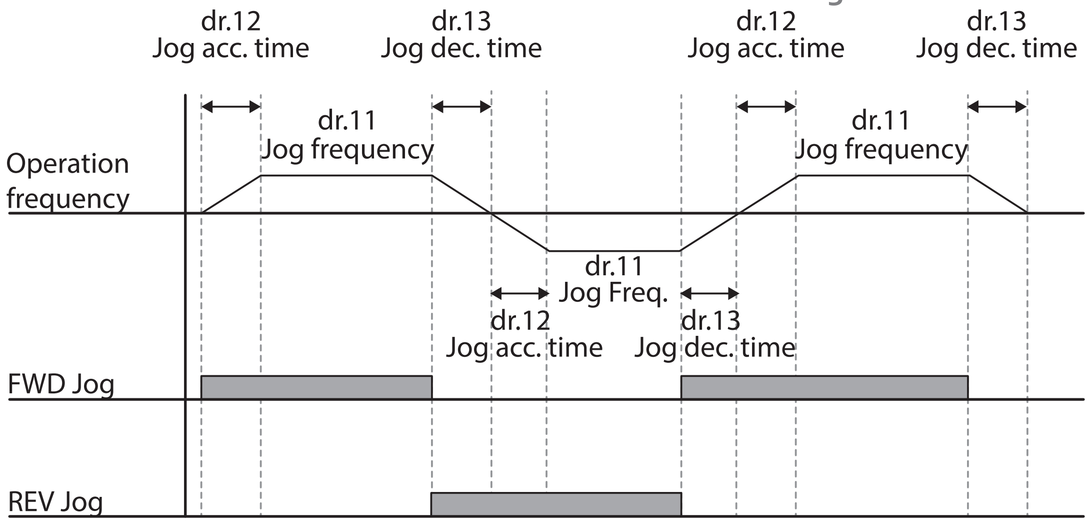


Operation frequency > Jog frequency   Operation frequency < Jog frequency

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

When using jog operation 1, a run command must also be applied along with the jog input. When using jog operation 2, a digital input terminal that is set for a forward or reverse jog also starts the inverter. The settings for JOG frequency and JOG Acc/Dec times are the same as jog operation 1. Jog operation 2 also overrides the other operating modes (3-wire, up/down, etc.). If a different operation command is entered during a jog operation, it is ignored and the operation maintains the jog frequency.

Group	Code	Name	LCD Display	Parameter setting		Setting Range	Unit
dr	11	Jog frequency	JOG Frequency	10.00		0.50-Maximum frequency	Hz
	12	Jog operation acceleration time	JOG Acc Time	20.00		0.00-600.00	sec
	13	Operation deceleration time	JOG Dec Time	30.00		0.00-600.00	sec
In	65-69	Px terminal configuration	Px Define(Px: P1-P5)	46	FWD JOG	-	-
				47	REV JOG		

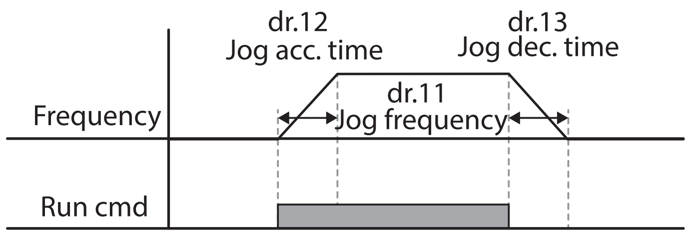


5.2.3 Jog Operation by Keypad

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Dr	90	[ESC] key functions	-	1	JOG Key	-	-
	06	Command source	Cmd Source*	0	Keypad	-	-

* Displayed under DRV-06 on the LCD keypad.

Set dr.90 to 1 (JOG Key) and set the drv code in the Operation group to 0 (Keypad). Set the jog frequency and Acc/Dec times at dr.11, dr.12 and dr.13. When the [ESC] key is pressed, the SET display light flashes and the jog operation is ready to start. Pressing and holding the [RUN] key starts the operation and the inverter accelerates or decelerates to the designated jog frequency. Releasing the [RUN] key stops the jog operation..

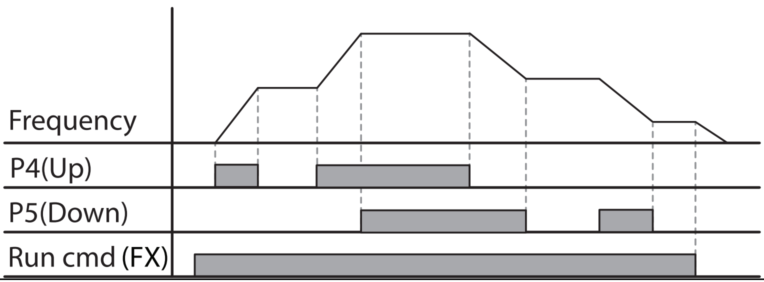


5.3 Up-down Operation

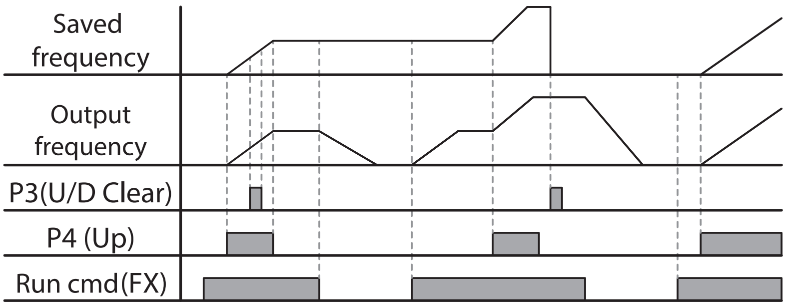
The Acc/Dec time can be controlled through inputs at the digital input terminals. The up-down operation can be applied easily to a system that uses the upper-lower limit switch signals for Acc/Dec commands.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	59	Up-down operation frequency save	U/D Save Mode	1	Yes	0-1	-
In	65-71	Px terminal configuration	Px Define(P1-P5)	17	Up	-	-
				18	Down		
				20	U/D Clear		

Up-down Operation Setting Details

Code	Description
In.65-71 Px Define	Select two terminals for up-down operation and set them to 17 (Up) and 18 (Down), respectively. Acceleration begins when the Up terminal signal is on along with the run command input. Acceleration stops and constant speed operation is maintained when the Up signal is removed. While running, deceleration begins when the Down signal is on (Up signal removed). Deceleration stops and constant speed operation is maintained when Down signal is removed. Note that when both Up and Down signals are applied at the same time, constant speed is maintained. 
In.59 U/D Save Mode	During a constant speed operation, the operating frequency is saved automatically in the following conditions: the operation command (Fx or Rx) is off, a fault occurs, or the power is off. When the operation command is turned on again, or when the inverter regains the power source or resumes to a normal operation from a fault, it resumes operation at the saved frequency. To delete the saved frequency, set one of the digital input terminals to 20 (U/D Clear) and apply signals to it during constant speed operation. The saved frequency and the up-down

Code	Description
	operation configuration will be deleted.



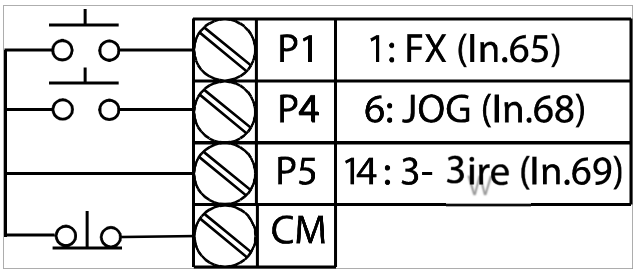
5.4 3-Wire Operation

3-wire operation is used in conjunction with momentary push buttons. A momentary input to the start/run terminal (Fx) latches the input signal. Opening the momentary stop button releases the run command.

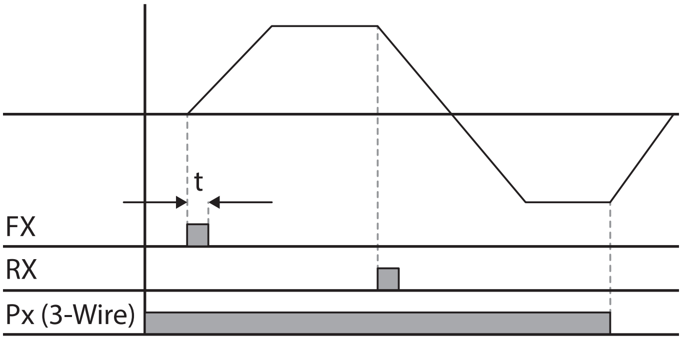
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Operation	drv	Command source	Cmd Source*	1	Fx/Rx - 1	-	-
In	65-71	Px terminal configuration	Px Define(Px: P1-P5)	14	3-Wire	-	-

* Displayed under DRV-06 in an LCD keypad.

To enable the 3-wire operation, the following circuit sequence is necessary. The minimum input time (t) for 3-wire operation is 1ms. The operation stops when the stop button is opened OR both a forward and a reverse command are entered at the same time.



[Terminal connections for 3-wire operation]



[3-wire operation]

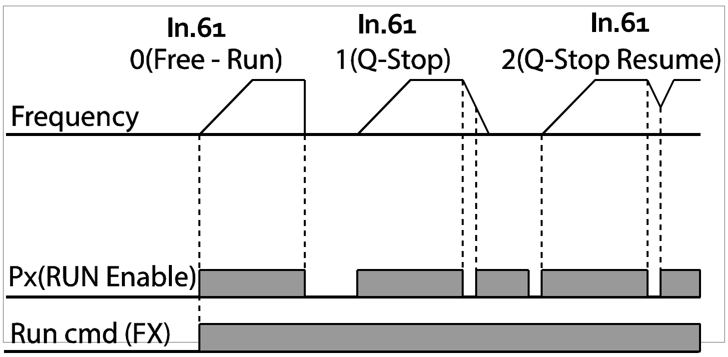
5.5 Safe Operation Mode

When a digital terminal is configured to operate in safe mode (Run Enable), other operation commands will be acknowledged only when the Run enable input closed. Safe operation mode is used to interlock other safety devices and will allow control of the inverter only when the digital input terminal (Run enable) is closed.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	60	Safe operation selection	Run En Mode	1	DI Dependent	-	-
	61	Safe operation stop mode	Run Dis Stop	0	Free-Run	0-2	-
	62	Safe operation deceleration time	Q-Stop Time	5.0		0.0-600.0	sec
In	65-69	Px terminal configuration	Px Define(Px: P1-P5)	13	RUN Enable	-	-

Safe Operation Mode Setting Details

<table>
<tr><th>Code</th><th colspan="3">Description</th></tr>
<tr><td>In.65–69 Px Define</td><td colspan="3">From the multi-function terminals, select a terminal to operate in safe operation mode and set it to 13 (RUN Enable).</td></tr>
<tr><td rowspan="3">In.60 Run En Mode</td><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Always Enable</td><td>Enables safe operation mode.</td></tr>
<tr><td>1</td><td>DI Dependent</td><td>Recognizes the operation command from a digital input terminal.</td></tr>
<tr><td rowspan="5">In.61 Run Dis Stop</td><td colspan="3">When the inverter is running, set the operation of the inverter when the digital input terminal set to Run Enable is opened.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>1</td><td>Free-Run</td><td>Blocks the inverter output when the digital input terminal is open. Coast to stop.</td></tr>
<tr><td>2</td><td>Q-Stop</td><td>The deceleration time (In.62, Q-Stop Time) is used and the inverter stops after deceleration. Operation can resume only when the run enable input along with the opertation command (Fx) is appled again. The operation will not begin if only the Run enable input is applied.</td></tr>
<tr><td>3</td><td>Q-Stop Resume</td><td>The deceleration time (IN.62, Q-Stop Time) is used and the inverter decelerates. If the Run enable input is re-appled, the operation resumes.</td></tr>
<tr><td>In.62 Q-Stop Time</td><td colspan="3">Sets the deceleration time when In.61 (Run Dis Stop) is set to 1 (Q-Stop) or 2 (Q-Stop Resume).</td></tr>
</table>



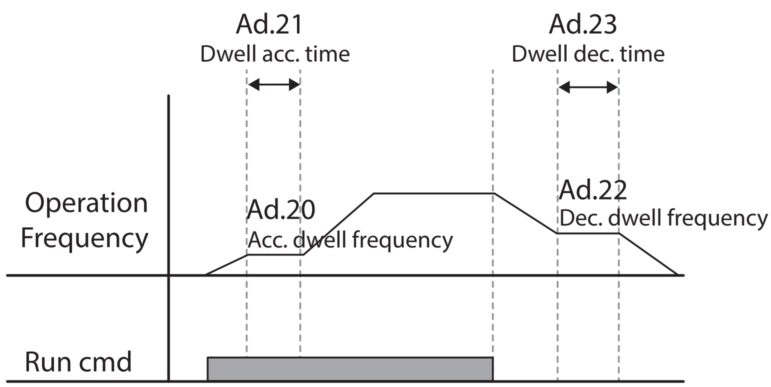
5.6 Dwell Operation

The dwell operation is used to manitain torque during the application and release of the brakes on lift-type loads. Inverter dwell operation is based on the Acc/Dec dwell frequency and the dwell time set by the user. The following points also affect dwell operation:

- **Acceleration Dwell Operation:** When a start command is applied, the inverter accelerates up to the acceleration dwell frequency. It stays at dwell frequency based on the acceleration dwell operation time (Acc Dwell Time). After the Acc Dwell Time has passed, acceleration is carried out based on the acceleration time and the operation speed that was originally set.
- **Deceleration Dwell Operation**: When a stop command is applied, the inverter decelerates down to the deceleration dwell frequency. It stays at the dwell frequency based on the deceleration dwell operation time (Dec Dwell Freq). After the Dec Dwell Freq time has passed, deceleration is carried out based on the deceleration time that was originally set.

When dr.09 (Control Mode) is set to 0 (V/F), the inverter can be used for operations with dwell frequency before opening the mechanical brake of lift-type loads, such as an elevator.

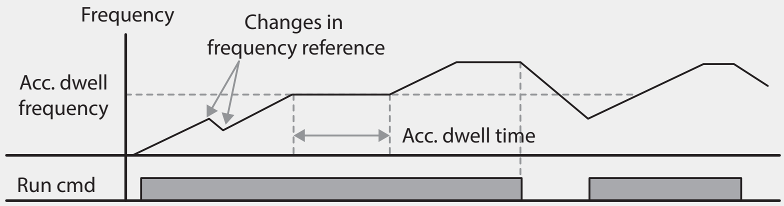
Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
Ad	20	Dwell frequency during acceleration	Acc Dwell Freq	5.00	Start frequency – Maximum frequency	Hz
	21	Operation time during acceleration	Acc Dwell Time	0.0	0.0–10.0	s
	22	Dwell frequency during deceleration	Dec Dwell Freq	5.00	Start frequency – Maximum frequency	Hz
	23	Operation time during deceleration	Dec Dwell Time	0.0	0 .0-60.0	s



Note

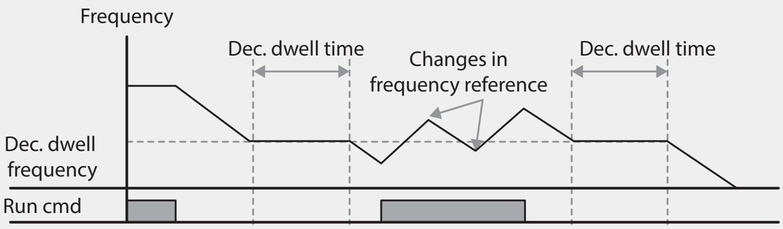
Dwell operation does not work when:

- 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, as only the first acceleration dwell operation command is valid.



[Acceleration dwell operation]

Deceleration dwell operation is carried out whenever stop commands are entered and the deceleration dwell frequency is reached. It does not work during a deceleration by frequency reference change (which is not a deceleration due to a stop operation), or during external brake control applications.



[Deceleration dwell operation]

Caution

When a dwell operation is carried out for a lift - type load, motors can be damaged if the mechanical brake is not released.

5.7 Slip Compensation Operation

Slip refers to the variation between the setting frequency (synchronous speed) and motor rotation speed. As the load increases there can be variations between the setting frequency and motor rotation speed. Slip compensation is used for loads that require compensation of these speed variations. Parameter settings in the table below are based on a 0.75kW, 4 pole motor.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	2	Slip Compen	-	-
	14	Motor capacity	Motor Capacity	2	0.75 kW	0-15	-
bA	11	Number of motor poles	Pole Number	4		2-48	-
	12	Rated slip speed	Rated Slip	90		0-3000	rpm
	13	Rated motor current	Rated Curr	3.6		1.0-1000.0	A
	14	Motor no-load current	Noload Curr	1.6		0.5-1000.0	A
	16	Motor efficiency	Efficiency	72		64-100	%
	17	Load inertia rate	Inertia Rate	0		0-8	-

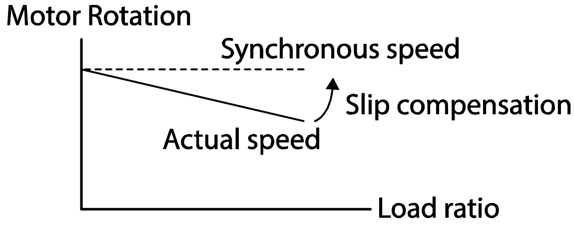
Slip Compensation Operation Setting Details

Code	Description
dr.09 Control Mode	Set dr.09 to 2 (Slip Compen) to carry out the slip compensation operation.
dr.14 Motor Capacity	Set the capacity of the motor connected to the inverter.
bA.11 Pole Number	Enter the number of poles from the motor rating plate.
bA.12 Rated Slip	Enter the number of rated rotations from the motor rating plate.
bA.13 Rated Curr	Enter the rated current from the motor rating plate.
bA.14 Noload Curr	Enter the measured current when the load on the motor axis is removed and when the motor is operated at the rated frequency. If no-load current is difficult to measure, enter a current equivalent to 30-50% of the rated motor current.
bA.16 Efficiency	Enter the efficiency from the motor rating place.
bA.17 Inertia Rate	Select load inertia based on motor inertia. Setting / Function: 0 – Less than 10 times motor inertia 1 – 10 times motor inertia 2-8 – More than 10 times motor inertia $f_s = f_r - \frac{Rpm \times P}{120}$ f_s=Rated slip frequency f_r=Rated frequency rpm=Number of the rated motor rotations P=Number of motor poles

Setting	Function
0	Less than 10 times motor inertia
1	10 times motor inertia
2-8	More than 10 times motor inertia

$$f_s = f_r - \frac{Rpm \times P}{120}$$

f_s=Rated slip frequency
f_r=Rated frequency
rpm=Number of the rated motor rotations
P=Number of motor poles



5.8 PID Control

Pid control is one of the most common auto-control methods. It uses a combination of proportional, integral, and differential (PID) control that provides more effective control for automated systems. The functions of PID control that can be applied to the inverter operation are as follows:

Purpose	Function
Speed control	Controls speed by using feedback based on the existing speed of the equipment or machinery being controlled. Control maintains consistent speed or operates at the target speed.
Pressure control	Controls pressure by using feedback based on the existing pressure of the equipment or machinery being controlled. Control maintains consistent pressure or operates at the target pressure.
Flow control	Controls flow by using feedback based on the existing flow in the equipment or machinery being controlled. Control maintains consistent flow or operates at a target flow.
Temperature control	Controls temperature by using feedback based on the existing temperature level of the equipment or machinery being controlled. Control maintains a consistent temperature or operates at a target termperature.

5.8.1 PID Basic Operation

PID operates by controlling the output frequency of the inverter through automated system process control to maintain a target (setpoint) speed, pressure, flow, temperature or tension.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
AP	01	Application function selection	App Mode	2	Proc PID	0–2	-
	16	PID output monitor	PID Output	-		-	-
	17	PID reference monitor	PID Ref Value	-		-	-
	18	PID feedback monitor	PID Fdb Value	-		-	-
	19	PID reference setting	PID Ref Set	50.00		-100.00-100.00	%
	20	PID reference source	PID Ref Source	0	Keypad	0-11	-
	21	PID feedback source	PID F/B Source	0	V1	0-10	-
	22	PID controller	PID P-Gain	50.0		0.0-1000.0	%

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		proportional gain					
	23	PID controller integral time	PID I-Time	10.0		0.0-200.0	sec
	24	PID controller differential time	PID D-Time	0		0-1000	msec
	25	PID controller feed-forward compensation gain	PID F-Gain	0.0		0-1000	%
	26	Proportional gain scale	P Gain Scale	100.0		0.0-100.0	%
	27	PID output filter	PID Out LPF	0		0-10000	ms
	28	PID Mode	PID Mode	0	Process PID	0-1	-
				1	Normal PID		
	29	PID maximum frequency	PID Limit Hi	60.00		-300.00-300.00	Hz
	30	PID minimum frequency	PID Limit Lo	0.5		-300.00-300.00	Hz
	31	PID output reverse	PID Out Inv	0	No	0-1	-
	32	PID output scale	PID Out Scale	100.0		0.1-1000.0	%
	34	PID controller motion frequency	Pre-PID Freq	0.00		0–Maximum frequency	Hz
	35	PID controller motion level	Pre-PID Exit	0.0		0.0-100.0	%
	36	PID controller motion delay time	Pre-PID Delay	600		0-9999	sec
	37	PID sleep mode delay time	PID Sleep DT	60.0		0-999.9	sec
	38	PID sleep mode frequency	PID Sleep Freq	0.00		0–Maximum frequency	Hz
	39	PID wake-up level	PID WakeUp Lev	35		0-100	%
	40	PID wake-up mode selection	PID WakeUp Mod	0	Below Level	0-2	-
	42	PID controller unit selection	PID Unit Sel	0	%	0-12	-
	43	PID unit gain	PID Unit Gain	100.0		0-300	%
	44	PID unit scale	PID Unit Scale	2	x 1	0-4	-
	45	PID 2nd proportional gain	PID P2-Gain	100.00		0-1000	%
In	65-69	Px terminal configuration	Px Define (Px: P1-P5)	22	I-Term Clear	-	-
				23	PID Openloop		
				24	P Gain2		

PID Basic Operation Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP.01 App Mode</td><td>Set the code to 2 (Proc PID) to select functions for the process PID.</td></tr>
<tr><td>AP.16 PID Output</td><td>Displays the existing output value of the PID controller. The unit, gain, and scale that were set at AP. 42-44 are applied on the display.</td></tr>
<tr><td>AP.17 PID Ref Value</td><td>Displays the existing value of the PID controller reference (setpoint) source. The unit, gain, and scale that were set at AP. 42-44 are applied on the display.</td></tr>
<tr><td>AP.18 PID Fdb Value</td><td>Displays the existing value of the PID controller feedback source. The unit, gain, and scale that were set at AP. 42-44 are applied on the display.</td></tr>
<tr><td>AP.19 PID Ref Set</td><td>When AP.20 (PID control reference source) is set to 0 (Keypad), the reference value can be entered. If the reference source is set to any other value, the setting values for AP.19 are void.</td></tr>
<tr><td>AP.20 PID Ref Source</td><td>Selects the source of the reference (setpoint) input for PID control. The reference (setpoint) source cannot be the same source as the PID feedback source (PID F/B Source).
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>-10-10V input voltage terminal</td></tr>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal
[When analog voltage/current input switch (SW2) at the terminal block is set to I (current), input 4-20mA current. If it is set to V (voltage), input 0–10V voltage]</td></tr>
<tr><td>4</td><td>I2</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>
<tr><td>9</td><td>UserSeqLink</td><td>Link the common area with the user sequence output.</td></tr>
<tr><td>11</td><td>Pulse</td><td>TI Pulse input terminal (0-32kHz Pulse input)</td></tr>
</table>
When using the 7-segment keypad, the PID reference setting can be displayed at AP.17. When using the LCD keypad, the PID reference setting can be viewed in the Monitor Mode by assigning config mode parameters (CNF).21-23, set to 17 (PID Ref Value).</td></tr>
<tr><td>AP.21 PID F/B Source</td><td>Selects the source of the feedback input to the PID control. The same list of sources (above) can be selected, except the keypad input (Keypad-1 and Keypad-2). Also, the feedback source cannot be the same as the reference (setpoint) source. When using the LCD keypad, the feedback can be viewed in the Monitor Mode by assigning config mode parameters (CNF).21-23, set to 18 (PID Fbk Value).</td></tr>
</table>

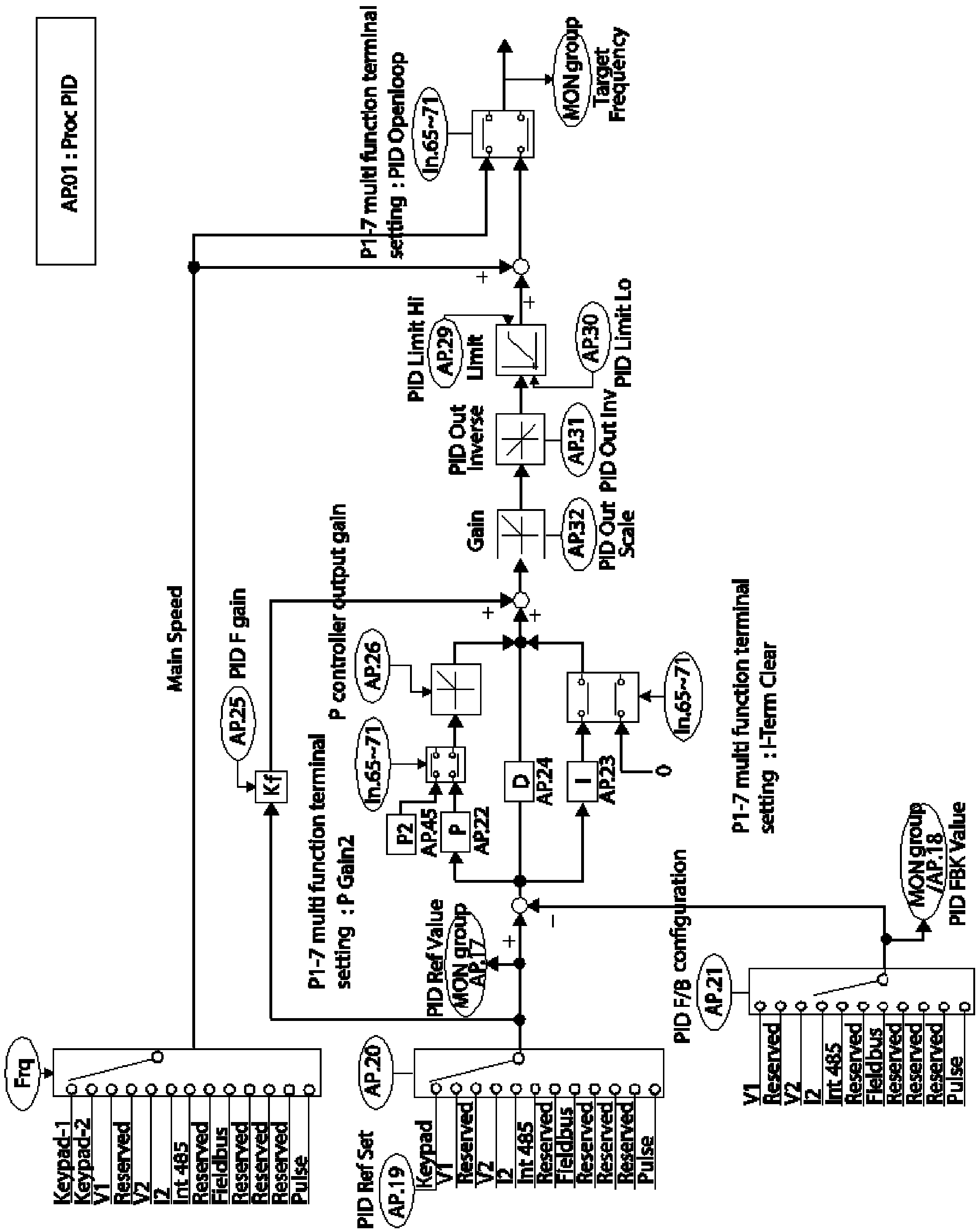
Code	Description
AP.22 PID P-Gain, AP.26 P Gain Scale	Sets the output ratio for differences (errors) between reference (setpoint) and feedback. If the Pgain is set to 50%, then 50% of the error is output. The setting range for Pgain is 0.0-1,000%. For ratios below 0.1%, use AP.26 (P Gain Scale).
AP.23 PID I-Time	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. Also, a digital input can be set to 21 (I-Term Clear) to clear all of the accumulated errors.
AP.24 PID D-Time	Sets the output volume for the rate of change in errors. If the differential time (PID D-Time) is set to 1ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10ms.
AP.25 PID F-Gain	Sets the ratio that adds the target to the PID output. Adjusting this value leads to a faster response.
AP.27 PID Out LPF	Used when the output of the PID controller changes too fast or the entire system is unstable due to severe oscillations. 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.
AP.28 PID Mode	Process PID (0) or Normal PID (1). Process PID is used in applications when the monitored (process) variable increases, the response is to decrease the output of the inverter. In Normal PID applications, as the process variable increases, the response is to increase the output of the inverter.
AP.29 PID Limit Hi, AP.30 PID Limit Lo	Limits the output frequency of the controller.
AP.32 PID Out Scale	Adjusts the volume of the controller output.
AP.42 PID Unit Sel	Sets the unit of the control variable.

Setting		Function
0	%	Displays a percentage without a physical quantity given.
1	Bar	Various units of pressure can be selected.
2	mBar	
3	Pa	
4	kPa	
5	Hz	Displays the inverter output frequency or the motor rotation speed.
6	rpm	
7	V	Displays in voltage/current/power/horsepower.
8	I	
9	kW	
10	HP	
11	°C	Displays in Celsius or Fahrenheit.

Code	Description
	12 °F
AP.43 PID Unit Gain, AP.44 PID Unit Scale	Adjusts the scaling (Maximum Value) of the units selected at AP.42 PID Unit Sel. Can further adjust the unit scaling with AP.44.
AP.45 PID P2-Gain	The PID controller's gain can be changed using a digital input terminal. When a terminal is set to 24 (P Gain2) and activated, the gain set in AP.22 and AP.23 can be switched to the gain set in AP.45.

Note

When a digital input (Px) is used to switch to open loop mode, values in [%] 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 calculation of 100.0% is based on the dr.20 (Max Freq) parameter setting.



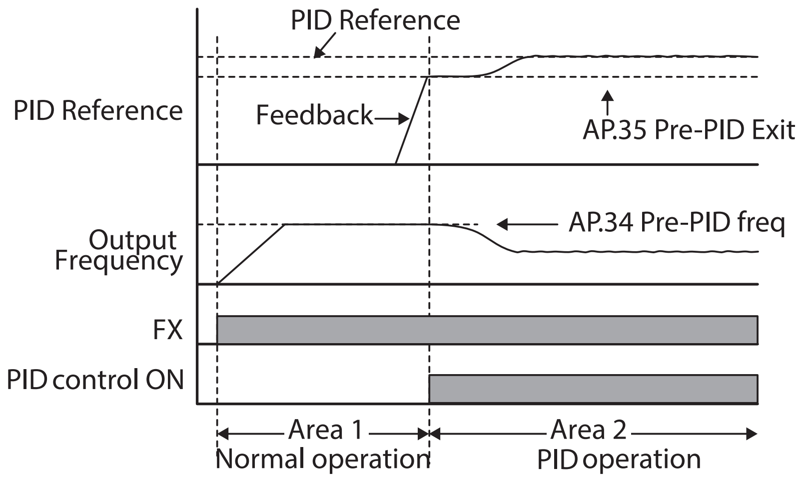
[PID control block diagram]

5.8.2 Pre-PID Operation

Pre-PID allows the system to accelerate and run at a preset frequency (AP.34, Pre PID Freq) before PID operation begins. When a run command is applied, acceleration occurs up to the preset frequency. When the controlled variable (feedback) increases beyond the Pre-PID Exit setting (AP.35, Pre-PID Exit), PID operation begins. If the monitored variable (feedback) does not increase to the reference frequency (AP.19 PID Ref Set, setpoint), a fault will occur.

Pre-PID Operation Setting Details

Code	Description
AP.34 Pre-PID Freq	Set the operating frequency to run at during Pre PID operation. If Pre PID Freq is set to 30Hz, the inverter continues to run at 30 Hz. until the monitored variable (PID feedback value) exceeds the value set at AP. 35 (Pre-PID Exit), then PID operation begins.
AP.35 Pre-PID Exit, AP.36 Pre-PID Delay	When the feedback variable of the PID controller exceeds the value set at AP. 35, PID operation begins. However, if the delay time (AP.36, Pre-PID Delay) expires before the feedback variable reaches the exit value set at AP.35, a "pre-PID Fail" fault will occur and the operation will stop.

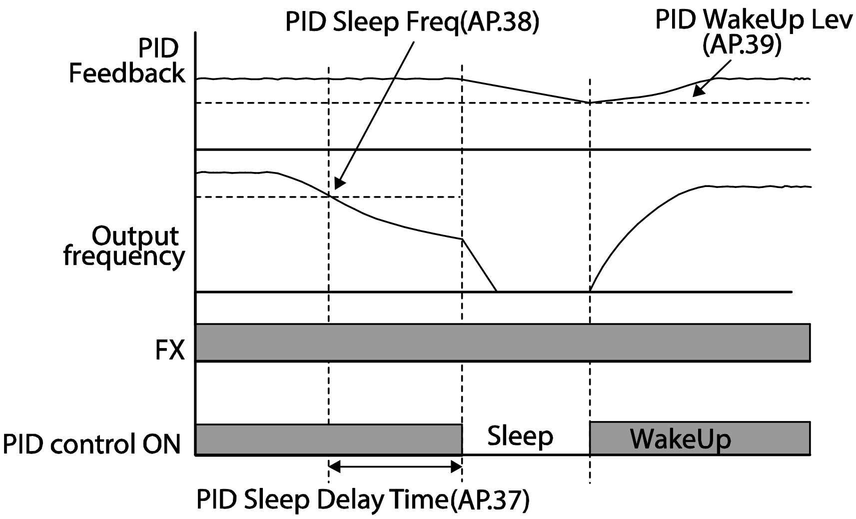


5.8.3 PID Operation Sleep Mode

The inverter will go into sleep mode if the operation has been running below the sleep frequency (PID Sleep Freq, AP.38) for the time period set in the sleep delay time (PID Sleep DT, AP.37). While in sleep mode, the inverter continuously monitors the feedback value. When the feedback value meets the conditions set in PID WakeUp Lev, AP.39 and PID WakeUp Mod, AP.40, PID operation will resume.

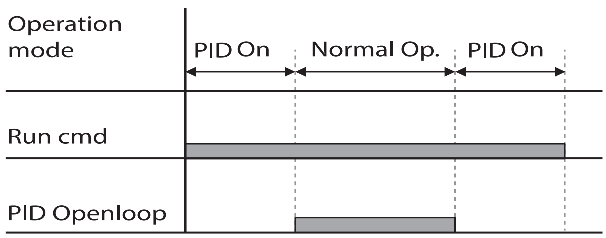
PID Operation Sleep Mode Setting Details

Code	Description
AP.37 PID Sleep DT, AP.38 PID Sleep Freq	When the operation frequency is lower than the value set at AP.38 and for a period of time period set in AP.37, PID operation stops and the inverter goes into sleep mode.
AP.39 PID WakeUp Lev, AP.40 PID WakeUp Mod	The inverter will wake up and resume PID operation based on the Wake Up Level and the condition set in Ap.40, Wake Up Mode. The level is a percentage of the full scale operating range, AP.43. If AP. 40 is set to 0 (Below Level), the PID operation starts when the feedback variable is less than the value set as the AP. 39 parameter setting. If AP. 40 is set to 1 (Above Level), the operation starts when the feedback variable is higher than the value set at AP. 39. If AP. 40 is set to 2 (Beyond Level), the operation starts when 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 digital input terminals (In. 65-71) is set to 23 (PID Openloop) and is turned on, the PID operation stops and the inverter switches to general operation. When the terminal turns off, the PID operation starts again.



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 Motor

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	14	Motor capacity	Motor Capacity	1	0.75 kW	0-15	-
bA	11	Motor pole number	Pole Number	4		2-48	-
	12	Rated slip speed	Rated Slip	40		0-3000	rpm
	13	Rated motor current	Rated Curr	3.6		1.0-1000.0	A
	14	Motor no-load current	Noload curr	1.6		0.5-1000.0	A
	15	Motor rated voltage	Motor Volt	230		170-480	V
	16	Motor efficiency	Efficiency	72		64-100	%
	20	Auto tuning	Auto Tuning	0	None	-	-
	21	Stator resistance	Rs	26.00		Depends on the motor setting	Ω
	22	Leakage inductance	Lsigma	179.4		Depends on the motor setting	mH
	23	Stator inductance	Ls	1544		Depends on the motor setting	mH
	24	Rotor time constant	Tr	145		25-5000	ms

Auto Tuning Default Parameter Setting

Motor Capacity (kW)		Rated Current (A)	No-load Current (A)	Rated Slip Frequency(Hz)	Stator Resistance(Ω)	Leakage Inductance (mH)
200V	0.2	1.1	0.8	3.33	14.0	40.4
	0.4	2.4	1.4	3.33	6.70	26.9
	0.75	3.4	1.7	3.00	2.600	17.94
	1.5	6.4	2.6	2.67	1.170	9.29
	2.2	8.6	3.3	2.33	0.840	6.63
	3.7	13.8	5.0	2.33	0.500	4.48
	5.5	21.0	7.1	1.50	0.314	3.19
	7.5	28.2	9.3	1.33	0.169	2.844
	11	40.0	12.4	1.00	0.120	1.488
	15	53.6	15.5	1.00	0.084	1.118
	18.5	65.6	19.0	1.00	0.068	0.819
	22	76.8	21.5	1.00	0.056	0.948
400V	0.2	0.7	0.5	3.33	28.00	121.2
	0.4	1.4	0.8	3.33	14.0	80.8
	0.75	2.0	1.0	3.00	7.81	53.9
	1.5	3.7	1.5	2.67	3.52	27.9
	2.2	5.0	1.9	2.33	2.520	19.95
	3.7	8.0	2.9	2.33	1.500	13.45
	5.5	12.1	4.1	1.50	0.940	9.62
	7.5	16.3	5.4	1.33	0.520	8.53
	11	23.2	7.2	1.00	0.360	4.48
	15	31.0	9.0	1.00	0.250	3.38
	18.5	38.0	11.0	1.00	0.168	2.457
	22	44.5	12.5	1.00	0.168	2.844

*When Dr.09 (Control Mode) is set to 6 (PM Sensorless), auto tuning will configure the rated current and the stator resistor values by default.

Auto Tuning Parameter Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>bA.20 Auto Tuning</td><td>Select an auto tuning type then press the [ENT] key to run the auto tuning.
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>Auto tuning function is not enabled. Note: when you select one of the auto tuning options below and run it, this parameter value will revert back to “0” when the auto tuning is complete.</td></tr>
<tr><td>1</td><td>All (rotating type)</td><td>Measures all motor parameters, including stator resistance (Rs), stator inductance (Lsigma), no-load current (Noload Curr), rotor time constant</td></tr>
</table>
</td></tr>
</table>

Code	Description		
			(Tr), etc., while 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. Also, the rotor time constant (Tr) will 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), stator inductance (Lsigma), no-load current (Noload Curr), rotor time constant (Tr), etc. The measurements are not affected when the load is connected to the motor spindle. However, when measuring parameters, do not rotate the motor from 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 IM Sensorless.
	7	All (PM)	When dr.09 (Control Mode) is set to 6 (PM Sensorless), the motor parameters are measured in the stopped position. Check the motor's name plate for motor specifications, such as the base frequency (dr.18), motor rated voltage (bA.15), pole number (bA.11). Then, perform auto tuning by setting bA.20 to 7 [All (PM)]. The auto tuning operation will configure parameters bA.21 (Rs), bA.28 [Ld (PM)], bA.29 [Lq (PM)], and bA.30 (PM Flux Ref).
bA.14 Noload Curr, bA.21 Rs–bA.24 Tr	Displays motor parameters measured by auto tuning. 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 after selecting 2 (All - static type) at bA20: compared with rotation type auto tuning where parameters are measured while the motor is rotating, parameter values measured with static auto tuning may be less accurate. Inaccuracy of the measured parameters

may degrade the performance of sensorless operation. 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).

- In PM synchronous motor sensorless control mode, check the motor's name plate and enter the motor specifications, such as the base frequency, pole number, rated current and voltage, and efficiency, before performing auto tuning as the detected parameter values may not be accurate if the motor's base specifications are not entered.

5.10 Sensorless Vector Control for Induction Motors

Sensorless vector control is an operation to carry out vector control without the rotation speed feedback from the motor. An estimation of the motor rotation speed calculated by the inverter. Compared to V/F control, sensorless vector control can generate greater torque at lower speeds and with lower levels of current.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	4	IM Sensorless	-	-
	14	Motor capacity	Motor Capacity	Depends on the motor capacity		0-15	-
	18	Base frequency	Base Freq	60		30-400	Hz
bA	11	Motor pole number	Pole Number	4		2-48	-
	12	Rated slip speed	Rated Slip	Depends on the motor capacity		0-3000	Hz
	13	Rated motor current	Rated Curr	Depends on the motor capacity		1-1000	A
	14	Motor no-load current	Noload curr	Depends on the motor capacity		0.5-1000	A
	15	Rated motor voltage	Motor Volt	230/380/460/480		170-480	V
	16	Motor efficiency	Efficiency	Depends on the motor capacity		64-100	%
	20	Auto tuning	Auto Tuning	1	All	-	-
Cn	09	Pre-Excite time	PreExTime	1.0		0.0-60.0	s
	10	Pre-Excite amount	Flux Force	100.0		100.0-300.0	%
	20	Sensorless second gain display setting	SL2 G View Sel	1	Yes	0-1	-
	21	Sensorless speed controller proportional	ASR-SL P Gain1	Depends on the motor capacity		0-5000	%

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		gain1					
	22	Sensorless speed controller integral gain 1	ASR-SL I Gain1	Depends on the motor capacity		10-9999	ms
	23*	Sensorless speed controller proportional gain 2	ASR-SL P Gain2	Depends on the motor capacity		1-1000	%
	24*	Sensorless speed controller integral gain 2	ASR-SL I Gain2	Depends on the motor capacity		1-1000	%
	26*	Flux estimator proportional gain	Flux P Gain	Depends on the motor capacity		10-200	%
	27*	Flux estimator integral gain	Flux I Gain	Depends on the motor capacity		10-200	%
	28*	Speed estimator proportional gain	S-Est P Gain1	Depends on the motor capacity		0-32767	-
	29*	Speed estimator integral gain1	S-Est I Gain1	Depends on the motor capacity		100-1000	-
	30*	Speed estimator integral gain2	S-Est I Gain2	Depends on the motor capacity		100-10000	-
	31*	Sensorless current controller proportional gain	ACR SL P Gain	75		10-1000	-
	32*	Sensorless current controller integral gain	ACR SL I Gain	120		10-1000	-
	52	Torque controller output filter	Torque Out LPF	0		0-2000	ms
	53	Torque limit	Torque Lmt Src	0	Keypad-1	0-12	-

Advanced Features

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		setting				
	54	Forward direction retrograde torque limit	FWD +Trq Lmt	180.0	0.0-200.0	%
	55	Forward direction regenerative torque limit	FWD -Trq Lmt	180.0	0.0-200.0	%
	56	Reverse direction retrograde torque limit	REV +Trq Lmt	180.0	0.0-200.0	%
	57	Reverse direction regenerative torque limit	REV -Trq Lmt	180.0	0.0-200.0	%
	85*	Flux estimator proportional gain 1	Flux P Gain1	370	100-700	-
	86*	Flux estimator proportional gain 2	Flux P Gain2	0	0-100	-
	87*	Flux estimator proportional gain 3	Flux P Gain3	100	0-500	-
	88*	Flux estimator integral gain 1	Flux I Gain1	50	0-200	-
	89*	Flux estimator integral gain2	Flux I Gain2	50	0-200	-
	90*	Flux estimator integral gain 3	Flux I Gain3	50	0-200	-
	91*	Sensorless voltage compensation 1	SL Volt Comp1	30	0-60	-
	92*	Sensorless voltage compensation 2	SL Volt Comp2	20	0-60	-
	93*	Sensorless voltage compensation	SL Volt Comp3	20	0-60	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		3				
	94*	Sensorless field weakening start frequency	SL FW Freq	95.0	80.0-110.0	%
	95*	Sensorless gain switching frequency	SL Fc Freq	2.00	0.00-8.00	Hz

*Cn.23-32 and Cn.85-95 can be displayed only when Cn.20 is set to 1 (Yes).

ⓘ 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 you will use at dr.14 (Motor Capacity), and enter the name plate information of the motor in the below parameters.

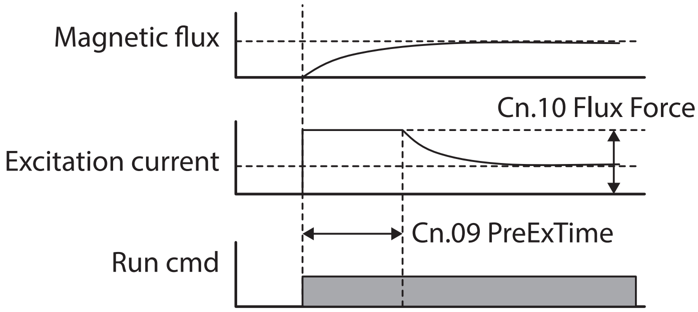
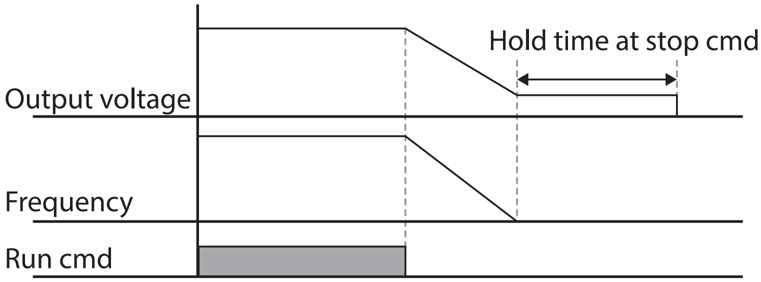
Code	Input (Motor Rating Plate Information)
drv.18 Base Freq	Base frequency
bA.11 Pole Number	Motor pole number
bA.12 Rated Slip	Rated slip
bA.13 Rated Curr	Rated current
bA.15 Motor Volt	Motor rated voltage
bA.16 Efficiency	Efficiency (when no information is on the rating plate, default values are used.)

After setting each code, 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 auto tuning. Select 1 (All - rotation type) and press ENT to run auto tuning. Note: when you select one of the auto tuning options below and run it, this parameter value will revert back to "0" when the auto tuning is complete.

Note

Excitation Current
A motor can be operated only after magnetic flux is generated by current flowing through the stator. When the stator 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	Description
Cn.09 PreExTime	Sets pre-excitation time. Pre-excitation is used to start the operation after performing 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 CN.09 as shown in the following figure. To reduce the time taken to reach the rated flux, a higher motor flux force, Cn.10 must be provided. When the magnetic flux reaches the rated flux, the provided motor flux base value, Cn.10 is reduced. 
Cn.11 Hold Time	Sets the zero-speed control time (hold time) in the stopped position. When a stop command is applied, the motor decelerates to zero speed. The inverter applies an ouput (at zero speed) to hold the motor for the Hold Time, Cn.11. 
Cn.21 ASR-SL P Gain1, Cn.22 ASR-SL I Gain1	**Speed Controller P & I Gains.** Changes the speed PI controller gains. **Speed controller P Gain1** is a proportional gain for the speed deviation. If speed deviation becomes higher than the torque, the output command increases accordingly. As the value increases, the faster the speed deviation decreases. The **speed controller I gain1** is the integral gain for speed deviation. It is the time taken for the gain to reach the rated torque output command while a constant speed deviation continues. The lower the value becomes, the faster the speed deviation decreases.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>Cn.20 SL2 G View Sel</td><td>
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>No</td><td>Does not display sensorless (II) vector control gain code.</td></tr>
<tr><td>1</td><td>Yes</td><td>Allows the user to set various gains applied when the motor rotates faster than medium speed (approx. 1/2 of the base frequency) through sensorless (II) vector control.</td></tr>
</table>
Codes available when setting to 1 (Yes): Cn.23 ASR-SL P Gain2/Cn.24 ASR-SL I Gain2/Cn.26 Flux P Gain/Cn.27 Flux I Gain Gain3/Cn.28 S-Est P Gain1/Cn.29 S-Est I Gain1/Cn.30 S-Est I Gain1/Cn.31 ACR SL P Gain/Cn.32 ACR SL I Gain</td></tr>
<tr><td>Cn.23 ASR-SL P Gain2,
Cn.24 ASR-SL I Gain2</td><td>Speed Controller P Gain2 and I Gain2 appear only when Cn.20 (SL2 G view Sel) is set to 1 (Yes). The overall speed controller gain can be increased to more than the medium speed for sensorless vector control. Cn.23 ASR-SL P Gain2 is set as a percentage of the low speed gain Cn.21 ASR-SL P Gain1 - if P Gain 2 is less than 100.0%, the responsiveness decreases. For example, if Cn.21 ASR-SL P Gain1 is 50.0% and Cn.23 ASR-SL P Gain2 is 50.0%, the actual middle speed or faster speed controller P gain is 25.0%.

Cn.24 ASR-SL I Gain2 is set as a percentage of the Cn.22 ASR-SL I Gain1. For I gain, the smaller the I gain 2 becomes, the slower the response time becomes. For example, if Cn.22 ASR-SL I Gain1 is 100ms and Cn.24 ASR-SL I Gain2 is 50.0%, the middle speed or faster speed controller I gain is 200 ms. The controller gain is set according to the default motor parameters and Acc/Dec time.</td></tr>
<tr><td>Cn.26 Flux P Gain,
Cn.27 Flux I Gain,
Cn.85-87 Flux P Gain13,
Cn.88-90 Flux I Gain1-3</td><td>Rotor Flux Estimator P & I Gains. Sensorless vector control requires the rotor flux estimator. For the adjustment of flux estimator gain, refer to 5.10.2_.</td></tr>
<tr><td>Cn.28 S-Est P Gain1,
Cn.29 S-Est I Gain1,
Cn.30 S-Est I Gain2</td><td>Speed Estimator P & I Gains. Speed estimator gain for sensorless vector control can be adjusted. To adjust speed estimator gain, refer 5.10.2_.</td></tr>
<tr><td>Cn.31 ACR SL P Gain,
Cn.32 ACR SL I Gain</td><td>Current Controller P & I Gains. Adjusts the current controller P and I gains. For the adjustment of sensorless current controller gain, refer to 5.10.2_.</td></tr>
<tr><td>Cn.53 Torque Lmt Src</td><td>Select a source for torque limit setting: keypad, analog input (V1 and I2) or communication. When setting torque limit, adjust the torque size by limiting the speed controller output. Set the retrograde (motoring) and regenerative limits for forward and reverse operation.
<table>
<tr><th colspan="2">Setting</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</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>4</td><td>V2</td><td rowspan="2">analog input terminal of the terminal block.</td></tr>
<tr><td>5</td><td>I2</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>
<tr><td>9</td><td>UserSeqLink</td><td>This enters the torque reference by linking the common area with the user sequence output.</td></tr>
<tr><td>12</td><td>Pulse</td><td>Sets the torque limit with the pulse input of the terminal block.</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 retrograde (motoring) operation.</td></tr>
<tr><td>Cn.57 REV –Trq Lmt</td><td>Sets the torque limit for reverse regenerative operation.</td></tr>
<tr><td>In.02 Torque at 100%</td><td>Sets the maximum torque. For example, if In.02 is set to 200% and an input voltage (V1) is used, the torque limit is 200% when 10V is entered. However, when the VI terminal is set up with the factory default setting and the torque limit setup uses a method other than the keypad, check the parameter settings in the monitor mode. In the Config Mode CNF.21-23 (only displayed when using LCD keypad), select 21(Torque limit).</td></tr>
<tr><td>Cn.91-93
SL Volt Comp1-3</td><td>Adjust output voltage compensation values for sensorless vector control. For output voltage compensation, refer to 5.10.2 .</td></tr>
<tr><td>Cn.52 Torque Out LPF</td><td>Sets the time constant for torque command by setting the torque controller output filter.</td></tr>
</table>

ⓘ Caution

Adjust the controller gain according to the load’s characteristics. However, the motor can overheat or the system may become unstable depending on the controller gain settings.

Note

Speed controller gain can improve the speed control waveform while monitoring the changes in speed. If speed deviation does not decrease quickly, increase the speed controller P gain or decrease I gain (time in ms). However, if the P gain is increased too high or I gain is decreased too low, severe vibration may occur. If oscillation occurs in the speed waveform, try to increase I gain (ms) or reduce P gain to adjust the waveform.

5.10.2 Sensorless Vector Control Operation Guide for Induction Motors

Problem	Relevant function code	Troubleshooting
The amount of starting torque is insufficient.	bA.24 Tr Cn.09 PreExTime Cn.10 Flux Force Cn.31 ACR SL P Gain	Set the value of Cn. 09 to be more than 3 times the value of bA.24 or increase the value of Cn.10 by increments of 50%. If the value of Cn.10 is high, an overcurrent trip at start can occur. In this case, reduce the value of Cn.31 by decrements of 10.
	Cn.54–57 Trq Lmt	Increase the value of Trg Lmt (Cn.54-57) by increments of 10%.
	Cn.93 SL Volt Comp3	Increase the value of Cn.93 by increments of 5
The output frequency is higher than the base frequency during no-load operation at low speed (10Hz or lower).	Cn.91 SL Volt Comp1	Decrease the value of Cn.91 by decrements of 5.
The motor hunts or the amount of torque is not sufficient while the load is increasing at low speed (10Hz or lower).	Cn.04 Carrier Freq Cn.21 ASR-SL P Gain1 Cn.22 ASR-SL I Gain1 Cn.93 SL Volt Comp3	If the motor hunts at low speed, increase the value of Cn.22 by increments of 50m/s, and if hunting does not occur, increase the value of Cn.21 to find the optimal operating condition.
		If the amount of torque is insufficient, increase the value of Cn.93 by increments of 5.
		If the motor hunts or the amount of torque is insufficient in the 5-10Hz range, decrease the value of Cn.04 by increments of 1kHz (if Cn.04 is set to exceed 3kHz).
The motor hunts or overcurrent trip occurs in regenerative load at low speed (10 Hz or lower).	Cn.92 SL Volt Comp2 Cn.93 SL Volt Comp3	Increase the value of Cn.92-93 by increments of 5 at the same time.
Over voltage trip occurs due to sudden acceleration/deceleration or sudden load fluctuation (with no brake resistor installed) at mid speed (30Hz or higher).	Cn.24 ASR-SL I Gain2	Decrease the value of Cn.24 by decrements of 5%.
Over current trip occurs due to sudden load fluctuation at high speed (50 Hz or higher).	Cn.54–57 Trq Lmt Cn.94 SL FW Freq	Decrease the value of Cn.54-57 by decrements of 10% (if the parameter setting is 150% or higher).
		Increase/decrease the value of Cn.94 by increments/decrements of 5% (set below

Problem	Relevant function code	Troubleshooting
		100%).
The motor hunts when the load increases from the base frequency or higher.	Cn.22 ASR-SL I Gain1 Cn.24 ASR-SL I Gain2	Increase the value of Cn.22 by increments of 50m/s or decrease the value of Cn.24 by decrements of 5%.
The motor hunts as the load increases.	Cn.28 S-Est P Gain1 Cn.29 S-Est I Gain1	At low speed (10Hz or lower), increase the value of Cn.29 by increments of 5.
		At mid speed (30 Hz or higher), increase the value of Cn.28 by increments of 500. If the parameter setting is too extreme, over current trip may occur at low speed.
The motor speed level decreases.	bA.20 Auto Tuning	Select 6. Tr (static type) from bA. 24 and run bA.24 Rotor time constant tuning.

*Hunting: Symptom of irregular vibration of the equipment.

5.11 Sensorless Vector Control for PM (Permanent-Magnet) Synchronous Motors

Sensorless vector control is an operation that carries out vector control without rotation speed feedback from the motor but instead, with an estimation of the motor rotation speed calculated by the inverter.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	6	PM Sensorless	-	-
	14	Motor capacity	Motor Capacity	Depends on the motor capacity		0–15	-
	18	Base frequency	Base Freq	Depends on the PM motor capacity		30–180	Hz
	20	Maximum frequency	Max Freq	Depends on the PM motor capacity		40–180	Hz
bA	11	Motor pole number	Pole Number	4		2–48	-
	13	Rated motor current	Rated Curr	Depends on the motor capacity		1–1000	A
	15	Motor-rated voltage	Motor Volt	230/380/460/480		170–480	V
	16	Motor efficiency	Efficiency	Depends on the motor capacity		64–100	%
	19	Motor input voltage	AC Input Volt	230/460		170–480	
	20	Auto tuning	Auto Tuning	7		All (PM)	-
	32	Q-axis	Lq (PM) Scale	100%		50–150	%

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		inductance scale				
	34	Auto tuning level for Ld and Lq	Ld,Lq Tune Lev	33.3%	20.0–50.0	%
	35	Auto tuning frequency for Ld and Lq	Ld,Lq Tune Hz	100.0%	80.0–150.0	%
Cn	12	PM speed controller P gain 1	ASR P Gain 1	100	0–5000	-
	13	PM speed controller I gain 1	ASR I Gain 1	150	0–5000	-
	15	PM speed controller P gain 2	ASR P Gain 2	100	0–5000	-
	16	PM speed controller I gain 2	ASR I Gain 2	150	0–9999	-
	33	PM D-axis back-EMF estimated gain (%)	PM EdGain Perc	100.0	0–300.0	%
	34	PM Q-axis back-EMF estimated gain (%)	PM EqGain Perc	100.0	0–300.0	%
	35	Initial pole position estimation retry	PD Repeat Num	2	0–10	-
	36	Initial pole position estimation interval	Pulse Interval	20	1–100	ms
	37	Initial pole position estimation pulse current (%)	Pulse Curr %	15	10–100	%
	38	Initial pole position estimation	Pulse Volt %	500	100–4000	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		pulse voltage (%)				
	39	PM dead-time range (%)	PMdeadBand Per	100.0	50.0–200.0	%
	40	PM dead-time voltage (%)	PMdeadVolt Per	100.0	50.0–200.0	%
	41	PM speed estimator proportional gain	PM SpdEst Kp	100	0–32000	-
	42	PM speed estimator integral gain	PM SpdEst Ki	10	0–32000	-
	43	PM speed estimator proportional gain 2	PM SpdEst Kp 2	300	0–32000	-
	44	PM speed estimator integral gain 2	PM SpdEst Ki 2	30	0–32000	-
	45	Speed estimator feedforward high speed range (%)	PM Flux FF %	300	0–1000	%
	46	Initial pole position estimation type	Init Angle Sel	1: Angle Detect	0–2	0–2
	48	Current controller P gain	ACR P Gain	1200	0–10000	-
	49	Current controller I gain	ACR I Gain	120	0–10000	-
	50	Voltage controller limit	V Con HR	10.0%	0–1000	%
	51	Voltage controller I gain	V Con Ki	10.0%	0–20000	%
	52	Torque controller output filter	Torque Out LPF	0	0–2000	msec

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	53	Torque limit source	Torque Lmt Src	0	Keypad-1	0–12
	54	FWD reverse torque limit	FWD +Trq Lmt	180.0	0.0–200.0	%
	55	FWD regenerative torque limit	FWD -Trq Lmt	180.0	0.0–200.0	%
	56	REV reverse torque limit	REV +Trq Lmt	180.0	0.0–200.0	%
	57	REV regenerative torque limit	REV -Trq Lmt	180.0	0.0–200.0	%

Caution

Enter the motor-related parameters in the Basic function group from the motor name plate. For high-performance operation, the other parameter values must be estimated. Perform auto tuning by setting bA. 20 (Auto Tuning) to 7 [All (PM)] to automatically measure the other parameters before operating a PM synchronous motor in sensorless vector control mode. For high-performance PM sensorless vector control, the inverter and the motor must have the same capacity. The inverter control may be inaccurate if the motor capacity and the inverter capacity do not match. In sensorless vector control mode, do not connect multiple motors to the inverter output. Note: when you select one of the auto tuning options below and run it, this parameter value will revert back to “0” when the auto tuning is complete.

5.11.1 Detecting the Initial Pole Position

Initial pole position detection is a process to match the rotor position calculated by the inverter and the actual rotor position in a motor. In a permanent-magnet (PM) synchronous motor, rotor flux is generated from the permanent magnet attached to the rotor. Therefore, to run the motor in vector control mode, the exact rotor position (flux position) must be detected for accurate control of the torque generated by the motor.

At Cn. 46 (InitAngle Sel), select the type of initial pole position detection.

When Cn. 46 is set to 0 (None), the motor is operated according to the pole position estimated by the inverter’s internal algorithm, instead of actually detecting the physical position of the rotor pole.

When Cn. 46 is set to 1 (Angle Detect), the motor is operated according to the pole position detected by changes in the current. The voltage pulse input is used to detect the pole position and results in a small amount of noise at motor startup.

When Cn. 46 is set to 2 (Alignment), the inverter forcefully aligns the rotor position by supplying DC current for a certain period of time.

Group	Code	Name	LCD display	Setting		Setting range	Unit
Cn	35	Pole position detection retry count	PD Repeat Num	1		0–10	-
	36	Pole position detection interval	Pulse Interval	20		1–100	Ms
	37	Pole position detection pulse current (%)	Pulse Curr %	15		10–100	%
	38	Pole position detection pulse voltage (%)	Pulse Volt %	500		100–4000	-
	46	Pole position detection type	Init Angle Sel	0	None	0–2	-
				1	Angle Detect		
				2	Alignment		

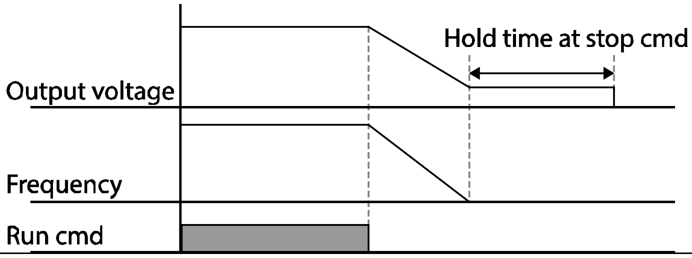
5.11.2 Sensorless Vector Control Mode Settings for PM Synchronous Motors

To operate a PM synchronous motor in sensorless vector control mode, set dr.09 (Control Mode) to 6 (PM Sensorless), select the motor capacity at dr.14 (Motor Capacity), and enter the nameplate motor parameters in the Basic (bA) group. If a specific motor capacity does not exist in the setting options, select the next higher motor capacity.

Code	Input Values (Motor's Rating Plate Information)
dr.18 Base Freq	Base frequency
dr.20 Max Freq	Maximum frequency
bA.11 Pole Number	Motor pole number
bA.13 Rated Curr	Rated current
bA.15 Motor Volt	Motor rated voltage
bA.16 Efficiency	Efficiency
bA.19 AC Input Volt	Input power voltage

After entering the codes, set bA.20 (Auto tuning) to 7 [All(PM)] and perform a static auto tuning operation. When auto tuning is complete, the bA.21 (Rs), bA.28 Ld (PM), bA. 29 Lq (PM), and bA. 30 (PM Flux Ref) parameters are automatically measured and saved. Note: when you select one of the auto tuning options below and run it, this parameter value will revert back to "0" when the auto tuning is complete.

Sensorless Vector Control Operation Setting Details

Code	Description
Cn.4 Carrier Freq	Sets the PWM interrupter cycle and sampling frequency cycle. The default carrier frequency is set at 5 kHz, and the setting range is 2–10 kHz.
Cn.11 Hold Time	Sets the zero-speed control time (hold time) in the stopped position. When a stop command is applied, the motor decelerates to zero speed. The inverter applies an ouput (at zero speed) to hold the motor for the Hold Time, Cn.11. 
Cn.12 ASR P Gain1, Cn.13 ASR I Gain1 Cn.15 ASR P Gain2 Cn.16 ASR I Gain2	**Speed controller P & I Gains.** Changes the speed PI controller gain. **P gain** is a proportional gain for the speed deviation. If the speed deviation becomes greater than the torque, the output command will increase accordingly. The higher the value becomes, the faster the speed deviation will decrease. The speed controller **I gain** is the integral gain for speed deviation. It is the time taken for the gain to reach the rated torque output command while constant speed deviation continues. The lower the value becomes, the faster the speed deviation will decrease. As the motor inertia varies by motor, the gain values should be changed according to the motor speeds. Cn.12 and Cn. 13 set the low speed P/I controller gain values, while Cn.15 and Cn.16 set the high speed P/I controller gain values, so that an appropriate gain value can be used for different motor speeds.
Cn.33 PM EdGain Perc, Cn.34 PM EqGain Perc	**Back EMF d & q Gains.** To ensure that the back-EMF with rotor position information can be appropriately estimated, set these values as a percentage of the speed controller proportional gain, which is designed to have stable estimator polarity. Higher values result in faster responses, with higher chances of increased motor vibration. Excessively low values may result in motor startup failure due to slow response rate.
Cn.41 PM SpdEst Kp,	**Speed Estimator P & I Gains**. Set these parameters to change the

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>Cn.42 PM SpdEst Ki
Cn.43 PM SpdEst Kp2
Cn.44 PM SpdEst Ki2</td><td>speed estimator gains. If a fault occurs or excessive oscillation is observed at low speeds, decrease the value at Cn.41 in 10% decrements until the motor operates stably. If ripples occur during normal operation, increase the value at Cn. 42. The values at Cn.43 and Cn.44 are used for low speed operations in 200 V motors.</td></tr>
<tr><td>Cn.39 PMdeadBand Per
Cn.40PMdeadVolt Per</td><td>Sets the output compensation values. If the motor fails to operate at low speeds at or below 5% of the rated motor speed, increase the values set at Cn.39 and Cn.40 by 10% increments. Decrease the values in 10% decrements if a clanking noise occurs at motor startup and motor stop.</td></tr>
<tr><td>Cn.45 PM Flux FF %</td><td>Sets the high-speed portion of the feed forward rate against the back-EMF. Feed forwarding enhances operation of the speed estimator. Increase the value at Cn.45 in 10% increments to suppress motor oscillation under load. A fault may occur if this value is set too high.</td></tr>
<tr><td>Cn.48 ACR P-Gain
Cn.49 ACR I-Gain</td><td>Current Controller P & I Gains. Sets the gain values for the PI current controller in a synchronous motor. The P gain is the proportional gain for the current deviation. The current deviation decreases faster with higher values, as the deviation in voltage output command increases with increased deviation.
The I gain is the integral gain for the current deviation. Deviation in normal operation decreases with higher values.

However, the gain values are limited by the carrier frequency. A fault may occur due to interference if you set the gain values too high.</td></tr>
<tr><td>Cn.53 Torque Lmt Src</td><td>Select a source for torque limit input: Keypad, analog input (V1 and I2), or input via network communication.
The torque limit value is used to adjust the torque reference size by limiting the speed controller output. The reverse and regenerative torque limits may be set for operations in the forward or reverse direction.
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>KeyPad-1</td><td rowspan="2">Sets the torque limit via the keypad.</td></tr>
<tr><td>1</td><td>KeyPad-2</td></tr>
<tr><td>2</td><td>V1</td><td rowspan="3">Sets the torque limit via the analog input terminals of the terminal block.</td></tr>
<tr><td>4</td><td>V2</td></tr>
<tr><td>5</td><td>I2</td></tr>
<tr><td>6</td><td>Int 485</td><td>Sets the torque limit via 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>
<tr><td>9</td><td>UserSeqLink</td><td>Sets the torque limit with a user sequence output. The torque reference is received via the common area addresses.</td></tr>
</table>
</td></tr>
</table>

Code	Description
	12 | Pulse | Sets the torque limit with the pulse input of the terminal block. The torque limit can be set up to 200% of the rated motor torque.
Cn.54 FWD +Trq Lmt	Sets the reverse torque limit for forward operation.
Cn.55 FWD –Trq Lmt	Sets the regenerative torque limit for forward operation.
Cn.56 REV +Trq Lmt	Sets the reverse torque limit for reverse operation.
Cn.57 REV –Trq Lmt	Sets the regenerative torque limit for reverse operation.
In.02 Torque at 100%	Sets the **maximum torque**. For example, if In.02 is set to 200% and an input voltage (V1) is used, the torque limit will be 200% when 10 V is entered. When the torque limit input source is any device other than the keypad, Torque limit can be viewed in the Monitor mode. Set one of CnF.21–23 (only displayed when an LCD keypad is used) to 21 (Torque limit).
Cn.52 Torque Out LPF	Sets the time constant for torque command by setting the torque controller output filter.

Caution

Adjust the controller gain according to the load's characteristics. However, the motor can overheat or the system can become unstable depending on the controller gain settings.

Note

Speed controller gain can improve the speed control waveform while monitoring the changes in speed. If the speed deviation does not decrease fast enough, increase the speed controller P gain or decrease I gain (time in ms). However, if the P gain value is increased too much or the I gain value is decreased too much, severe vibrations may occur. If oscillation occurs in the speed waveform, try to increase the I gain (ms) or reduce the P gain to adjust the waveform.

5.11.3 Guidelines for Running a PM Synchronous Motor in Sensorless Vector Control Mode

Problem	Relevant function code	Troubleshooting
Starting torque is insufficient.	Cn.48 ACR P-Gain Cn.39 PMdeadBand Per Cn.40[Note1) PMdeadVolt Per	If an overcurrent trip occurs at startup, try decreasing the value at Cn.48 in 10% decrements. Try increasing the value at Cn.39 or Cn.40 in 10% increments.
The motor hunts when starting up.	Cn.40 PMdeadVolt Per	Try decreasing the value at Cn.40 in 10% decrements.

Problem	Relevant function code	Troubleshooting
The motor hunts with regenerative load at low speed (10Hz or lower), or an "OCT" fault occurs.	Cn.40 PMdeadVolt Per	Try increasing the value at Cn.40 in 10% increments.
The motor hunts* or the torque is not sufficient while the load is increasing at low speed (10Hz or lower).	Cn.04 Carrier Freq Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1	If the motor hunts at low speeds, try increasing the value at Cn.13 in 50 msec increments. If the motor does not hunt, try increasing the value at Cn.12 in 10% increments until the motor runs in an optimal operation condition.
		If the motor hunts and the torque is not sufficient at 5–10Hz speed range, and if the carrier frequency at Cn.04 is set to more than 3 kHz, try decreasing the value in 1 kHz decrements.
The motor hunts excessively during no-load operation when rated current is supplied to the motor.	Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1 Cn.15 ASR P Gain 2 Cn.16 ASR I Gain 2	Try decreasing the speed controller gains at Cn. 12–16 in 30% decrements.
The value at bA.30 (PM Flux Ref) becomes "0" after performing an auto tuning operation when setting bA. 20 to 7 [All (PM)].	bA.11 Pole Number bA.15 Motor Volt dr.18 Base Freq	Refer to the motor's name plate and set the number of poles at bA.11 (Pole Number), or enter the calculated number of poles. Pole Number = (120 x BaseFreq/BaseRPM) Refer to the motor's name plate and set the motor rated voltage and base frequency at bA-15 (Motor Volt) and dr.18 (Base Freq), and then run auto tuning again by setting bA-20 (Auto Tuning) to 7 [All (PM)].
Faults occur after a static auto tuning.	bA.21 Rs bA.28 Ld (PM) bA.29 Lq (PM) bA.30 PM Flux Ref	Motor operation may fail if a static PM auto tuning result is not accurate. Refer to the motor's rating plate and set the motor-related parameters again.
"OVT" occurs due to abrupt acceleration, deceleration, or massive load change while the motor is operated at mid-speed (above 30Hz).Note2)	Cn.16 ASR I Gain 2	Try decreasing the value at Cn.16 in 5% decrements.
Speed variation occurs during an operation at rated motor speed, or during an overloaded high	Cn.45 PM Flux FF % Cn.50 V Con HR Cn.51 V Con Ki	If the motor is operated at the rated speed, try decreasing the value at Cn.50 in 5% increments.

Problem	Relevant function code	Troubleshooting
speed operation.		If the motor response is slow, try increasing the value at Cn.51 in 5% increments (or, try increasing the value at Cn.45 in 100% increments).
"OC1" fault or jerking occurs during a high speed operation.	Cn.41 PM SpdEst Kp Cn.42 PM SpdEst Ki	Try increasing the value at Cn. 41 in increments of 10 and the value at Cn.42 in increments of 1. Note that a fault may occur if the values at Cn. 41 and Cn.42 are set too high.
Jerking occurs during a low speed operation.	Cn.13 ASR I Gain 1	Try increasing the value at Cn.13 (low speed range speed controller I gain) to eliminate jerking.
A "clanking" noise is heard at the beginning of startup or during deceleration.	Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1 Cn.40 PMdeadVolt Per	Try increasing the values at Cn.12 and Cn.13 in 10% increments, or try decreasing the value at Cn.40 in 10% decrements.
The motor cannot reach the speed reference when it is operated at or above the rated speed, or when the acceleration is not responsive.	Cn.50 V Con HR Cn.51 V Con Ki	Try increasing the value at Cn.50 in 1% increments if the motor cannot reach the speed reference. Try increasing the value at Cn.51 in 10% increments if the motor acceleration is not responsive.
"OC1" trip occurs after an abrupt regenerative load (over 100%).	Cn.12 ASR P Gain 1 Cn.13 ASR I Gain 1	Try decreasing the values at Cn.12 and Cn.13 in 10% decrements.
The motor jerks during acceleration.	Cn.42 PM SpdEst Ki	Try increasing the speed estimator proportional gain at Cn.42 in increments of 5.
A major current rise occurs when the motor is stopped during a 20:1 speed startup.	Cn.13 ASR I Gain 1	Try increasing the value at Cn. 13 in 10% increments.
An oscillation occurs when an abrupt load is applied to the motor during a low speed operation.	Cn.41 PM SpdEst Kp Cn.42 PM SpdEst Ki	Try increasing the values at Cn. 41 and Cn.42 in 10% increments.
During a PM speed search, the speed search stops at around 20% of the base frequency, and the motor is stopped and starts again after a major current rise.	Cn.69 SS Pulse Curr	Try decreasing the value at Cn.69 in 5% decrements.
During a high-speed operation in PM control mode utilizing the	Cn.78 KEB Start Lev Cn.79 KEB Stop Lev	Try increasing the values at Cn.78 and Cn.79 in 5% increments, or try doubling

Advanced Features

Problem	Relevant function code	Troubleshooting
kinetic energy buffering, a major current rise occurs at around 20% of the base frequency, the motor is stopped, and it fails to start.	Cn.80 KEB P Gain Cn.81 KEB I Gain	the gain values at Cn.80 and Cn. 81.
1. When the motor is overloaded, the maximum torque limit current is supplied to the motor at startup, and the motor fails to operate due to an inverter overload fault. 2. Speed search fails when the a load exceeding the rated load is applied to the motor at each speed section, or a current equal to or exceeding 150% of the rated current is supplied to the motor.	bA.29 Lq (PM)	This happens when the Lq parameter value is decreasing due to certain causes, such as self-saturation. Try increasing the value (100%) at bA.32 in 5% increments.
A fault occurs when the motor tries to start up or accelerate from a free run at certain speed range.	Cn.71 Speed Search	During a PM synchronous motor operation in sensorless vector mode, the motor starts up after the initial pole position detection is made. To accelerate the motor in a free-run state, enable speed search at acceleration by setting bit 0 (0001) at Cn.71 (Speed Search).
During a low speed operation, the output speed search becomes unstable when a massive load exceeding the rated load is abruptly applied to the motor.	Cn.13 ASR I Gain 1 Cn.40 PMdeadVolt Per	The motor control may become unstable due to input voltage deviation during a low-speed operation with low voltage input. Try decreasing the values at Cn.13 and Cn.40 in 10% decrements.

5.12 Kinetic Energy Buffering (KEB) Operation

When the input power supply is disconnected the inverter's DC link voltage decreases and a low voltage trip occurs shutting off the output. A kinetic energy buffering (KEB) operation uses regenerative energy from the motor to maintain the DC link voltage. This extends the time before a low voltage trip occurs, after the power interruption.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Cn	77	Kinetic energy buffering selection	KEB Select	0	None	0~2	-
				1	KEB-1		
				2	KEB-2		
	78	Kinetic energy buffering start level	KEB Start Lev	125.0		110.0~200.0	%
	79	Kinetic energy buffering stop level	KEB Stop Lev	130.0		Cn-78~210.0	%
	80	Energy buffering P gain	KEB P Gain	1000		0-20000	-
	81	Energy buffering I gain	KEB I Gain	500		1~20000	msec
	82	Energy buffering Slip gain	KEB Slip Gain	30.0		0~2000.0	%
	83	Energy buffering acceleration time	KEB Acc Time	10.0		0.0~600.0	sec
In	65 ~71	Pn terminal function setting	Pn Define	52	KEB-1 Select	-	-

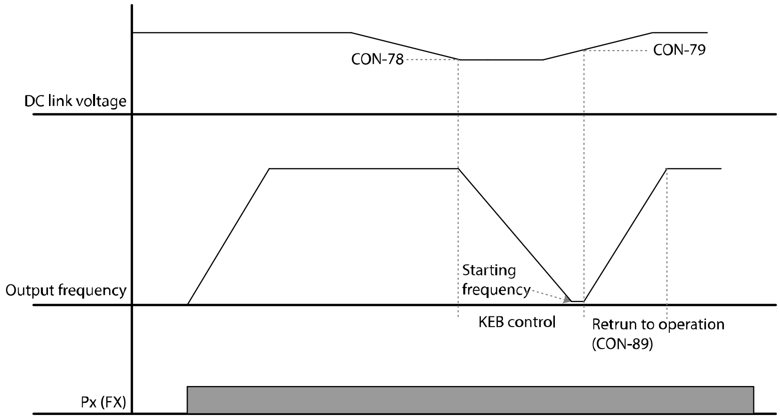
Kinetic Energy Buffering Operation Setting Details

Code	Description
Cn.77 KEB Select	Select the KEB (kinetic energy buffering) operation for installations that have frequent power source interuptions. When either KEB-1 or KEB-2 is selected, it controls the inverter's output frequency and charges the DC link with energy generated from the motor. This function can also be enabled using a digital input. From the Pn terminal function settings, select (52)KEB-1 Select, and then activate the input to enable the KEB-1 function. Note: If KEB-1 Select is set via the Pn terminal,

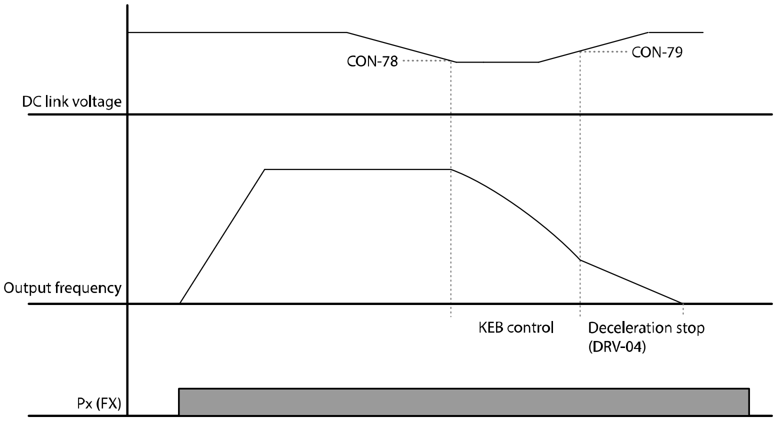
Code	Description
	KEB-1 or KEB-2 cannot be set in Cn-77.

Setting		Function
0	None	General deceleration is carried out until a low voltage trip occurs.
1	KEB-1	When the input power is disconnected, the DC link charges with regenerated energy from the motor. When the input power is restored, operation changes from the KEB operation to the frequency reference operation. KEB Acc Time in Cn-89 is used as the acceleration time when restoring to normal operation.
2	KEB-2	When the input power is disconnected, the DC Link charges with regenerated energy from the motor. When the input power is restored, operation changes from the KEB operation to a deceleration to a stop. The Dec Time in dr-04 is used as the deceleration time during the deceleration to stop.

[KEB-1]



[KEB-2]

Code	Description
	
Cn.78 KEB Start Lev, Cn.79 KEB Stop Lev	Sets the start and stop points of the KEB (kinetic energy buffering) operation. The set values aer 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).
Cn.80 KEB P Gain	The controller P Gain is for maintaining the voltage of the DC power section during the KEB (kinetic energy buffering) operation. Increase the setting 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 power section during the KEB (kinetic energy buffering) operation. Decrease the gain to maintain the frequency during KEB 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 after power is disconnected.
Cn.83 KEB Acc Time	Set the acceleration time to the operation frequency when operation changes from KEB (kinetic energy buffering) to normal operation when the input power is restored.

Caution

Depending on the duration of the power interruptions and the amount of load inertia, a low voltage trip may still occur even during kinetic energy buffering operation. Motors may vibrate during kinetic energy buffering operation for some loads except variable torque load (for example, fan or pump loads).

5.13 Torque Control

The torque control function controls the motor to maintain the preset torque value. The motor rotation speed is constant when the output torque and load torque are balanced. Therefore, the motor rotation speed is decided by the load when controlling the torque.
When the motor output torque is greater than the load torque required, the speed of motor becomes too fast. To prevent this, set the speed limit. (The torque control function cannot be used while the speed limit function is running.)

Torque control setting option

Group	Code	Name	LCD Display	Parameter Setting		Unit
dr	09	Control mode	Control Mode	4	IM Sensorless	-
	10	Torque control	Torque Control	1	Yes	-
dr	02	Cmd Torque			0.0	%
	08	Trq Ref Src		0	Keypad-1	-
	09	Control Mode		4	IM Sensorless	-
	10	Torque Control		1	Yes	-
	22	(+) Trq Gain		-	50-150	%
	23	(-) Trq Gain		-	50-150	%
bA	20	Auto Tuning		1	Yes	-
Cn	62	Speed LmtSrc		0	Keypad-1	-
	63	FWD Speed Lmt		-	60.00	Hz
	64	REV Speed Lmt		-	60.00	Hz
	65	Speed Lmt Gain		-	100	%
In	65-71	Px Define		35	Speed/Torque	-
OU	31-33	Relay x or Q1		27	Torque Dect	-
	59	TD Level		-	100	%
	60	TD Band		-	5.0	%

Note

- To operate in torque control mode, basic operation conditions must be set. For more information, refer to .
- The torque control cannot be used in a low speed regeneration area or low load conditions.
- If you change the rotation direction while operating, an over current trip or low speed reverse direction error will be generated.

Torque reference setting option

The torque reference can be set to the same setting as the frequency reference setting. When in Torque Control Mode, the reference frequency is not used.

Group	Code	Name	LCD Display	Parameter Setting		Unit
dr	02	Torque command	Cmd Torque	-180-180		%
	08	Torque reference setting	Trq Ref Src	0	Keypad-1	-
				1	Keypad-2	
				2	V1	
				4	V2	
				5	I2	
				6	Int 485	
				8	FieldBus	
				9	UserSeq Link	
				12	Pulse	
Cn	62	Speed limit setting	Speed LmtSrc	0	Keypad-1	-
				1	Keypad-2	
				2	V1	
				4	V2	
				5	I2	
				6	Int 485	
				7	FieldBus	
				8	UserSeq Link	
	63	Positive-direction speed limit	FWD Speed Lmt	0-Maximum frequency		Hz
	64	Negative-direction speed limit	REV Speed Lmt	0- Maximum frequency		Hz
	65	Speed limit operation gain	Speed Lmt Gain	100-5000		%
In	02	Torque at	Torque at	0.0 – 200.0		%

Group	Code	Name	LCD Display	Parameter Setting		Unit
		maximum analog input	100%			
CNF*	21	Monitor mode display 1	Monitor Line-1	1	Speed	
	22	Monitor mode display 2	Monitor Line-2	2	Output Current	
	23	Monitor mode display 3	Monitor Line-3	3	Output Voltage	

*Available on LCD keypad only.

Torque reference setting details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>dr-08</td><td>Select an input method to use as the torque reference.
<table>
<tr><th colspan="2">Parameter Setting</th><th>Description</th></tr>
<tr><td>0</td><td>Keypad-1</td><td rowspan="2">Sets the torque reference with the keypad.</td></tr>
<tr><td>1</td><td>Keypad-2</td></tr>
<tr><td>2,4,5</td><td>V1,V2,I2</td><td>Sets the torque reference using the voltage or current input terminal of the terminal block.</td></tr>
<tr><td>6</td><td>Int 485</td><td>Sets the torque reference with the communication terminal of the terminal block.</td></tr>
<tr><td>8</td><td>FieldBus</td><td>Input the torque reference using the inverter's FieldBus option.</td></tr>
<tr><td>9</td><td>UserSeqLink</td><td>Enters torque reference by linking common area with the user sequence output.</td></tr>
<tr><td>12</td><td>Pulse</td><td>Input the torque reference using the pulse input on the inverter's terminal block.</td></tr>
</table></td></tr>
<tr><td>Cn-02</td><td>The torque reference can be set up to 180% of the maximum rated motor torque.</td></tr>
<tr><td>In-02</td><td>Sets the maximum torque. You can view the torque reference in Monitor (MON) mode. Set one of CNF.21 ~ CNF.23.</td></tr>
<tr><td>CNF-21–23</td><td>Select a parameter from the Config (CNF) mode and then select(19 Torque Ref).</td></tr>
</table>

Speed limit details

Code	Description
Cn-62	Select a method for setting the speed limit value. Parameter Setting / Description: 0 Keypad-1, 1 Keypad-2: Sets the speed limit value with the keypad. 2,4,5 V1,V2,I2; 6 Int 485; 7 FieldBus; 8 UserSeqLink: Sets the speed limit value using the same method as the frequency command. You can check the setting in Monitor (MON) mode.
Cn-63	Sets the positive-direction speed limit value.
Cn-64	Sets the negative-direction speed limit value.
Cn-65	Sets the decrease rate of the torque reference when the motor speed exceeds the speed limit value.
CNF-21~23	To view speed limit setting, select a parameter from the Config (CNF) mode and then select 21 Torque Bias.
In 65-71	Select a digital input terminal to set as the (35 Speed/Torque). If you activate the terminal while the operation is stopped, it operates in vector control (speed limit) mode.

Cn-62 settings:

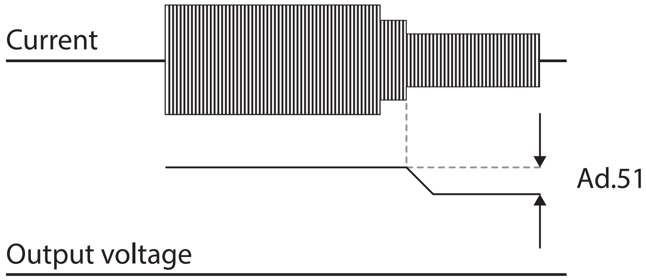
Parameter Setting		Description
0	Keypad-1	Sets the speed limit value with the keypad.
1	Keypad-2	
2,4,5	V1,V2,I2	Sets the speed limit value using the same method as the frequency command. You can check the setting in Monitor (MON) mode.
6	Int 485	
7	FieldBus	
8	UserSeqLink	

5.14 Energy Saving Operation

5.14.1 Manual Energy Saving Operation

If the inverter output current is lower than the current which is set at bA.13 (Motor rated current), the output voltage can be reduced as low as the level set at 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	LCD Display	Parameter Setting		Setting Range	Unit
Ad	50	Energy saving operation	E-Save Mode	1	Manual	-	-
	51	Energy saving amount	Energy Save	30		0–30	%



5.14.2 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	LCD Display	Parameter Setting		Setting Range	Unit
Ad	50	Energy saving operation	E-Save Mode	2	Auto	-	-

Caution

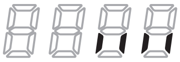
If operation frequency is changed or an acceleration or deceleration is carried out during the energy saving operation, the actual Acc/Dec time may take longer than the set Acc/Dec time due to the time required to return to the gerneral operation from the energy saving operation.

5.15 Speed Search Operation

This operation is used to prevent faults that can occur when the inverter is operated (started) and the motor is idling. Because this feature estimates the motor rotation speed based on the inverter output current, it does not give the exact speed.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Cn	69	PM speed search pulse current	SS Pulse Curr	15		10~100	%
	70	Speed search mode	SS Mode	0	Flying Start-1	-	-
				1	Flying Start-2		
				2	Flying Start-3		
	71	Speed search operation selection	Speed Search	0000*		-	bit
	72	Speed search reference current	SS Sup-Current	-	Below 75kW	80–200	%
	73	Speed search proportional gain	SS P-Gain	100		0–9999	-
	74	Speed search	SS I-Gain	200		0–9999	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		integral gain				
	75	Output block time before speed search	SS Block Time	1.0	0–60	sec
OU	31	Multi-function relay 1 item	Relay 1	19 Speed Search	-	-
	33	Multi-function output 1 item	Q1 Define			

*Displayed as  on the Keypad.

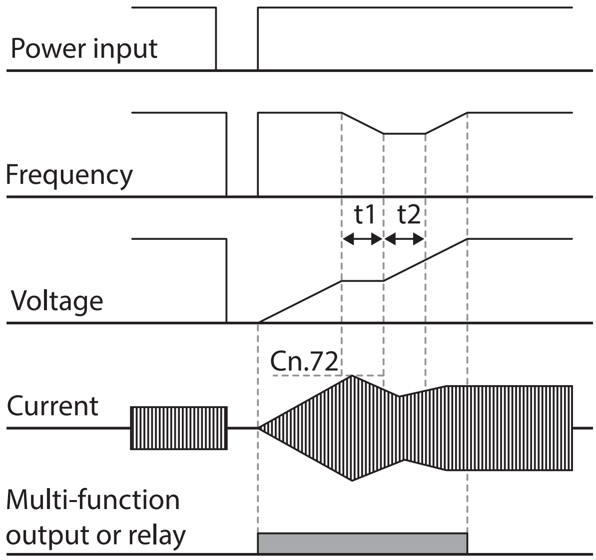
Speed Search Operation Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>Cn.69 SS Pulse Curr</td><td>Sets the speed search current based on the motor's rated current. This parameter is only displayed when dr.09 (Control Mode) is set to 6 (PM Sensorless).</td></tr>
<tr><td>Cn.70 SS Mode</td><td>Select a speed search type.
<table>
<tr><th colspan="2">Setting</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 during idling below the Cn.72 (SS Sup-Current) parameter setting. If the direction of the idling motor and the direction of operation command at restart 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 operation command at restart are different, the speed search does not produce a satisfactory result because the direction of idling 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. Because this mode establishes the direction of the idling motor (forward/reverse), the speed search function is stable regardless of the direction of the idling motor and direction of operation command. However because the ripple current is used which is generated by the counter electromotive force at idle (the counter electromotive force is proportional to the idle speed), the idle frequency is not determined accurately and re-acceleration may start from zero speed when the speed search is performed</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td></td><td>for the idling motor at low speed (about 10 - 15 Hz, though it depends on motor characteristics).</td></tr>
<tr><td>2</td><td>Flying Start-3</td><td>This speed search is available when operating a PM synchronous motor. It is used when dr.09 (Control Mode) is set to 6 (PM Sensorless).</td></tr>
</table>
</td></tr>
<tr><td>Cn.71 Speed Search</td><td>
Speed search can be selected from the following 4 options. If the top display segment is on it is enabled (On), and if the bottom segment is on it is disabled (Off).
<table>
<tr><td>Item</td><td>Bit Setting On Status</td><td>Bit setting Off Status</td></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
<tr><td>LCD keypad</td><td></td><td></td></tr>
</table>
Type and Functions of Speed Search Setting
<table>
<tr><td colspan="4">Setting</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>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>

Speed search for general acceleration: If bit 1 is set to 1 and a start command is applied to the inverter, acceleration starts with speed search operation. The speed search function prevents faults from occurring when a start command is applied and the motor is still rotating.
Initialization after a fault: If Bit 2 is set to 1 and Pr.08 (RST Restart) is set to 1 (Yes), when a fault reset is performed (keypad or digital input), the speed search operation automatically accelerates the motor to the operation frequency used before the fault.
Automatic restart after reset of a fault: If bit 3 is set to 1, and if a low voltage trip occurs due to a power interruption but the power is restored before the internal power shuts down, the speed search operation accelerates the motor back to its frequency reference before the low voltage trip.

If an instantaneous power interruption occurs and the input power is
</td></tr>
</table>

Code	Description
	disconnected, the inverter generates a low voltage trip and blocks the output. When the input power returns, the operation frequency and the output voltage are increased to levels before the low voltage trip occurred. 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, the speed search operation accelerates the motor back to its frequency reference before the fault.  • **Starting with power-on:** Set bit 4 to 1 and Ad.10 (Power-on Run) to 1 (Yes). If inverter input power is supplied with a run command applied, the speed search operation will accelerate the motor up to the frequency reference.
Cn.72 SS Sup-Current	The amount of current flow is controlled during speed search operation 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 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 based on motor capacity are used and defined in dr.14 (Motor Capacity).

Note

- If operated within the rated output, the "S" 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 is guaranteed for 200V and 400V 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.

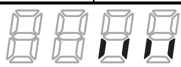
Caution

When operating in sensorless II mode while the load is spinning, 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.

5.16 Auto Restart Settings

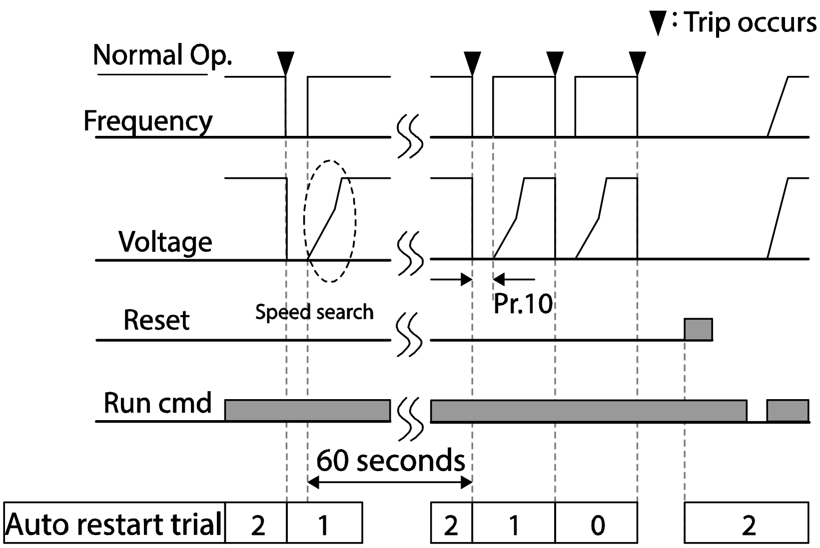
When inverter operation stops due to a fault, the inverter automatically restarts based on the parameter settings.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Pr	08	Select start at trip reset	RST Restart	0	No	0–1	-
	09	Auto restart count	Retry Number	0		0–10	-
	10	Auto restart delay time	Retry Delay	1.0		0.0–60.0	s
Cn	71	Select speed search operation	Speed Search	-		0000*–1111	bit
	72	Speed search startup current	SS Sup-Current	150		80–200	%
	73	Speed search proportional gain	SS P-Gain	100		0–9999	
	74	Speed search integral gain	SS I-Gain	200		0–9999	
	75	Output block time before speed search.	SS Block Time	1.0		0.0–60.0	s

*Displayed as  on the keypad.

Auto Restart Setting Details

Code	Description
Pr.08 RST Restart, Pr.09 Retry Number, Pr.10 Retry Delay	Only operates when Pr.08 (RST Restart) is set to 1(Yes). The number of attempts to try the auto restart is set at Pr.09 (Auto Restart Count). If a fault occurs during normal operation, the inverter automatically restarts after the set time programmed at Pr.10 (Retry Delay). At each restart, the inverter counts the number of tries and subtracts it from the number set at Pr.09 until the retry number count reaches 0. After an auto restart, if a fault does not occur within 60 sec, it will increase the restart count number. The maximum count number is limited by the number set at Pr.09 (Auto Restart Count). If the inverter stops due to low voltage, emergency stop (Bx), inverter overheating, or hardware diagnosis, an auto restart is not activated. 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 5.15.



[Example of auto restart with a setting of 2]

Caution

If the auto restart number is set, be careful when the inverter resets a fault, the motor may automatically start to rotate.

5.17 Operational Noise Settings (carrier frequency settings)

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Cn	04	Carrier Frequency	Carrier Freq	3.0		1.0–15.0	kHz
	05	Switching Mode	PWM* Mode	0	Normal PWM	0–1	-

* PWM: Pulse width modulation

Operational Noise Setting Details

<table>
<tr><th>Code</th><th colspan="3">Description</th></tr>
<tr><td>Cn.04 Carrier Freq</td><td colspan="3">Adjust motor operational noise by changing carrier frequency settings. Power transistors (IGBT) in the inverter generate and supply high frequency switching voltage to the motor. The switching speed in this process refers to the carrier frequency. If the carrier frequency is set high, it reduces operational noise from the motor, and if the carrier frequency is set low, it increases operational noise from the motor.</td></tr>
<tr><td rowspan="8">Cn.05 PWM Mode</td><td colspan="3">The heat loss and leakage current from the inverter can be reduced by changing the load rate option at Cn.05 (PWM Mode). Selecting 1 (LowLeakage PWM) reduces heat loss and leakage current, compared to when 0 (Normal PWM) is selected. However, it increases the motor noise. Low leakage PWM uses 2 phase PWM modulation mode, which helps minimize degradation and reduces switching loss by approximately 30%.</td></tr>
<tr><td rowspan="3">Item</td><td colspan="2">Carrier frequency</td></tr>
<tr><td>1.0kHz</td><td>15kHz</td></tr>
<tr><td>Low Leakage PWM</td><td>Normal PWM</td></tr>
<tr><td>Motor noise</td><td>↑</td><td>↓</td></tr>
<tr><td>Heat generation</td><td>↓</td><td>↑</td></tr>
<tr><td>Noise generation</td><td>↓</td><td>↑</td></tr>
<tr><td>Leakage current</td><td>↓</td><td>↑</td></tr>
</table>

Note

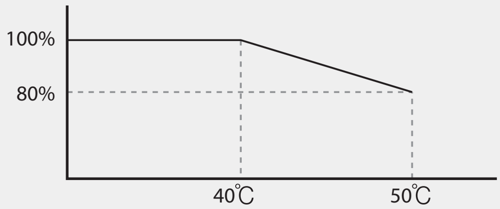
Carrier Frequency at Factory Default Settings (0.4–22kW)

- Normal load: 2kHz (Max 5kHz)
- Heavy load: 3kHz (Max 15kHz)

"S" Series inverter Derating Standard

- "S" Series inverter is designed to respond to two types of load rates. Heavy load (heavy duty) and normal load (normal duty). The overload rate represents an acceptable load current that exceeds rated load, and is expressed in a ratio based on the rated load current for 1 minute. The overload capacity on the "S" Series inverter is 150%/1min for heavy loads, and 120%/1min for normal loads.

- The current rating differs from the load rating, as it also has an ambient temperature limit. For derating specifications, refer to 11.7 *Continuous Rated Current D.*
- Current rating for ambient temperature at normal load operation.



[Ambient temperature versus current rating at normal load]

- Guaranteed carrier frequency for current rating by load.

Inverter capacity	Normal load	Heavy load
0.4–22kW	2kHz	6kHz

5.18 2nd Motor Operation

The 2nd motor operation is used when a single inverter switches between two different motors. When using the 2nd motor operation, set the parameters for the 2nd motor in the M2 group. The 2nd motor parameters are used when a digital input terminal, defined as a 2nd motor function is activated.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65– 69	Px terminal configuration	Px Define(Px: P1–P5)	26	2nd Motor	-	-

2nd Motor Operation Setting Details

Code	Description
In.65–71 Px Define	Set one of the the digital input terminals (P1–P5) to 26 (2nd Motor) to display M2 (2nd motor group) group. An input signal to the digital input terminal will operate the motor according to the M2 parameter settings listed below. The inverter cannot be switched to the second motor while running. Pr.50 (Stall Prevent) must be set first to view M2.28 (M2-Stall Lev) settings. Also, Pr.40 (ETH Trip Sel) must be set first to view M2.29 (M2-ETH 1min) and M2.30 (M2.ETH Cont) settings.

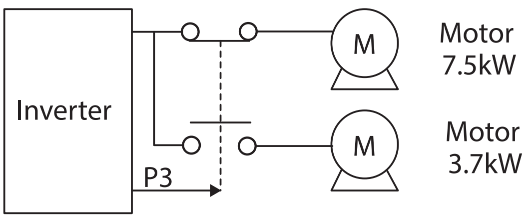
Parameter Setting at Multi-function Terminal Input on a 2nd Motor

Code	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 Motor Volt	Motor rated voltage	M2.29 ETH 1min	Motor heat protection 1min rating
M2.15 Efficiency	Motor efficiency	M2.30 ETH Cont	Motor heat protection continuous rating

Example - 2nd Motor Operation

Use the 2nd motor operation when switching operation between a 7.5kW motor and a secondary 3.7kW motor connected to terminal P3. Refer to the following settings.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	67	Terminal P3 configuration	P3 Define	26	2nd Motor	-	-
M2	06	Motor capacity	M2-Capacity	-	3.7kW	-	-
	08	Control mode	M2-Ctrl Mode	0	V/F	-	-

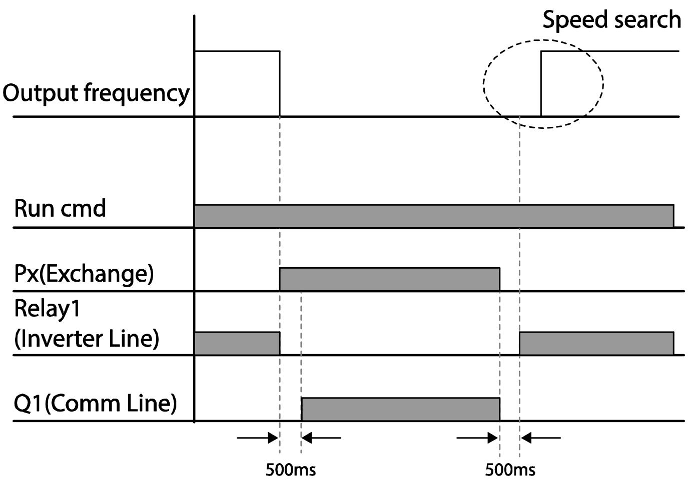


5.19 Supply Power Transition

Supply power transition is used to switch the power source for the motor between the inverter output to the main supply power source (commercial power source) and vice versa.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	16	Exchange	-	-
OU	31	Multi-function relay1 items	Relay1	17	Inverter Line	-	-
	33	Multi-function output1 items	Q1 Define	18	Comm Line	-	-

Supply Power Transition Setting Details

Code	Description
In.65–69 Px Define	When the motor power source changes from inverter output to main supply power, select a terminal to use and set the code value to 16 (Exchange). Power will be switched when the selected terminal is on. To reverse the transition, switch off the terminal.
OU.31 Realy 1 Define, OU.33 Q1 Define	Set multi-function relay or multi-function output to 17 (Inverter Line) or 18 (COMM line). Relay operation sequence is as follows. 

5.20 Cooling Fan Control

This function turns the inverter's heat-sink cooling fan on and off. It is used in situations where the load stops and starts frequently, or noise free environment is required. The correct use of cooling fan control can extend the cooling fan's life.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	64	Cooling fan control	FAN Control	0	During Run	0–2	-

Cooling Fan Control Detail Settings

Code	Settings		Description
Ad.64 Fan Control	0	During Run	Cooling fan runs when the operation (run) command is on. The cooling fan stops when the operation command is off. When the inverter heat sink temperature is higher than a safe level, the cooling fan operates automatically regardless of its operation status.
	1	Always On	Cooling fan runs constantly when power is supplied to the inverter.
	2	Temp Control	With power connected and the run operation command on, if the setting is in Temp Control, the cooling fan will not operate unless the temperature in the heat sink reaches the set temperature.

Note

Despite setting Ad.64 to 0(During Run), if the heat sink temperature reaches an unsafe level, the cooling fan may run as a protection function.

5.21 Input Power Frequency and Voltage Settings

Select the frequency for inverter input power. If the frequency changes from 60Hz to 50Hz, all other frequency (or RPM) settings including the maximum frequency, base frequency etc., will be scaled to 50Hz. Likewise, changing the input power frequency setting from 50Hz to 60Hz will scale all related settings from 50Hz to 60Hz.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	10	Input power frequency	60/50 Hz Src	0	60Hz	0–1	-

Set Inverter input power voltage at bA.19. The low voltage fault level changes automatically with the set voltage.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
bA	19	Input power voltage	AC Input Volt	240V	240	170–240	V
				480V	480	320–480	

5.22 Read, Write, and Save Parameters

Use read, write and save function parameters on the inverter to copy parameters from the inverter to the keypad or from the keypad to the inverter.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	46	Parameter read	Parameter Read	1	Yes	-	-
	47	Parameter write	Parameter Write	1	Yes	-	-
	48	Parameter save	Parameter Save	1	Yes	-	-

*Available on LCD keypad only.

Read, Write, and Save Parameter Setting Details

Code	Description
CNF-46 Parameter Read	Copies saved parameters from the inverter to the keypad. Saved parameters on the keypad will be deleted and replaced with copied parameters.
CNF-47 Parameter Write	Copies saved parameters from the keypad to the inverter. Saved parameters on the inverter will be deleted and replaced with copied parameters. If an error occurs during parameter writing, previous saved data will be used. If there is no saved data on the Keypad, 'EEP Rom Empty' message will be displayed.
CNF-48 Parameter Save	As parameters set during communication transmission are saved to RAM, the setting values will be lost if the power goes off and on. When setting parameters during communication transmission, select 1 (Yes) from CNF-48 code to save the set parameter.

5.23 Parameter Initialization

User changes to parameters can be initialized (reset) to factory default settings on all or selected groups. However, during a fault or during operation, parameters cannot be initialized.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr*	93	Parameter initialization	-	0	No	0–16	
CNF**	40	Parameter initialization	Parameter Init	0	No	0–16	

* For keypad   **For LCD keypad

Parameter Initialization Setting Details

Code	Description			
dr.93, CNF-40 Parameter Init	Setting		LCD Display	Function
	0	No	No	-
	1	Initialize all groups	All Grp	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	DRV Grp	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	BAS Grp	
	4	Initialize Ad group	ADV Grp	
	5	Initialize Cn group	CON Grp	
	6	Initialize In group	IN Grp	
	7	Initialize OU group	OUT Grp	
	8	Initialize CM group	COM Grp	
	9	Initialize AP group	APP Grp	
	12	Initialize Pr group	PRT Grp	
	13	Initialize M2 group	M2 Grp	
	16	Initialize OperationGroup	SPS Grp	

5.24 Parameter View Lock

Use parameter view lock to hide parameters after registering and entering a user password.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF*	50	Parameter view lock	View Lock Set	Unlocked	0–9999	
	51	Parameter view lock password	View Lock Pw	Password	0–9999	

* Available on LCD keypad only.

Parameter View Lock Setting Details

Code	Description	
CNF-51 View Lock Pw	Register a password to allow access to parameter view lock. Follow the steps below to register a password.	
	No	Procedure
	1	[PROG/ENT] key on CNF-51 code will show the previous

Code	Description	
		password input window. If registration is made for the first time, enter 0. It is the factory default.
	2	If a password had been set, enter the saved password.
	3	If the entered password matches the saved password, a new window prompting the user to enter a new password will be displayed (the process will not progress to the next stage until the user enters a valid password).
	4	Register a new password.
	5	After registration, code CNF-51 will be displayed.
CNF-50 View Lock Set	To enable parameter view lock, enter a registered password. [Locked] sign will be displayed on the screen to indicate that parameter view lock is enabled. To disable parameter view lock, re-enter the password. The [locked] sign will disappear.	

5.25 Parameter Lock

Use parameter lock to prevent unauthorized modification of parameter settings. To enable parameter lock, register and enter a user password first.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
dr	94	Password registration	-	-	0–9999	-
	95	Parameter lock password	-	-	0–9999	-
CNF*	52	Parameter lock	Key Lock Set	Unlocked	0–9999	-
	53	Parameter lock password	Key Lock PW	Password	0–9999	-

*Available on LCD keypad only.

Parameter Lock Setting Details

Code	Description	
CNF-53 Key Lock Pw	Register a password to prohibit parameter modifications. Follow the procedures below to register a password.	
	No	Procedures
	1	Press the [PROG/ENT] key on CNF-53 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.
	2	If a saved password has been set, enter the saved password.
	3	If the entered password matches the saved password, then a new window to enter a new password will be displayed. (The process

Code	Description	
		will not move to next stage until the user enters a valid password).
	4	Register a new password.
	5	After registration, Code CNF-51 will be displayed.
CNF-52 Key Lock Set	To enable parameter lock, enter the registered password. [Locked] sign will be displayed on the screen to indicate that parmeter lock is enabled. Once enabled, pressing the [PROG/ENT] key on a parameter will not allow the display to enter the edit mode. To unlock parameters, re-enter the password. The [Locked] sign will disappear.	

Caution

If parameter view lock and parameter lock functions are enabled, no inverter operation changes can be made. It is very important that you memorize the password.

5.26 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	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	41	Changed parameter display	Changed Para	0	View All	-	-

* Available on LCD keypad only.

Changed Parameter Display Setting Details

Code	Description		
CNF-41 Changed Para	Setting		Function
	0	View All	Display all parameters
	1	View Changed	Display changed parameters only

5.27 User Group

Create a user defined group and register user-selected parameters from the existing parameter groups. The user group can carry up to a maximum of 64 parameter registrations.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	42	Multi-function key settings	Multi Key Sel	3	UserGrp SelKey	-	-
	45	Delete all user registered codes	UserGrp AllDel	0	No	-	-

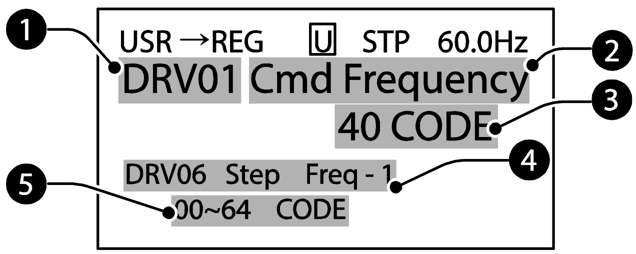
* Available on LCD keypad only.

User Group Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>CNF-42
Multi-Key
Sel</td><td>
Select 3(UserGrp SelKey) from the multi-function key setting options. If user group parameters are not registered, setting the multi-function key to the user group select key (UserGrp SelKey) will not display user group (USR Grp) item on the Keypad.

Follow the procedures below to register parameters to a user group.

<table>
<tr><th>No</th><th>Procedure</th></tr>
<tr><td>1</td><td>Set CNF- 42 to 3(UserGrp SelKey). A $\boxed{U}$ icon will be displayed at the top of the LCD display.</td></tr>
<tr><td>2</td><td>In the parameter mode (PAR Mode), move to the parameter you need to register and press the [MULTI] key. For example, if the [MULTI] key is pressed in the frequency reference in DRV 01 (Cmd Frequency), the screen below will be displayed.



❶ Group name and code number of the parameter
❷ Name of the parameter
❸ Code number to be used in the user group. Pressing the [PROG/ENT] key on the code number (40 Code) will register DRV-01 as code 40 in the user group.
❹ Existing parameter registered as the user group code 40
❺ Setting range of the user group code. Entering 0 cancels the settings.</td></tr>
<tr><td>3</td><td>Set a code number (❸) to use to register the parameter in the user group. Select code number and press [PROG/ENT] key.</td></tr>
<tr><td>4</td><td>Changing the value in ❸ will also change the value in ❹. If no code is registered, 'Empty Code' will be displayed. Entering 0 cancels the settings.</td></tr>
<tr><td>5</td><td>The registered parameters are listed in the user group in U&M mode. You can register one parameter multiple times if necessary. For example, a parameter can be registered as code 2, code 11, and more in the user group.</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>Follow the procedures below to delete parameters in the user group.
<table>
<tr><td>No.</td><td>Settings</td></tr>
<tr><td>1</td><td>Set CNF- 42 to 3(UserGrp SelKey). A U icon will be displayed at the top of the LCD display.</td></tr>
<tr><td>2</td><td>In the USR group in U&M mode, move the cursor to the code that is to be deleted.</td></tr>
<tr><td>3</td><td>Press the [MULTI] key.</td></tr>
<tr><td>4</td><td>Move to YES on the deletion confirmation screen, and press the [PROG/ENT] key.</td></tr>
<tr><td>5</td><td>Deletion completed.</td></tr>
</table>
</td></tr>
<tr><td>CNF-25 UserGrp AllDel</td><td>Set to 1(Yes) to delete all registered parameters in the user group.</td></tr>
</table>

5.28 Easy Start On

Run Easy Start On to easily setup the basic motor parameters required to operate a motor in a batch. Set CNF-61(Easy Start On) to 1(Yes) to activate the feature, initialize all parameters by setting CNF-40 (Parameter Init) to 1 (All Grp), and restart the inverter to activate Easy Start On.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	61	Parameter easy start settings	Easy Start On	1	Yes	-	-

*Available on LCD keypad only.

Easy Start On Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>CNF-61 Easy Start On</td><td>Follow the procedures listed below to set parameter easy start.
<table>
<tr><td>No</td><td>Procedures</td></tr>
<tr><td>1</td><td>Set CNF-61 (Easy Start On) to 1(Yes).</td></tr>
<tr><td>2</td><td>Select 1(All Grp) in CNF-40 (Parameter Init) to initialize all parameters in the inverter.</td></tr>
<tr><td>3</td><td>Restarting the inverter will activate the Easy Start On. Set the values in the following screens on the LCD keypad. To escape from the Easy Start On, press the [ESC] key.

• Start Easy Set: Select Yes.
• DRV-14 Motor Capacity: Set motor capacity.
• BAS-11 Pole Number: Set motor pole number.
• BAS-15 Motor Volt: Set motor rated voltage.
• BAS-10 60/50Hz Src: Set motor rated frequency.
• BAS-19 AC Input Volt: Set input voltage.</td></tr>
</table>
</td></tr>
</table>

Code	Description	
		• **DRV-06 Cmd Source:** Set command source. • **DRV-01 Cmd Frequency:** Set operation frequency. When the settings are completed, the minimum parameter settings of the motor has been made. The LCD keypay will return to a monitoring display. Now the motor can be operated with the command source set at DRV-06.

5.29 Config(CNF) Mode

The config mode parameters are used to configure the LCD keypad related features.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF*	2	LCD brightness/contrast adjustment	LCD Contrast	-	-	
	10	Inverter S/W version	Inv S/W Ver	x.xx	-	
	11	Keypad S/W version	Keypad S/W Ver	x.xx	-	-
	12	Keypad title version	KPD Title Ver	x.xx	-	-
	30–32	Power slot type	Option-x Type	None	-	-
	44	Erase trip history	Erase All Trip	No	-	-
	60	Add title update	Add Title Up	No	-	-
	62	Initialize kWH (accumulated electric energy)	WH Count Reset	No	-	-

* Available on the LCD keypad only.

Config Mode Parameter Setting Details

Code	Description
CNF-2 LCD contrast	Adjusts LCD brightness/contrast on the LCD keypad.
CNF-10 Inv S/W Ver, CNF-11 Keypad S/W Ver	Check OS version in the inverter and on the LCD keypad.
CNF-12 KPD title Ver	Checks title version on the LCD keypad.
CNF-30–32 Option-x type	Checks type of powerboard installed in 1–3 power slot.
CNF-44 Erase all trip	Deletes stored trip history.
CNF-60 Add Title Up	When inverter SW version is updated and more code is added, CNF-60 settings will add, display, and operate the added codes. Set CNF-60 to 1(Yes) and disconnect the LCD keypad from the inverter. Reconnecting

Code	Description
	the LCD keypad to the inverter updates titles.
CNF-62 WH Count Reset	Initialize kWH (accumulated electric energy consumption).

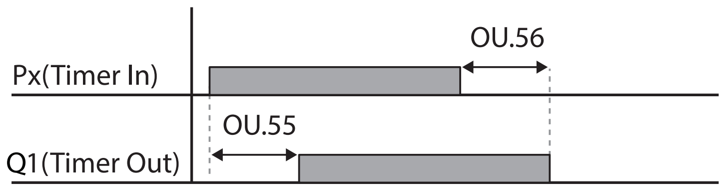
5.30 Timer Settings

Set a digital input terminal to activate a timer to control the multi-function outputs (Relay1 or Q1) according to the timer settings.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
In	65–69	Px terminal configuration	Px Define(Px: P1–P5)	38	Timer In	-	-
OU	31	Multi-function relay1	Relay 1	28	Timer Out	-	-
	33	Multi-function output1	Q1 Define				
	55	Timer on delay	Timer on delay	3.00		0.00–100	sec
	56	Timer off delay	Timer off delay	1.00		0.00–100	sec

Timer Setting Details

Code	Description
In.65–71 Px Define	Choose one of the digital input terminals and change it to a timer input terminal by setting it to 38 (Timer In).
OU.31 Relay1, OU.33 Q1 Define	Set either one of the multi-function outputs (Relay1 or Q1) to 28 (Timer out).
OU.55 TimerOn Delay, OU.56 TimerOff Delay	Configure the On delay and Off delay settings of the multi-function output. When the digital input terminal is activated to operate the timer, the multi-function output will close after the time set at OU.55 has passed. When the digital input terminal is de-activated (opened), the multi-function output opens after the time set at OU.56.



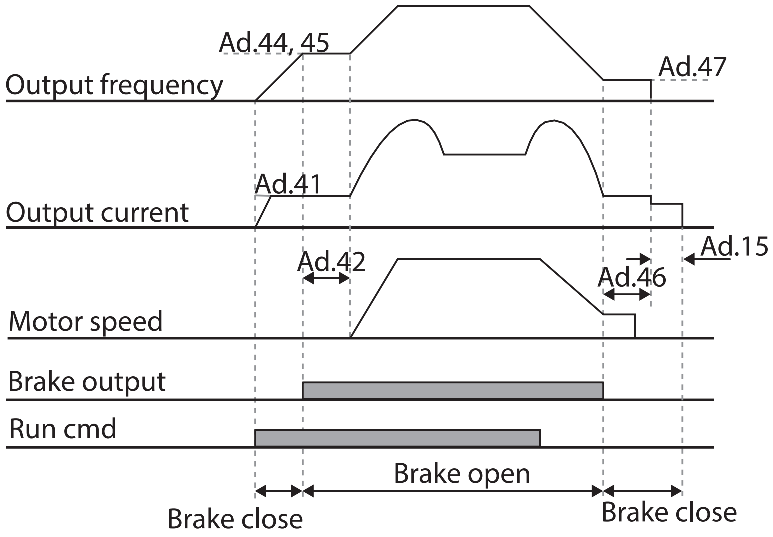
5.31 Brake Control

Brake control is used to control the On/Off operation of electronic brake load system. A multi-function output (Relay1 or Q1) is used to engage and disengage the load brake (self locking electromechanical device) that holds the load in place.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
dr	09	Control mode	Control Mode	0	V/F	-	-
Ad	41	Brake open current	BR Rls Curr	50.0		0.0–180%	%
	42	Brake open delay time	BR Rls Dly	1.00		0.0–10.0	sec
	44	Brake open forward frequency	BR Rls Fwd Fr	1.00		0–Maximum frequency	Hz
	45	Brake open reverse frequency	BR Rls Rev Fr	1.00		0–Maximum frequency	Hz
	46	Brake close delay time	BR Eng Dly	1.00		0.00–10.00	sec
	47	Brake close frequency	BR Eng Fr	2.00		0–Maximum frequency	Hz
OU	31	Multi-function relay1 item	Relay 1	35	BR Control:	-	-
	33	Multi-function output1 item	Q1 Define				

When either of the multi-funcion outputs are set to BR Control, the DC injection braking functions at start (Ad.07) and the dwell functions (Ad.20) do not operate.

- **Brake release sequence:** During motor stop state, when a run command is applied, the inverter accelerates up to brake release frequency (Ad.44– 45) in forward or in reverse direction. After reaching brake release frequency, if motor current reaches brake release current (BR Rls Curr), the multi-function output (Relay1 or Q1) sends a release signal (closes) to release the mechanical brake. Once the signal has been sent, acceleration will begin after maintaining frequency for brake release delay time (BR Rls Dly).
- **Brake engage sequence:** When a stop command is sent during operation, the motor decelerates. Once the output frequency reaches the brake engage frequency (BR Eng Fr), the motor stops deceleration and the multi-function output (Relay1 or Q1) sends out a brake engage signal (opens) to engage the mechanical brake. Frequency is maintained for the brake engage delay time (BR Eng Dly) and will become off afterwards. If DC injection braking time (Ad.15) and DC injection braking rate (Ad.16) are set (Stop Mode settings), inverter output is blocked after DC injection braking. For DC injection braking, refer to 4.17.2 *Stop with DC B*.



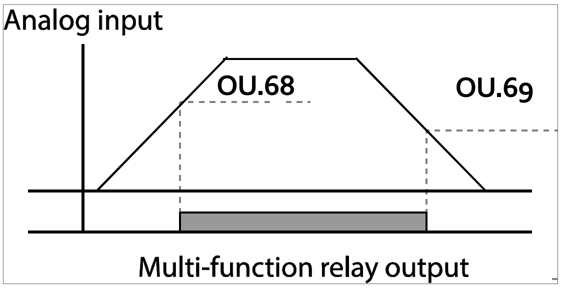
5.32 Multi-Function Output On/Off Control

Activates the multi-function outputs (Relay1 or Q1) based on an analog input level. Both On (closed) and Off (open) levels can be set.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	67	Output terminal on/off control mode	On/Off Ctrl Src	1	V1	-	-
	68	Output terminal on level	On-C Level	90.00		Output terminal off level– 100.00%	%
	69	Output terminal off level	Off-C Level	10.00		0.00–Output terminal on level	%
OU	31	Multi-function relay1 item	Relay 1	34	On/Off	-	-
	33	Multi-function output1 item	Q1 Define				

Multi-function Output On/Off Control Setting Details

Code	Description
OU.67 On/Off Ctrl Src	Select the source of the analog input for On/Off control.
OU.68 On-C Level, OU.69 Off-C Level	Set On/Off level for the multi-function output terminal.



5.33 Press Regeneration Prevention

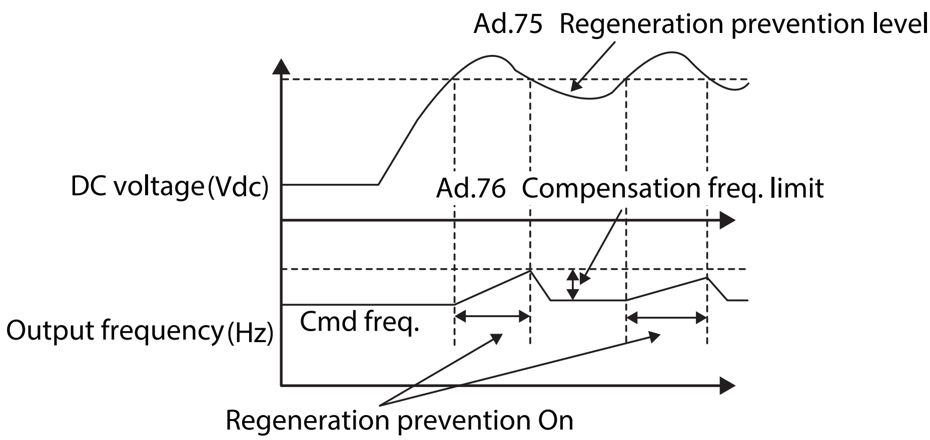
Press regeneration prevention is used during press operations to prevent dynamic braking during the regeneration process. If motor regeneration occurs during a press operation, motor operation speed automatically increases to avoid the regeneration zone.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
Ad	74	Select press regeneration prevention for press	RegenAvd Sel	0	No	0–1	-
	75	Press regeneration prevention operation voltage level	RegenAvd Level	350V		200V: 300–400V	V
				700V		400V: 600–800V	
	76	Press regeneration prevention compensation frequency limit	CompFreq Limit	1.00(Hz)		0.00–10.00Hz	Hz

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	77	Press regeneration prevention P gain	RegenAvd Pgain	50.0(%)	0 .0–100.0%	%
	78	Press regeneration prevention I gain	RegenAvd Igain	500(ms)	20–30000ms	ms

Press Regeneration Prevention Setting Details

Code	Description
Ad.74 RegenAvd Sel	Frequent regeneration voltage from a press type load during constant speed motor operation may force excessive activation of the dynamic brake unit which may damage or shorten the brake life. To prevent this situation, select Ad.74 (RegenAvd Sel) to control DC link voltage and disable the brake unit operation.
Ad.75 RegenAvd Level	Set brake operation prevention level voltage when the DC link voltage goes up due to regeneration.
Ad.76 CompFreq Limit	Set the frequency limit of the inverter output when in regeneration prevention.
Ad.77 RegenAvd Pgain, Ad.78 RegenAvd Igain	Set the P gain and I gain in the DC link voltage supress PI controller. These will control how fast the inverter responds to the increased DC link voltage.



Note

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

5.34 Analog Output

The analog output terminal (AO) provides outputs of 0–10V or (0)4–20mA. The type of output (voltage or current) is switch selectable with switch SW3 on the main board. A pulsed output (0–32kHz pulse) can also be used from terminal Q1 (when set to TO). See 5.34.2.

5.34.1 Voltage and Current Analog Output

Select 1 of 15 functions with parameter OU.01, Analog Output1 to be represented by the analog output. Set switch (SW3) to change the output type (voltage or current).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	01	Analog output1	AO1 Mode	0	Frequency	0–15	-
	02	Analog output1 gain	AO1 Gain	100.0		-1000.0–1000.0	%
	03	Analog output1 bias	AO1 Bias	0.0		-100.0–100.0	%
	04	Analog output1 filter	AO1 Filter	5		0–10000	ms
	05	Analog constant output1	AO1 Const %	0.0		0.0–100.0	%
	06	Analog output1 monitor	AO1 Monitor	0.0		0.0–1000.0	%

Voltage and Current Analog Output Setting Details

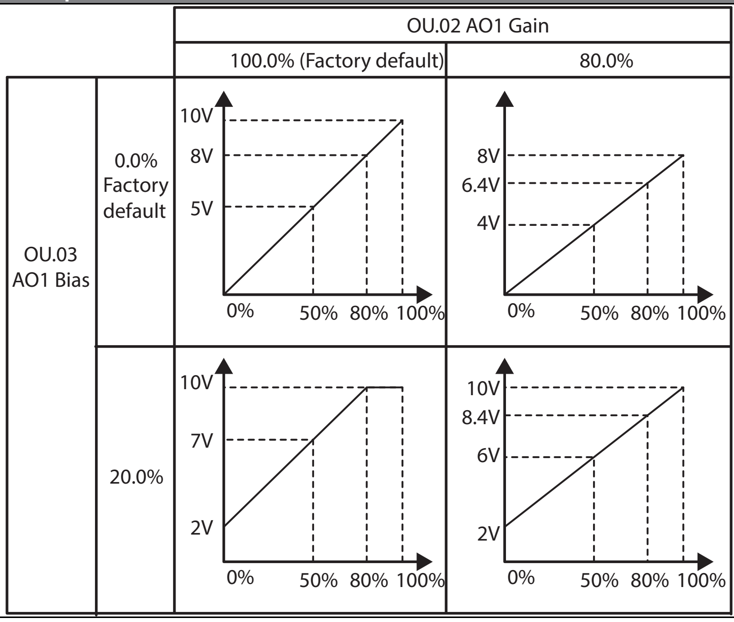
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>OU.01 AO1 Mode</td><td>Select a function to output at the analog output terminal. The following example is for output frequency setting (OU.01=0).
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>Frequency</td><td>Outputs 0-10V based on operating frequency. The 10V output represents the frequency set at dr.20(Max Freq)</td></tr>
<tr><td>1</td><td>Output Current</td><td>Outputs 0-10V based on output current. The 10V output represents 200% of inverter rated current.</td></tr>
<tr><td>2</td><td>Output Voltage</td><td>Outputs 0-10V based on the inverter output voltage. The 10V output represents the set voltage in bA.15 (Motor Rated Volt).
If 0V is set in bA.15, 200V/400V models output 10V based on the actual input voltages.</td></tr>
<tr><td>3</td><td>DC Link Volt</td><td>Output is based on the inverter DC link voltage where</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td></td><td>10V represents 410VDC for 200V models and 820VDC for 400V models.</td></tr>
<tr><td>4</td><td>Torque</td><td>Outputs the generated torque where 10V represents 250% of motor rated torque.</td></tr>
<tr><td>5</td><td>Ouput Power</td><td>Monitors output wattage. An output of 10V represents 200% of inverter rated output.</td></tr>
<tr><td>6</td><td>Idse</td><td>Outputs no load current (magnetizing current) where 10V represents 200% of no load current.</td></tr>
<tr><td>7</td><td>Iqse</td><td>Outputs torque producing current where 10V represents 250% of rated torque current.
$rated\ torque\ current = \sqrt{rated\ current^2 - no\ load\ current^2}$</td></tr>
<tr><td>8</td><td>Target Freq</td><td>Outputs the set target (reference) frequency where 10V is the maximum frequency (dr.20).</td></tr>
<tr><td>9</td><td>Ramp Freq</td><td>Outputs the frequency calculated using the Acc/Dec function. This may vary from the actual output frequency.</td></tr>
<tr><td>12</td><td>PID Ref Value</td><td>Outputs the reference (setpoint) value of a PID controller where 6.6V represents 100%.</td></tr>
<tr><td>13</td><td>PID Fdk Value</td><td>Outputs the feedback value of a PID controller where 6.6V represents 100%.</td></tr>
<tr><td>14</td><td>PID Output</td><td>Outputs the PID output value of a PID controller where 10V represents 100%.</td></tr>
<tr><td>15</td><td>Constant</td><td>Outputs OU.05 (AO1 Const %) value as a standard.</td></tr>
</table>
</td></tr>
<tr><td>OU.02 AO1 Gain,
OU.03 AO1 Bias</td><td>Adjusts output value and offset. If frequency is selected as an output item, it will operate as shown below.

$$AO1 = \frac{Frequency}{MaxFreq} \times AO1\ \ Gain + AO1\ \ Bias$$

The graph below illustrates the analog voltage output (AO1) changes depend on OU.02 (AO1 Gain) and OU.3 (AO1 Bias) values. Y-axis is analog output voltage (0‒10V), and X-axis is % value of the output item.

Example, if the maximum frequency set at dr.20 (Max Freq) is 60Hz and the present output frequency is 30Hz, then the x-axis value on the next graph is 50%.</td></tr>
</table>

Code	Description
	
OU.04 AO1 Filter	Set filter time constant on analog output.
OU.05 A01 Const %	Used for calibration of the analog output. If analog output at OU.01 (AO1 Mode) is set to 15(Constant), the analog voltage output is dependent on the percentage set in OU.02 (Gain) and OU.03 (Bias) values (0–100%). See 4-20mA scaling example below.
OU.06 AO1 Monitor	Monitors analog output value. Displays the maximum output voltage as a percentage (%) with 10V as the standard.

Example: 4-20mA scaling

OU.02 AO1 Gain and OU.03 AO1 Bias Tuning Method for 4–20mA output.

1. Set OU.01 (AO1 Mode) to constant, and set OU.05 (AO1 Const %) to 0.0 %.
2. Set OU.03 (AO1 Bias) to 20.0% and then check current output. 4mA output should be displayed.
3. If the value is less than 4mA, gradually increase OU.03 (AO1 Bias) until 4mA is measured. If the value is more than 4mA, gradually decrease OU.03 (AO1 Bias) until 4mA is measured.
4. Set OU.05 AO1 Const % to 100.0%

   Set OU.02 (AO1 Gain) to 80.0% and measure current output at 20mA. If the value is less than 20 gradually increase OU.02 (AO1 Gain) until 20mA is measured. If the value is more than 20mA, gradually decrease OU.02 (AO1 Gain) until 20mA is measured.

The scaling for the other functions is identical to the example for the 4-20mA output range.

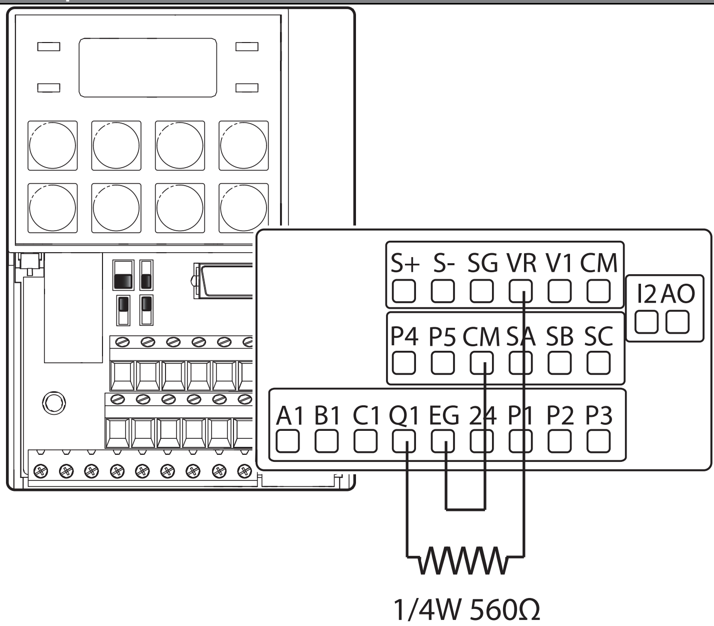
5.34.2 Analog Pulse Output

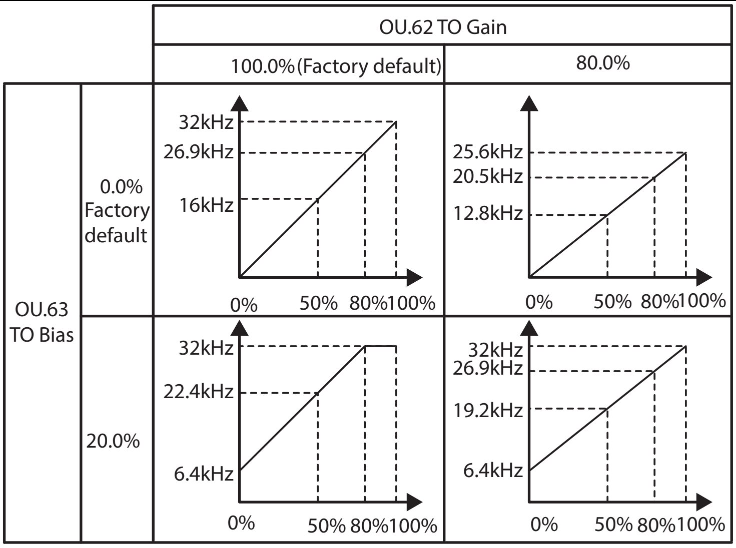
Select 1 of 15 functions with parameter OU.01, Analog Output1 to be represented by the pulsed output. Note the Q1 terminal must be set to TO, Pulse Output.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	33	Multi-function output 1	Q1 define	39	TO	0–38	-
	61	Pulse output setting	TO Mode	0	Frequency	0–15	-
	62	Pulse output gain	TO Gain	100.0		-1000.0–1000.0	%
	63	Pulse output bias	TO Bias	0.0		-100.0-100.0	%
	64	Pulse output filter	TO Filter	5		0–10000	ms
	65	Pulse output constant output2	TO Const %	0.0		0.0-100.0	%
	66	Pulse output monitor	TO Monitor	0.0		0.0–1000.0	%

Analog Pulse Output Setting Details

Code	Description
OU.33 Q1 Define	In case of Standard I/O, pulse output TO and multi-function output Q1 share the same terminal. Set OU.33 to TO which represents a 32kHz pulse output and follow the instructions below to make wiring connections that configure the open collector output circuit. 1. Connect a 1/4W, 560Ω resistor between VR and Q1 terminals. 2. Connect EG and CM terminals. When wiring the resistor, a resistance of 560Ω or less is recommended to stably provide 32kHz pulse output.

Code	Description
	 When connecting a pulse output to another inverter, connect pulse output (Q1-EG) to pulse input(P5-CM) directly without resistor and wire. • Standard I/O <-> Standard I/O : Connect to Q1 -> P5, EG -> CM
OU.62 TO Gain, OU.63 TO Bias	Adjusts output values (gain and bias). If frequency is selected as an output (OU.61=0), it will operate as shown below. $$TO\ \ (Q1) = \frac{Frequency}{MaxFreq} \times TO\ \ Gain + TO\ \ Bias$$ The following graph illustrates that the pulse output (TO/ Q1) changes depending on OU.62 (TO Gain) and OU.63 (TO Bias) values. The Y-axis is an analog output frequency (0–32kHz) and the X-axis is a % of the output frequency. For example, if the maximum frequency set with dr.20 (Max Freq) is 60Hz and actual output frequency is 30Hz (Y-axis at 16kHz.), then the x-axis value on the first graph is 50%.

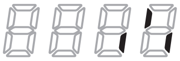
Code	Description
	
OU.64 TO Filter	Sets filter time constant on analog output.
OU.65 TO Const %	Used for calibration of the Q1 frequency output. If analog output at OU.01 (AO1 Mode) is set to 15(Constant), the frequency output is dependent on the percentage set in OU.62 (Gain) and OU.63 (Bias) values (0–100%).
OU.66 TO Monitor	Monitors analog output value. Displays the maximum output pulse (32kHz) as a percentage (%) of the standard.

5.35 Digital Output

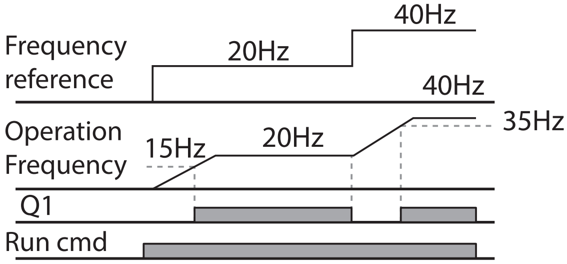
5.35.1 Multi-function Output Terminal and Relay Settings

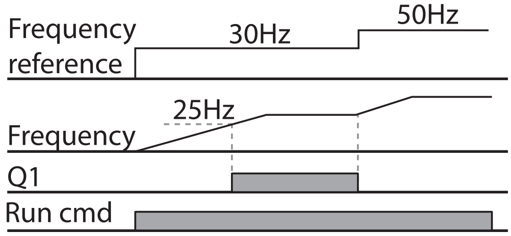
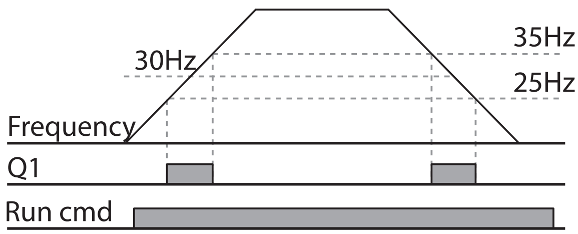
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	30	Fault output item	Trip Out Mode	010*		-	bit
	31	Multi-function relay1 setting	Relay 1	29	Trip	-	-
	33	Multi-function output1	Q1 Define	14	Run	-	-

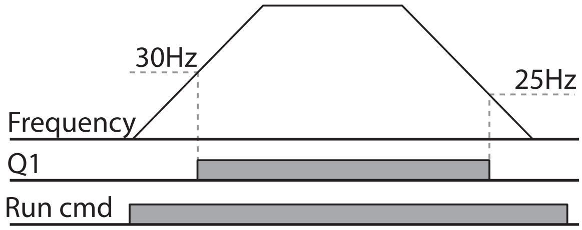
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		setting					
	41	Multi-function output monitor	DO Status	-		00–11	bit
	57	Detection frequency	FDT Frequency	30.00		0.00–Maximum frequency	Hz
	58	Detection frequency band	FDT Band	10.00			
In	65–71	Px terminal configuration	Px Define	16	Exchange	-	-

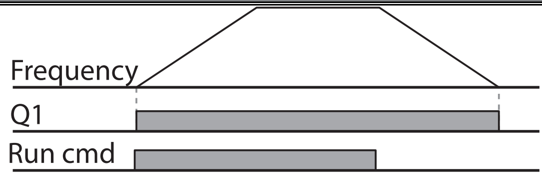
*Displayed as  on the keypad.

Multi-function Output Terminal and Relay Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>OU.31 Relay1</td><td>Set relay (Relay 1) output options.</td></tr>
<tr><td>OU.33 Q1 Define</td><td>Select terminal (Q1) output options. Q1 is an open collector transistor output.</td></tr>
<tr><td>OU.41 DO Status</td><td>When terminal Q1 and/or Relay1 outputs are set for frequency related functions FDT-1 through FDT-4, use parameters OU.57 FDT (Frequency), OU.58 (FDT Band) settings for the detection criteria.
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>No output signal.</td></tr>
<tr><td>1</td><td>FDT-1</td><td>FDT-1 setting compares the reference frequency to the actual output (operating) frequency. Relay1 (or Q1) closes when the difference between the two frequencies is within ½ the FDT Band, OU.58.
Eq: Absolute value (set frequency–output frequency) < detected frequency band/2.
Ex: When OU.58, FDT Band = 10Hz, FDT-1 functions as shown in the graph below.

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

Code	Description		
	2	FDT-2	FDT-2 compares the reference frequency to the detect frequency OU.57, FDT frequency. Relay1 (or Q1) closes when the reference frequency and the detect frequency are within ½ of the FDT Band, OU.58. **Eq:** [Absolute value (set frequency-detected frequency) < detected frequency width/2]&[FDT-1] **Ex:** OU.57, FDT Frequency = 30 Hz. OU.58, FDT Band = 10 Hz. FDT-2 functions as shown in the graph below. 
	3	FDT-3	FDT-3 compares the output frequency to the detect frequency OU.57, FDT Frequency. Relay1 (or Q1) closes when the output frequency and the detect frequency OU.57 are within ½ the FDT Band, OU.58. **Eq:** Absolute value (output frequency–operation frequency) < detected frequency width/2. **Ex:** OU.57, FDT Frequency = 30 Hz. OU.58, FDT Band = 10 Hz. FDT-3 functions as shown in the graph below. 
	4	FDT-4	FDT-4 compares the output frequency to the detect frequency OU.57, FDT Frequency. Relay1 (or Q1) closes when the output frequency reaches the detect frequency OU.57, FDT Frequency and remains closed above the detect frequency (does not consider the FDT Band frequency). During deceleration, Relay1 (or Q1) closes when the output frequency reaches the detect frequency OU.57, FDT Frequency and is below ½ the FDT Band, OU.58.

Code	Description		
			Eq during acceleration: Operation frequency≧ Detect frequency **Eq during deceleration:** Operation frequency>(Detected frequency–Detected frequency width/2) **Ex:** OU.57, FDT Frequency = 30 Hz. OU.58, FDT Band = 10 Hz. FDT-4 functions as shown in the graph below. 
	5	Overload	Outputs a signal when the motor overload is detected based on Pr.18 and Pr.19.
	6	IOL	Outputs a signal when the inverter trips on an inverter overload fault.
	7	Underload	Outputs a signal when the inverter trips on an under load fault.
	8	Fan Warning	Outputs a signal at fan fault warning.
	9	Stall	Outputs a signal when a motor is overloaded and stalled.
	10	Over voltage	Outputs a signal when the inverter DC link voltage rises above the over voltage protection level.
	11	Low Voltage	Outputs a signal when the inverter DC link voltage drops below the low voltage protective level.
	12	Over Heat	Outputs signal when the inverter overheats.
	13	Lost command	Outputs a signal when there is a loss of the analog input. Outputs a signal when RS-485 communication command is lost. Outputs a signal when an expansion I/O card is installed and signal is lost.
	14	RUN	Outputs a signal when operation command (run) is entered and the inverter outputs voltage. There is no output during DC braking at start.

Code	Description		
			
	15	Stop	Outputs a signal when a stop command is entered and after there is no inverter output voltage.
	16	Steady	Outputs a signal in steady operation.
	17	Inverter line	Outputs a signal while the motor is driven by the inverter output.
	18	Comm line	Outputs a signal while the motor is driven by a commercial power source. For details, refer to 5.19_ *Supply Power* .
	19	Speed search	Outputs a signal during inverter speed search operation. For details, refer to 5.15_.
	22	Ready	Outputs signal when the inverter is in stand by operation and ready to receive an external operation command.
	28	Timer Out	A timer function to operate the output terminal after a certain time delay. For more details, refer to 5.30_ *Timer* .
	29	Trip	Outputs a signal after any fault. Refer to 5.32_.
	31	DB Warn %ED	Refer to 0_.
	34	On/Off Control	Outputs a signal using an analog input value as a standard. Refer to 5.32_.
	35	BR Control	Outputs a brake release signal. Refer to 5.31_.
	40	KEB Operating	This outputs when the energy buffering operation is started because of low voltage of the inverter's DC power section due to a power failure on the input power. (This outputs in the energy buffering state before the input power restoration regardless of KEB-1 and KEB-2 mode settings.)

5.35.2 Fault Trip Output using Multi-Function Output Terminal and Relay

The inverter can output a fault state using multi-function output terminal (Q1) and relay (Relay 1).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OU	30	Fault trip output mode	Trip Out Mode	010		-	bit
	31	Multi-function relay1	Relay 1	29	Trip	-	-
	33	Multi-function output1	Q1 Define	14	Run	-	-
	53	Fault trip output on delay	TripOut OnDly	0.00		0.00–100.00	sec
	54	Fault trip output off delay	TripOut OffDly	0.00		0.00–100.00	sec

Fault Trip Output by Multi-function Output Terminal and Relay - Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>OU.30 Trip Out Mode</td><td>Fault relay operates based on the fault output settings.
<table>
<tr><td>Item</td><td>bit on</td><td>bit off</td></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
<tr><td>LCD keypad</td><td></td><td></td></tr>
</table>
Select 29(Trip Mode) at codes OU. 31 for Relay1 terminal or OU.33 for the Q1 terminal . When a fault occurs the relevant relay or terminal will operate. Depending on the fault type, the relay or terminal operation can be configured as shown in the table below.
<table>
<tr><td colspan="3">Setting</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 fault occur</td></tr>
<tr><td></td><td>✓</td><td></td><td>Operates when 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>
</table></td></tr>
<tr><td>OU.31 Relay1</td><td>Set relay output (Relay 1) to 29 (Trip Mode) for fault output.</td></tr>
<tr><td>OU.33 Q1 Define</td><td>Set multi-function output terminal (Q1) to 29 (Trip Mode) for fault output. Q1 is open collector transistor output.</td></tr>
<tr><td>OU.53 TripOut</td><td>If a fault occurs, relay or multi-function output operates after the time delay set in</td></tr>
</table>

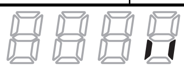
Code	Description
On Dly, OU.54 TripOut OffDly	OU.53. Terminal is reset (opened) when the fault is reset after the time delay set in OU.53.

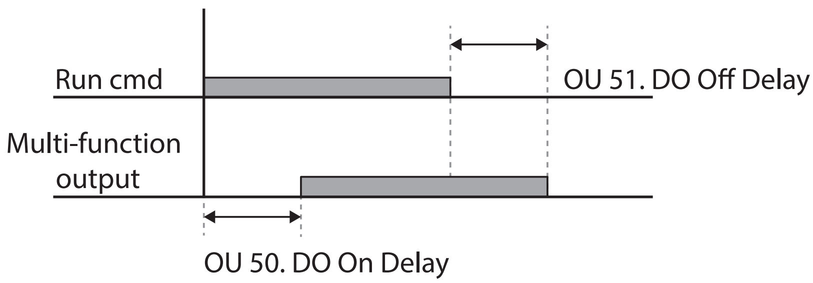
5.35.3 Multi-function Output Terminal Delay Time Settings

Set on-delay and off-delay times separately to control the Q1 output terminal and relay operation times. The delay time set at codes OU.50–51 applies to multi-function output terminal (Q1) and relay (Relay 1), except when the multi-function output function is in a fault mode.

Output Terminal Delay Time Setting Details

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
OU	50	Multi-function output On delay	DO On Delay	0.00	0.00–100.00	s
	51	Multi-function output Off delay	DO Off Delay	0.00	0.00–100.00	s
	52	Select multi-function output terminal	DO NC/NO Sel	00*	00–11	bit

* Displayed as  on keypad.



Output Terminal Normally Closed/Normally Open Setting Details

Code	Description
OU.52 DO NC/NO Sel	Select the normal (non-faulted) state of the output terminals. By setting the relevant bit to 0, it will operate as a Form A terminal (Normally Open) and setting it to 1 it will operate as a Form B terminal (Normally Closed). Shown below in the table are Relay 1 and Q1 settings starting from the right bit. An additional three selection bits at the terminal block will be added when an expansion I/O is added. Item / bit on / bit off Keypad /  /  LCD keypad /  / 

5.36 Keypad Language Settings

Select the language to be displayed on the LCD keypad. Keypad S/W Ver 1.04 and above provides language selections.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	01	Select keypad language	Language Sel	0	English	-	-
				1	Korean		

* Available on LCD keypad only.

5.37 Operation State Monitor

The inverter's operation condition can be monitored using the LCD keypad. If the monitoring option is selected in config (CNF) mode, a maximum of four items can be monitored simultaneously. Monitoring mode displays three different items on the LCD keypad, but only one item can be displayed in the status window at a time.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	20	Display item condition display window	Anytime Para	0	Frequency	-	-
	21	Monitor mode display 1	Monitor Line-1	0	Frequency	-	Hz
	22	Monitor mode display 2	Monitor Line-2	2	Output Current	-	A
	23	Monitor mode display 3	Monitor Line-3	3	Output Voltage	-	V
	24	Monitor mode initialize	Mon Mode Init	0	No	-	-

*Available on LCD keypad only.

Operation State Monitor Setting Details

Code	Description		
CNF-20 AnyTime Para	Select items to display on the top-right side of the LCD keypad screen. Choose the parameter settings based on the information to be displayed. Codes CNF-20–23 share the same setting options as listed in the table below.		
	Setting		Function
	0	Frequency	During operation, displays the actual output frequency (Hz). When stopped, displays the reference frequency.
	1	Speed	During operation, displays the actual operating speed (rpm). When stopped, displays the set speed (rpm).
	2	Output Current	Displays output current.
	3	Output Voltage	Displays output voltage.
	4	Output Power	Displays output power.
	5	WHour Counter	Display inverter power consumption. See Note below on Inverter Power Consumption.
	6	DCLink Voltage	Displays DC link voltage within the inverter.
	7	DI Status	Displays input terminal status of the terminal block. Starting from the right, displays P1–P8.
	8	DO Status	Displays output terminal status of the terminal block. Starting from the right, Relay1, Relay2, and Q1.
	9	V1 Monitor[V]	Displays the input voltage at terminal V1 (V).
	10	V1 Monitor[%]	Displays the input voltage at terminal V1 as a percentage. If -10V, 0V, +10V is measured, -100%, 0%, 100% will be displayed.
	13	V2 Monitor[V]	Displays the input voltage at terminal V2 (V).
	14	V2 Monitor[%]	Displays the input voltage at terminal V2 as a percentage.
	15	I2 Monitor[mA]	Displays the input current at terminal I2 (mA).
	16	I2 Monitor[%]	Displays the input current at terminal I2 as a percentage.
	17	PID Output	Displays output of PID controller.
	18	PID Ref Value	Displays the reference (setpoint) value of the PID controller.
	19	PID Fdb Value	Displays the feedback value of the PID controller.
	20	Torque	If the torque reference command mode (DRV-08) is set to a value other than keypad (0 or 1), the torque reference value is displayed.
	21	Torque Limit	If torque limit setting (Cn.53) is set to a value other than keypad (0 or 1), the torque limit value is displayed.

Code	Description		
	23	Spd Limit	If the speed limit setting (Cn.62) on torque control mode is set to a value other than keypad (0 or 1), the speed limit setting is displayed.
	24	Load Speed	Displays the speed of a load in the desired scale and units. Displays the speed of a load that ADV-61 (Load Spd Gain) and ADV-62 (Load Spd Scale) are applied as rpm or mpm set at ADV-63 (Load Spd Unit).
CNF-21–23 Monitor Line-x	Select the items to be displayed in monitor mode. Monitor mode is the first displayed mode when the inverter is powered on. A total of three items, from monitor line-1 to monitor line- 3, can be displayed simultaneously.		
CNF-24 Mon Mode Init	Selecting 1(Yes) initializes CNF-20–23.		

Load Speed Display Setting

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV(M2)	61(40)	Rotation count speed gain	Load Spd Gain	-	100.0	1~6000.0[%]	-
	62(41)	Rotation count speed scale	Load Spd Scale	0	x 1	0~4	Hz
	63(42)	Rotation count speed unit	Load Spd Unit	2	rpm	0~1	A

Load Speed Display Setting Detail

Code	Description
ADV-61(M2-40) Load Spd Gain	If monitoring item 24 Load Speed is selected and if the motor spindle and the load are connected with belt, the actual number of revolutions can be displayed by calculating the pulley ratio.
ADV-62(M2-41) Load Spd Scale	Selects the decimal places that monitoring item 24 Load Speed displays (from x1–x0.0001).
ADV-63(M2-42) Load Spd Unit	Selects the unit of monitoring item 24 Load Speed. Selects between RPM (Revolution Per Minute) and MPM (Meter Per Minute) for the unit. For example, if line speed is 300 [mpm] at 800 [rpm], set ADV61 (Load Spd Gain) to "37.5%" to display the line speed. Also, set ADV62 (Load Sped

Code	Description
	Scale) to "X 0.1" to display the value to the first decimal point. And set ADV63 (Load Spd Unit) to mpm. Now, the monitoring item 24 Load Speed is displayed on the keypad display as 300.0 mpm instead of 800 rpm.

Note

Inverter power consumption
Values are calculated using voltage and current. Electric power is calculated every second and the results are accumulated. Setting CNF-62 (WH Count Reset) value to 1(Yes) will reset cumulated electric energy consumption. Power consumption is displayed as shown below:

- Less than 1,000 kW: Units are in kW, displayed in 999.9 kW format.
- 1–99 MW: Units are in MW, displayed in 99.99 MWh format.
- 100–999 MW: Units are in MW, displayed in 999.9 MWh format.
- More than 1,000 MW: Units are in MW, displayed in 9,999 MWh format and can be displayed up to 65,535 MW. (Values exceeding 65,535MW will reset the value to 0, and units will return to kW. It will be displayed in 999.9 kW format).

5.38 Operation Time Monitor

Monitor inverter and fan operation time.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF*	70	Inverter operation accumulated time	On-time	0/00/00 00:00		-	min
	71	Inverter operation accumulated time	Run-time	0/00/00 00:00		-	min
	72	Inverter operation accumulated time initialization	Time Reset	0	No	0–1	-
	74	Cooling fan operation accumulated time	Fan time	0/00/00 00:00		-	min
	75	Cooling fan operation accumulated time initialization	Fan Time Reset	0	No	0–1	-

*Available on LCD keypad only.

Operation Time Monitor Setting Details

Code	Description
CNF-70 On-time	Displays accumulated power supply time. Information is displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF-71	Displays accumulated time of voltage output by operation command input.

Code	Description
Run-time	Information is displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF-72 Time Reset	Setting 1(Yes) will delete power supply accumulated time (On-time) and operation accumulated time (Run-time) and is displayed as 0/00/00 00:00 format.
CNF-74 Fan time	Displays accumulated time of inverter cooling fan operation. Information will be displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF-75 Fan Time Reset	Setting 1(Yes) will delete cooling fan operation accumulated time(on-time) and operation accumulated time (Run-time) and will display it in 0/00/00 00:00 format.

6 Learning Protection Features

Protection features provided by the S serie"S" Series inverter are categorized into two types: protection from overheating damage to the motor, and protection against the inverter malfunction.

6.1 Motor Protection

6.1.1 Electronic Thermal Motor Overheating Prevention (ETH)

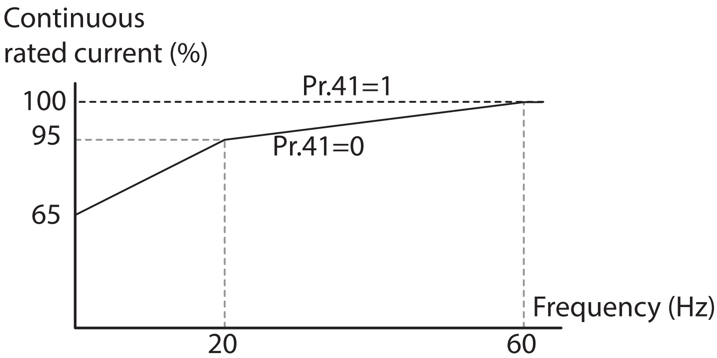
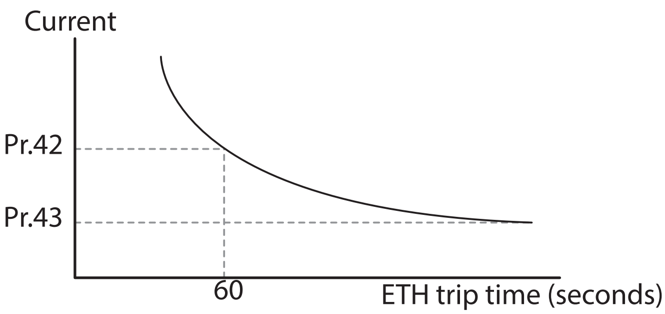
ETH is a protective function that uses the output current of the inverter to predict a rise in motor temperature without a separate temperature sensor. Protection of the motor is based on current, time and speed. See settings below.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	40	Electronic thermal prevention fault selection	ETH Trip Sel	0	None	0-2	-
	41	Motor cooling fan type	Motor Cooling	0	Self-cool	-	-
	42	Electronic thermal one minute rating	ETH 1min	150		120-200	%
	43	Electronic thermal prevention continuous rating	ETH Cont	120		50-150	%

Electronic Thermal (ETH) Prevention Function Setting Details

<table>
<tr><th>Code</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 LCD fault screen displays "E-Thermal".
<table><tr><td colspan="2">Setting</td><td>Function</td></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>
<tr><td>Pr.41 Motor Cooling</td><td>Select the drive mode of the cooling fan attached to the motor.
<table><tr><td colspan="2">Setting</td><td>Function</td></tr><tr><td>0</td><td>Self-cool</td><td>As the cooling fan is connected to the motor shaft, the cooling effect varies with motor speed.</td></tr><tr><td>1</td><td>Forced-cool</td><td>Separate power is supplied to operate the cooling fan.</td></tr></table></td></tr>
</table>

Protection Features

Code	Description
	This provides extended operation at low speeds. Motors designed for inverters typically have this design. 
Pr.42 ETH 1 min	Sets the amount of current that when continuously supplied to the motor for 1 minute, an ETH fault will occur. Percentage is based on the motor-rated current (bA.13).
Pr.43 ETH Cont	Sets the amount of continuous current that will not activate the ETH function. The range below details the set values that can be used during continuous operation without the protection function. 

6.1.2 Overload Early Warning and Trip

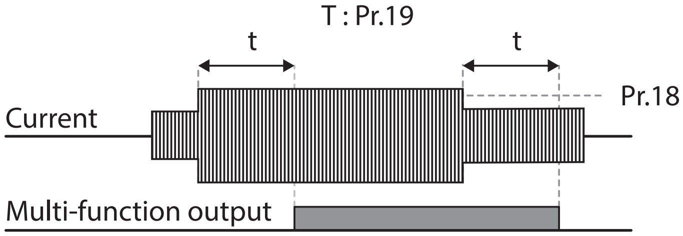
Overload warning level and time, Trip level and time can be programmed separately. A warning or trip occurs when the motor reaches the levels and times set in the following parameters. The levels are based on the motor's rated current. The multi-function outputs (Relay1 and/or Q1) can be activated when set to (5) Overload.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	04	Load level setting	Load Duty	1	Heavy Duty	-	-
	17	Overload warning selection	OL Warn Select	1	Yes	0-1	-
	18	Overload warning level	OL Warn Level	150		30-180	%
	19	Overload warning time	OL Warn Time	10.0		0-30	s
	20	Motion at overload trip	OL Trip Select	1	Free-Run	-	-
	21	Overload trip level	OL Trip Level	180		30-200	%
	22	Overload trip time	OL Trip Time	60.0		0-60.0	s
OU	31	Multi-function relay 1 item	Relay 1	5 Or 29	Over Load Or Trip	-	-
	33	Multi-function output 1 item	Q1 Define				

Overload Early Warning and Trip Setting Details

Coden	Description
Pr.04 Load Duty	Select the load level. Setting: 0 Normal Duty — Function: Used in underloads, like fans and pumps (overload tolerance: 120% of rated underload current for 1 minute). Setting: 1 Heavy Duty — Function: Used in heavy loads, like hoists, cranes, and parking devices (overload tolerance: 150% of rated heavy load current for 1 minute).
Pr.17 OL Warn Select	To activate, set to 1 (Yes). If 0 (No) is selected, it will not operate.
Pr.18 OL Warn Level, Pr.19 OL Warn Time	When the input current to the motor is greater than the overload warning level (OL Warn Level) and continues at that level during the overload warning time (OL Warn Time), a multi-function output (Relay 1, Q1) can send a warning signal. When Over Load is selected at OU.31 and 33, the multi-function output terminal or relay outputs a signal. **The warning signal does not block the inverter output.**
Pr.20 OL Trip Select	Select the inverter protective action in the event of an overload trip. Setting: 0 None — Function: No protective action is taken. Setting: 1 Free-Run — Function: In the event of an overload fault, inverter output is

Coden	Description
	| | | blocked and the motor will free-run due to inertia. | | 3 | Dec | If a fault occurs, the motor decelerates and stops. |
Pr.21 OL Trip Level, Pr.22 OL Trip Time	When the current supplied to the motor is greater than the preset value at the overload trip level (OL Trip Level) and continues to be supplied during the overload trip time (OL Trip Time), the inverter output is either blocked or slows to a stop after deceleration according to the preset mode from Pr. 20.



Note

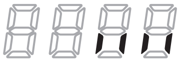
Overload warnings warn of an overload before an overload fault occurs. The overload warning signal may not work in an overload fault situation, if the overload warn level (OL Warn Level) and the overload warn time (OL Warn Time) are set higher than the overload trip level (OL Trip Level) and overload 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 conditions caused by overloads. During a stall condition, high currents may cause motor over heating or damage. These high currents are sensed and the inverter operating frequency is adjusted automatically based on the below parameter settings. Stall prevention can also be applied during deceleration. The inverter senses the DC Link voltage to detect regenerative conditions and adjusts the deceleration time to avoid over voltage trips. Flux braking can also be applied during deceleration to help dissipate the regenerative energy.

Group	Code	Name	LCD Display	Parameter Setting	Setting range	Unit
Pr	50	Stall prevention and flux braking	Stall Prevent	0000*	-	bit
	51	Stall frequency 1	Stall Freq 1	60.00	Start frequency–Stall Freq 1	Hz
	52	Stall level 1	Stall Level 1	180	30-250	%
	53	Stall frequency 2	Stall Freq 2	60.00	Stall Freq 1–Stall Freq 3	Hz
	54	Stall level 2	Stall Level 2	180	30-250	%

Group	Code	Name	LCD Display	Parameter Setting	Setting range	Unit
	55	Stall frequency 3	Stall Freq 3	60.00	Stall Freq 2–Stall Freq 4	Hz
	56	Stall level 3	Stall Level 3	180	30-250	%
	57	Stall frequency 4	Stall Freq 4	60.00	Stall Freq 3–Maximum frequency	Hz
	58	Stall level 4	Stall Level 4	180	30-250	%
OU	31	Multi-function relay 1 item	Relay 1	9 Stall	-	-
	33	Multi-function output 1 item	Q1 Define			

* The value is displayed on the keypad as .

Stall Prevention Function and Flux Braking Setting Details

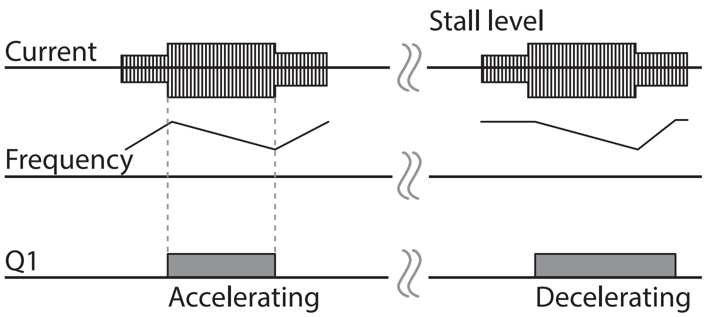
Code	Description
Pr.50 Stall Prevent	Stall prevention can be configured for acceleration, deceleration, or while operating a motor at constant speed. When the top LED/LCD segment is on, the corresponding bit is set On (or 1). When the bottom LED/LCD segment is on, the corresponding bit is set Off (or 0).

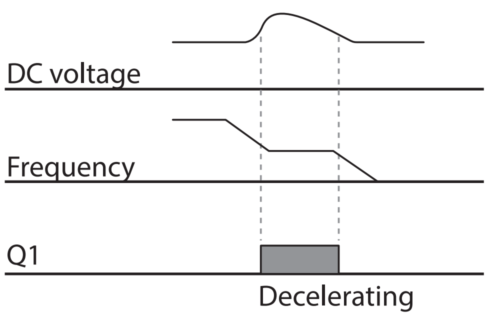
Item	Bit Status (On)	Bit Status (Off)
Keypad		
LCD keypad		

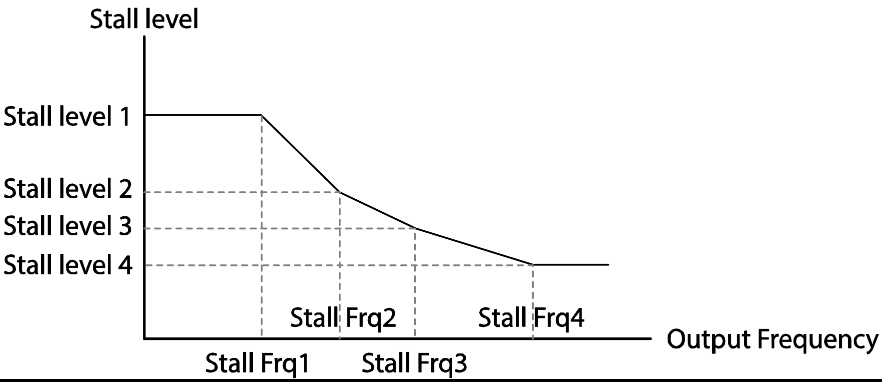
Setting				Function
Bit 4	Bit 3	Bit 2	Bit 1	
			✓	Stall protection during acceleration
		✓		Stall protection while operating at a constant speed
	✓			Stall protection during deceleration
✓				Flux braking during deceleration

Setting		Function
0001	Stall protection during acceleration	If inverter output current exceeds the preset stall levels (Pr. 52, 54, 56, 58) during acceleration, the motor stops accelerating and starts decelerating. If current level stays above the stall level, the motor decelerates to the start frequency (dr.19). If the current level drops below the preset level while operating

Code	Description		
			the stall protection function, the motor resumes acceleration.
	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.
	0100	Stall protection during deceleration	The inverter holds the deceleration to keep the DC link voltage below a certain level. This helps to prevent over voltage faults 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	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 (11xx) 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.
When using a Dynamic Brake resistor, the motor may vibrate under the Flux braking operation. In this case, turn off the Flux braking (Pr.50, 0xxx).

Caution

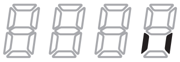
- Acceleration stops when stall protection operates during acceleration. This may make the actual acceleration time longer than the preset acceleration time.
- Use caution when decelerating while using stall protection as the deceleration time can take longer than the time set.
- When the motor is operating,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

6.2 Inverter and Sequence Protection

6.2.1 Open-phase Protection

Open-phase monitoring and protection can be set for either (or both) the input and output of the inverter. An input phase loss can cause overcurrent levels in the remaining inverter inputs. Detection of an input phase loss is determined by monitoring the DC Link ripple voltage. An output phase loss will cause the motor to stall due to a lack of torque. Output phase loss detection is determined by monitoring the output phase currents and comparing to motor no load currents along with a time factor.

Group	Code	Name	LCD Display	Parameter Setting	Setting range	Unit
Pr	05	Input/output open-phase protection	Phase Loss Chk	00*	-	bit
	06	Open-phase input voltage band	IPO V Band	40	1-100V	V

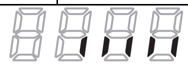
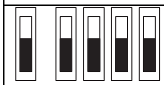
* The value is displayed on the keypad as .

Input and Output Open-phase Protection Setting Details

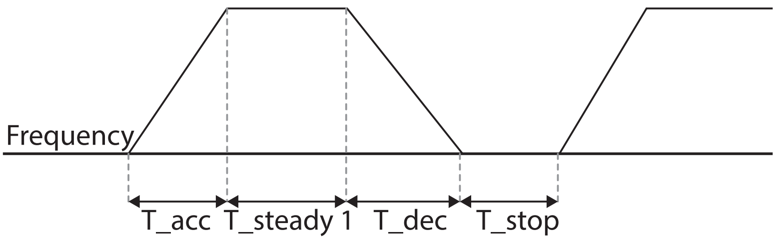
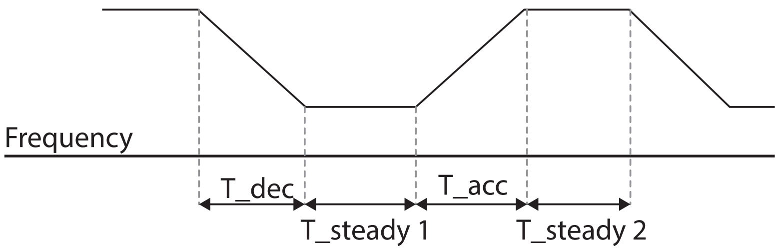
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>Pr.05 Phase Loss Chk, Pr.06 IPO V Band</td><td>When activating open-phase protection, input and output phase loss protection is set independently. Bit 0 is for output phase monitoring and Bit 1 is for input phase monitoring. When the top LED/LCD segment is on, the corresponding bit is set to On (or 1). When the bottom LED/LCD segment is on, the corresponding bit is set to Off (or 0).
<table>
<tr><td>Item</td><td>Bit status (On)</td><td>Bit status (Off)</td></tr>
<tr><td>Keypad</td><td></td><td></td></tr>
<tr><td>LCD keypad</td><td></td><td></td></tr>
</table>
<table>
<tr><td colspan="2">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>Bit 1</td><td>Bit 0</td></tr>
<tr><td></td><td>✓</td><td>Output open-phase protection</td></tr>
<tr><td>✓</td><td></td><td>Input open-phase protection</td></tr>
</table>
</td></tr>
</table>

6.2.2 External Trip Signal

Set one of the digital input terminals Pn to 4 (External Trip). When activated, the output of the inverter is blocked and the motor coasts to a stop. The digital input terminal can be set to NC or NO by changing the applicable bit at parameter In.87.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
In	65-71	Px terminal setting options	Px Define (Px: P1-P5)	4	External Trip	-	-
	87	Multi-function input contact selction	DI NC/NO Sel	 		00000 - 11111	bit

6.2.3 Dynamic Breaking Resistor Setting Details

Code	Description
Pr.66 DB Warn %ED	Set braking resistor configuration (%ED: Duty cycle). Braking resistor configuration sets the rate at which the braking resistor operates for one operation cycle. The maximum time for continuous braking is 15 secs. After 15 secs., the braking signal is shut off. 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 spee d operation or the stop time from constant speed operation freq uency • T_stop: Stop time until operation resumes

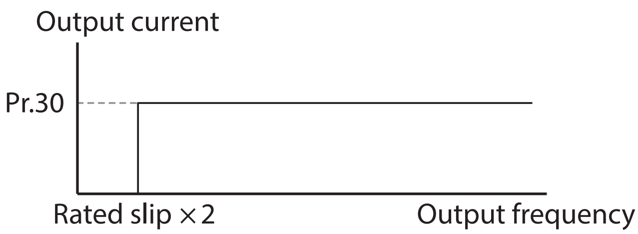
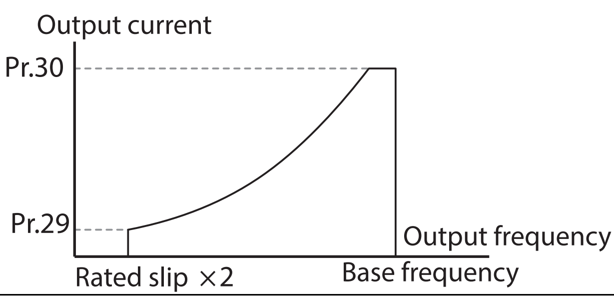
Caution

Do not select a resistor with a power rating lower than that specified in 11.7. If the resistor is overloaded, it can overheat and cause a fire. When using a resistor with a thermal switch, the switch can be used as an external trip input signal to the inverter.

6.3 Under load Fault Trip and Warning

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	04	Load level selection	Load Duty	0	Normal Duty	-	-
	25	Under load warning selection	UL Warn Sel	1	Yes	0-1	-
	26	Under load warning time	UL Warn Time	10.0		0-600	sec
	27	Under load trip selection	UL Trip Sel	1	Free-Run	-	-
	28	Under load trip timer	UL Trip Time	30.0		0-600	sec
	29	Under load upper limit level	UL LF Level	30		10-100	%
	30	Under load lower limit level	UL BF Level	30		10-100	%

Under Load Trip and Warning Setting Details

Code	Description
Pr.27 UL Trip Sel	Sets the inverter response when an underload fault occurs. When set to 0(None), the inverter does not detect the underload fault. If set to 1 (Free-Run), the inverter output is shut off and the motor coasts to a stop. If set to 2 (Dec), the motor decelerates and stops when an underload trip occurs.
Pr.25 UL Warn Sel	The multi-function output terminals (Relay1 and Q1) can be set to provide an underload warning. Set to Pr.25 to 1(Yes) and parameters OU.31 and/or OU.33 for the multi-function output terminals to 7 (Underload). The terminals activate (close) when an underload condition occurs.
Pr.26 UL Warn Time, Pr.28 UL Trip Time	Delay times can be set for both the underload warning and trip protective functions. This function does not operate if energy-saving operation is activated at Ad-50 (E-Save Mode).
Pr.29 UL LF Level, Pr.30 UL BF Level	• Setting Heavy Duty - Pr.29 does not apply when Pr.04 is set to heavy duty.. - Pr.30, the underload level (percentage) is based on the motor's rated current.  • Setting Normal Duty - Pr.29, the under load rate is based on twice the operation frequency of the motor's rated slip speed (bA.12 Rated Slip). - Pr.30, the under load rate is based on the base frequency set at dr.18 (Base Freq). An upper limit and lower limit is based on the inverter's rated current. 

6.3.1 Fan Fault Detection

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	79	Cooling fan fault selection	FAN Trip Mode	0		Trip	
OU	31	Multi-function relay 1	Relay 1	8	FAN Warning		-
OU	33	Multi-function output 1	Q1 Define				

Fan Fault Detection Setting Details

<table>
<tr><th>Code</th><th colspan="3">Description</th></tr>
<tr><td rowspan="4">Pr.79 FAN Trip Mode</td><td colspan="3">Set the cooling fan fault mode.</td></tr>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Trip</td><td>The inverter output is shut off and the fan trip is displayed when a cooling fan error is detected.</td></tr>
<tr><td>1</td><td>Warning</td><td>When OU.33 (Q1 Define) and OU.31 (Relay1) are set to 8 (FAN Warning), the fan warning signal is output, but operation continues. Caution: when the inverter inside temperature rises above a certain level, output is shut off due to activation of inverter overheat protection.</td></tr>
</table>

Lifetime diagnosis for fans

Fan operating hours is monitored and can be viewed at Pr.86, FAN Time Perc. The (%) is based on 50,000 hours of operation. A Fan warning will be displayed on the keypad when fan usage has reached the percentage entered in Pr-87, (Fan exchange level). When exchanging fans, you can initialize the accumulated value to 0 by setting Pr.88, FAN Time Rst to 1.

Group	Code	Name	LCD Display	Setting value		Setting Range	Unit
Pr	86	Accumulated percent of fan usage	FAN Time Perc	0.0		0.0-6553.5	%
	87	Fan exchange warning Level	FAN Exchange level	90.0		0.0-100.0	%
Pr	88	Initialize operation time of cooling fans	FAN Time Rst	0	No	-	-
				1	Yes		
OU	31	Multi-function relay 1	Relay 1	38	FAN Exchange		-
	33	Multi-function output 1	Q1 Define				

*Available on LCD keypad only.

6.3.2 Low Voltage Fault Trip

When the inverters DC link voltage drops below the low voltage trip level, the inverter shuts off the output and a low voltage trip occurs.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	81	Low voltage trip decision delay time	LVT Delay	0.0		0-60	sec
OU	31	Multi-function relay 1	Relay 1	11	Low Voltage		-
	33	Multi-function output 1	Q1 Define				

Low Voltage Fault Setting Details

Code	Description
Pr.81 LVT Delay	When a low voltage trip occurs, the inverter shuts off the output. The delay time applies to the fault indication. The multi-function output terminals (Relay1 and Q1) can be set to provide a low voltage trip output. Set parameters OU.31 and/or OU.33 to 11 (Low Voltage). The terminals activate (close) when a low voltage trip occurs. The low voltage trip delay time (LVT Delay time) does not apply to these outputs.

6.3.3 Output Block by Multi-Function Terminal

Set one of the digital input terminals Px to 5 (Bx). When activated, the output of the inverter is blocked and the motor coasts to a stop. The digital input terminal can be set to NC or NO by changing the applicable bit at parameter In.87.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
In	65-71	Px terminal setting options	Px Define(P1-P5)	5	BX	-	-
Pr	45	Bx Trip Mode		0 1	Coast Dec	0 - 1	

Output Block by Multi-Function Terminal Setting Details

Code	Description
In.65-71 Px Define	When a multi-function input terminal is set to 5 (BX) and is activated during operation, the inverter shuts off the output and 'BX' is displayed on the keypad. While 'BX' is displayed on the keypad, the inverter's operation information including the operating frequency, current and status at the time of BX signal can be viewed by pressing the ENT key. The inverter will resume operation when the BX terminal is de-activated and operation command is re-applied.

6.3.4 Trip Status Reset

After a fault, the inverter can be reset using the keypad [Stop/Reset] key or a digital input terminal.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
In	65-71	Px terminal setting options	Px Define(P1-P5)	3	RST	-	-

Trip Status Reset Setting Details

Code	Description
In.65-71 Px Define	Set the digital input terminal to 3 (RST) and activate the terminal to reset the fault. A reset can also be done by pressing the [Stop/Reset] key on the keypad.

6.3.5 Operation Mode on Option Card Trip

Option card trips may occur when an option card is used with the inverter. Set the operation mode for the inverter when a communication error occurs between the option card and the inverter, or when the option card is detached during operation.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	80	Operation mode on option card trip	Opt Trip Mode	0	None	0-3	-
				1	Free-Run		
				2	Dec		

Operation Mode on Option Trip Setting Details

Code	Description		
Pr.80 Opt Trip Mode	Setting		Function
	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).

6.3.6 No Motor Trip

If the inverter is running and the output current drops below Pr.32, No Motor Level for the Pr.33, No Motor Time, or when the motor is disconnected from the inverter, a 'no motor trip' occurs.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	31	Operation on no motor trip	No Motor Trip	0	None	-	-
	32	No motor trip current level	No Motor Level	5		1-100	%

Group	Code	Name	LCD Display	Parameter Setting	Setting range	Unit
	33	No motor detection time	No Motor Time	3.0	0.1-10	s

No Motor Trip Setting Details

Code	Description
Pr.32 No Motor Level, Pr.33 No Motor Time	If the output current value [based on the 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.

① Caution

If bA.07 (V/F Pattern) is set to 1 (Square), set Pr.32 (No Motor Level) to a value lower than the factory default. Otherwise, 'no motor trip' due to a lack of output current will result when the 'no motor trip' operation is set.

6.3.7 Low voltage trip 2

If you set the Pr-82(LV2 Selection) code to Yes (1), this changes the low voltage fault to a latched fault and the fault notification is displayed. Reset the inverter to clear the fault. The trip history will not be saved.

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

6.4 Fault/Warning List

The following list shows the types of faults and warnings that can occur while using the "S" Series inverter. Please refer to 6*Trips and Warnings* for details about faults and warnings.

Category		LCD Display	Details
Major fault	Latch type	Over Current1	Over current trip
		Over Voltage	Over voltage trip
		External Trip	Trip due to an external signal
		NTC Open	Temperature sensor fault
		Over Current2	ARM short current fault
		Option Trip-x*	Option fault*
		Over Heat	Over heat fault
		Out Phase Open	Output open-phase fault
		In Phase Open	Input open-phase fault
		Inverter OLT	Inverter overload fault trip
		Ground Trip	Ground fault
		Fan Trip	Fan fault
		E-Thermal	Motor overheat fault trip
		Pre-PID Fail	Pre-PID operation failure
		IO Board Trip	IO Board connection fault
		Ext-Brake	External brake fault
		No Motor Trip	No motor fault
		Low Voltage 2	Low voltage fault during operation
		ParaWrite Trip**	Write parameter fault
	Level type	Low Voltage	Low voltage fault
		BX	Emergency stop fault
		Lost Command	Command loss trip
		Safety A(B) Err	Safety A(B) contact trip
	Hardware damage	EEP Err	External memory error

Protection Features

Category		LCD Display	Details
		ADC Off Set	Analog input error
		Watch Dog-1	CPU Watch Dog fault trip
		Watch Dog-2	
Minor fault		Over Load	Motor overload fault
		Under Load	Motor underload fault trip
Warning		Lost Command	Command loss fault warning
		Over Load	Overload warning
		Under Load	Under load warning
		Inverter OLT	Inverter overload warning
		Fan Warning	Fan operation warning
		DB Warn %ED	Braking resistor braking rate warning
		Retry Tr Tune	Rotor time constant tuning error
		FAN Exchange	Fan replacement warning

* Applies only when an option board is used.

** Displayed on an LCD keypad only.

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 these 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, the inverter can exchange data with a PLC and/or a 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.

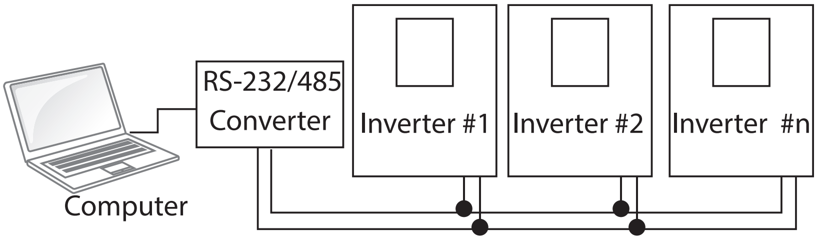
Item	Standard
Communication method/ Transmission type	RS-485/Bus type, Multi-drop Link System
Inverter type name	Benshaw "S" Series
Number of connected inverters/ Transmission distance	Maximum of 16 inverters / Maximum1,200m (recommended distance: within 700m)
Recommended cable size	0.75mm^2 , (18AWG), Shielded Type Twisted-Pair (STP) Wire
Installation type	Dedicated terminals (S+/S-/SG) on the control terminal block
Power supply	Supplied by the inverter - insulated power source from the inverter's internal circuit
Communication speed	1,200/2,400/9,600/19,200/38,400/57,600/115,200 bps
Control procedure	Asynchronous communications system
Communication system	Half duplex system
Character system	Modbus-RTU: Binary / LS Bus: ASCII
Stop bit length	1-bit/2-bit
Frame error check	2 bytes
Parity check	None/Even/Odd

Communication

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, a converter must be integrated with the computer, so that it can communicate with the inverter through the USB/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

Make sure that the inverter is turned off completely, and then connect the RS-485 communication line to the S+/S-/SG terminals of the terminal block. 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.

Caution

When wiring the communication line, make sure that the SG terminals (grond) on the PLC and inverter are connected. SG terminals prevent communication errors due to electronic noise interference.

7.2.2 Setting Communication Parameters

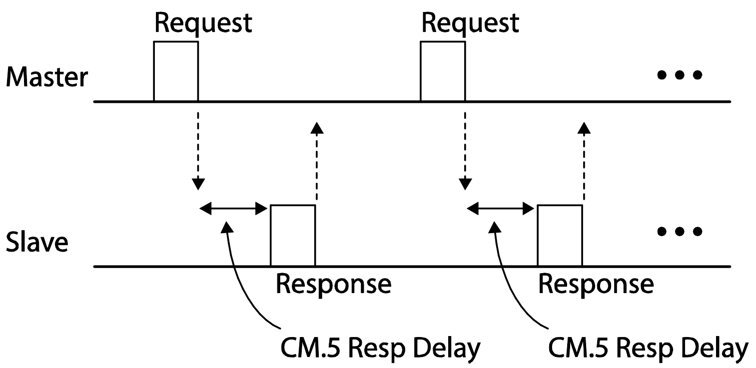
Before proceeding with setting communication configurations, make sure that the communication lines are connected properly. Turn on the inverter and set the communication parameters.

Group	Code	Name	LCD Display	Parameter Setting	Setting range	Unit
CM	01	Built-in communication inverter ID	Int485 St ID	1	1-250	-

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
	02	Built-in communication protocol	Int485 Proto	0	ModBus RTU	0, 2	-
	03	Built-in communication speed	Int485 BaudR	3	9600 bps	0-7	-
	04	Built-in communication frame setting	Int485 Mode	0	D8/PN/S1	0-3	-
	05	Transmission delay after reception	Resp Delay	5		0-1000	ms

Communication Parameters Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>CM.01 Int485 St ID</td><td>Set the inverter station ID between 1 and 250.</td></tr>
<tr><td>CM.02 Int485 Proto</td><td>Select one of the two built-in protocols: Modbus-RTU or LS INV 485.
<table><tr><th colspan="2">Setting</th><th>Function</th></tr><tr><td>0</td><td>Modbus-RTU</td><td>Modbus-RTU compatible protocol</td></tr><tr><td>2</td><td>LS INV 485</td><td>Dedicated protocol for the L"S" Series inverter</td></tr></table></td></tr>
<tr><td>CM.03 Int485 BaudR</td><td>Set a communication setting speed up to 115,200 bps.
<table><tr><th>Setting</th><th>Function</th></tr><tr><td>0</td><td>1,200 bps</td></tr><tr><td>1</td><td>2,400 bps</td></tr><tr><td>2</td><td>4,800 bps</td></tr><tr><td>3</td><td>9,600 bps</td></tr><tr><td>4</td><td>19,200 bps</td></tr><tr><td>5</td><td>38,400 bps</td></tr><tr><td>6</td><td>56K bps</td></tr><tr><td>7</td><td>115 Kbps</td></tr></table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>CM.04 Int485 Mode</td><td>Set a communication configuration. Set the data length, parity check method, and the number of stop bits.
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>D8/PN/S1</td><td>8-bit data / no parity check / 1 stop bit</td></tr>
<tr><td>1</td><td>D8/PN/S2</td><td>8-bit data / no parity check / 2 stop bits</td></tr>
<tr><td>2</td><td>D8/PE/S1</td><td>8-bit data / even parity / 1 stop bit</td></tr>
<tr><td>3</td><td>D8/PO/S1</td><td>8-bit data / odd parity / 1 stop bit</td></tr>
</table>
</td></tr>
<tr><td>CM.05 Resp Delay</td><td>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.


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

7.2.3 Setting Operation Command and Frequency

To select the built-in RS485 communication as the source of command, set the Frq code to 6 (Int485) on the keypad (basic keypad with 7-segment display). On an LCD keypad, set the DRV code to 3 (Int485). Then, set common area parameters for the operation (start/Stop) command and frequency (speed) via communication.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Pr	12	Speed command loss operation mode	Lost Cmd Mode	1	Free-Run	0-5	-
	13	Time to determine speed command	Lost Cmd Time	1.0		0.1-120	s

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
		loss					
	14	Operation frequency at speed command loss	Lost Preset F	0.00		Start frequency–Maximum frequency	Hz
OU	31	Multi-function relay 1	Relay 1	13	Lost Command	0-35	-
	33	Multi-function output 1	Q1 Define				

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
Operation	DRV	Command source	Cmd Source*	3	Int 485	0-5	-
	Frq	Frequency setting method	Freq Ref Src	6	Int 485	0-12	-

* Displayed in DRV-06 on an LCD keypad.

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</th><th>Description</th></tr>
<tr><td>Pr.12 Lost Cmd Mode,
Pr.13 Lost Cmd Time</td><td>Select the operation to run when a communication error has occurred and lasted exceeding the time set at Pr. 13.
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>The speed command immediately becomes the operation 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 at the time set at Pr.07 (Trip Dec Time).</td></tr>
</table></td></tr>
</table>

Code	Description		
	3	Hold Input	The inverter calculates the average input value for 10 seconds before the loss of the speed command and uses it as the speed reference.
	4	Hold Output	The inverter calculates the average output value for 10 seconds before the loss of the speed command and uses it as the speed reference.
	5	Lost Preset	The inverter operates at the frequency set at Pr. 14 (Lost Preset F).

7.2.5 Setting Virtual Multi-Function Input

Multi-function input 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 operates independently from In.65-71 analog multi-function inputs and cannot be set redundantly. Virtual multi-function input can be monitored using CM.86 (Virt DI Status). Before you configure the virtual multi-function inputs, set the DRV code according to the command source.

Group	Code	Name	LCD Display	Parameter		Setting	Unit
CM	70-77	Communication multi-function input x	Virtual DI x (x: 1-8)	0	None	0-49	-
	86	Communication multi-function input monitoring	Virt DI Status	-	-	-	-

Example: When sending an Fx command by controlling virtual multi-function input in the common area via Int485, set CM.70 to FX and set address 0h0322 to 0h0001.

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 and operate the inverter, the changes are lost and the values changed via communication revert to the previous setting values when you turn on the inverter.
Set CNF-48 to 1 (Yes) to allow all the changes over comunication to be saved, so that the inverter

retains all the existing values even after the power has been turned off.
Setting address 0h03E0 to 0 and then setting it again to 1 via communication allows the existing parameter settings to be saved. However, setting address 0h03E0 to 1 and then setting it to 0 does not carry out the same function. Parameters defined by communication can only be saved using an LCD keypad.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
CNF*	48	Save parameters	Parameter Save	0	No	0 -1	-
				1	Yes		

*Available on an LCD keypad only.

7.2.7 Total Memory Map for Communication

Communication Area	Memory Map	Details
Communication common compatible area	0h0000-0h00FF	Benshaw S Series, SG, GX compatible area
Parameter registration type area	0h0100-0h01FF	Areas registered at CM.31–38 and CM.51–58
	0h0200-0h023F	Area registered for User Group
	0h0240-0h027F	Area registered for Macro Group
	0h0280-0h02FF	Reserved
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	LCD Display	Parameter Setting		Setting range	Unit
CM	31-38	Output communication address x	Para Status-x	-	-	0000-FFFF	Hex
	51-58	Input communication address x	Para Control-x	-	-	0000-FFFF	Hex

Currently Registered CM Group Parameter

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. For example, when the parameter control frame has 5 parameter control items (Para Control - x), register the operation speed at Para Control-4 and the operation command to Para Control-5.

7.3 Communication Protocol

The built-in RS-485 communication supports Modbu-R TU 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. (starting address size is in bytes). For more information about communication addresses, refer to 7.4_ on page 241.

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	

Communication

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

Field Name
CRC Hi

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

Example of Modbus-RTU Communication in Use

When the Acc time (Communication address 0x1103) is changed to 5.0 sec and the Dec time (Communication address 0x1104) is changed to 10.0 sec.

Frame Transmission from Master to Slave (Request)

Item	Station ID	Function	Starting Address	# of Register	Byte Count	Data 1	Data 2
Hex	0x01	0x10	0x1102	0x0002	0x04	0x0032	0x0064
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1103-1)	-	-	50 (ACC time 5.0sec)	100 (DEC time 10.0sec)

Frame Transmission from Slave to Master (Response)

Item	Station ID	Function	Starting Address	# of Register	CRC
Hex	0x01	0x10	0x1102	0x0002	0xE534
Description	CM.01 Int485 St ID	Preset Multiple Register	Starting Address -1 (0x1103-1)	-	-

7.4 Compatible Common Area Parameter

The following are common area parameters.These are also compatible with other Benshaw inverters (Model's SG and GX).

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit
0h0000	Inverter model	-	-	R	6: S
0h0001	Inverter capacity	-	-	R	0: 0.75 kW, 1: 1.5 kW, 2: 2.2 kW 3: 3.7 kW, 4: 5.5 kW, 5: 7.5 kW 6: 11 kW, 7: 15 kW, 8: 18.5 kW 9: 22 kW 256: 0.4 kW, 257: 1.1 kW, 258: 3.0 kW 259: 4.0 kW
0h0002	Inverter input voltage	-	-	R	0: 240V product
					1: 480V product
0h0003	Version	-	-	R	Example 0h0100: Version 1.00
					Example 0h0101: Version 1.01
0h0004	Reserved	-	-	R/W	
0h0005	Command	0.01	Hz	R/W	

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
	frequency					
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: V2, 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	s	R/W	-	
0h0008	Deceleration time	0.1	s	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	-	-	R	B15	0: Remote, 1: Keypad Local
					B14	1: Frequency command source by communication (built-in, option)
					B13	1: Operation command source by communication (built-in, option)
					B12	Reverse operation command

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
					B11	Forward operation 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 trip 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-B7	Reserved
					B6	P7
					B5	P6
					B4	P5
					B3	P4
					B2	P3
					B1	P2
					B0	P1
0h0011	Output terminal	-	-	R	B15	Reserved

Comm. Address	Parameter	Scale	Unit	R/W	Assigned Content by Bit	
	information				B14	Reserved
					B13	Reserved
					B12	Reserved
					B11	Reserved
					B10	Reserved
					B9	Reserved
					B8	Reserved
					B7	Reserved
					B6	Reserved
					B5	Reserved
					B4	Reserved
					B3	Reserved
					B2	Reserved
					B1	MO
					B0	Relay 1
0h0012	V1	0.01	%	R	V1 input voltage	
0h0013	V2	0.01	%	R	V2 input voltage	
0h0014	I2	0.01	%	R	I2 input current	
0h0015	Motor rotation speed	1	rpm	R	Displays existing motor rotation speed	
0h0016 - 0h0019	Reserved	-	-	-	-	
0h001A	Select Hz/rpm	-	-	R	0: Hz unit, 1: rpm unit	
0h001B	Display the number of poles for the selected motor	-	-	R	Display the number of poles for the selected motor	

7.5 Expansion Common Area Parameter

7.5.1 Monitoring Area Parameter (Read Only)

Comm. Address	Parameter	Scale	Unit	Assigned content by bit	
0h0300	Inverter model	-	-	S: 0006h	
0h0301	Inverter capacity	-	-	0.4 kW: 1900h, 0.75 kW: 3200h 1.1 kW: 4011h, 1.5 kW: 4015h 2.2 kW: 4022h, 3.0 kW: 4030h 3.7 kW: 4037h, 4.0 kW: 4040h 5.5 kW: 4055h, 7.5 kW: 4075h 11 kW: 40B0h, 15 kW: 40F0h 18.5 kW: 4125h, 22 kW: 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	-	-	(Ex) 0h0100: Version 1.00	
				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 (Trip Out Mode) setting.]
				B14	
				B13	
				B12	
				B11 -	-
				B8	
				B7	1: Speed searching 2: Accelerating 3: Operating at constant rate 4: Decelerating 5: Decelerating to stop
				B6	
				B5	
				B4	

Comm. Address	Parameter	Scale	Unit	Assigned content by bit	
					6: H/W OCS 7: S/W OCS 8: Dwell operating
				B3 B2 B1 B0	0: Stopped 1: Operating in forward direction 2: Operating in reverse direction 3: DC operating (0 speed control)
0h0306	Inverter operation frequency command source	-	-	B15 B14 B13 B12 B11 B10 B9 B8	Operation command source 0: Keypad 1: Communication option 2: User Sequence 3: Built-in RS 485 4: Terminal block
				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: V2, 8: I2 9: Pulse 10: Built-in RS 485 11: Communication option 12: User Sequence 13: Jog 14: PID 25-39: Multi-step speed frequency
0h0307	LCD keypad S/W version	-	-	(Ex.) 0h0100: Version 1.00	
0h0308	LCD keypad title version	-	-	(Ex.) 0h0101: Version 1.01	
0h0309 -0h030F	Reserved	-	-	-	
0h0310	Output current	0.1	A	-	
0h0311	Output frequency	0.01	Hz	-	
0h0312	Output rpm	0	rpm	-	
0h0313	Motor feedback speed	0	rpm	-32768 rpm-32767 rpm (directional)	
0h0314	Output voltage	1	V	-	
0h0315	DC Link voltage	1	V	-	

Comm. Address	Parameter	Scale	Unit	Assigned content by bit	
oh0316	Output power	0.1	kW	-	
oh0317	Output torque	0.1	%	-	
oh0318	PID reference	0.1	%	-	
oh0319	PID feedback	0.1	%	-	
oh031A	Display the number of poles for the 1st motor	-	-	Displays the number of poles for the first motor	
oh031B	Display the number of poles for the 2nd motor	-	-	Displays the number of poles for the 2nd motor	
oh031C	Display the number of poles for the selected motor	-	-	Displays the number of poles for the selected motor	
oh031D	Select Hz/rpm	-	-	0: Hz, 1: rpm	
oh031E - oh031F	Reserved	-	-	-	
oh0320	Digital input information			BI5	Reserved
				-	-
				B7	Reserved
				B6	P7(I/O board)
				B5	P6(I/O board)
				B4	P5(I/O board)
				B3	P4(I/O board)
				B2	P3(I/O board)
				B1	P2(I/O board)
				B0	P1(I/O board)
oh0321	Digital output information	-	-	BI5	Reserved
				-	Reserved
				B4	Reserved
				B3	Reserved
				B2	Reserved
				B1	Q1
				B0	Relay 1
oh0322	Virtual digital input information	-	-	B15	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)

Comm. Address	Parameter	Scale	Unit	Assigned content by bit	
				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	%	Analog input V2 (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	Input open-phase trip
				B5	Output open-phase 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	Reserved
				BI3	Safety B
				BI2	Safety A
				BI1	Reserved
				BI0	Bad option card
				B9	No motor trip

Comm. Address	Parameter	Scale	Unit	Assigned content by bit	
				B8	External brake trip
				B7	Bad contact at basic I/O board
				B6	Pre PID Fail
				B5	Error while writing parameter
				B4	Reserved
				B3	FAN Trip
				B2	Reserved
				B1	Reserved
				B0	Reserved
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	Queue Full
				B4	Reserved
				B3	Watchdog-2 error
				B2	Watchdog-1 error
				B1	EEPROM error
				B0	ADC error
pr0h0334	Warning information	-	-	B15	Reserved
				-	Reserved
				B10	Reserved
				B9	Auto Tuning failed
				B8	Keypad lost
				B7	Encoder disconnection
				B6	Wrong installation of
				B5	DB
				B4	FAN running

Comm. Address	Parameter	Scale	Unit	Assigned content by bit	
				B3	Lost command
				B2	Inverter Overload
				B1	Underload
				B0	Overload
0h0335 -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	
0h0346 -0h0348	Reserved	-	-	-	
0h0349	Reserved	-	-	-	
0h034A	Option 1	-	-	0: None, 9: CANopen	
0h034B	Reserved	-	-		
0h034C	Reserved				

7.5.2 Control Area Parameter (Read/ Write)

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
0h0380	Frequency command	0.01	Hz	Command frequency setting	
0h0381	RPM command	1	rpm	Command rpm setting	
0h0382	Operation command	-	-	B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Reserved
				B3	0 → 1: Free-run stop
				B2	0 → 1: Trip initialization
				B1	0: Reverse command, 1: Forward

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit	
					command
				B0	0: Stop command, 1: Run command
				Example: Forward operation command 0003h, Reverse operation command 0001h	
0h0383	Acceleration time	0.1	s	Acceleration time setting	
0h0384	Deceleration time	0.1	s	Deceleration time setting	
0h0385	Virtual digital input control (0: Off, 1:On)	-	-	B15	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)	-	-	B15	Reserved
				B14	Reserved
				B13	Reserved
				B12	Reserved
				B11	Reserved
				B10	Reserved
				B9	Reserved
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Relay 4 (I/O board, OU.31: None)
				B3	Relay 3 (I/O board, OU.31: None)
				B2	Relay 2 (I/O board, OU.31: None)
				B1	Q1 (I/O board, OU.33: None)
				B0	Relay 1 (I/O board, 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	-	

Comm. Address	Parameter	Scale	Unit	Assigned Content by Bit
0h038C-0h038F	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	%	Forward regenerative torque limit
0h0393	Rev Pos Torque Limit	0.1	%	Reverse motoring torque limit
0h0394	Rev Neg Torque Limit	0.1	%	Reverse regenerative torque limit
0h0395	Torque Bias	0.1	%	Torque bias
0h0396- 0h399	Reserved	-	-	-
0h039A	Anytime Para	-	-	Set the CNF.20* value (refer to 5.37_ on page 207)
0h039B	Monitor Line-1	-	-	Set the CNF.21* value (refer to 5.37_ on page 207)
0h039C	Monitor Line-2	-	-	Set the CNF.22* value (refer to 5.37_ on page 207)
0h039D	Monitor Line-3	-	-	Set the CNF.23* value (refer to 5.37_ on page 207)

* Displayed on an LCD keypad only.

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 dr.07 to Keypad-1 and select a random target frequency.

2 Set the frequency via communication into the parameter area frequency address (0h1101).

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.

7.5.3 Inverter 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 Setting is prohibited during fault interruptions.
0h03E3	Display changed parameters	-	-	O	0: No, 1: Yes
0h03E4	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 Read: 0: Unlock, 1: Lock
0h03E8	Lock parameter mode	0	Hex	O	Write: 0-9999 Read: 0: Unlock, 1: Lock
0h03E9	Easy start on (easy parameter setup mode)	-	-	O	0: No, 1: Yes
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 to the inverter operation, but are not saved. All set values are cleared following an inverter power cycle and revert back to its previous values. When setting parameters via communication, ensure that a parameter save is completed prior to shutting the inverter down.

- Set parameters very 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. Be careful as communication may be lost during parameter setup if parameter setup is continues for an extended period of time.

8 Table of Functions

This chapter lists all the parameter settings for the "S" Series inverter. Set the parameters required according to the following tables. If a programmed value is out of range, the value will not be accepted using the [ENT] key and the following messages will be displayed.

- **rd:** Value out of range
- **OL** – Over Lap: Set value is duplcated (when programming multi-function inputs, PID references, PID feedback, etc.)**.**
- **no** – No: Set value not allowed.

8.1 Operation Group

The Operation group is used only in the basic keypad mode. It will not be displayed on an LCD keypad. If the LCD keypad is connected, the corresponding functions will be found in the Drive(DRV) group.

***Property Column:** First letter **O or X**, Adjustable during Run **O = Yes, X = No**
Second digit or letter **7 or L or A**, Viewable with which keypad
7 = 7 segment display, **L** = LCD display, **A** = Common to both types.
V/F Column: O or X, **O** = Used in V/F mode, **X**=Used in other control modes (Slip Compensation, Torque Control or Sensorless)**.**
SL Column: Sensorless vector (dr.09) , **I**=IM Sensorless only, **P=**PM Sensorless only, **I/P**=Both

Code	Comm. Address	Name	Keypad Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
	oh1F00	Target frequency	0.00	0-Maximum frequency(Hz)		0.00	O/7	O	I/P	p.43
-	oh1F01	Acceleration time	ACC	0.0-600.0(s)		20.0	O/7	O	I/P	p.84
-	oh1F02	Deceleration time	dEC	0.0-600.0(s)		30.0	O/7	O	I/P	p.84
-	oh1F03	Command source	drv	0	Keypad	1: Fx/Rx-1	X/7	O	I/P	p.77
				1	Fx/Rx-1					
				2	Fx/Rx-2					
				3	Int 485					
				4	Field Bus[1]					
-	oh1F04	Frequency reference source	Frq	0	Keypad-1	0: Keypad-1	X/7	O	I/P	p.62
				1	Keypad-2					
				2	V1					

[1] Table of options are provided separately in the option manual.

Code	Comm. Address	Name	Keypad Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				4	V2					
				5	I2					
				6	Int 485					
				8	Field Bus					
				12	Pulse					
-	oh1F05	Multi-step speed frequency 1	St1	0.00-Maximum frequency(Hz)		10.00	O/7	O	I/P	p.75
-	oh1F06	Multi-step speed frequency 2	St2	0.00-Maximum frequency(Hz)		20.00	O/7	O	I/P	p.75
-	oh1F07	Multi-step speed frequency 3	St3	0.00-Maximum frequency(Hz)		30.00	O/7	O	I/P	p.75
-	oh1F08	Output current	CUr				-/7	O	I/P	p.55
-	oh1F09	Motor revolutions per minute	Rpm				-/7	O	I/P	-
-	oh1F0A	Inverter direct current voltage	dCL	-		-	-/7	O	I/P	p.55
-	oh1F0B	Inverter output voltage	vOL				-/7	O	I/P	p.55
-	oh1F0C	Fault code display	nOn				-/7	O	I/P	-
-	oh1F0D	Select rotation direction	drC	F	Forward run	F	O/7	O	I/P	-
				r	Reverse run					

8.2 Drive group (PAR→dr)

In the following table, data shaded in grey will be displayed when the related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

*O/X: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial value	Property*	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99		9	O/A	O	I/P	p.43
01[2]	0h1101	Target frequency	Cmd Frequency	Start frequency - Maximum frequency(Hz)		0.00	O/L	O	I/P	p.48
02[3]	0h1102	Torque command	Cmd Torque	-180~180[%]		0.0	O/A	X	I	-
03[2]	0h1103	Acceleration time	Acc Time	0.0-600.0(s)		20.0	O/L	O	I/P	p.84
04[2]	0h1104	Deceleration time	Dec Time	0.0-600.0(s)		30.0	O/L	O	I/P	p.84
06[2]	0h1106	Command source	Cmd Source	0	Keypad	1: Fx/Rx-1	X/L	O	I/P	p.77
				1	Fx/Rx-1					
				2	Fx/Rx-2					
				3	Int 485					
				4	Field Bus					
				5	UserSeqLink					
07[2]	0h1107	Frequency reference source	Freq Ref Src	0	Keypad-1	0: Keypad-1	X/L	O	I/P	p.62
				1	Keypad-2					
				2	V1					
				4	V2					
				5	I2					
				6	Int 485					
				8	Field Bus					
				9	UserSeqLink					
				12	Pulse					
08	0h1108	Torque reference setting	Trq Ref Src	0	Keypad-1	0: Keypad-1	X/A	X	I	-
				1	Keypad-2					
				2	V1					
				4	V2					
				5	I2					

[2] Displayed when an LCD keypad is in use.

[3] Displayed when dr.09 is set to IM Sensorless

Code	Comm. Address	Name	LCD Display	Setting Range	Initial value	Property*	V/F	SL	Ref.
				6 Int 485 8 FieldBus 9 UserSeqLink 12 Pulse					
09	0h1109	Control mode	Control Mode	0 V/F 2 Slip Compen 4 IM Sensorless 6 PM S/L	0: V/F	X/A	O	I/P	p.91, p.133, p.146
10	0h110A	Torque Control	Torque Control	0 No 1 Yes	0: No	X/A	X	I	-
11	0h110B	Jog frequency	Jog Frequency	0.00, Start frequency-Maximum frequency(Hz)	10.00	O/A	O	I/P	p.125
12	0h110C	Jog run acceleration time	Jog Acc Time	0.0-600.0(s)	20.0	O/A	O	I/P	p.125
13	0h110D	Jog run deceleration time	Jog Dec Time	0.0-600.0(s)	30.0	O/A	O	I/P	p.125
14	0h110E	Motor capacity	Motor Capacity	0: 0.3HP, 1: 0.5HP 2: 1.0HP, 3: 1.5HP 4: 2.0HP, 5: 3.0HP 6: 4.0HP, 7: 5.0HP 8: 5.5HP, 9: 7.5HP 10: 10.0HP	Varies by Motor capacity	X/A	O	I/P	p.143
15	0h110F	Torque boost options	Torque Boost	0 Manual 1 Auto1 2 Auto2	0: Manual	X/A	O	X	-
16[4]	0h1110	Forward Torque boost	Fwd Boost	0.0-15.0(%)	2.0	X/A	O	X	p.94

[4] Displayed when dr.15 is set to 0 (Manual) or 2(Auto2)

Code	Comm. Address	Name	LCD Display	Setting Range		Initial value	Property*	V/F	SL	Ref.
17[4]	oh1111	Reverse Torque boost	Rev Boost	0.0-15.0(%)		2.0	X/A	O	X	p.94
18	oh1112	Base frequency	Base Freq	30.00~400.00(Hz) [V/F, Slip Compen] 40.00~120.00(Hz) [IM Sensorless] 30.00~180.00(Hz) [PM Sensorless]		60.00	X/A	O	I/P	p.91
19	oh1113	Start frequency	Start Freq	0.01-10.00(Hz)		0.50	X/A	O	I/P	p.91
20	oh1114	Maximum frequency	Max Freq	40.00~400.00(Hz) [V/F, Slip Compen] 40.00~120.00(Hz) [IM Sensorless] 40.00~180.00(Hz) [PM Sensorless]		60.00	X/A	O	I/P	p.100
21	oh1115	Select speed unit	Hz/Rpm Sel	0	Hz Display	0:Hz Display	O/L	O	I/P	p.74
				1	Rpm Display					
22[5]	oh1116	(+)Torque gain	(+)Trq Gain	50.0 ~ 150.0[%]		100.0	O/A	X	I	-
23[5]	oh1117	(-)Torque gain	(-)Trq Gain	50.0 ~ 150.0[%]		100.0	O/A	X	I	-
24[5]	oh1118	(-)Torque gain 0	(-)Trq Gain0	50.0 ~ 150.0[%]		80.0	O/A	X	I	-
25[5]	oh1119	(-)Torque offset	(-)Trq Offset	0.0 ~ 100.0[%]		40.0	O/A	X	I	-
80[6]	oh1150	Select ranges at power input	-	Select code inverter displays at power input		0: run frequency	O/7	O	I/P	-
				0	Run					

[5] Displayed when dr.10 is set to 1 (YES)

[6] Will not be displayed when an LCD keypad is in use

Code	Comm. Address	Name	LCD Display	Setting Range		Initial value	Property*	V/F	SL	Ref.
					frequency					
				1	Acceleration time					
				2	Deceleration time					
				3	Command source					
				4	Frequency reference source					
				5	Multi-step speed frequency1					
				6	Multi-step speed frequency2					
				7	Multi-step speed frequency3					
				8	Output current					
				9	Motor RPM					
				10	Inverter DC voltage					
				11	User select signal (dr.81)					
				12	Currently out of order					
				13	Select run direction					
				14	output current2					
				15	Motor RPM2					
				16	Inverter DC voltage2					
				17	User select signal2 (dr.81)					
81[6]	0h1151	Select monitor code	-	Monitors user selected code		0: output	O/7	O	I/P	-

Code	Comm. Address	Name	LCD Display	Setting Range		Initial value	Property*	V/F	SL	Ref.
				0	Output voltage(V)	voltage				
				1	Output electric power(kW)					
				2	Torque(kgf · m)					
89[6]	0h03E3	Display changed parameter	-	0	View All	0: View All	O/7	O	I/P	p.186
				1	View Changed					
90[6]	0h115A	[ESC] key functions	-	0	Move to initial position	0: None	X/7	O	I/P	p46, p.79, p.127
				1	JOG Key					
				2	Local/Remote					
91	0h115B	Smart copy	SmartCopy	0	None	0:None	X/A	O	I/P	-
				1	SmartDownload					
				3	SmartUpLoad					
93[6]	0h115D	Parameter initialization	-	0	No	0:No	X/7	O	I/P	p.183
				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					
				16	run Grp					
94[6]	0h115E	Password registration		0-9999			O/7	O	I/P	p.184
95[6]	0h115F	Parameter lock settings		0-9999			O/7	O	I/P	p185
97[6]	0h1161	Software version	-				-/7	O	I/P	-
98	0h1162	Display I/O board version	IO S/W Ver				-/A	O	I/P	-
99	0h1163	Display I/O	IO H/W Ver	0	Multiple IO	Standard	-/A	O	I/P	-

Code	Comm. Address	Name	LCD Display	Setting Range		Initial value	Property*	V/F	SL	Ref.
		board H/W version		1	Standard IO	IO				

8.3 Basic Function group (PAR→bA)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control function (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99		20	O	O	I/P	p.43
01	0h1204	2nd command source	Cmd 2nd Src	0	Keypad	1: Fx/Rx-1	X/A	O	I/P	p.102
				1	Fx/Rx-1					
				2	Fx/Rx-2					
				3	Int 485					
				4	FieldBus					
02	0h1205	2nd frequency source	Freq 2nd Src	0	Keypad-1	0: Keypad-1	O/A	O	I/P	p.102
				1	Keypad-2					
				2	V1					
				4	V2					
				5	I2					
				6	Int 485					
				8	FieldBus					
				9	UserSeqLink					
				12	Pulse					
03	0h1201	Auxiliary reference source	Aux Ref Src	0	None	0:None	X/A	O	I/P	p.120
				1	V1					
				3	V2					
				4	I2					
				6	Pulse					
04[7]	0h1202	Auxiliary command calculation type	Aux Calc Type	0	M+(G*A)	0: M+(GA)	X/A	O	I/P	p.120
				1	Mx (G*A)					
				2	M/(G*A)					
				3	M+[M*(G*A)]					
				4	M+G*2(A-					

7 Displayed if bA.03 is not set to 0 (None).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
					50%)					
				5	Mx[G*2(A-50%)					
				6	M/[G*2(A-50%)]					
				7	M+M*G*2(A-50%)					
05[7]	oh1203	Auxiliary command gain	Aux Ref Gain	-200.0-200.0(%)		100.0	O/A	O	I/P	p.120
06	oh1206	2nd Torque command source	Trq 2nd Src	0	Keypad-1	0: Keypad-1	O	X	I	
				1	Keypad-2					
				2	V1					
				4	V2					
				5	I2					
				6	Int 485					
				8	FieldBus					
				9	UserSeqLink					
				12	Pulse					
07	oh1207	V/F pattern options	V/F Pattern	0	Linear	0: Linear	X/A	O	X	p.91
				1	Square					
				2	User V/F					
				3	Square 2					
08	oh1208	Acc/dec standard frequency	Ramp T Mode	0	Max Freq	0: Max Freq	X/A	O	I/P	p.84
				1	Delta Freq					
09	oh1209	Time scale settings	Time Scale	0	0.01 sec	1:0.1 sec	X/A	O	I/P	p.84
				1	0.1 sec					
				2	1 sec					
10	oh120A	Input power frequency	60/50 Hz Src	0	60Hz	0:60Hz	X/A	O	I/P	p.182
				1	50Hz					
11	oh120B	Number of motor poles	Pole Number	2-48		Dependent on motor setting	X/A	O	I/P	p.133
12	oh120C	Rated slip speed	Rated Slip	0-3000(Rpm)			X/A	O	I	p.133
13	oh120D	Motor rated current	Rated Curr	1.0-1000.0(A)			X/A	O	I/P	p.133
14	oh120E	Motor noload current	Noload Curr	0.0-1000.0(A)			X/A	O	I	p.133
15	oh120F	Motor rated voltage	Motor Volt	170-480(V)		0	X/A	O	I/P	p.95
16	oh1210	Motor efficiency	Efficiency	64-100(%)		Dependent on motor	X/A	O	I/P	p.133

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
					setting				
17	oh1211	Load inertia rate	Inertia Rate	0-8	0	X/A	O	I/P	p.133
18	oh1212	Trim power display	Trim Power %	70-130(%)		O/A	O	I/P	-
19	oh1213	Input power voltage	AC Input Volt	170-480V	240/480 V	O/A	O	I/P	p.182
20	-	Auto Tuning	Auto Tuning	0 None 1 All (Rotation type) 2 ALL (Static type) 3 Rs+Lsigma (Rotation type) 6 Tr (Static type) 7 All PM	0:None	X/A	X	I/P	p.143
21	-	Stator resistance	Rs			X/A	X	I/P	p.143
22	-	Leakage inductance	Lsigma	Dependent on motor setting	Dependent on motor setting	X/A	X	I	p.143
23	-	Stator inductance	Ls			X/A	X	I	p.143
24[8]	-	Rotor time constant	Tr	25-5000(ms)	-	X/A	X	I	p.143
25[8]	-	Stator inductance scale	Ls Scale	50 ~ 150[%]	100	X/A	X	I	-
26[8]	-	Rotor time constant scale	Tr Scale	50 ~ 150[%]	100	X/A	X	I	-
28[9]	-	D-axis inductance	Ld (PM)		0	X/A	X	P	
29[9]		Q-axis inductance	Lq (PM)	Settings vary depending on the motor specifications.	0	X/A	X	P	
30[9]		Flux reference	PM Flux Ref		0.147	X/A	X	P	
31[8]		Regeneration inductance scale	Ls Regen Scale	70 ~ 100[%]	80	X/A	X	I	-

[8] Displayed when dr.09 is set to 4(IM Sensorless)

[9] Displayed when dr.09 (Control Mode) is set to 6 (PM Sensorless).

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
32[9]	-	Q-axis inductance scale	Lq(PM) Scale	50–150[%]	100	X/A	X	P	
34[9]	-	PM auto tuning level	Ld,Lq Tune Lev	20.0–50.0[%]	33.3	X/A	X	P	
35[9]	-	PM auto tuning frequency	Ld,Lq Tune Hz	80.0–150.0[%]	100.0	X/A	X	P	
41[10]	0h1229	User frequency1	User Freq 1	0.00-Maximum frequency(Hz)	15.00	X/A	O	X	p.92
42[10]	0h122A	User voltage1	User Volt 1	0-100(%)	25	X/A	O	X	p.92
43[10]	0h122B	User frequency2	User Freq 2	0.00-0.00-Maximum frequency(Hz)	30.00	X/A	O	X	p.92
44[10]	0h122C	User voltage2	User Volt 2	0-100(%)	50	X/A	O	X	p.92
45[10]	0h122D	User frequency3	User Freq 3	0.00-Maximum frequency(Hz)	45.00	X/A	O	X	p.92
46[10]	0h122E	User voltage3	User Volt 3	0-100(%)	75	X/A	O	X	p.92
47[10]	0h122F	User frequency4	User Freq 4	0.00-Maximum frequency(Hz)	Maximum frequency	X/A	O	X	p.92
48[10]	0h1230	User voltage4	User Volt 4	0-100(%)	100	X/A	O	X	p.92
50[11]	0h1232	Multi-step speed frequency1	Step Freq-1	0.00-Maximum frequency(Hz)	10.00	O/L	O	I/P	p.75
51[11]	0h1233	Multi-step speed frequency2	Step Freq-2	0.00-Maximum frequency(Hz)	20.00	O/L	O	I/P	p.75
52[11]	0h1234	Multi-step speed frequency3	Step Freq-3	0.00-Maximum frequency(Hz)	30.00	O/L	O	I/P	p.75
53[12]	0h1235	Multi-step speed frequency4	Step Freq-4	0.00-Maximum frequency(Hz)	40.00	O/A	O	I/P	p.75
54[12]	0h1236	Multi-step speed	Step Freq-5	0.00-Maximum frequency(Hz)	50.00	O/A	O	I/P	p.75

[10] Displayed if either bA.07 or M2.25 is set to 2 (User V/F).

[11] Displayed when an LCD keypad is in use.

[12] Displayed if one of In.65-71 is set to Speed-L/M/H

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
		frequency5							
55[12]	oh1237	Multi-step speed frequency6	Step Freq-6	0.00-Maximum frequency(Hz)	Maximum frequency	O/A	O	I/P	p.75
56[12]	oh1238	Multi-step speed frequency7	Step Freq-7	0.00-Maximum frequency(Hz)	Maximum frequency	O/A	O	I/P	p.75
69		Xcel Change Frequency	Xcel Change Frq	0.00-Maximum frequency(Hz)	30	O/A	O	I/P	p.89
70	oh1246	Multi-step acceleration time1	Acc Time-1	0.0-600.0(s)	20.0	O/A	O	I/P	p.86
71	oh1247	Multi-step deceleration time1	Dec Time-1	0.0-600.0(s)	20.0	O/A	O	I/P	p.86
72[13]	oh1248	Multi-step acceleration time2	Acc Time-2	0.0-600.0(s)	30.0	O/A	O	I/P	p.86
73[13]	oh1249	Multi-step deceleration time2	Dec Time-2	0.0-600.0(s)	30.0	O/A	O	I/P	p.86
74[13]	oh124A	Multi-step acceleration time3	Acc Time-3	0.0-600.0(s)	40.0	O/A	O	I/P	p.86
75[13]	oh124B	Multi-step deceleration time3	Dec Time-3	0.0-600.0(s)	40.0	O/A	O	I/P	p.86
76[13]	oh124C	Multi-step acceleration time4	Acc Time-4	0.0-600.0(s)	50.0	O/A	O	I/P	p.86
77[13]	oh124D	Multi-step deceleration time4	Dec Time-4	0.0-600.0(s)	50.0	O/A	O	I/P	p.86
78[13]	oh124E	Multi-step acceleration time5	Acc Time-5	0.0-600.0(s)	40.0	O/A	O	I/P	p.86
79[13]	oh124F	Multi-step deceleration time5	Dec Time-5	0.0-600.0(s)	40.0	O/A	O	I/P	p.86

[13] Displayed one of In.65-71 is set to Xcel–L/M/H.

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
80[13]	0h1250	Multi-step acceleration time6	Acc Time-6	0.0-600.0(s)	30.0	O/A	O	I/P	p.86
81[13]	0h1251	Multi-step deceleration time6	Dec Time-6	0.0-600.0(s)	30.0	O/A	O	I/P	p.86
82[13]	0h1252	Multi-step acceleration time7	Acc Time-7	0.0-600.0(s)	20.0	O/A	O	I/P	p.86
83[13]	0h1253	Multi-step deceleration time7	Dec Time-7	0.0-600.0(s)	20.0	O/A	O	I/P	p.86

8.4 Expanded Function group (PAR→Ad)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99		24	O/A	O	I/P	p.43
01	0h1301	Acceleration pattern	Acc Pattern	0	Linear	0: Linear	X/A	O	I/P	p.88
02	0h1302	Deceleration pattern	Dec Pattern	1	S-curve		X/A	O	I/P	p.88
03[14]	0h1303	S-curve acceleration start point gradient	Acc S Start	1-100(%)		40	X/A	O	I/P	p.88
04[14]	0h1304	S-curve acceleration end point gradient	Acc S End	1-100(%)		40	X/A	O	I/P	p.88
05[15]	0h1305	S-curve deceleration start point gradient	Dec S Start	1-100(%)		40	X/A	O	I/P	p.88
06[15]	0h1306	S-curve deceleration end point gradient	Dec S End	1-100(%)		40	X/A	O	I/P	p.88
07	0h1307	Start Mode	Start Mode	0	Acc	0:Acc	X/A	O	I/P	p.96
				1	DC-Start					
08[16]	0h1308	Stop Mode	Stop Mode	0	Dec	0:Dec	X/A	O	I/P	p.97
				1	DC-Brake					
				2	Free-Run					
				4	Power Braking					
09	0h1309	Selection of prohibited rotation direction	Run Prevent	0	None	0: None	X/A	O	I/P	p.81
				1	Forward Prev					
				2	Reverse Prev					
10	0h130A	Starting with	Power-on	0	No	0:No	O/A	O	I/P	p.81

[14] Displayed when Ad. 01 is set to 1 (S-curve).

[15] Displayed when Ad. 02 is set to 1 (S-curve).

[16] DC braking and power braking (Ad.08, stop mode options 1 and 4) are not available when dr.09 (Control Mode) is set to 6 (PM Sensorless).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		power on	Run	1	Yes					
12[17]	oh130C	DC braking time at startup	DC-Start Time	0.00-60.00(s)		0.00	X/A	O	I/P	p.96
13	oh130D	Amount of applied DC	DC Inj Level	0-200(%)		50	X/A	O	I/P	p.96
14[18]	oh130E	Output blocking time before DC braking	DC-Block Time	0.00- 60.00(s)		0.10	X/A	O	I/P	p.97
15[18]	oh130F	DC braking time	DC-Brake Time	0.00- 60.00(s)		1.00	X/A	O	I/P	p.97
16[18]	oh1310	DC braking rate	DC-Brake Level	0-200(%)		50	X/A	O	I/P	p.97
17[18]	oh1311	DC braking frequency	DC-Brake Freq	Start frequency-60Hz		5.00	X/A	O	I/P	p.97
20	oh1314	Dwell frequency on acceleration	Acc Dwell Freq	Start frequency-Maximum frequency(Hz)		5.00	X/A	O	I/P	p.132
21	oh1315	Dwell operation time on acceleration	Acc Dwell Time	0.0-60.0(s)		0.0	X/A	O	I/P	p.132
22	oh1316	Dwell frequency on deceleration	Dec Dwell Freq	Start frequency-Maximum frequency(Hz)		5.00	X/A	O	I/P	p.132
23	oh1317	Dwell operation time on deceleration	Dec Dwell Time	0.0-60.0(s)		0.0	X/A	O	I/P	p.132
24	oh1318	Frequency limit	Freq Limit	0	No	0:No	X/A	O	I/P	p.100
				1	Yes					
25[19]	oh1319	Frequency lower limit value	Freq Limit Lo	0.00-Upper limit frequency(Hz)		0.50	O/A	O	I/P	p.100
26[19]	oh131A	Frequency upper limit value	Freq Limit Hi	Lower limit frequency-Maximum frequency(Hz)		maximum frequency	X/A	O	I/P	p.100
27	oh131B	Frequency jump	Jump Freq	0	No	0:No	X/A	O	I/P	p.101
				1	Yes					

[17] Displayed when Ad. 07 is set to 1 (DC-Start).

[18] Displayed when Ad. 08 is set to 1 (DC-Brake).

[19] Displayed when Ad. 24 is set to 1 (Yes).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
28[20]	oh131C	Jump frequency lower limit1	Jump Lo 1	0.00-Jump frequency upper limit1(Hz)		10.00	O/A	O	I/P	p.101
29[20]	oh131D	Jump frequency upper limit1	Jump Hi 1	Jump frequency lower limit1-Maximum frequency(Hz)		15.00	O/A	O	I/P	p.101
30[20]	oh131E	Jump frequency lower limit2	Jump Lo 2	0.00-Jump frequency upper limit2(Hz)		20.00	O/A	O	I/P	p.101
31[20]	oh131F	Jump frequency upper limit2	Jump Hi 2	Jump frequency lower limit2-Maximum frequency(Hz)		25.00	O/A	O	I/P	p.101
32[20]	oh1320	Jump frequency lower limit3	Jump Lo 3	0.00-Jump frequency upper limit3(Hz)		30.00	O/A	O	I/P	p.101
33[20]	oh1321	Jump frequency upper limit3	Jump Hi 3	Jump frequency lower limit3-Maximum frequency(Hz)		35.00	O/A	O	I/P	p.101
41[21]	oh1329	Brake release current	BR Rls Curr	0.0-180.0(%)		50.0	O/A	O	I/P	p.190
42[21]	oh132A	Brake release delay time	BR Rls Dly	0.00-10.00(s)		1.00	X/A	O	I/P	p.190
44[21]	oh132C	Brake release Forward frequency	BR Rls Fwd Fr	0.00-Maximum frequency(Hz)		1.00	X/A	O	I/P	p.190
45[21]	oh132D	Brake release Reverse frequency	BR Rls Rev Fr	0.00-Maximum frequency(Hz)		1.00	X/A	O	I/P	p.190
46[21]	oh132E	Brake engage delay time	BR Eng Dly	0.00-10.00(s)		1.00	X/A	O	I/P	p.190
47[21]	oh132F	Brake engage frequency	BR Eng Fr	0.00-Maximum frequency(Hz)		2.00	X/A	O	I/P	p.190
50	oh1332	Energy saving operation	E-Save Mode	0	None	0:None	X /A	O	X	p.167
				1	Manual					
				2	Auto					
51[22]	oh1333	Energy saving	Energy Save	0-30(%)		0	O/A	O	X	p.167

[20] Displayed when Ad. 27 is set to 1 (Yes).

[21] Displayed if either OU.31 or OU.33 is set to 35 (BR Control).

[22] Displayed if Ad.50 is not set to 0 (None).

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
		level							
61	oh133D	Rotation count speed gain	Load Spd Gain	0.1~6000.0[%]	100.0	O/A	O	I/P	-
62	oh133E	Rotation count speed scale	Load Spd Scale	0 x 1 1 x 0.1 2 x 0.01 3 x 0.001 4 x 0.0001	0: x 1	O/A	O	I/P	-
63	oh133F	Rotation count speed unit	Load Spd Unit	0 Rpm 1 mpm	0: rpm	O/A	O	I/P	-
64	oh1340	Cooling fan control	FAN Control	0 During Run 1 Always ON 2 Temp Control	0:During Run	O/A	O	I/P	p.181
74[23]	oh134A	Selection of regeneration evasion function for press	RegenAvd Sel	0 No 1 Yes	0:No	X/A	O	I	p.193
75[24]	oh134B	Voltage level of regeneration evasion motion for press	RegenAvd Level	200V : 300-400V 400V : 600-800V	350 700	X/A	O	I	p.193
76[24]	oh134C	Compensation frequency limit of regeneration evasion for press	CompFreq Limit	0.00- 10.00Hz	1.00	X/A	O	I	p.193
77[24]	oh134D	Regeneration evasion for press P gain	RegenAvd Pgain	0.0- 100.0%	50.0	O/A	O	I	p.193
78[24]	oh134E	Regeneration evasion for press I gain	RegenAvd Igain	20-30000(ms)	500	O/A	O	I	p.193
79	oh134F	DB Unit turn on voltage level	DB Turn On Lev	200V: Min[25]~400[V] 400V: Min[25]~800[V]	390[V] 780[V]	X/A	O	I/P	-
80	oh1350	Fire mode selection	Fire Mode Sel	0 None 1 Fire Mode 2 Fire Mode	0:None	X/A	O	I/P	p.116

[23] Displayed when dr.09 (Control Mode) is not set to 6 (PM Sensorless).

[24] Displayed when Ad.74 is set to 1 (Yes).

[25] DC voltage value (convert bA.19 AC Input voltage) + 20V (200V type) or + 40V (400V type)

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
					Test					
81[26]	oh1351	Fire mode frequency	Fire Mode Freq	0.00~60.00(Hz)		60.00	X/A	O	I/P	p.116
82[26]	oh1352	Fire mode direction	Fire Mode Dir	0	Forward	0: Forward	X/A	O	I/P	p.116
				1	Reverse					
83[26]		Fire Mode Count	Fire Mode Cnt	Can not be modified						p.116

[26] Displayed when Ad.80 is set to 1 (Yes).

8.5 Control Function group (PAR→Cn)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

<table>
<tr><th>Code</th><th>Comm. Address</th><th>Name</th><th>LCD Display</th><th colspan="2">Setting Range</th><th>Initial Value</th><th>Property *</th><th>V/F</th><th>SL</th><th>Ref.</th></tr>
<tr><td>00</td><td>-</td><td>Jump Code</td><td>Jump Code</td><td colspan="2">1-99</td><td>4</td><td>O/A</td><td>O</td><td>I/P</td><td>p.43</td></tr>
<tr><td rowspan="2">04</td><td rowspan="2">0h1404</td><td rowspan="2">Carrier frequency</td><td rowspan="2">Carrier Freq</td><td>Heavy Duty</td><td>V/F: 1.0~15.0 (kHz) [27]
IM: 2.0~15.0 (kHz)
PM: 2.0~10.0(kHz)</td><td>3.0</td><td rowspan="2">X/A</td><td rowspan="2">O</td><td rowspan="2">I/P</td><td>p.177</td></tr>
<tr><td>Normal Duty[28]</td><td>V/F: 1.0~ 5.0 (kHz) [29]
IM: 2.0~5.0 (kHz)</td><td>2.0</td><td>p.177</td></tr>
<tr><td rowspan="2">05</td><td rowspan="2">0h1405</td><td rowspan="2">Switching mode</td><td rowspan="2">PWM Mode</td><td>0</td><td>Normal PWM</td><td rowspan="2">0:Normal PWM</td><td rowspan="2">X/A</td><td rowspan="2">O</td><td rowspan="2">I</td><td rowspan="2">p.177</td></tr>
<tr><td>1</td><td>Lowleakage PWM</td></tr>
<tr><td>09[30]</td><td>0h1409</td><td>Initial excitation time</td><td>PreExTime</td><td colspan="2">0.00-60.00(s)</td><td>1.00</td><td>X/A</td><td>X</td><td>I</td><td>p.150</td></tr>
<tr><td>10[30]</td><td>0h140A</td><td>Initial excitation amount</td><td>Flux Force</td><td colspan="2">100.0-300.0(%)</td><td>100.0</td><td>X/A</td><td>X</td><td>I</td><td>p.150</td></tr>
<tr><td>11</td><td>0h140B</td><td>Continued operation duration</td><td>Hold Time</td><td colspan="2">0.00-60.00(s)</td><td>0.00</td><td>X/A</td><td>X</td><td>I</td><td>p.150</td></tr>
</table>

[27] In case of 0.4~4.0kW, the setting range is 2.0~15.0(kHz).

[28] PM synchronous motor sensorless vector control mode does not support normal duty operation [when dr.09 (Control Mode) is set to 6 (PM Sensorless)].

[29] In case of 0.4~4.0kW, the setting range is 2.0~5.0(kHz).

[30] Displayed when dr.09 (Control Mode) is not set to 6 (PM Sensorless).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
12[31]	oh140D	PM S/L speed controller proportional gain1	ASR P Gain 1	0~5000		100	X/A	X	P	
13[31]	oh140F	PM S/L speed controller integral gain1	ASR P Gain 1	0~5000		150	X/A	X	P	
15[31]	oh1410	PM S/L speed controller proportional gain2	ASR P Gain 1	0~5000		100	X/A	X	P	
16[31]	oh1410	PM S/L speed controller integral gain2	ASR P Gain 1	0~9999		150	X/A	x	P	
20[30]	oh1414	Sensorless 2nd gain display setting	SL2 G View Sel	0	No	0:No	O/A	X	I	p.150
				1	Yes					
21[30]	oh1415	Sensorless speed controller proportional gain1	ASR-SL P Gain1	0-5000(%)		Dependent on motor setting	O/A	X	I	p.150
22[30]	oh1416	Sensorless speed controller integral gain1	ASR-SL I Gain1	10-9999(ms)			O/A	X	I	p.150
23[32]	oh1417	Sensorless speed controller proportional gain2	ASR-SL P Gain2	1.0-1000.0(%)		Dependent on motor setting	O/A	X	I	p.150
24[32]	oh1418	Sensorless speed controller integral gain2	ASR-SL I Gain2	1.0-1000.0(%)			O/A	X	I	p.150
25[32]	oh1419	Sensorless speed controller integral gain 0	ASR-SL I Gain0	10~9999(ms)			O/A	X	I	-
26[32]	oh141A	Flux estimator proportional gain	Flux P Gain	10-200(%)			O/A	X	I	p.150
27[32]	oh141B	Flux estimator	Flux I Gain	10-200(%)			O/A	X	I	p.150

[31] Displayed when dr.09 (Control Mode) is set to 6 (PM Sensorless).

[32] Displayed when dr.09 is set to 4 (IM Sensorless) and Cn.20 is set to 1 (YES).

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property *	V/F	SL	Ref.
		integral gain							
28[32]	oh141C	Speed estimator proportional gain	S-Est P Gain1	0-32767		O/A	X	I	p.150
29[32]	oh141D	Speed estimator integral gain1	S-Est I Gain1	100-1000		O/A	X	I	p.150
30[32]	oh141E	Speed estimator integral gain2	S-Est I Gain2	100-10000		O/A	X	I	p.150
31[32]	oh141F	Sensorless current controller proportional gain	ACR SL P Gain	10-1000		O/A	X	I	p.150
32[32]	oh1420	Sensorless current controller integral gain	ACR SL I Gain	10 -1000		O/A	X	I	p.150
33[33]	oh1421	PM D-axis back-EMF estimation gain [%]	PM EdGain Perc	0~300.0[%]	100.0	X/A	X	P	
34[33]	oh1422	PM Q-axis back-EMF estimation gain [%]	PM EqGain Perc	0~300.0[%]	100.0	X/A	X	P	
35[33]	oh1423	Initial pole position detection retry number	PD Repeat Num	0~10	2	X/A	X	P	
36[33]	oh1424	Initial pole position detection pulse interval	Pulse Interval	1~100	20	X/A	X	P	
37[33]	oh1425	Initial pole position detection current level [%]	Pulse Curr %	10~100	15	X/A	X	P	
38[33]	oh1426	Initial pole position detection voltage level [%]	Pulse Volt %	100~4000	500	X/A	X	P	
39[33]	oh1427	PM dead time range [%]	PMdeadBan d Per	50.0~100.0	100.0	X/A	X	P	
40[33]	oh1428	PM dead time voltage [%]	PMdeadVolt Per	50.0~100.0	100.0	X/A	X	P	
41[33]	oh1429	Speed estimator P gain1	PM SpdEst Kp	0~32000	100	X/A	X	P	
42[33]	oh142A	Speed estimator I gain1	PM SpdEst Ki	0~32000	10	X/A	X	P	
43[33]	oh142B	Speed estimator P gain2	PM SpdEst Kp 2	0~32000	300	X/A	X	P	

[33] Displayed when dr.09 (Control Mode) is set to 6 (PM Sensorless).

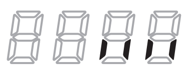
Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property *	V/F	SL	Ref.
44[33]	oh142C	Speed estimator I gain2	PM SpdEst Ki 2	0~32000	30	X/A	X	P	
45[33]	oh142D	Speed estimator feed forward high speed rate [%]	PM Flux FF %	0~100[%]	30.0	X/A	X	P	
46[33]	oh142E	Initial pole position detection options	Init Angle Sel	0 None 1 Angle 2 Align	1	X/A		P	- -
48[32]	-	Current controller P gain	ACR P Gain	0-10000	1200	O/A	X	I/P	-
49[32]	-	Current controller I gain	ACR I Gain	0-10000	120	O/A	X	I/P	-
50[33]	oh1432	Voltage controller limit	V Con HR	0~100.0[%]	10.0	X/A	X	P	
51[33]	oh1433	Voltage controller I gain	V Con Ki	0~1000.0[%]	10.0	X/A	X	P	
52	oh1434	Torque controller output filter	Torque Out LPF	0-2000(ms)	0	X/A	X	I/P	p.150
53	oh1435	Torque limit setting options	Torque Lmt Src	0 Keypad-1 1 Keypad-2 2 V1 4 V2 5 I2 6 Int 485 8 FieldBus 9 UserSeqLink 12 Pulse	0: Keypad-1	X/A	X	I/P	p.150
54[34]	oh1436	Positive-direction reverse torque limit	FWD +Trq Lmt	0.0-200.0(%)	180	O/A	X	I/P	p.150
55[34]	oh1437	Positive-direction regeneration torque limit	FWD –Trq Lmt	0.0-200.0(%)	180	O/A	X	I/P	p.150
56[34]	oh1438	Negative-direction reverse torque limit	REV +Trq Lmt	0.0-200.0(%)	180	O/A	X	I/P	p.150

[34] 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%.

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property *	V/F	SL	Ref.
57[34]	oh1439	Negative-direction regeneration torque limit	REV –Trq Lmt	0.0-200.0(%)	180	O/A	X	I/P	p.150
62[34]	oh143E	Speed limit Setting	Speed Lmt Src	0 Keypad-1 1 Keypad-2 2 V1 4 V2 5 I2 6 Int 485 7 FieldBus 8 UserSeqLink	0: Keypad -1	X/A	X	I/P	-
63[34]	oh143F	Positive-direction speed limit	FWD Speed Lmt	0.00~ Maximum frequency (Hz)	60.00	O/A	X	I/P	-
64[34]	oh1440	Negative-direction speed limit	REV Speed Lmt	0.00~ Maximum frequency (Hz)	60.00	O/A	X	I/P	-
65[34]	oh1441	Speed limit operation gain	Speed Lmt Gain	100~5000[%]	500	O/A	X	I/P	-
69[35]		PM speed search current	SS Pulse Curr	15	10~100	O/A	X	P	
70	oh 1446	Speed search mode selection	SS Mode	0 Flying Start-1[36] 1 Flying Start-2 2 Flying Start-3[35]	0: Flying Start-1	X/A	O	I/P	p.171
71	oh1447	Speed search operation selection	Speed Search	bit 0000- 1111 0001 Selection of speed search on acceleration	0000[37]	X/A	O	I/P	p.171

35 Displayed when dr.09 (Control Mode) is set to 6 (PM Sensorless).

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

37 The initial value 0000 will be displayed on the keypad as .

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
				0010	When starting on initialization after fault trip					
				0100	When restarting after instantaneous power interruption					
				1000	When starting with power on					
72[38]	oh1448	Speed search reference current	SS Sup-Current	80-200(%)		150	O/A	O	I/P	p.171
73[39]	oh1449	Speed search proportional gain	SS P-Gain	0-9999		Flying Start-1 : 100 Flying Start-2 : 600[40]	O/A	O	I	p.171
74[39]	oh144A	Speed search integral gain	SS I-Gain	0-9999		Flying Start-1 : 200 Flying Start-2 : 1000	O/A	O	I	p.171
75[39]	oh144B	Output blocking time before speed search	SS Block Time	0.0-60.0(s)		1.0	X/A	O	I/P	p.171
76[39]	oh144C	Speed search Estimator gain	Spd Est Gain	50-150(%)		100	O/A	O	I	-
77	oh144D	Energy buffering selection	KEB Select	0	No	0:No	X/A	O	I/P	p.154
				1	KEB-1					

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

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

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

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
				2	KEB-2					
78[41]	oh144E	Energy buffering start level	KEB Start Lev	110.0-200.0(%)		125.0	X/A	O	I/P	p.154
79[41]	oh144F	Energy buffering stop level	KEB Stop Lev	Cn78~210.0(%)		130.0	X/A	O	I/P	p.154
80[41]	oh1450	Energy buffering P gain	KEB P Gain	0-20000		1000	O/A	O	I/P	p.154
81[41]	oh1451	Energy buffering I gain	KEB I Gain	1~20000		500	O/A	O	I/P	p.154
82[41]	oh1452	Energy buffering Slip gain	KEB Slip Gain	0~2000.0%		30.0	O/A	O	I	p.154
83[41]	oh1453	Energy buffering acceleration time	KEB Acc Time	0.0~600.0(s)		10.0	O/A	O	I/P	p.154
85[42]	oh1455	Flux estimator proportional gain1	Flux P Gain1	100-700		370	O/A	X	I	p.150
86[42]	oh1456	Flux estimator proportional gain2	Flux P Gain2	0-100		0	O/A	X	I	p.150
87[42]	oh1457	Flux estimator proportional gain3	Flux P Gain3	0-500		100	O/A	X	I	p.150
88[42]	oh1458	Flux estimator integral gain1	Flux I Gain1	0-200		50	O/A	X	I	p.150
89[42]	oh1459	Flux estimator integral gain2	Flux I Gain2	0-200		50	O/A	X	I	p.150
90[42]	oh145A	Flux estimator integral gain3	Flux I Gain3	0-200		50	O/A	X	I	p.150
91[42]	oh145B	Sensorless voltage compensation1	SL Volt Comp1	0-60		Dependent on motor setting	O/A	X	I	p.150
92[42]	oh145C	Sensorless voltage compensation2	SL Volt Comp2	0-60		Dependent on motor setting	O/A	X	I	p.150
93[42]	oh145D	Sensorless voltage compensation3	SL Volt Comp3	0-60		Dependent on motor setting	O/A	X	I	p.150
94[42]	oh145E	Sensorless field weakening start frequency	SL FW Freq	80.0-110.0(%)		100.0	X/A	X	I	p.146

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

[42] Displayed when Cn.20 is set to 1 (Yes).

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property *	V/F	SL	Ref.
95[42]	oh145F	Sensorless gain switching frequency	SL Fc Freq	0.00-8.00(Hz)	2.00	X/A	X	I	p.146

8.6 Input Terminal Block Function group (PAR→In)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99	65	O/A	O	I/P	p.43
01	oh1501	Frequency for maximum analog input	Freq at 100%	Start frequency-Maximum frequency(Hz)	Maximum frequency	O/A	O	I/P	p.63
02	oh1502	Torque at maximum analog input	Torque at100%	0.0-200.0(%)	100.0	O/A	X	X	-
05	oh1505	V1 input voltage display	V1 Monitor(V)	-12.00-12.00(V)	0.00	-/A	O	I/P	p.63
06	oh1506	V1 input polarity selection	V1 Polarity	0 Unipolar 1 Bipolar	0: Unipolar	X/A	O	I/P	p.63
07	oh1507	Time constant of V1 input filter	V1 Filter	0-10000(ms)	10	O/A	O	I/P	p.63
08	oh1508	V1 Minimum input voltage	V1 Volt x1	0.00-10.00(V)	0.00	O/A	O	I/P	p.63
09	oh1509	V1 output at Minimum voltage (%)	V1 Perc y1	0.00-100.00(%)	0.00	O/A	O	I/P	p.63
10	oh150A	V1 Maximum input voltage	V1 Volt x2	0.00-12.00(V)	10.00	O/A	O	I/P	p.63
11	oh150B	V1 output at Maximum voltage (%)	V1 Perc y2	0.00-100.00(%)	100.00	O/A	O	I/P	p.63
12[44]	oh150C	V1 Minimum input voltage	V1 –Volt x1'	-10.00- 0.00(V)	0.00	O/A	O	I/P	p.66
13[44]	oh150D	V1output at Minimum voltage (%)	V1 –Perc y1'	-100.00-0.00(%)	0.00	O/A	O	I/P	p.66

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
14[44]	oh150E	V1 Maximum input voltage	V1 –Volt x2'	-12.00- 0.00(V)		-10.00	O/A	O	I/P	p.66
15[44]	oh150F	V1 output at Maximum voltage (%)	V1 –Perc y2'	-100.00-0.00(%)		-100.00	O/A	O	I/P	p.66
16	oh1510	V1 rotation direction change	V1 Inverting	0	No	0: No	O/A	O	I/P	p.63
				1	Yes					
17	oh1511	V1 quantization level	V1 Quantizing	0.00[45], 0.04-10.00(%)		0.04	X/A	O	I/P	p.63
35[46]	oh1523	V2 input voltage display	V2 Monitor(V)	0.00-12.00(V)		0.00	-/A	O	I/P	p.70
37[46]	oh1525	V2 input filter time constant	V2 Filter	0-10000(ms)		10	O/A	O	I/P	p.70
38[46]	oh1526	V2 Minimum input voltage	V2 Volt x1	0.00-10.00(V)		0.00	O/A	X	I/P	p.70
39[46]	oh1527	V2 output at Minimum voltage (%)	V2 Perc y1	0.00-100.00(%)		0.00	O/A	O	I/P	p.70
40[46]	oh1528	V2 Maximum input voltage	V2 Volt x2	0.00-10.00(V)		10	O/A	X	I/P	p.70
41[46]	oh1529	V2 output at Maximum voltage (%)	V2 Perc y2	0.00-100.00(%)		100.00	O/A	O	I/P	p.70
46[46]	oh152E	V2 rotation direction change	V2 Inverting	0	No	0:No	O/A	O	I/P	p.70
				1	Yes					
47[46]	oh152F	V2 quantization level	V2 Quantizing	0.00[45], 0.04-10.00(%)		0.04	O/A	O	I/P	p.70
50[47]	oh1532	I2 input current display	I2 Monitor (mA)	0-24(mA)		0.00	-/A	O	I/P	p.68
52[47]	oh1534	I2 input filter time constant	I2 Filter	0-10000(ms)		10	O/A	O	I/P	p.68
53[47]	oh1535	I2 minimum input current	I2 Curr x1	0.00-20.00(mA)		4.00	O/A	O	I/P	p.68
54[47]	oh1536	I2 output at Minimum	I2 Perc y1	0.00-100.00(%)		0.00	O/A	O	I/P	p.68

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

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

[46] Displayed when V is selected on the analog current/voltage input circuit selection switch (SW2).

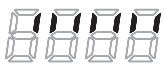
[47] Displayed when I is selected on the analog current/voltage input circuit selection switch (SW2).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		current (%)								
55[47]	oh1537	I2 maximum input current	I2 Curr x2	0.00-24.00(mA)		20.00	O/A	O	I/P	p.68
56[47]	oh1538	I2 output at Maximum current (%)	I2 Perc y2	0.00-100.00(%)		100.00	O/A	O	I/P	p.68
59	oh1341	Up/down operation frequency save	U/D Save Mode	0	No	0:No	O/A	O	I/P	p.128
60	oh1346	Safe operation selection	Run En Mode	0 1	Always Enable DI Dependent	0	X/A	O	I/P	p.130
61[48]	oh1347	Safe operation stop options	Run Dis Stop	0 1 2	Free-Run	Q-Stop Q-Stop Resume	X/A	O	I/P	p.130
62[48]	oh1348	Safe operation deceleration time	Q-Stop Time	0.0-600.0(s)		5.0	O/A	O	I/P	p.130
61[47]	oh153D	Changing rotation direction of I2	I2 Inverting	0 1	No Yes	0:No	O/A	O	I/P	p.68
62[47]	oh153E	I2 quantization level	I2 Quantizing	0.00[45],0.04-10.00(%)		0.04	O/A	O	I/P	p.68
65	oh1541	P1 terminal function setting	P1 Define	0 1	None Fx	1:Fx	X/A	O	I/P	p.77
66	oh1542	P2 terminal function setting	P2 Define	2	Rx	2:Rx	X/A	O	I/P	p.77
67	oh1543	P3 terminal function setting	P3 Define	3	RST	5:BX	X/A	O	I/P	p.227
68	oh1544	P4 terminal function setting	P4 Define	4	External Trip	3:RST	X/A	O	I/P	p.220
69	oh1545	P5 terminal function setting	P5 Define	5	BX	7:Sp-L	X/A	O	I/P	p.226
70[50]	oh1546	P6 terminal function setting	P6 Define	6	JOG	8:Sp-M	X/A	O	I/P	p.125

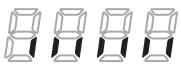
[48] Displayed when In.60 is set to 1 (DI Dependent).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
71[50]	oh1547	P7 terminal function setting	P7 Define	7	Speed-L	9:Sp-H	X/A	O	I/P	p.75
				8	Speed-M					p.75
				9	Speed-H					p.75
				11	XCEL-L					p.86
				12	XCEL-M					p.86
				13	RUN Enable					p.130
				14	3-Wire					p.129
				15	2nd Source					p.102
				16	Exchange					p.180
				17	Up					p.128
				18	Down					p.128
				20	U/D Clear					p.128
				21	Analog Hold					p.74
				22	I-Term Clear					p.135
				23	PID Openloop					p.135
				24	P Gain2					p.135
				25	XCEL Stop					p.91
				26	2nd Motor					p.179
				34	Pre Excite					-
				38	Timer In					p.190
				40	dis Aux Ref					p.120
				46	FWD JOG					p.126
				47	REV JOG					p.126
				49	XCEL-H					p.86
				50	User Seq					p.107
				51	Fire Mode					p.116
				52	KEB-1 Select					p.154
				54	TI[50]					p.71
84	oh1554	Multi-function input terminal On filter selection	DI Delay Sel	P7 ~ P1		1 1111[51]	O/A	O	I/P	p.103
				0	Disable(Off)					
				1	Enable(On)					
85	oh1555	Multi-function input terminal	DI On Delay	0-10000(ms)		10	O/A	O	I/P	p.103

[50] Displayed when P5 is selected on Px terminal function.(Only Standard I/O). Terminals P6 and P7 not available with Standard I/O.

[51] The initial value 11111 will be displayed on the keypad as 

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
		On filter							
86	oh1556	Multi-function input terminal Off filter	DI Off Delay	0-10000(ms)	3	O/A	O	I/P	p.103
87	oh1557	Multi-function input contact selection	DI NC/NO Sel	P7 – P1 0: A contact (NO) 1: B contact (NC)	0 0000[52]	X/A	O	I/P	p.103
89	oh1559	Multi-step command delay time	InCheck Time	1-5000(ms)	1	X/A	O	I/P	p.75
90	oh155A	Multi-function input terminal status	DI Status	P7 – P1 0: release(Off) 1: Connection (On)	0 0000[52]	-/A	O	I/P	p.103
91	oh155B	Pulse input amount display	Pulse Monitor (kHz)	0.00-50.00(kHz)	0.00	-/A	O	I/P	p.71
92	oh155C	TI input filter time constant	TI Filter	0-9999(ms)	10	O/A	O	I/P	p.71
93	oh155D	TI Minimum input pulse	TI Pls x1	0.00-32.00(kHz)	0.00	O/A	O	I/P	p.71
94	oh153E	TI output at Minimum pulse (%)	TI Perc y1	0.00-100.00(%)	0.00	O/A	O	I/P	p.71
95	oh155F	TI Maximum input pulse	TI Pls x2	0.00-32.00(kHz)	32.00	O/A	O	I/P	p.71
96	oh1560	TI Output at Maximum pulse (%)	TI Perc y2	0-100(%)	100.00	O/A	O	I/P	p.71
97	oh1561	TI rotation direction change	TI Inverting	0: No 1: Yes	0:No	O/A	O	I/P	p.71
98	oh1562	TI quantization level	TI Quantizing	0.00[45], 0.04-10.00(%)	0.04	O/A	O	I/P	p.71
99	oh1563	SW1(NPN/PNP) SW2(V1/V2[I2]) status	IO SW State	Bit: 00~11 00: V2, NPN 01: V2, PNP 10: I2, NPN	00	-/A	O	I/P	-

[52] The initial value 0000 will be displayed on the keypad as .

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				11	I2, PNP					

8.7 Output Terminal Block Function group (PAR→OU)

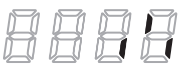
In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
00	-	Jump Code	JumpCode	1-99		30	O/A	O	I/P	p.43
01	oh1601	Analog output 1 item	AO1 Mode	0	Frequency	0:Frequency	O/A	O	I/P	p.195
				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					
02	oh1602	Analog output 1 gain	AO1 Gain	-1000.0-1000.0(%)		100.0	O/A	O	I/P	p.195
03	oh1603	Analog output 1 bias	AO1 Bias	-100.0-100.0(%)		0.0	O/A	O	I/P	p.195
04	oh1604	Analog output 1	AO1 Filter	0-10000(ms)		5	O/A	O	I/P	p.195

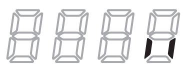
Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		filter								
05	oh1606	Analog constant output 1	AO1 Const %	0.0-100.0(%)		0.0	O/A	O	I/P	p.195
06	oh1606	Analog output 1 monitor	AO1 Monitor	0.0-1000.0(%)		0.0	-/A	O	I/P	p.195
30	oh161E	Fault output item	Trip Out Mode	bit	000-111	010[53]	O/A	O	I/P	p.205
				1	Low voltage					
				2	Any faults other than low voltage					
				3	Automatic restart final failure					
31	oh161F	Multi-function relay 1 item	Relay 1	0	None	29:Trip	O/A	O	I/P	p.200
				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					

53 The initial value 010 will be displayed on the keypad as .

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				17	Inverter Line					
				18	Comm Line					
				19	Speed Search					
				22	Ready					
				28	Timer Out					
				29	Trip					
				31	DB Warn%ED					
				34	On/Off Control					
				35	BR Control					
				36						
				37	FAN Exchange					
				38	Fire Mode					
				39	TO[54]					
				40	KEB Operating					
33	oh1621	Multi-function output1 item	Q1 Define	0	None	14:Run	O/A	O	I/P	p.200
				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					

[54] Standard I/O only

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				16	Steady					
				17	Inverter Line					
				18	Comm Line					
				19	Speed Search					
				22	Ready					
				28	Timer Out					
				29	Trip					
				31	DB Warn%ED					
				34	On/Off Control					
				35	BR Control					
				36						
				37	FAN Exchange					
				38	Fire Mode					
				39	TO[54]					
				40	KEB Operating					
41	oh1629	Multi-function output monitor	DO Status	-		00	-/A	-	-	p.200
50	oh1632	Multi-function output On delay	DO On Delay	0.00-100.00(s)		0.00	O/A	O	I/P	p.206
51	oh1633	Multi-function output Off delay	DO Off Delay	0.00-100.00(s)		0.00	O/A	O	I/P	p.206
52	oh1634	Multi-function output contact selection	DO NC/NO Sel	Q1, Relay1		00[55]	X/A	O	I/P	p.206
				0	A contact (NO)					
				1	B contact (NC)					
53	oh1635	Fault	TripOut	0.00-100.00(s)		0.00	O/A	O	I/P	p.205

55 The initial value 00 will be displayed on the keypad as .

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
		output On delay	OnDly						
54	oh1636	Fault output Off delay	TripOut OffDly	0.00-100.00(s)	0.00	O/A	O	I/P	p.205
55	h1637	Timer On delay	TimerOn Delay	0.00-100.00(s)	0.00	O/A	O	I/P	p.190
56	oh1638	Timer Off delay	TimerOff Delay	0.00-100.00(s)	0.00	O/A	O	I/P	p.190
57	oh1639	Detected frequency	FDT Frequency	0.00-Maximum frequency(Hz)	30.00	O/A	O	I/P	p.200
58	oh163A	Detected frequency band	FDT Band	0.00-Maximum frequency(Hz)	10.00	O/A	O	I/P	p.200
61	oh163D	Pulse output gain	TO Mode	0 Frequency 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	0: Frequency	O/A	O	I/P	p.198
62	oh163E	Pulse output gain	TO Gain	-1000.0-1000.0(%)	100.0	O/A	O	I/P	p.198
63	oh163F	Pulse output bias	TO Bias	-100.0-100.0(%)	0.0	O/A	O	I/P	p.198
64	oh1640	Pulse output	TO Filter	0-10000(ms)	5	O/A	O	I/P	p.198

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		filter								
65	oh1641	Pulse output constant output 2	TO Const %	0.0-100.0(%)		0.0	O/A	O	I/P	p.198
66	oh1642	Pulse output monitor	TO Monitor	0.0-1000.0(%)		0.0	-/A	O	I/P	p.198
67	oh1342	Output contact On/Off control options	On/Off Ctrl Src	0	None	0:None	X/A	O	I/P	p.128
				1	V1					
				3	V2					
				4	I2					
				6	Pulse					
68	oh1343	Output contact On level	On-Ctrl Level	Output contact off level-100.00%		90.00	X/A	O	I/P	p.192
69	oh1344	Output contact Off level	Off-Ctrl Level	-100.00-output contact on level (%)		10.00	X/A	O	I/P	p.192

8.8 Communication Function group (PAR→CM)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X:** Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99		20	O/A	O	I/P	p.43
01	oh1701	Built-in communication inverter ID	Int485 St ID	1-250		1	O/A	O	I/P	p.232
02[56]	oh1702	Built-in communication protocol	Int485 Proto	0	ModBus RTU	0: ModBus RTU	O/A	O	I/P	p.232
				2	LS Inv 485					
	oh1703	Built-in	Int485	0	1200 bps	3:	O/A	O	I/P	p.232

[56] Will not be displayed when P2P and MultiKPD is set.

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
03[56]		communication speed	BaudR	1	2400 bps	9600 bps				
				2	4800 bps					
				3	9600 bps					
				4	19200 bps					
				5	38400 bps					
				6	56 Kbps					
				7	115 Kbps[57]					
04[56]	oh1704	Built-in communication frame setting	Int485 Mode	0	D8/PN/S1	0: D8/PN/S1	O/A	O	I/P	p.232
				1	D8/PN/S2					
				2	D8/PE/S1					
				3	D8/PO/S1					
05[56]	oh1705	Transmission delay after reception	Resp Delay	0-1000(ms)		5ms	O/A	O	I/P	p.232
06[58]	oh1706	Communication option S/W version	FBus S/W Ver	-		0.00	O/A	O	I/P	-
07[58]	oh1707	Communication option inverter ID	FBus ID	0-255		1	O/A	O	I/P	-
08[58]	oh1708	FIELD BUS communication speed	FBUS BaudRate	-		12Mbps	-/A	O	I/P	-
09[58]	oh1709	Communication option LED status	FieldBus LED	-		-	O/A	O	I/P	-
30	oh171E	Number of output parameters	ParaStatus Num	0-8		3	O/A	O	I/P	
31[59]	oh171F	Output Communication address1	Para Stauts-1	0000-FFFF Hex		000A	O/A	O	I/P	p.238
32[59]	oh1720	Output Communication address2	Para Stauts-2	0000-FFFF Hex		000E	O/A	O	I/P	p.238
33[59]	oh1721	Output Communication	Para Stauts-3	0000-FFFF Hex		000F	O/A	O	I/P	p.238

[57] 115,200bps

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

[59] Only the range of addresses set at COM-30 is displayed.

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
		address3							
34[59]	oh1722	Output Communication address4	Para Stauts-4	0000-FFFF Hex	0000	O/A	O	I/P	p.238
35[59]	oh1723	Output Communication address5	Para Stauts-5	0000-FFFF Hex	0000	O/A	O	I/P	p.238
36[59]	oh1724	Output Communication address6	Para Stauts-6	0000-FFFF Hex	0000	O/A	O	I/P	p.238
37[59]	oh1725	Output Communication address7	Para Stauts-7	0000-FFFF Hex	0000	O/A	O	I/P	p.238
38[59]	oh1726	Output Communication address8	Para Stauts-8	0000-FFFF Hex	0000	O/A	O	I/P	p.238
50	oh1732	Number of input parameters	Para Ctrl Num	0-8	2	O/A	O	I/P	
51[60]	oh1733	Input Communication address1	Para Control-1	0000-FFFF Hex	0005	X/A	O	I/P	p.238
52[60]	oh1734	Input Communication address2	Para Control-2	0000-FFFF Hex	0006	X/A	O	I/P	p.238
53[60]	oh1735	Input Communication address3	Para Control-3	0000-FFFF Hex	0000	X/A	O	I/P	p.238
54[60]	oh1736	Input Communication address4	Para Control-4	0000-FFFF Hex	0000	X/A	O	I/P	p.238
55[60]	oh1737	Input Communication address5	Para Control-5	0000-FFFF Hex	0000	X/A	O	I/P	p.238
56[60]	oh1738	Input Communication address6	Para Control-6	0000-FFFF Hex	0000	X/A	O	I/P	p.238
57[60]	oh1739	Input Communication address7	Para Control-7	0000-FFFF Hex	0000	X/A	O	I/P	p.238
58[60]	oh173A	Input Communication	Para Control-8	0000-FFFF Hex	0000	X/A	O	I/P	p.238

[60] Only the range of addresses set at COM-50 is displayed.

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		address8								
68	0h1744	Field bus data swap	FBus Swap Sel	0	No	0	X/A	O	I/P	p.238
				1	Yes					
70	0h1746	Communication multi-function input 1	Virtual DI 1	0	None	0:None	O/A	O	I/P	p.251
71	0h1747	Communication multi-function input 2	Virtual DI 2	1	Fx	0:None	O/A	O	I/P	p.251
72	0h1748	Communication multi-function input 3	Virtual DI 3	2	Rx	0:None	O/A	O	I/P	p.251
73	0h1749	Communication multi-function input 4	Virtual DI 4	3	RST	0:None	O/A	O	I/P	p.251
74	0h174A	Communication multi-function input 5	Virtual DI 5	4	External Trip	0:None	O/A	O	I/P	p.251
75	0h174B	Communication multi-function input 6	Virtual DI 6	5	BX	0:None	O/A	O	I/P	p.251
76	0h174C	Communication multi-function input 7	Virtual DI 7	6	JOG	0:None	O/A	O	I/P	p.251
77	0h174D	Communication multi-function input 8	Virtual DI 8	7	Speed-L	0:None	O/A	O	I/P	p.251
				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					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
					Openloop					
				24	P Gain2					
				25	XCEL Stop					
				26	2nd Motor					
				34	Pre Excite					
				38	Timer In					
				40	dis Aux Ref					
				46	FWD JOG					
				47	REV JOG					
				49	XCEL-H					
				50	User Seq					
				51	Fire Mode					
				52	KEB-1 Select					
				54	TI[61]					
86	0h1756	Communication multi-function input monitoring	Virt DI Status	-		0	X/A	O	I/P	p.236
90	0h175A	Selection of data frame communication monitor	Comm Mon Sel	0	Int485	0	O/A	O	I/P	-
				1	KeyPad					
91	0h175B	Data frame Rev count	Rcv Frame Num	0~65535		0	O/A	O	I/P	-
92	0h175C	Data frame Err count	Err Frame Num	0~65535		0	O/A	O	I/P	-
93	0h175D	NAK frame count	NAK Frame Num	0~65535		0	O/A	O	I/P	-
94[62]	-	Communication data upload	Comm Update	0	No	0:No	-/A	O	I/P	-
				1	Yes					
95	0h1760	P2P communication selection	Int 485 Func	0	Disable All	0: Disable All	X/A	O	I/P	p.105
				1	P2P Master					
				2	P2P Slave					
				3	M-KPD Ready					
96[63]	-	DO setting selection	P2P OUT Sel	Bit	000~111	0:No	O/A	O	I/P	p.105
				001	Analog					

61 Displayed when P5 is selected on Px terminal function

62 Displayed only when a communication option card is installed.

63 Displayed when AP.01 is set to 2 (Proc PID).

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
					output					
				010	Multi-function relay					
				100	Multi-function output					

8.9 Application Function group (PAR→AP)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99		20	O/A	O	I/P	p.43
01	oh1801	Application function selection	App Mode	0	None	0: None	X/A	O	I/P	p.135
				1	-					
				2	Proc PID					
02	-	Enable user sequence	User Seq En	0	No	0:No	X/A	O	I/P	p.107
				1	Yes					
16[64]	oh1810	PID output monitor	PID Output	(%)		0.00	-/A	O	I/P	p.135
17[64]	oh1811	PID reference monitor	PID Ref Value	(%)		50.00	-/A	O	I/P	p.135
18[64]	oh1812	PID feedback monitor	PID Fdb Value	(%)		0.00	-/A	O	I/P	p.135
19[64]	oh1813	PID reference setting	PID Ref Set	-100.00-100.00(%)		50.00	O/A	O	I/P	p.135
20[64]	oh1814	PID reference source	PID Ref Source	0	Keypad	0: Keypad	X/A	O	O	p.135
				1	V1					
				3	V2					
				4	I2					
				5	Int 485					
				7	FieldBus					
				8	UserSeq Link					

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

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
				11	Pulse					
21[64]	oh1815	PID feedback source	PID F/B Source	0	V1	0:V1	X/A	O	I/P	p.135
				2	V2					
				3	I2					
				4	Int 485					
				6	FieldBus					
				7	UserSeq Link					
				10	Pulse					
22[64]	oh1816	PID controller proportional gain	PID P-Gain	0.0-1000.0(%)		50.0	O/A	O	I/P	p.135
23[64]	oh1817	PID controller integral time	PID I-Time	0.0-200.0(s)		10.0	O/A	O	I/P	p.135
24[64]	oh1818	PID controller differentiation time	PID D-Time	0-1000(ms)		0	O/A	O	I/P	p.135
25[64]	oh1819	PID controller feed-forward compensation gain	PID F-Gain	0.0-1000.0(%)		0.0	O/A	O	I/P	p.135
26[64]	oh181A	Proportional gain scale	P Gain Scale	0.0-100.0(%)		100.0	X/A	O	I/P	p.135
27[64]	oh181B	PID output filter	PID Out LPF	0-10000(ms)		0	O/A	O	I/P	p.135
28[64]	oh181C	PID Mode	PID Mode	0	Process PID	0	X/A	O	I/P	-
				1	Normal PID					
29[64]	oh181D	PID upper limit frequency	PID Limit Hi	PID lower limit frequency-300.00(Hz)		60.00	O/A	O	I/P	p.135
30[64]	oh181E	PID lower limit frequency	PID Limit Lo	-300.00 -PID upper limit frequency(Hz)		-60.00	O/A	O	I/P	p.135
31[64]	oh181F	PID output inverse	PID Out Inv	0	No	0:No	X/A	O	I/P	p.135
				1	Yes					
32[64]	oh1820	PID output scale	PID Out Scale	0.1-1000.0(%)		100.0	X/A	O	I/P	p.135
34[64]	oh1822	PID controller motion frequency	Pre-PID Freq	0.00-Maximum frequency(Hz)		0.00	X/A	O	I/P	p.135

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property *	V/F	SL	Ref.
35[64]	0h1823	PID controller motion level	Pre-PID Exit	0.0-100.0(%)	0.0	X/A	O	I/P	p.135
36[64]	0h1824	PID controller motion delay time	Pre-PID Delay	0-9999(s)	600	O/A	O	I/P	p.135
37[64]	0h1825	PID sleep mode delay time	PID Sleep DT	0.0-999.9(s)	60.0	O/A	O	I/P	p.135
38[64]	0h1826	PID sleep mode frequency	PID Sleep Freq	0.00-Maximum frequency(Hz)	0.00	O/A	O	I/P	p.135
39[64]	0h1827	PID wake-up level	PIDWakeUp Lev	0-100(%)	35	O/A	O	I/P	p.135
40[64]	0h1828	PID wake-up mode setting	PID WakeUp Mod	0 Below Level 1 Above Level 2 Beyond Level	0:Below Level	O/A	O	I/P	p.135
42[64]	0h182A	PID controller unit selection	PID Unit Sel	0 % 1 Bar 2 mBar 3 Pa 4 kPa 5 Hz 6 rpm 7 V 8 I 9 kW 10 HP 11 ℃ 12 ˚F	0:%	O/A	O	I/P	p.135
43[64]	0h182B	PID unit gain	PID Unit Gain	0.00-300.00(%)	100.00	O/A	O	I/P	p.135
44[64]	0h182C	PID unit scale	PID Unit Scale	0 X100 1 X10 2 X 1 3 X 0.1 4 X 0.01	2:X 1	O/A	O	I/P	p.135
45[64]	0h182D	PID 2nd proportional gain	PID P2-Gain	0.0-1000.0(%)	100.0	X/A	O	I/P	p.135

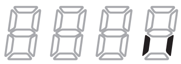
8.10 Protection Function group (PAR→Pr)

In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99		40	O/A	O	I/P	p.43
04	oh1B04	Load level setting	Load Duty	0	Normal Duty	1:Heavy Duty	X/A	O	I/P	p.214
				1	Heavy Duty					
05	oh1B05	Input/output open-phase protection	Phase Loss Chk	bi	00-11	00[65]	X/A	O	I/P	p.220
				01	Output open phase					
				10	Input open phase					
06	oh1B06	Input voltage range during open-phase	IPO V Band	1-100(V)		15	X/A	O	I/P	p.220
07	oh1B07	Deceleration time at fault trip	Trip Dec Time	0.0-600.0(s)		3.0	O/A	O	I/P	-
08	oh1B08	Selection of startup on trip reset	RST Restart	0	No	0:No	O/A	O	I/P	p.175
				1	Yes					
09	oh1B09	Number of automatic restarts	Retry Number	0-10		0	O/A	O	I/P	p.175
10[66]	oh1B0A	Automatic restart delay time	Retry Delay	0.0-60.0(s)		1.0	O/A	O	I/P	p.175
12	oh1B0C	Motion	Lost Cmd	0	None	0:None	O/A	O	I/P	p.222

[65] The initial value 00 will be displayed on the keypad as .

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

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
		at speed command loss	Mode	1	Free-Run					
				2	Dec					
				3	Hold Input					
				4	Hold Output					
				5	Lost Preset					
13[67]	oh1BoD	Time to decide speed command loss	Lost Cmd Time	0.1-120(s)		1.0	O/A	O	I/P	p.222
14[67]	oh1BoE	Operation frequency at speed command loss	Lost Preset F	Start frequency-Maximum frequency(Hz)		0.00	O/A	O	I/P	p.222
15[67]	oh1BoF	Analog input loss decision level	AI Lost Level	0	Half x1	0:Half of x1	O/A	O	I/P	p.222
				1	Below x1					
17	oh1B11	Overload warning selection	OL Warn Select	0	No	0:No	O/A	O	I/P	p.214
				1	Yes					
18	oh1B12	Overload alarm level	OL Warn Level	30-180(%)		150	O/A	O	I/P	p.214
19	oh1B13	Overload warning time	OL Warn Time	0.0-30.0(s)		10.0	O/A	O	I/P	p.214
20	oh1B14	Motion at overload fault	OL Trip Select	0	None	1:Free-Run	O/A	O	I/P	p.214
				1	Free-Run					
				2	Dec					
21	oh1B15	Overload fault level	OL Trip Level	30-200(%)		180	O/A	O	I/P	p.214
22	oh1B16	Overload fault time	OL Trip Time	0.0-60.0(s)		60.0	O/A	O	I/P	p.214
25	oh1B19	Underload warning selection	UL Warn Sel	0	No	0:No	O/A	O	I/P	p.223
				1	Yes					
26	oh1B1A	Underload warning time	UL Warn Time	0.0-600.0(s)		10.0	O/A	O	I/P	p.223
27	oh1B1B	Underload fault	UL Trip Sel	0	None	0:None	O/A	O	I/P	p.223

67 Displayed when Pr.12 is not set to 0 (NONE).

Trouble-shooting

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
		selection		1	Free-Run					
				2	Dec					
28	oh1B1C	Underload fault time	UL Trip Time	0.0-600.0(s)		30.0	O/A	O	I/P	*p.223*
29	oh1B1D	Underload lower limit level	UL LF Level	10-30(%)		30	O/A	O	I/P	*p.223*
30	oh1B1E	Underload upper limit level	UL BF Level	30-100(%)		30	O/A	O	I/P	*p.223*
31	oh1B1F	No motor motion at detection	No Motor Trip	0	None	0:None	O/A	O	I/P	*p.227*
				1	Free-Run					
32	oh1B20	No motor detection current level	No Motor Level	1-100(%)		5	O/A	O	I	*p.227*
33	oh1B21	No motor detection delay	No Motor Time	0.1-10.0(s)		3.0	O/A	O	I	*p.227*
40	oh1B28	Electronic thermal fault selection	ETH Trip Sel	0	None	0:None	O/A	O	I/P	*p.213*
				1	Free-Run					
				2	Dec					
41	oh1B29	Motor cooling fan type	Motor Cooling	0	Self-cool	0:Self-cool	O/A	O	I/P	*p.213*
				1	Forced-cool					
42	oh1B2A	Electronic thermal 1 minute rating	ETH 1min	120-200(%)		150	O/A	O	I/P	*p.213*
43	oh1B2B	Electronic thermal continuous rating	ETH Cont	50-150(%)		120	O/A	O	I/P	*p.213*
45	oh1B2D	BX trip mode	BX Mode	0	Free-Run	0	X/A	O	I/P	-
				1	Dec					
50	oh1B32	Stall prevention motion and flux braking	Stall Prevent	bit	0000-1111	0000	X/A	O	X	*p.216*
				00 01	Acceleratin g					
				001 0	At constant speed					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
				0100	At deceleration					
				1000	FluxBraking					
51	oh1B33	Stall frequency1	Stall Freq 1	Start frequency-Stall frequency2(Hz)		60.00	O/A	O	X	p.216
52	oh1B34	Stall level1	Stall Level 1	30-250(%)		180	X/A	O	X	p.216
53	oh1B35	Stall frequency2	Stall Freq 2	Stall frequency1-Stall frequency3(Hz)		60.00	O/A	O	X	p.216
54	oh1B36	Stall level2	Stall Level 2	30-250(%)		180	X/A	O	X	p.216
55	oh1B37	Stall frequency3	Stall Freq 3	Stall frequency2-Stall frequency4(Hz)		60.00	O/A	O	X	p.216
56	oh1B38	Stall level3	Stall Level 3	30-250(%)		180	X/A	O	X	p.216
57	oh1B39	Stall frequency4	Stall Freq 4	Stall frequency3-Maximum frequency(Hz)		60.00	O/A	O	X	p.216
58	oh1B3A	Stall level4	Stall Level 4	30-250(%)		180	X/A	O	X	p.216
59	oh1B3B	Flux braking gain	Flux Brake Kp	0 ~ 150[%]		0	O/A	O	I	-
66	oh1B42	DB resistor warning level	DB Warn %ED	0-30(%)		0	O/A	O	I/P	p.222
73	oh1B22	Speed deviation trip	Speed Dev Trip	0	No	0:No	O/A	O	I/P	
				1	Yes					
74[69]	oh1B23	Speed deviation band	Speed Dev Band	1 ~ 20		5	O/A	O	I/P	
75[69]	oh1B24	Speed deviation time	Speed Dev Time	0 ~ 120		60	O/A	O	I/P	
79	oh1B4F	Cooling fan fault selection	FAN Trip Mode	0	Trip	1:Warning	O/A	O	I/P	p.225
				1	Warning					
80	oh1B50	Motion selection at option trip	Opt Trip Mode	0	None	1:Free-Run	O/A	O	I/P	p.227
				1	Free-Run					
				2	Dec					
81	oh1B51	Low voltage fault decision	LVT Delay	0.0-60.0(s)		0.0	X/A	O	I/P	p.225

69 Displayed when Pr.73 is set to 1(YES)

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
		delay time								
82	oh1B52	LV2 Selection	LV2 Enable	0	No	0	X/A	O	I/P	-
				1	Yes					
86	oh1B56	Accumulated percent of fan usage	Fan Time Perc	0.0~100.0[%]		0.0	-/A	O	I/P	-
87	oh1B57	Fan exchange warning level	Fan Exchange level	0.0~100.0[%]		90.0	O/A	O	I/P	-
88[70]	oh1B58	Fan reset time	Fan Time Rst	0	No	0	X/A	O	I/P	-
				1	Yes					
89	oh1B59	FAN Status	FAN State	Bit	00~10	0	-/A	O	I/P	-
				00	-					
				01						
				10	FAN Warning					
90[70]	oh1B5A	Warning information	-	-		-	-/7	O	I/P	-
91[70]	oh1B5B	Fault history 1	-	-		-	-/7	O	I/P	-
92[70]	oh1B5C	Fault history 2	-	-		-	-/7	O	I/P	-
93[70]	oh1B5D	Fault history 3	-	-		-	-/7	O	O	-
94[70]	oh1B5E	Fault history 4	-	-		-	-/7	O	O	-
95[70]	oh1B5F	Fault history 5	-	-		-	-/7	O	O	-
96[70]	oh1B60	Fault history deletion	-	0	No	0:No	-/7	O	O	-
				1	Yes					

[70] Will not be displayed when an LCD keypad is in use.

8.11 2nd Motor Function group (PAR→M2)

The 2nd Motor function group will be displayed if any of In.65-71 are set to 26 (2nd MOTOR). In the following table, the data shaded in grey will be displayed when a related code has been selected.

SL: Sensorless vector control (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: Keypad/LCD keypad/Common

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property *	V/F	SL	Ref.
00	-	Jump Code	Jump Code	1-99	14	O/A	O	I	p.43
04	oh1C04	Acceleration time	M2-Acc Time	0.0-600.0(s)	20.0	O/A	O	I	p.179
05	oh1C05	Deceleration time	M2-Dec Time	0.0-600.0(s)	30.0	O/A	O	I	p.179
06	oh1C06	Motor capacity	M2-Capacity	0 0.3 HP 1 0.5 HP 2 1.0 HP 3 1.5 HP 4 2.0 HP 5 3.0 HP 6 4.0 HP 7 5.0 HP 8 5.5 HP 9 7.5 HP 10 10.0 HP	-	X/A	O	I	p.179
07	oh1C07	Base frequency	M2-Base Freq	30.00-400.00(Hz)	60.00	X/A	O	I	p.179
08	oh1C08	Control mode	M2-Ctrl Mode	0 V/F 2 Slip Compen 4 IM Sensorless	0:V/F	X/A	O	I	p.179
10	oh1C0A	Number of motor poles	M2-Pole Num	2-48	Dependent on motor settings	X/A	O	I	p.179
11	oh1C0B	Rated slip speed	M2-Rated Slip	0-3000(rpm)		X/A	O	I	p.179
12	oh1C0C	Motor rated current	M2-Rated Curr	1.0-1000.0(A)		X/A	O	I	p.179
13	oh1C0D	Motor no-load current	M2-Noload Curr	0.5-1000.0(A)		X/A	O	I	p.179
14	oh1C0E	Motor rated voltage	M2-Rated Volt	170-480(V)		X/A	O	I	p.179
15	oh1C0F	Motor	M2-	64-100(%)		X/A	O	I	p.179

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property *	V/F	SL	Ref.
		efficiency	Efficiency							
16	oh1C10	Load inertia rate	M2-Inertia Rt	0-8			X/A	O	I	p.179
17	-	Stator resistance	M2-Rs	Dependent on motor settings			X/A	O	I	p.179
18	-	Leakage inductance	M2-Lsigma				X/A	O	I	p.179
19	-	Stator inductance	M2-Ls				X/A	O	I	p.179
20[71]	-	Rotor time constant	M2-Tr	25-5000(ms)			X/A	O	I	p.179
25	oh1C19	V/F pattern	M2-V/F Patt	0	Linear	0: Linear	X/A	O	I	p.179
				1	Square					
				2	User V/F					
26	oh1C1A	Forward Torque boost	M2-Fwd Boost	0.0-15.0(%)		2.0	X/A	O	I	p.179
27	oh1C1B	Reverse Torque boost	M2-Rev Boost	0.0-15.0(%)			X/A	O	I	p.179
28	oh1C1C	Stall prevention level	M2-Stall Lev	30-150(%)		150	X/A	O	I	p.179
29	oh1C1D	Electronic thermal 1 minute rating	M2-ETH 1min	100-200(%)		150	X/A	O	I	p.179
30	oh1C1E	Electronic thermal continuous rating	M2-ETH Cont	50-150(%)		100	X/A	O	I	p.179
40	oh1C28	Rotation count speed gain	Load Spd Gain	0~6000.0[%]		100.0	O/A	O	I	-
41	oh1C29	Rotation count speed scale	Load Spd Scale	0	x 1	0: x 1	O/A	O	I	-
				1	x 0.1					
				2	x 0.01					
				3	x 0.001					
				4	x 0.0001					
42	oh1C2A	Rotation count speed unit	Load Spd Unit	0	Rpm	0: rpm	O/A	O	I	-
				1	mpm					

71 Displayed when M2.08 is set to 4 (IM Sensorless).

8.12 User Sequence group (US)

This group appears when AP.02 is set to 1 (Yes) or CM.95 is set to 2 (P2P Master). The parameter cannot be changed while the user sequence is running.

SL: Sensorless vector control function (dr.09) , I – IM Sensorless, P – PM Sensorless

***O/X**: Write-enabled during operation, **7/L/A**: keypad/LCD keypad/common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
00	-	Jump code	Jump Code	1-99		31	O/A	O	I/P	p.43
01	0h1D01	User sequence operation command	User Seq Con	0	Stop	0:Stop	X/A	O	I/P	p.107
				1	Run					
				2	Digital In Run					
02	0h1D02	User sequence operation loop time	US Loop Time	0	0.01s	1:0.02s	X/A	O	I/P	p.107
				1	0.02s					
				2	0.05s					
				3	0.1s					
				4	0.5s					
				5	1s					
11	0h1D0B	Output address link1	Link UserOut1	0-0xFFFF		0	X/A	O	I/P	p.107
12	0h1D0C	Output address link2	Link UserOut2	0-0xFFFF		0	X/A	O	I/P	p.107
13	0h1D0D	Output address link3	Link UserOut3	0-0xFFFF		0	X/A	O	I/P	p.107
14	0h1D0E	Output address link4	Link UserOut4	0-0xFFFF		0	X/A	O	I/P	p.107
15	0h1D0F	Output address link5	Link UserOut5	0-0xFFFF		0	X/A	O	I/P	p.107
16	0h1D10	Output address link6	Link UserOut6	0-0xFFFF		0	X/A	O	I/P	p.107
17	0h1D11	Output address link7	Link UserOut7	0-0xFFFF		0	X/A	O	I/P	p.107
18	0h1D12	Output address link8	Link UserOut8	0-0xFFFF		0	X/A	O	I/P	p.107
19	0h1D13	Output address link9	Link UserOut9	0-0xFFFF		0	X/A	O	I/P	p.107
20	0h1D14	Output address link10	Link UserOut10	0-0xFFFF		0	X/A	O	I/P	p.107
21	0h1D15	Output address link11	Link UserOut11	0-0xFFFF		0	X/A	O	I/P	p.107
22	0h1D16	Output address link12	Link UserOut12	0-0xFFFF		0	X/A	O	I/P	p.107
23	0h1D17	Output address	Link	0-0xFFFF		0	X/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
		link13	UserOut13						
24	oh1D18	Output address link14	Link UserOut14	0-0xFFFF	0	X/A	O	I/P	p.107
25	oh1D19	Output address link15	Link UserOut15	0-0xFFFF	0	X/A	O	I/P	p.107
26	oh1D1A	Output address link16	Link UserOut16	0-0xFFFF	0	X/A	O	I/P	p.107
27	oh1D1B	Output address link17	Link UserOut17	0-0xFFFF	0	X/A	O	I/P	p.107
28	oh1D1C	Output address link18	Link UserOut18	0-0xFFFF	0	X/A	O	I/P	p.107
31	oh1D1F	Input constant setting1	Void Para1	-9999-9999	0	X/A	O	I/P	p.107
32	oh1D20	Input constant setting2	Void Para2	-9999-9999	0	X/A	O	I/P	p.107
33	oh1D21	Input constant setting3	Void Para3	-9999-9999	0	X/A	O	I/P	p.107
34	oh1D22	Input constant setting4	Void Para4	-9999-9999	0	X/A	O	I/P	p.107
35	oh1D23	Input constant setting5	Void Para5	-9999-9999	0	X/A	O	I/P	p.107
36	oh1D24	Input constant setting6	Void Para6	-9999-9999	0	X/A	O	I/P	p.107
37	oh1D25	Input constant setting7	Void Para7	-9999-9999	0	X/A	O	I/P	p.107
38	oh1D26	Input constant setting8	Void Para8	-9999-9999	0	X/A	O	I/P	p.107
39	oh1D27	Input constant setting9	Void Para9	-9999-9999	0	X/A	O	I/P	p.107
40	oh1D28	Input constant setting10	Void Para10	-9999-9999	0	X/A	O	I/P	p.107
41	oh1D29	Input constant setting11	Void Para11	-9999-9999	0	X/A	O	I/P	p.107
42	oh1D2A	Input constant setting12	Void Para12	-9999-9999	0	X/A	O	I/P	p.107
43	oh1D2B	Input constant setting13	Void Para13	-9999-9999	0	X/A	O	I/P	p.107
44	oh1D2C	Input constant setting14	Void Para14	-9999-9999	0	X/A	O	I/P	p.107
45	oh1D2D	Input constant setting15	Void Para15	-9999-9999	0	X/A	O	I/P	p.107
46	oh1D2E	Input constant setting16	Void Para16	-9999-9999	0	X/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
47	0h1D2F	Input constant setting17	Void Para17	-9999-9999	0	X/A	O	I/P	p.107
48	0h1D30	Input constant setting18	Void Para18	-9999-9999	0	X/A	O	I/P	p.107
49	0h1D31	Input constant setting19	Void Para19	-9999-9999	0	X/A	O	I/P	p.107
50	0h1D32	Input constant setting20	Void Para20	-9999-9999	0	X/A	O	I/P	p.107
51	0h1D33	Input constant setting21	Void Para21	-9999-9999	0	X/A	O	I/P	p.107
52	0h1D34	Input constant setting22	Void Para22	-9999-9999	0	X/A	O	I/P	p.107
53	0h1D35	Input constant setting23	Void Para23	-9999-9999	0	X/A	O	I/P	p.107
54	0h1D36	Input constant setting24	Void Para24	-9999-9999	0	X/A	O	I/P	p.107
55	0h1D37	Input constant setting25	Void Para25	-9999-9999	0	X/A	O	I/P	p.107
56	0h1D38	Input constant setting26	Void Para26	-9999-9999	0	X/A	O	I/P	p.107
57	0h1D39	Input constant setting27	Void Para27	-9999-9999	0	X/A	O	I/P	p.107
58	0h1D3A	Input constant setting28	Void Para28	-9999-9999	0	X/A	O	I/P	p.107
59	0h1D3B	Input constant setting29	Void Para29	-9999-9999	0	X/A	O	I/P	p.107
60	0h1D3C	Input constant setting30	Void Para30	-9999-9999	0	X/A	O	I/P	p.107
80	0h1D50 S	Analog input 1	P2P In V1	0-12,000		-/A	O	I/P	p.107
81	0h1D51	Analog input2	P2P In I2	-12,000-12,000		-/A	O	I/P	p.107
82	0h1D52	Digital input	P2P In DI	0-0x7F		-/A	O	I/P	p.107
85	0h1D55	Analog output	P2P OutAO1	0-10,000	0	X/A	O	I/P	p.107
88	0h1D58	Digital output	P2P OutDO	0-0x03	0	X/A	O	I/P	p.107

8.13 User Sequence Function group(UF)

This group appears when AP.02 is set to 1 (Yes) or CM.95 is set to 2 (P2P Master). The parameter cannot be changed while the user sequence is running.

SL: Sensorless vector control function (dr.09) , I – IM Sensorless, P – PM Sensorless

*__O/X__: Write-enabled during operation, **7/L/A**: keypad/LCD keypad/common

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
00	-	Jump code	Jump Code	1-99		41	O/A	O	I/P	p.43
01	0h1E01	User function1	User Func1	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				28	DOWNCOUNT					
02	oh1E02	User function input1-A	User Input1-A	0-0xFFFF		0	X/A	O	I/P	p.107
03	oh1E03	User function input1-B	User Input1-B	0-0xFFFF		0	X/A	O	I/P	p.107
04	oh1E04	User function input1-C	User Input1-C	0-0xFFFF		0	X/A	O	I/P	p.107
05	oh1E05	User function output1	User Output1	-32767-32767		0	-/A	O	I/P	p.107
06	oh1E06	User function 2	User Func2	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
07	0h1E07	User function input2-A	User Input2-A	0-0xFFFF		0	X/A	O	I/P	p.107
08	0h1E08	User function input2-B	User Input2-B	0-0xFFFF		0	X/A	O	I/P	p.107
09	0h1E09	User function input2-C	User Input2-C	0-0xFFFF		0	X/A	O	I/P	p.107
10	0h1E0A	User function output2	User Output2	-32767-32767		0	-/A	O	I/P	p.107
11	0h1E0B	User function3	User Func3	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
12	0h1E0C	User function input3-A	User Input3-A	0-0xFFFF		0	X/A	O	I/P	p.107
13	0h1E0D	User function input3-B	User Input3-B	0-0xFFFF		0	X/A	O	I/P	p.107
14	0h1E0E	User function input3-C	User Input3-C	0-0xFFFF		0	X/A	O	I/P	p.107
15	0h1E0F	User function output3	User Output3	-32767-32767		0	-/A	O	I/P	p.107
16	0h1E10	User function4	User Func4	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
17	0h1E11	User function input4-A	User Input4-A	0-0xFFFF		0	X/A	O	I/P	p.107
18	0h1E12	User function input4-B	User Input4-B	0-0xFFFF		0	X/A	O	I/P	p.107
19	0h1E13	User function input4-C	User Input4-C	0-0xFFFF		0	X/A	O	I/P	p.107
20	0h1E14	User function output4	User Output4	-32767-32767		0	-/A	O	I/P	p.107
21	0h1E15	User function5	User Func5	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
22	0h1E16	User function input5-A	User Input5-A	0-0xFFFF		0	X/A	O	I/P	p.107
23	0h1E17	User function input5-B	User Input5-B	0-0xFFFF		0	X/A	O	I/P	p.107
24	0h1E18	User function input5-C	User Input5-C	0-0xFFFF		0	X/A	O	I/P	p.107
25	0h1E19	User function output5	User Output5	-32767-32767		0	-/A	O	I/P	p.107
26	0h1E1A	User function6	User Func6	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
27	0h1E1B	User function input6-A	User Input6-A	0-0xFFFF		0	X/A	O	I/P	p.107
28	0h1E1C	User function input6-B	User Input6-B	0-0xFFFF		0	X/A	O	I/P	p.107
29	0h1E1D	User function input6-C	User Input6-C	0-0xFFFF		0	X/A	O	I/P	p.107
30	0h1E1E	User function output6	User Output6	-32767-32767		0	-/A	O	I/P	p.107
31	0h1E1F	User function7	User Func7	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
32	0h1E20	User function input7-A	User Input7-A	0-0xFFFF		0	X/A	O	I/P	p.107
33	0h1E21	User function input7-B	User Input7-B	0-0xFFFF		0	X/A	O	I/P	p.107
34	0h1E22	User function input7-C	User Input7-C	0-0xFFFF		0	X/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
35	oh1E23	User function output7	User Output7	-32767-32767		0	-/A	O	I/P	p.107
36	oh1E24	User function8	User Func8	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
37	oh1E25	User function input8-A	User Input8-A	0-0xFFFF		0	X/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
38	oh1E26	User function input8-B	User Input8-B	0-0xFFFF		0	X/A	O	I/P	p.107
39	oh1E27	User function input8-C	User Input8-C	0-0xFFFF		0	X/A	O	I/P	p.107
40	oh1E28	User function output8	User Output8	-32767-32767		0	-/A	O	I/P	p.107
41	oh1E29	User function9	User Func9	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				27	UPCOUNT					
				28	DOWNCOUNT					
42	oh1E2A	User function input9-A	User Input9-A	0-0xFFFF		0	X/A	O	I/P	p.107
43	oh1E2B	User function input9-B	User Input9-B	0-0xFFFF		0	X/A	O	I/P	p.107
44	oh1E2C	User function input9-C	User Input9-C	0-0xFFFF		0	X/A	O	I/P	p.107
45	oh1E2D	User function output9	User Output9	-32767-32767		0	-/A	O	I/P	p.107
46	oh1E2E	User function10	User Func10	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
47	0h1E2F	User function input10-A	User Input10-A	0-0xFFFF		0	X/A	O	I/P	p.107
48	0h1E30	User function input10-B	User Input10-B	0-0xFFFF		0	X/A	O	I/P	p.107
49	0h1E31	User function input10-C	User Input10-C	0-0xFFFF		0	X/A	O	I/P	p.107
50	0h1E32	User function output10	User Output10	-32767-32767		0	-/A	O	I/P	p.107
51	0h1E33	User function11	User Func11	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
52	oh1E34	User function input11-A	User Input11-A	0-0xFFFF		0	X/A	O	I/P	p.107
53	oh1E35	User function input11-B	User Input11-B	0-0xFFFF		0	X/A	O	I/P	p.107
54	oh1E36	User function input11-C	User Input11-C	0-0xFFFF		0	X/A	O	I/P	p.107
55	oh1E37	User function output11	User Output11	-32767-32767		0	-/A	O	I/P	p.107
56	oh1E38	User function12	User Func12	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
57	0h1E39	User function input12-A	User Input12-A	0-0xFFFF		0	X/A	O	I/P	p.107
58	0h1E3A	User function input12-B	User Input12-B	0-0xFFFF		0	X/A	O	I/P	p.107
59	0h1E3B	User function input12-C	User Input12-C	0-0xFFFF		0	X/A	O	I/P	p.107
60	0h1E3C	User function output12	User Output12	-32767-32767		0	-/A	O	I/P	p.107
61	0h1E3D	User function13	User Func13	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
62	0h1E3E	User function input13-A	User Input13-A	0-0xFFFF		0	X/A	O	I/P	p.107
63	0h1E3F	User function input13-B	User Input13-B	0-0xFFFF		0	X/A	O	I/P	p.107
64	0h1E40	User function input13-C	User Input13-C	0-0xFFFF		0	X/A	O	I/P	p.107
65	0h1E41	User function output13	User Output13	-32767-32767		0	-/A	O	I/P	p.107
66	0h1E42	User function14	User Func14	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
67	oh1E43	User function input14-A	User Input14-A	0-0xFFFF		0	X/A	O	I/P	p.107
68	oh1E44	User function input14-B	User Input14-B	0-0xFFFF		0	X/A	O	I/P	p.107
69	oh1E45	User function input14-C	User Input14-C	0-0xFFFF		0	X/A	O	I/P	p.107
70	oh1E46	User function output14	User Output14	-32767-32767		0	-/A	O	I/P	p.107
71	oh1E47	User function15	User Func15	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					

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Code	Comm. Address	Name	LCD Display	Setting Range	Initial Value	Property*	V/F	SL	Ref.
				3 ADDSUB					
				4 MIN					
				5 MAX					
				6 ABS					
				7 NEGATE					
				8 MPYDIV					
				9 REMAINDER					
				10 COMPARE-GT					
				11 COMPARE-GEQ					
				12 COMPARE-EQUAL					
				13 COMPARE-NEQUAL					
				14 TIMER					
				15 LIMIT					
				16 AND					
				17 OR					
				18 XOR					
				19 ANDOR					
				20 SWITCH					
				21 BITTEST					
				22 BITSET					
				23 BITCLEAR					
				24 LOWPASSFILTER					
				25 PI_CONTORL					
				26 PI_PROCESS					
				27 UPCOUNT					
				28 DOWNCOUNT					
72	0h1E48	User function input15-A	User Input15-A	0-0xFFFF	0	X/A	O	I/P	p.107
73	0h1E49	User function input15-B	User Input15-B	0-0xFFFF	0	X/A	O	I/P	p.107
74	0h1E4A	User function input15-C	User Input15-C	0-0xFFFF	0	X/A	O	I/P	p.107
75	0h1E4B	User function	User Output1	-32767-32767	0	-/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		output15	5							
76	oh1E4C	User function 16	User Func16	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
77	oh1E4D	User function input16-A	User Input16-A	0-0xFFFF		0	X/A	O	I/P	p.107
78	oh1E4E	User function input16-B	User Input16-B	0-0xFFFF		0	X/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
79	0h1E4F	User function input16-C	User Input16-C	0-0xFFFF		0	X/A	O	I/P	p.107
80	0h1E50	User function output16	User Output16	-32767-32767		0	-/A	O	I/P	p.107
81	0h1E51	User function 17	User Func17	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					
				27	UPCOUNT					
				28	DOWNCOUNT					
82	0h1E52	User function	User Input17-	0-0xFFFF		0	X/A	O	I/P	p.107

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
		input17-A	A							
83	oh1E53	User function input17-B	User Input17-B	0-0xFFFF		0	X/A	O	I/P	p.107
84	oh1E54	User function input17-C	User Input17-C	0-0xFFFF		0	X/A	O	I/P	p.107
85	oh1E55	User function output17	User Output17	-32767-32767		0	-/A	O	I/P	p.107
86	oh1E56	User function 18	User Func18	0	NOP	0:NOP	X/A	O	I/P	p.107
				1	ADD					
				2	SUB					
				3	ADDSUB					
				4	MIN					
				5	MAX					
				6	ABS					
				7	NEGATE					
				8	MPYDIV					
				9	REMAINDER					
				10	COMPARE-GT					
				11	COMPARE-GEQ					
				12	COMPARE-EQUAL					
				13	COMPARE-NEQUAL					
				14	TIMER					
				15	LIMIT					
				16	AND					
				17	OR					
				18	XOR					
				19	ANDOR					
				20	SWITCH					
				21	BITTEST					
				22	BITSET					
				23	BITCLEAR					
				24	LOWPASSFILTER					
				25	PI_CONTORL					
				26	PI_PROCESS					

Code	Comm. Address	Name	LCD Display	Setting Range		Initial Value	Property*	V/F	SL	Ref.
				27	UPCOUNT					
				28	DOWNCOUNT					
87	oh1E57	User function input18-A	User Input18-A	0-0xFFFF		0	X/A	O	I/P	*p.107*
88	oh1E58	User function input18-B	User Input18-B	0-0xFFFF		0	X/A	O	I/P	*p.107*
89	oh1E59	User function input18-C	User Input18-C	0-0xFFFF		0	X/A	O	I/P	*p.107*
90	oh1E5A	User function output18	User Output18	-32767-32767		0	-/A	O	I/P	*p.107*

8.14 Groups for LCD Keypad Only

8.14.1 Trip Mode (TRP Last-x)

Code	Name	LCD Display	Setting Range		Initial Value	Ref.
00	Trip type display	Trip Name(x)	-		-	-
01	Frequency reference at trip	Output Freq	-		-	-
02	Output current at trip	Output Current	-		-	-
03	Acceleration/Deceleration state at trip	Inverter State	-		-	-
04	DC section state	DCLink Voltage	-		-	-
05	NTC temperature	Temperature	-		-	-
06	Input terminal state	DI Status	-		0000 0000	-
07	Output terminal state	DO Status	-		000	-
08	Trip time after Power on	Trip On Time	-		0/00/00	-
09 10	Trip time after operation start	Trip Run Time	-		0/00/00 00:00	-
10	Delete trip history	Trip Delete?	0	No		
			1	Yes		

8.14.2 Config Mode (CNF)

Code	Name	LCD Display	Setting Range		Initial Value	Ref.
00	Jump code	Jump Code	1-99		42	p.43
01	Keypad language selection	Language Sel	0 : English		0 : English	p.207
02	LCD constrast adjustment	LCD Contrast	-		-	p.189
03	Multi keypad ID	Multi KPD ID	3-99		3	p.105
10	Inverter S/W	Inv S/W Ver	-		-	p.189
11	LCD keypad S/W	Keypad S/W Ver	-		-	p.189
12	LCD keypad title	KPD Title Ver	-		-	p.189
20	Status window display item	Anytime Para	0	Frequency	0: Frequency	p.207
21	Monitor mode display item1	Monitor Line-1	1	Speed	0: Frequency	p.207

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Code	Name	LCD Display	Setting Range		Initial Value	Ref.
22	Monitor mode display item2	Monitor Line-2	2	Output Current	2:Output Current	p.207
23	Monitor mode display item3	Monitor Line-3	3	Output Voltage	3:Output Voltage	p.207
			4	Output Power		
			5	WHour Counter		
			6	DCLink Voltage		
			7	DI State		
			8	DO State		
			9	V1 Monitor(V)		
			10	V1 Monitor(%)		
			13	V2 Monitor(V)		
			14	V2 Monitor(%)		
			15	I2 Monitor(mA)		
			16	I2 Monitor(%)		
			17	PID Output		
			18	PID Ref Value		
			19	PID Fdb Value		
			20	Torque		
			21	Torque Limit		
			23	Speed Limit		
			24	Load Speed		
24	Monitor mode initialization	Mon Mode Init	0	No	0:No	p.207
			1	Yes		
30	Option slot 1 type	Option-1 Type	0	None	0:None	p.189
31	Option slot 2 type	Option-2 Type	6	Ethernet	0:None	p.189
32	Option slot 3 type display	Option-3 Type	9	CANopen	0:None	p.189
40	Parameter initialization	Parameter Init	0	No		p.183
			1	All Grp		
			2	DRV Grp		
			3	BAS Grp		
			4	ADV Grp		
			5	CON Grp		
			6	IN Grp		
			7	OUT Grp		
			8	COM Grp		

Code	Name	LCD Display	Setting Range		Initial Value	Ref.
			9	APP Grp		
			11	APO Grp[72]		
			12	PRT Grp		
			13	M2 Grp		
41	Display changed Parameter	Changed Para	0	View All	0:View All	p.186
			1	View Changed		
42	Multi key item	Multi Key Sel	0	None	0:None	p.186
			1	JOG Key		
			2	Local/Remote		
			3	UserGrp SelKey		
			4	Multi KPD		
43	Macro function item	Macro Select	0	None	0:None	-
44	Trip history deletion	Erase All Trip	0	No	0:No	p.189
			1	Yes		
45	User registration code deletion	UserGrp AllDel	0	No	0:No	p.186
			1	Yes		
46	Read parameters	Parameter Read	0	No	0:No	p.182
			1	Yes		
47	Write parameters	Parameter Write	0	No	0: No	p.182
			1	Yes		
48	Save parameters	Parameter Save	0	No	0:No	p.182
			1	Yes		
50	Hide parameter	View Lock Set	0-9999		Un-locked	p.184
51	Password for hiding parameter mode	View Lock Pw	0-9999		Password	p.184
52	Lock parameter	Key Lock Set	0-9999		Un-locked	p.185
53	Password for locking parameter edit	Key Lock Pw	0-9999		Password	p.185
60	Additional title update	Add Title Up	0	No	0:No	p.189
			1	Yes		
61	Simple parameter setting	Easy Start On	0	No	1:Yes	p.186
			1	Yes		
62	Power	WHCount Reset	0	No	0:No	p.189

[72] Supported only using Extension I/O(Option)

Code	Name	LCD Display	Setting Range		Initial Value	Ref.
	consumption		1	Yes		
70	Accumulated inverter motion	On-time	Year/month/day hour:minute		-	p.210
71	Accumulated inverter operation	Run-time	Year/month/day hour:minute		-	p.210
72	Accumulated inverter operation time initialization	Time Reset	0	No	0:No	p.210
			1	Yes		
74	Accumulated cooling fan operation time	Fan Time	Year/month/day hour:minute		-	p.210
75	Reset of accumulated cooling fan operation time	Fan Time Rst	0	No	0:No	p.210
			1	Yes		

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 Trips and Warnings

When the inverter detects a fault, it stops the operation (trips) or sends out a warning signal. When a trip or warning occurs, the keypad displays the information briefly. If the LCD keypad is used, detailed information is shown on the LCD display. Users can read the warning message at Pr.90. When more than 2 trips occur at roughly the same time, the keypad (basic keypad with 7-segment display) displays the higher priority fault information, while the LCD keypad shows the information for the fault that occurred first.

The fault conditions can be categorized as follows:

- Level: When the fault is corrected, the trip or warning signal disappears (automatically cleared) 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 trip 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. On power off, wait until the charge indicator light goes off the turn the inverter on again. If the the inverter is still in a fault condition after powering it on again, please contact the supplier or the customer service center.

9.1.1 Fault Trips

Protection Functions for Output Current and Input Voltage

Keypad Display	LCD Display	Type	Description
OLT	Over Load	Latch	Displayed when the motor overload trip is activated and the actual load level exceeds the set levels (Pr.21 and Pr.22). Operates when Pr.20 is set to a value other than 0.
ULT	Under Load	Latch	Displayed when the motor underload trip is activated and the actual load level is less than the set level. Operates when Pr.27 is set to a value other than 0.
OCT	Over Current1	Latch	Displayed when inverter output current exceeds 200% of the rated current.
ovt	Over Voltage	Latch	Displayed when internal DC circuit voltage exceeds the specified value.
LVT	Low Voltage	Level	Displayed when internal DC circuit voltage is less than the specified value.
LV2	Low Voltage2	Latch	Displayed when internal DC circuit voltage is less than the specified value during inverter operation.

Keypad Display	LCD Display	Type	Description
GFT	Ground Trip*	Latch	Displayed when a ground fault occurs on the output side of the inverter and causes the current to exceed the specified value. The specified value varies depending on inverter capacity.
ETH	E-Thermal	Latch	Displayed based on inverse time-limit thermal characteristics to prevent motor overheating. Operates when Pr.40 is set to a value other than 0.
POT	Out Phase Open	Latch	Displayed when a 3-phase inverter output has one or more phases in an open circuit condition. Operates when bit 1 of Pr.05 is set to 1.
IPO	In Phase Open	Latch	Displayed when a 3-phase inverter input has one or more phases in an open circuit condition. Operates only when bit 2 of Pr.05 is set to 1.
IOL	Inverter OLT	Latch	Displayed when the inverter has been protected from overload and resultant overheating, based on inverse time-limit thermal characteristics. Allowable overload rates for the inverter are 150% for 1 min and 200% for 4 sec. Protection is based on inverter rated capacity.
NMT	No Motor Trip	Latch	Displayed when the motor is not connected during inverter operation. Operates when Pr.31 is set to 1.

* "S" Series inverters rated for 4.0kW or less do not support the ground fault (GFT) feature. Therefore, an over current trip (OCT) or over voltage trip (OVT) may occur when there is a low-resistance ground fault.

Protection Functions - Internal Circuit Conditions and External Signals

Keypad Display	LCD Display	Type	Description
OHT	Over Heat	Latch	Displayed when the tempertature of the inverter heat sink exceeds the specified value.
OC2	Over Current2	Latch	Displayed when the DC circuit in the inverter detects a specified level of excessive, short circuit current.
EXT	External Trip	Latch	Displayed when an external fault signal is provided by the multi-function terminal. Set one of the multi-function input terminals at In.65-71 to 4 (External Trip) to enable external trip.
BX	BX	Level	Displayed when the inverter output is blocked by a signal provided from the multi-function terminal. Set one of the multi-function input terminals at In.65-71 to 5 (BX) to enable input block function.
HWT	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 Display	LCD Display	Type	Description
			keypad or memory (EEPRom) fault. ADC Off Set: An error in the current sensing circuit (U/V/W terminal, current sensor, etc.).
NTC	NTC Open	Latch	Displayed when an error is detected in the temperature sensor of the Insulated Gate Bipolar Transistor (IGBT).
FAN	Fan Trip	Latch	Displayed when an error is detected in the cooling fan. Set Pr.79 to 0 to activate fan trip (for models below 22kW capacity).
PID	Pre-PID Fail	Latch	Displayed when pre-PID is operating with functions set at AP.34–AP.36. A fault occurs when a controlled variable (PID feedback) is measured below the set value and the low feedback continues, as it is treated as a load fault.
XBR	Ext-Brake	Latch	Operates when the external brake signal is provided by the multi-function terminal. Occurs when the inverter output starting current remains below the set value at Ad.41. Set either OU.31 or OU.32 to 35 (BR Control).
SFA SFB	Safety A(B) Err	Latch	Displayed when at least one of the two safety input signals is off.

Protection Functions for Communication Options

Keypad Display	LCD Display	Type	Description
LCR	Lost Command	Level	Displayed when a frequency or operation command error is detected during inverter operation by controllers other than the keypad (e.g., using a terminal block and a communication mode). Activate by setting Pr.12 to any value other than 0.
IOT HOLD	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.
ERRC			Displayed when the S100 error code continues for more than 5 sec. ('Errc' -> '-rrc' -> E-rc' -> 'Er-c' -> 'Err-' -> '- -rc' -> 'Er- -' -> ' - - - -' -> 'Errc' -> ...)
PAR	ParaWrite Trip	Latch	Displayed when communication fails during parameter writing. Occurs when using an LCD keypad due to a control cable fault or a bad connection.
OPT	Option Trip-1	Latch	Displayed when a communication error is detected between the inverter and the communication board. Occurs when the communication option card is installed.

9.1.2 Warning Messages

Keypad Display	LCD Display	Description
OLW	Over Load	Displayed when the motor is overloaded. Operates when Pr.17 is set to 1. To operate, select 5. Set the digital output terminal or relay (OU.31 or OU.33) to 5 (Over Load) to receive overload warning output signals.
ULW	Under Load	Displayed when the motor is underloaded. Operates when Pr.25 is set to 1. Set the digital output terminal or relay (OU.31 or OU.33) to 7 (Under Load) to receive underload warning output signals.
IOLW	INV Over Load	Displayed when the overload time equivalent to 60% of the inverter overload protection (inverter IOLT) level, is accumulated. Set the digital output terminal or relay (OU.31 or OU.33) to 6 (IOL) to receive inverter overload warning output signals.
LCW	Lost Command	Lost command warning alarm occurs even with Pr.12 set to 0. The warning alarm occurs based on the condition set at Pr.13- 15. Set the digital output terminal or relay (OU.31 or OU.33) to 13 (Lost Command) to receive lost command warning output signals. If the communication settings and status are not suitable for P2P, a Lost Command alarm occurs.
FANW	Fan Warning	Displayed when an error is detected from the cooling fan while Pr.79 is set to 1. Set the digital output terminal or relay (OU.31 or OU.33) to 8 (Fan Warning) to receive fan warning output signals
EFAN	Fan Exchange	An alarm occurs when the value set at PRT-86 is less than the value set at PRT-87. To receive fan exchange output signals, set the digital output terminal or relay (OUT-31 or OUT-33) to 38 (Fan Exchange).
ECAP	CAP Exchange	Disabled – Capacitor moitoring not implemented.
DBW	DB Warn %ED	Displayed when the DB resistor usage rate exceeds the set value. Set the detection level at Pr.66.
TRER	Retry Tr Tune	Tr tune error warning alarm is activated when Dr.9 is set to 4. The warning alarm occurs when the motor's rotor time constant (Tr) is either too low or too high.

9.2 Troubleshooting Faults

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

Type	Cause	Remedy
Over Load	The load is greater than the motor's rated capacity.	Ensure that the motor and inverter have appropriate capacity ratings.
	The set value for the overload trip level (Pr.21) is too low.	Increase the set value for the overload trip level.
Under Load	There is a motor-load connection problem.	Replace the motor and inverter with models with lower capacity.

Type	Cause	Remedy
	The set value for underload level (Pr.29, Pr.30) is less than the system's minimum load.	Reduce the set value for the underload level.
Over Current1	Acc/Dec time is too short, compared to load inertia (GD2).	Increase Acc/Dec time.
	The inverter load is greater than the rated capacity.	Replace the inverter with a model that has increased capacity.
	The inverter supplied an output while the motor was idling.	Operate the inverter after the motor has stopped or use the speed search function (Cn.60).
	The mechanical brake of the motor is operating too fast.	Check the mechanical brake.
Over Voltage	Deceleration time is too short for the load inertia (GD2).	Increase the acceleration time.
	A generative load occurs at the inverter output.	Use the braking unit.
	The input voltage is too high.	Determine if the input voltage is above the specified value.
Low Voltage	The input voltage is too low.	Determine if the input voltage is below the specificed value.
	A load greater than the power capacity is connected to the system (e.g., a welder, direct motor connection, etc.)	Increase the power capacity.
	The magnetic contactor connected to the power source has a faulty connection.	Replace the magnetic contactor.
Low Voltage2	The input voltage has decreased during the operation.	Determine if the input voltage is above the specified value.
	An input phase-loss has occurred.	Check the input wiring.
	The power supply magnetic contactor is faulty.	Replace the magnetic contractor.
Ground Trip	A ground fault has occurred in the inverter output wiring.	Check the output wiring.
	The motor insulation is damaged.	Replace the motor.
E-Thermal	The motor has overheated.	Reduce the load or operation frequency.
	The inverter load is greater than the rated capacity.	Replace the inverter with a model that has increased capacity.
	The set value for electronic thermal protection is too low.	Set an appropriate electronic thermal level.
	The inverter has been operated at low speed for an extended duration.	Replace the motor with a model that supplies extra power to the cooling fan.
Output Phase Open	The magnetic contactor on the output side has a connection fault.	Check the magnetic contactor on the output side.
	The output wiring is faulty.	Check the output wiring.
Input Phase	The magnetic contactor on the input side	Check the magnetic contactor on the

Type	Cause	Remedy
Open	has a connection fault.	input side.
	The input wiring is faulty.	Check the input wiring.
	The DC link capacitor needs to be replaced.	Replace the DC link capacitors. Contact the retailer.
Inverter OLT	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 level.
Over Heat	There is a problem with the cooling system.	Determine if a foreign object is obstructing the air inlet, outlet, or vent.
	The inverter cooling fan has been operated for an extended period.	Replace the cooling fan.
	The ambient temperature is too high.	Keep the ambient temperature below 50℃.
Over Current2	Output wiring is short-circuited.	Check the output wiring.
	There is a fault with the electronic semiconductor (IGBT).	Do not operate the inverter. Contact the retailer or the customer service center.
NTC Open	The ambient temperature is too low.	Keep the ambient temperature above -10℃.
	There is a fault with the internal temperature sensor.	Contact the retailer or the customer service center.
FAN Lock	A foreign object is obstructing the fan's air vent.	Remove the foreign object from the air inlet or outlet.
	The cooling fan needs to be replaced.	Replace the cooling fan.
IP54 FAN Trip	The fan connector is not connected.	Connect the fan connector.
	The fan connector needs to be replaced.	Replace the fan connector.

9.3 Troubleshooting Other Faults

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

Type	Cause	Remedy
Parameters cannot be set.	The inverter is in operation (driving mode).	Stop the inverter to change to program mode and set the parameter.
	The parameter access is incorrect.	Check the correct parameter access level and set the parameter.
	The password is incorrect.	Check the password, disable the parameter lock and set the parameter.
	Low voltage is detected.	Check the power input to resolve the low voltage and set the parameter.
The motor does not rotate.	The frequency command source is set incorrectly.	Check the frequency command source setting.
	The operation command source is set incorrectly.	Check the operation 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 operation command is off.	Turn on the operation command (RUN).
	The motor is locked.	Unlock the motor or lower the load level.
	The load is too high.	Operate the motor independently.
	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 input option for the frequency command is incorrect.	Check the input option for the frequency command.
	The input voltage or current for the frequency command is incorrect.	Check the input voltage or current for the frequency command.
	The PNP/NPN mode is selected incorrectly.	Check the PNP/NPN mode setting.
	The frequency command value is too low.	Check the frequency command and input a value above the

Type	Cause	Remedy
		minimum frequency.
	The [STOP/RESET] key is pressed.	Check that the stoppage is normal, if so resume operation normally.
	Motor torque is too low.	Change the operation modes (V/F, IM, and Sensorless). If the fault remains, replace the inverter with a model with increased capacity.
The motor rotates in the opposite direction to the command.	The wiring for the motor output cable is incorrect.	Determine if the cable on the output side is wired correctly to the phase (U/V/W) of the motor.
	The signal connection between the control circuit terminal (forward/reverse rotation) of the inverter and the forward/reverse rotation signal on the control panel side is incorrect.	Check the forward/reverse rotation wiring.
The motor only rotates in one direction.	Reverse rotation prevention is selected.	Remove the reverse rotation prevention.
	The reverse rotation signal is not provided, even when a 3-wire sequence is selected.	Check the input signal associated with the 3-wire operation and adjust as necessary.
The motor is overheating.	The load is too heavy.	Reduce the load. Increase the Acc/Dec time.
		Check the motor parameters and set the correct values.
		Replace the motor and the inverter with models with appropriate capacity for the load.
	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 surges greater than the maximum surge voltage.
		Only use motors suitable for apllications with inverters.
		Connect the AC reactor to the inverter output (set the carrier frequency to 2 kHz).
	The motor fan has stopped or the fan is obstructed with debris.	Check the motor fan and remove

Type	Cause	Remedy
		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 the inverter with models with capacity appropriate for the load.
The motor does not accelerate. /The acceleration time is too long.	The frequency command value is low.	Set an appropriate value.
	The load is too high.	Reduce the load and 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 is still not corrected, replace the inverter with a model with increased capacity.
Motor speed varies during operation.	There is a high variance in load.	Replace the motor and inverter with models with increased capacity.
	The input voltage varies.	Reduce 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 torque is insufficient.	If motor parameters are normal, it is likely to be a motor capacity fault. Replace the motor with a model with increased capacity.
	The load is higher than the internal torque limit determined by the rated current of the inverter.	Replace the inverter with a model with increased capacity.
Operation is difficult in	The carrier frequency is too high.	Reduce the carrier frequency.

Type	Cause	Remedy
underload applications.	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.
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 200V inverters and less than 10Ω for 400V inverters.
		Check the capacity of the earth leakage breaker and make the appropriate connection, based on the rated current of the inverter.
		Lower 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.	Phase-to-phase voltage of 3-phase power source is not balanced.	Check the input voltage and balance the voltage.
		Check and test the motor's insulation.
The motor makes humming, or loud noises.	Resonance occurs between the motor's natural frequency and the carrier frequency.	Slightly increase or decrease the carrier frequency.
	Resonance occurs between the motor's natural frequency and the inverter's output frequency.	Slightly increase or decrease the carrier frequency.
		Use the frequency jump function to avoid the frequency band where resonance occurs.
The motor vibrates/hunts.	The frequency input command is an external, analog command.	In situations of noise inflow on the analog input side that results in command interference, change the input filter time constant (In.07).
	The wiring length between the inverter and the motor is too long.	Ensure that the total cable length between the inverter and the motor is less than 200m (50m for motors rated 3.7 kW or lower).
The motor does not come to	It is difficult to decelerate	Adjust the DC braking parameter.

Type	Cause	Remedy
a complete stop when the inverter output stops.	sufficiently, because DC braking is not operating normally.	Increase the set value for the DC braking current.
		Increase the set value for the DC braking stopping time.
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 exceeding the upper limit of the frequency command.	Set the upper limit of the frequency command higher than the frequency reference.
	Because the load is too heavy, the stall prevention function is working.	Replace the inverter with a model with increased capacity.
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 how to replace the cooling fan, the regular inspections to complete, and how to store and dispose of the product. An inverter is vulnerable to environmental conditions and faults can also occur due to component wear and tear. To prevent breakdowns, please follow the maintenance recommendations in this section.

Caution

- Before you inspect the product, read all safety instructions contained in this manual.
- Before you clean the product, ensure that the power is off.
- Clean the inverter with a dry cloth. Do not use wet cloths, water, solvents, or detergents. This may result in electric shock or damage to the product.

10.1 Regular Inspection Lists

10.1.1 Daily Inspections

Inspection area	Inspection item	Inspection details	Inspection method	Judgment standard	Inspection equipment
All	Ambient environment	Is the ambient temperature and humidity within the design range, and is there any dust or foreign objects present?	Refer to 1.3 *Installation Considerations* on page 4.	No icing (ambient temperature: -10 - +40) and no condensation (ambient humidity below 50%)	Thermometer, hygrometer, recorder
	Inverter	Is there any abnormal vibration or noise?	Visual inspection	No abnormality	
	Power voltage	Are the input and output voltages normal?	Measure voltages between R/ S/ T-phases in. the inverter terminal block.	Refer to 11.1 *Drive Ratings*.	Digital multimeter tester

Inspection area	Inspection item	Inspection details	Inspection method	Judgment standard	Inspection equipment
Input/Output circuit	Smoothing capacitor	Is there any leakage from the inside?	Visual inspection	No abnormality	-
		Is the capacitor swollen?			
Cooling system	Cooling fan	Is there any abnormal vibration or noise?	Turn off the system and check operation by rotating the fan manually.	Fan rotates smoothly	-
Display	Measuring device	Is the display value normal?	Check the display value on the panel.	Check and manage specified values.	Voltmeter, ammeter, etc.
Motor	All	Is there any abnormal vibration or noise?	Visual inspection	No abnormality	-
		Is there any abnormal smell?	Check for overheating or damage.		

10.1.2 Annual Inspections

Inspection area	Inspection item	Inspection details	Inspection method	Judgment standard	Inspection equipment
Input/Output circuit	All	Megger test (between input/output terminals and and earth terminal)	Disconnect inverter and short R/S/T/U/V/W terminals, and then measure from each terminal to the ground terminal using a Megger.	Must be above 5 MΩ	DC 500 V Megger
		Is there anything loose in the device?	Tighten up all screws.	No abnormality	
		Is there any evidence of parts	Visual inspection		

Inspection area	Inspection item	Inspection details	Inspection method	Judgment standard	Inspection equipment
		overheating?			
	Cable connections	Are there any corroded cables?	Visual inspection	No abnormality	-
		Is there any damage to cable insulation?			
	Terminal block	Is there any damage?	Visual inspection	No abnormality	-
	Smoothing condenser	Measure electrostatic capacity.	Measure with capacity meter.	Rated capacity over 85%	Capacity meter
	Relay	Is there any chattering noise during operation?	Visual inspection	No abnormality	-
		Is there any damage to the contacts?	Visual inspection		
	Braking resistor	Is there any damage from resistance?	Visual inspection	No abnormality	Digital multimeter / anaog tester
		Check for disconnection.	Disconnect one side and measure with a tester.	Must be within ±10% of the rated value of the resistor.	
Control circuit Protection circuit	Operation check	Check for output voltage imbalance while the inverter is in operation.	Measure voltage between the inverter output terminal U/V/W.	Balance the voltage between phases: within 4V for 200V series and within 8V for 400V series.	Digital multimeter or DC voltmeter
		Is there an error in the display circuit after the sequence protection test?	Test the inverter ouput protection in both short and open circuit conditions.	The circuit must work according to the sequence.	
Cooling system	Cooling fan	Are any of the fan parts loose?	Check all connected parts	No abnormality	-

Inspection area	Inspection item	Inspection details	Inspection method	Judgment standard	Inspection equipment
			and tighten all screws.		
Display	Display device	Is the display value normal?	Check the command value on the display device.	Specified and managed values must match.	Voltmeter, Ammeter, etc.

10.1.3 Bi-annual Inspections

Inspection area	Inspection item	Inspection details	Inspection method	Judgment standard	Inspection equipment
Motor	Insulation resistance	Megger test (between the input, output and earth terminals).	Disconnect the cables for terminals U/V/W and test the wiring.	Must be above 5 MΩ	DC 500 V Megger

Caution

Do not run an insulation resistance test (Megger) on the control circuit as it may result in damage to the product.

10.2 Storage and Disposal

10.2.1 Storage

If you are not using the product for an extended period, store it in the following way:

- Store the product in the same environmental conditions as specified for operation (refer to 1.3_*Installation Considerations*).
- When storing the product for a period longer than 3 months, store it between 10˚C and 30˚C, to prevent depletion of the electrolytic capacitor.
- 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.

10.2.2 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. Some of the plastic parts can also be recycled.

Caution

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.

11 Technical Specification

11.1 Drive Ratings

3 Phase 240V, 0.5 HP-10 HP (0.4 – 7.5 kW)

Model RSI-xxx-SS-2-C			000.5	001	002	003	005	007	010
Applied motor	Heavy load	HP	0.5	1.0	2.0	3.0	5.0	7.5	10
		kW	0.4	0.75	1.5	2.2	3.7	5.5	7.5
	Normal load	HP	1.0	2.0	3.0	5.0	5.4	10	15
		kW	0.75	1.5	2.2	3.7	4.0	7.5	11
Rated output	Rated apacity (kVA)	Heavy load	1.0	1.9	3.0	4.2	6.1	9.1	12.2
		Normal load	1.2	2.3	3.8	4.6	6.9	11.4	15.2
	Rated current [3-Phase input] (A)	Heavy load	2.5	5.0	8.0	11.0	16.0	24	32
		Normal load	3.1	6.0	9.6	12.0	18.0	30	40
	Rated current [Single-Phase input] (A)	Heavy load	1.5	2.8	4.6	6.1	8.8	13	18
		Normal load	1.8	3.3	5.7	6.6	9.9	16	22
	Output frequency		0-400 Hz (IM Sensorless: 0-120 Hz)						
	Output voltage (V)		3-phase 200-240 V						
Rated input	Working voltage (V)		3-phase 200-240 VAC (-15% to +10%) Single phase 240VAC(-5% to +10%)						
	Input frequency		50-60 Hz (±5%) (In case of single phase input, input frequency is only 60Hz(±5%).)						
	Rated current (A)	Heavy load	2.2	4.9	8.4	11.8	17.5	25.8	34.9
		Normal load	3.0	6.3	10.8	13.1	19.4	32.7	44.2
Weight (lb /kg)			2/0.9	2/0.9	2.86/1.3	3.3/1.5	4.4/2.0	7.3/3.3	7.3/3.3

- The standard motor capacity is based on a standard 4-pole motor.
- The standard used for 200 V inverters is based on a 240 V supply voltage, and for 400V inverters is based on a 480 V supply voltage.
- The rated output current is limited based on the carrier frequency set at Cn.04.
- The output voltage becomes 20~40% lower during no-load operations to protect the inverter from tripping on OCT faults when the load returns (0.4~4.0kW models only).

3-Phase 480V, 0.5 HP – 10 HP (0.4 – 7.5 kW)

Model RSI-xxx-SS-4-C			000.5	001	002	003	005	007	010
Applied motor	Heavy load	HP	0.5	1.0	2.0	3.0	5.0	7.5	10
		kW	0.4	0.75	1.5	2.2	3.7	5.5	7.5
	Normal load	HP	1.0	2.0	3.0	5.0	5.4	10	15
		kW	0.75	1.5	2.2	3.7	4.0	7.5	11
Rated output	Rated capacity (kVA)	Heavy load	1.0	1.9	3.0	4.2	6.1	9.1	12.2
		Normal load	1.5	2.4	3.9	5.3	7.6	12.2	17.5
	Rated current [3-Phase input] (A)	Heavy load	1.3	2.5	4.0	5.5	8.0	12	16
		Normal load	2.0	3.1	5.1	6.9	10.0	16	23
See Warning	Rated current [Single-Phase input] (A)	Heavy load	0.8	1.5	2.3	3.1	4.8	7.1	9.5
		Normal load	1.3	1.9	3.0	3.9	5.9	9.5	14
	Output frequency		0-400 Hz (IM Sensorless: 0-120 Hz)						
	Output voltage (V)		3-phase 380-480VAC (-15% to +10%) Single phase 480VAC(-5% to +10%)						
Rated input	Working voltage (V)		50-60 Hz (±5%) (In case of single phase input, input frequency is only 60Hz(±5%).)						
	Input frequency		50-60 Hz (±5%)						
	Rated current (A)	Heavy load	1.1	2.4	4.2	5.9	8.7	12.9	17.5
		Normal load	2.0	3.3	5.5	7.5	10.8	17.5	25.4
Weight (lb /kg) w/EMC filter			2.6/1.18	2.6/1.18	3.9/1.77	4/1.80	4.9/2.23	7.3/3.3	7.5/3.4

- The standard motor capacity is based on a standard 4-pole motor.
- The standard used for 200 V inverters is based on a 240 V supply voltage, and for 400V inverters is based on a 480 V supply voltage.
- The rated output current is limited based on the carrier frequency set at Cn.04.
- The output voltage becomes 20~40% lower during no-load operations to protect the inverter from the impact of the motor closing and opening (0.4~4.0kW models only).
- **Warning – 480V units only - When using single phase input, the built-in EMC filter must be disconnected. See section 2.2, Cable Wiring, Step 6.**

Note

Precautions for 1–phase input to 3-phase drive

- **Warning – 480V units only - When using single phase input, the built-in EMC filter must be disconnected. See section 2.2, Cable Wiring, Step 6.**
- Please connect single-phase input to R(L1) and T(L3).
- AC or DC reactor is necessary to reduce DC ripple. For 0.5HP-10HP (0.4~7.5kW), external AC or DC reactor should be installed.
- Same peripheral devices (including a fuse and reactor) as 3-phase can be used for 1-phase as well.
- If phase open trip occurs, turn off the input phase protection(PR-05).
- Protection for output current like OCT or IOLT is based on 3-phase ratings. User should set the parameters that are relative to motor information(bA-11~16), overload trip(Pr-17~22) and E-thermal functions(Pr-40~43)
- Performance of sensorless control could be unstable depending on DC ripple.
- The minimum input voltage must be larger than 228Vac for 240Vac supply and 456Vac for 480Vac supply to ensure motor voltage production of 207Vac and 415Vac, respectively.
- **To minimize the effect of voltage deprivation, please choose 208Vac motor for 240Vac supply and 400Vac motor for 480Vac supply.**

11.2 Product Specification Details

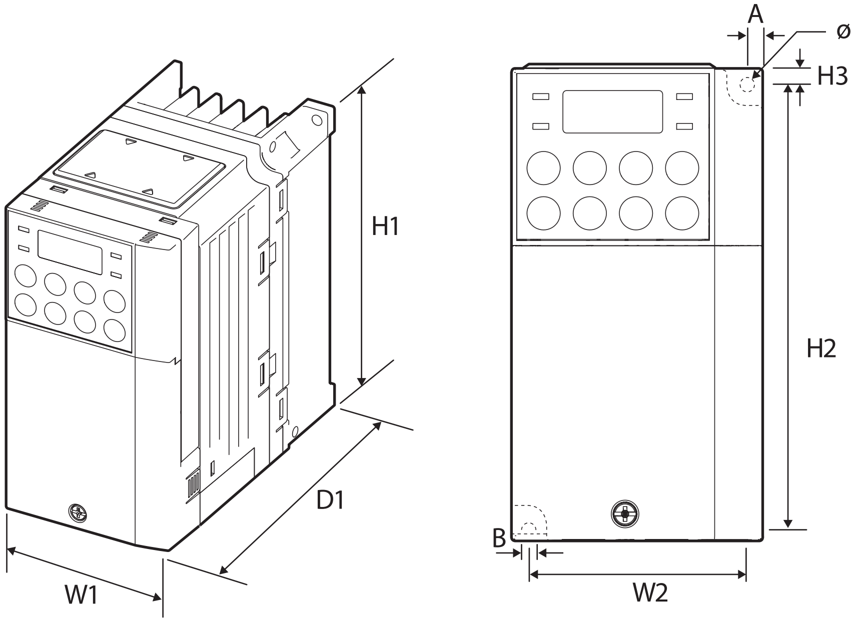
Items			Description	
Control	Control method		V/F control, slip compensation, sensorless vector	
	Frequency settings power resolution		Digital command: 0.01 Hz Analog command: 0.06 Hz (60 Hz standard)	
	Frequency accuracy		1% of maximum output frequency	
	V/F pattern		Linear, square reduction, user V/F	
	Overload capacity		Heavy load rated current: 150% 1 min, normal load rated current: 120% 1 min	
	Torque boost		Manual torque boost, automatic torque boost	
Operation	Operation type		Select key pad, terminal strip, or communication operation	
	Frequency settings		Analog type: -10~10V, 0~10V, 4~20mA Digital type: key pad, pulse train input	
	Operation function		• PID control • 3-wire operation • Frequency limit • Second function • Anti-forward and reverse direction rotation • Commercial transition • Speed search • Power braking • Leakage reduction	• Up-down operation • DC braking • Frequency jump • Slip compensation • Automatic restart • Automatic tuning • Energy buffering • Flux braking • Fire Mode
	Input	Multi function terminal P1-P5	Select PNP (Source) or NPN (Sink) mode. Functions can be set according to In.65- In.69 codes and parameter settings. (Standard I/O is only provided for P5.)	
			• Forward direction operation • Reset • Emergency stop • Multi step speed frequency-high/med/low • DC braking during stop • Frequency increase • 3-wire • Local/remote operation mode transition • Select acc/dec/stop	• Reverse direction operation • External trip • Jog operation • Multi step acc/dec-high/med/low • Second motor selection • Frequency reduction • Fix analog command frequency • Transtion from PID to general operation
		Pulse train	0-32 kHz, Low Level: 0-2.5V, High Level: 3.5-12V	
	Output	Multi function	Fault output and inverter operation status output	Less than DC 24V, 50mA

Items			Description	
		open collector terminal		
		Multi function relay terminal		Less than AC250V 1A, Less than DC 30V, 1A (N.O., N.C.)
		Analog output	0-12Vdc (0-24mA): Select frequency, output current, output voltage, DC terminal voltage and others	
		Pulse train	Maximum 32 kHz, 10-12V	
Protection function	Trip		• Over current trip • External signal trip • ARM short circuit current trip • Over heat trip • Input imaging trip • Ground trip • Motor over heat trip • I/O board link trip • No motor trip • Parameter writing trip • Emergency stop trip • Command loss trip • External memory error • CPU watchdog trip • Motor normal load trip	• Over voltage trip • Temperature sensor trip • Inverter over heat • Option trip • Output imaging trip • Inverter overload trip • Fan trip • Pre-PID operation failure • External break trip • Low voltage trip during operation • Low voltage trip • Safety A(B) trip • Analog input error • Motor overload trip
	Alarm		Command loss trip alarm, overload alarm, normal load alarm, inverter overload alarm, fan operation alarm, resistance braking rate alarm, number of corrections on rotor tuning error	
	Instantaneous Power Outage		Heavy load less than 15 ms (normal load less than 8 ms): continue operation (must be within the rated input voltage and rated output range) Heavy load more than 15 ms (normal load more than 8 ms): auto restart operation	
Structure/ working environment	Cooling type		Forced fan cooling structure Forced cooling type: 0.5 HP – 10 HP (0.4-7.5 Kw) 200v/400V	
	Protection structure		IP 20 , UL Open Type (UL Enclosed Type 1 is satisfied by conduit installation option.)	
	Ambient temperature		Heavy load: -10-50℃ (14–122°F), normal load: -10-40℃ (14–104°F) No ice or frost should be present.	

Items		Description
		Working under normal load at 50℃ (122°F), it is recommended that less than 80% load is applied.
	Ambient humidity	Relative humidity less than 90% RH (to avoid condensation forming)
	Storage temperature.	-20°C-65°C (-4–149°F)
	Surrounding environment	Prevent contact with corrosive gases, inflammable gases, oil stains, dust, and other pollutants (Pollution Degree 3 Environment).
	Operation altitude/oscillation	No higher than 3280ft (1,000m). Less than 9.8m/sec² (1G).
	Pressure	70-106 kPa

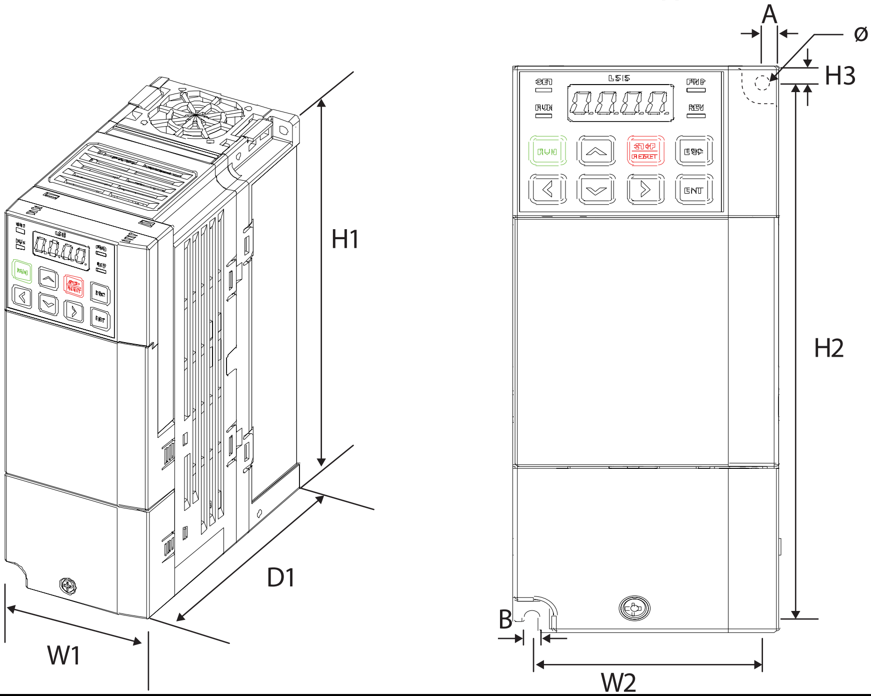
11.3 External Dimensions (IP 20 Type)

240V, 0.5 HP – 1.0 HP (0.4-0.8 kW), 3-Phase



Voltage	HP (kW)	W1	W2	H1	H2	H3	D1	A	B	Φ
240	0.5 (0.4)	68 (2.68)	61.1 (2.41)	128 (5.04)	119 (4.69)	5 (0.20)	123 (4.84)	3.5 (0.14)	4 (0.16)	4.2 (0.17)
240	1.0 (0.8)	68 (2.68)	61.1 (2.41)	128 (5.04)	119 (4.69)	5 (0.20)	128 (5.04)	3.5 (0.14)	4 (0.16)	4 (0.16)

480V, 0.5 HP – 1.0 HP (0.4 -0.8kW), 3-Phase, EMC filter Type

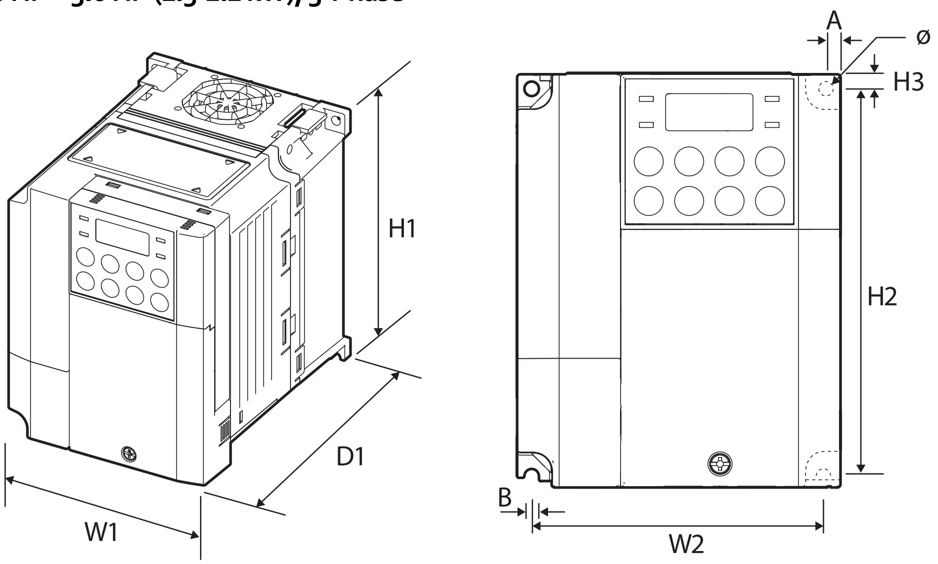


Voltage	HP (kW)	W1	W2	H1	H2	H3	D1	A	B	Φ
480 EMC Type	0.5 (0.4) 1.0 (0.8)	68 (2.68)	63.5 (2.50)	180 (7.09)	170.5 (6.71)	5 (0.20)	130 (5.12)	4.5 (0.18)	4.5 (0.18)	4.2 (0.17)

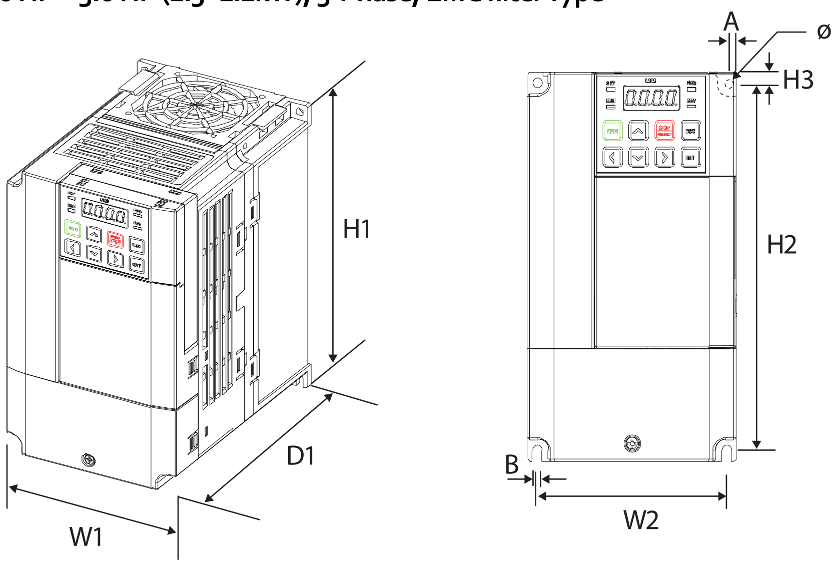
Units: mm (inches)

Specification

240V, 2.0 HP – 3.0 HP (1.5-2.2 kW), 3-Phase

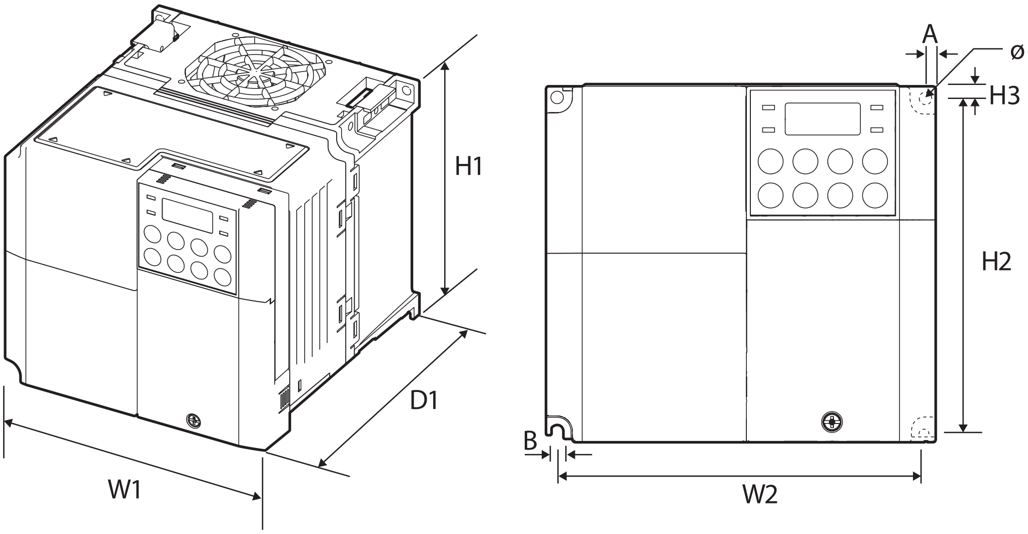


480V, 2.0 HP – 3.0 HP (1.5~2.2kW), 3-Phase, EMC filter Type

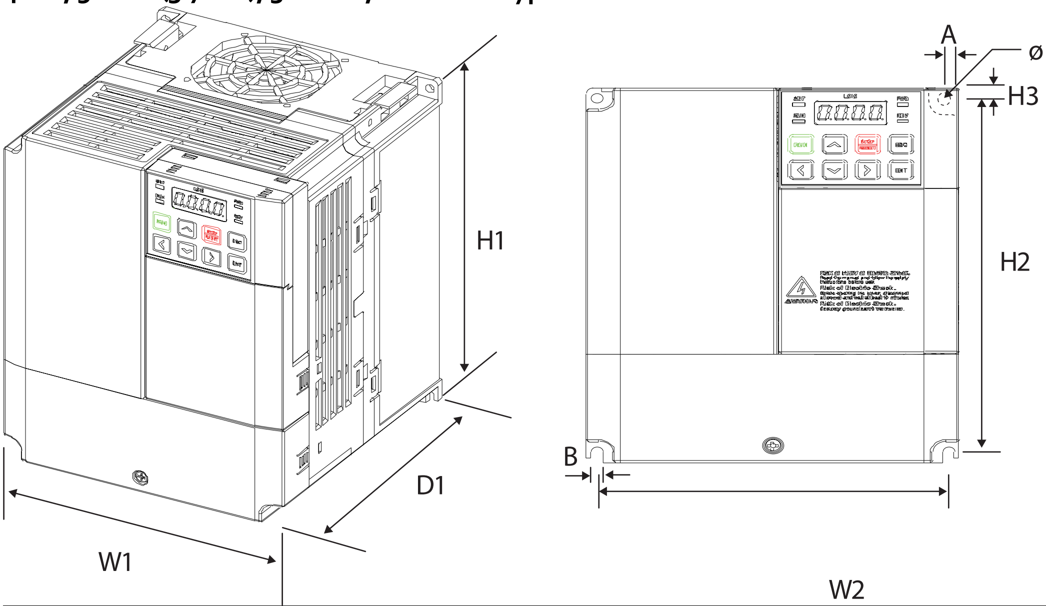


Voltage	HP(kW)	W1	W2	H1	H2	H3	D1	A	B	Φ
240	2.0 (1.5)	100 (3.94)	91 (3.58)	128 (5.04)	120 (4.72)	4.5 (0.18)	130 (5.12)	4.5 (0.18)	4.5 (0.18)	4.5 (0.18)
240	3.0 (2.2)	100 (3.94)	91 (3.58)	128 (5.04)	120 (4.72)	4.5 (0.18)	145 (5.71)	4.5 (0.18)	4.5 (0.18)	4.5 (0.18)
480 EMC Type	2.0(1.5) 3.0 (2.2)	100 (3.94)	91 (3.58)	180 (7.09)	170 (6.69)	5 (0.20)	140 (5.51)	4.5 (0.18)	4.5 (0.18)	4.2 (0.17)

240V, 5.0 HP (3.7 kW), 3 Phase



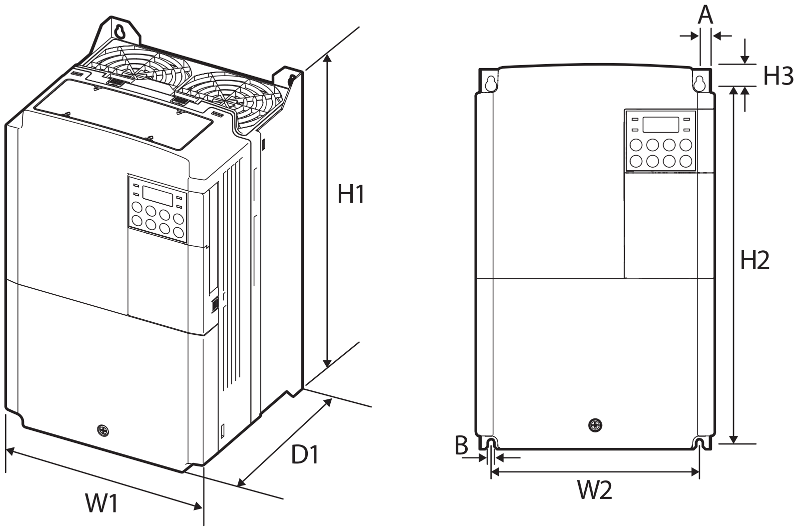
480V, 5.0 HP (3.7 kW), 3-Phase, EMC filter Type



Voltage	HP (kW)	W1	W2	H1	H2	H3	D1	A	B	Φ
240	5.0 (3.7)	140 (5.51)	132.2 (5.20)	128 (5.04)	120.7 (4.75)	3.7 (0.15)	145 (5.71)	3.9 (0.15)	4.4 (0.17)	4.5 (0.18)
480 EMC Type	5.0 (3.7)	140 (5.51)	132 (5.20)	180 (7.09)	170 (6.69)	5 (0.20)	140 (5.51)	4 (0.16)	4 (0.16)	4.2 (0.17)

Units: mm (inches)

240V, 7.5 HP – 10 HP (5.5-7.5 kW), 3-Phase
480V, 7.5 HP – 10 HP (5.5-7.5 kW), 3-Phase, EMC Filter Type



Voltage	HP (kW)	W1	W2	H1	H2	H3	D1	A	B	Φ
240	7.5 (5.5) 10 (7.5)	160 (6.30)	137 (5.39)	232 (9.13)	216.5 (8.52)	10.5 (0.41)	140 (5.51)	5 (0.20)	5 (0.20)	-
480	7.5 (5.5) 10 (7.5)	160 (6.30)	137 (5.39)	232 (9.13)	216.5 (8.52)	10.5 (0.41)	140 (5.51)	5 (0.20)	5 (0.20)	-

Units: mm (inches)

11.4 Fuse and Reactor Specifications

Product			AC Input Fuse		AC Reactor		DC Reactor	
Voltage	HP	kW	Current (A)	Voltage (V)	Inductance (mH)	Current(A)	Inductance (mH)	Current (A)
240	0.5	0.4	10		1.20	10	4	8.67
	1.0	0.75						
	2.0	1.5	15		0.88	14	3	13.05
	3.0	2.2	20		0.56	20	1.33	18.45
	5.0	3.7	32		0.39	30		26.35
	7.5	5.5	50		0.30	34	1.60	32
	10	7.5	63		0.22	45	1.25	43
480	0.5	0.4	10		4.81	4.8	16	4.27
	1.0	0.75						
	2.0	1.5			3.23	7.5	12	6.41
	3.0	2.2	15		2.34	10	8	8.9
	5.0	3.7	20		1.22	15	5.4	13.2
	7.5	5.5			1.12	19	3.20	17
	10	7.5	35		0.78	27	2.50	25

Caution

Only use Class H or RK5, UL listed input fuses and UL listed circuit breakers. See the table above for the voltage and current ratings for fuses and circuit breakers.

Specification

11.5 Terminal Screw Specification

Input/Output Terminal Screw Specification

Product (kW)		Terminal Screw Size	Screw Torque (Kgf·cm/Nm)
3-phase 240V	0.4	M3.5	2.1-6.1/0.2-0.6
	0.75		
	1.5		
	2.2		
	3.7	M4	
	5.5		
	7.5		
3-phase 480V	0.4	M3.5	2.1-6.1/0.2-0.6
	0.75		
	1.5		
	2.2		
	3.7	M4	
	5.5		
	7.5		

Control Circuit Terminal Screw Specification

Terminal	Terminal Screw Size	Screw Torque (Kgf·cm/Nm)
P1-P7/ CM/VR/V1/I2/AO/Q1/EG/24/TI /TO/ SA,SB,SC/S+,S-,SG	M2	2.2-2.5/0.22-0.25
A1/B1/C1	M2.6	4.0/0.4

* Standard I/O doesn't support P6/P7/TI/TO terminal. Refer to *Step 4 Control Terminal Wiring*.

① Caution

Apply the rated torque when tightening terminal screws. Loose screws may cause short circuits and malfunctions. Overtightening terminal screws may damage the terminals and cause short circuits and malfunctions. Use copper conductors only, rated at 600V, 75℃ for power terminal wiring, and rated at 300V, 75℃ for control terminal wiring.

11.6 Braking Resistor Specification

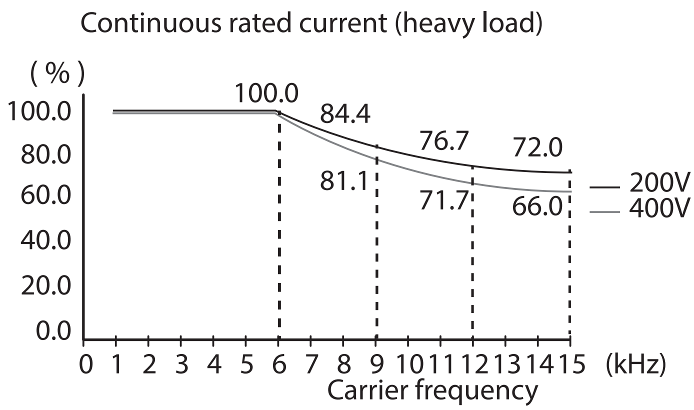
Product (kW)		Resistance (Ω)	Rated Capacity (W)
3-phase 200V	0.4	300	100
	0.75	150	150
	1.5	60	300
	2.2	50	400
	3.7	33	600
	5.5	20	800
	7.5	15	1,200
3-phase 400V	0.4	1,200	100
	0.75	600	150
	1.5	300	300
	2.2	200	400
	3.7	130	600
	5.5	85	1,000
	7.5	60	1,200

- The standard for braking torque is 150% and the working rate (%ED) is 5%. If the working rate is 10%, the rated capacity for braking resistance must be calculated at twice the standard.

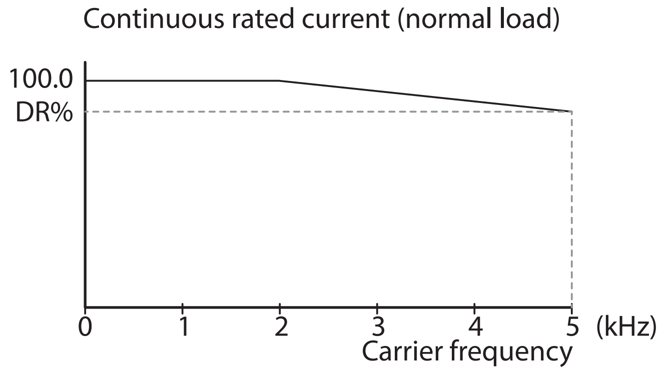
11.7 Continuous Rated Current Derating

Derating by Carrier Frequency

The continuous rated current of the inverter is limited based on the carrier frequency. Refer to the following graph.



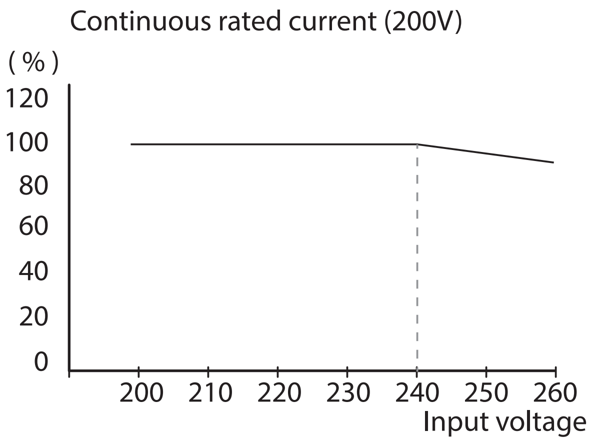
200V		400V	
Carrier Frequency (kHz)	Constant-rated Current (%)	Carrier Frequency (kHz)	Constant-rated Current (%)
1-6	100	1-6	100
9	84.4	9	81.1
12	76.7	12	71.7
15	72.0	15	66.0

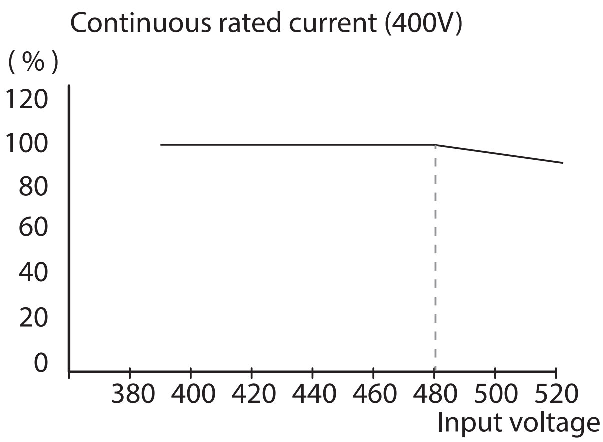


200V		400V	
Product (kW)	DR (%)	Product (kW)	DR (%)
5.5	85	5.5	81.3
7.5	85	7.5	77.2

Derating by Input Voltage

The continuous rated current of the inverter is limited based on the input voltage. Refer to the following graph.

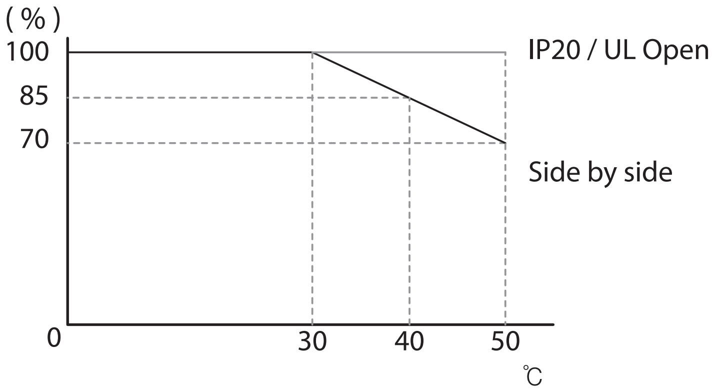




Derate by Ambient Temperature and Installation Type

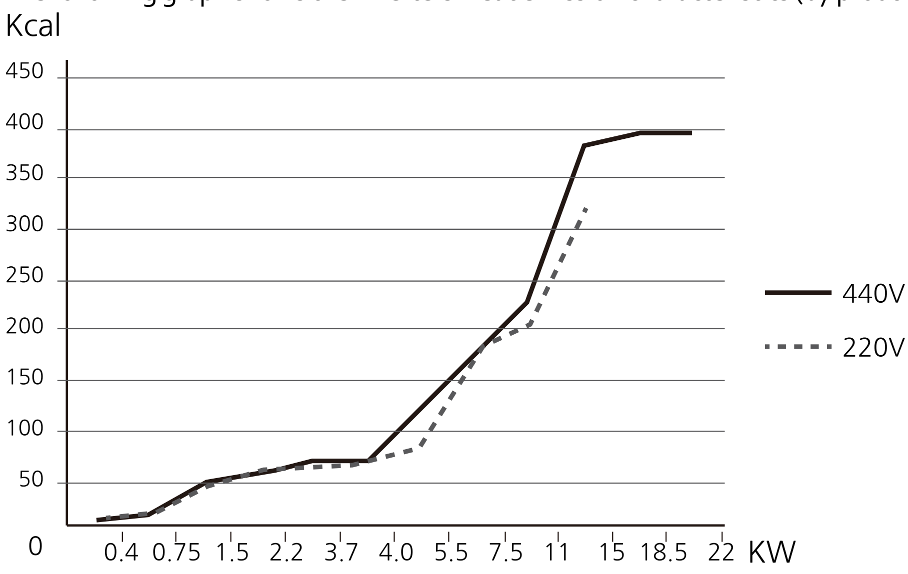
The constant-rated current of the inverter is limited based on the ambient temperature and installation type. Refer to the following graph.

Continuous rated current (400V)



11.8 Heat Emmission

The following graph shows the inverters' heat emission characteristics (by product capacity).



Heat emission data is based on operations with default carrier frequencysettings, under normal operating conditions. For detailed information on carrier frequency, refer to 5.17 *Operational Noise Settings (carrier frequency s)*.

12 Applying Drives to Single-Phase Input Application

12.1 Introduction

The "S" Series inverter is a three-phase standard variable frequency drive(VFD). When applying single-phase power to a three-phase VFD, there are several constraints that need to be considered. Standard Pulse-Width-Modulated (PWM) VFDs use a 6-pulse diode rectifier. The 6-pulse rectification results in 360 Hz DC bus ripple when used with a three-phase 60 Hz supply.
However, under single-phase use, the DC bus ripple becomes 120 Hz and the VFDs DC bus circuit is subject to higher stress in order to deliver equivalent power.
Additionally, input currents and harmonics increase beyond those encountered with three-phase input.
Input current distortion of 90% THD and greater can be expected under single-phase input compared to approximately 40% with three-phase input as indicated in Figure 2.
Therefore, single-phase use requires the three-phase VFD power rating be reduced (derated) to avoid over stressing the rectifier and DC link components.

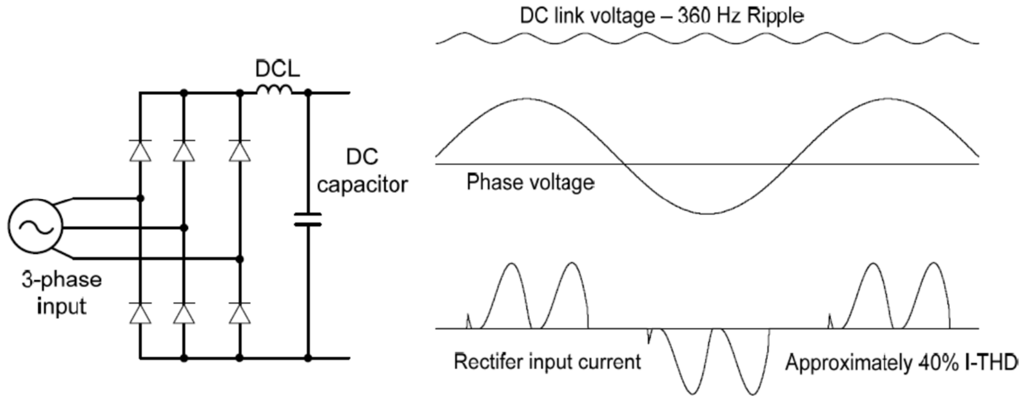


Figure-1 Typical Three-Phase Configuration

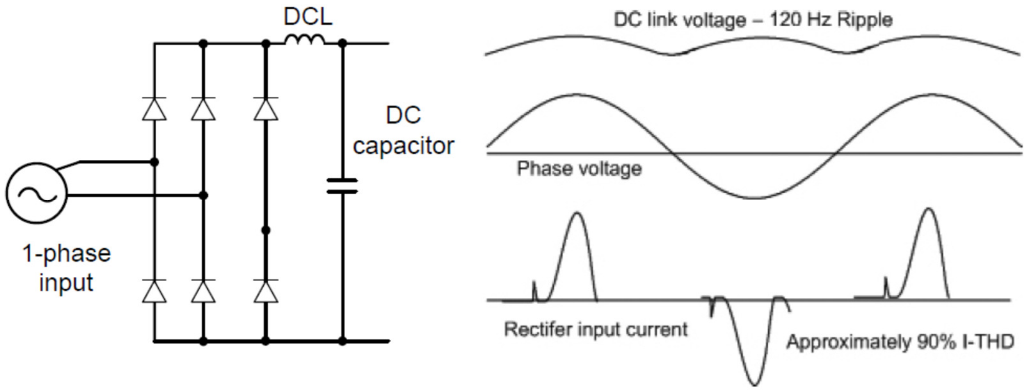


Figure-2 Typical Single-Phase Configuration

12.2 Power(HP), Input Current and Output Current

When using a three-phase VFD with single-phase input, derating the drive's output current and horsepower will be necessary because of the increase in DC bus ripple voltage and current. In addition, the input current through the remaining two phases on the diode bridge converter will approximately double, creating another derating consideration for the VFD. Input current harmonic distortion will increase beyond that with a three-phase supply making the overall input power factor low. Input current distortion over 100% is likely under single-phase conditions without a reactor. Therefore, the reactor is always required. Do not use a motor and drive of the same rating when using single phase input. This will result in poor performance and premature drive failure. The selected drive for single-phase current ratings must meet or exceed the motor current rating.

12.3 Input Frequency and Voltage Tolerance

The single-phase current ratings are valid for 60Hz input only. The AC supply voltage must be within the required voltage range of 240/480Vac +10% to –5% to maximize motor power production. Standard product with three-phase voltage input has an allowable range of +10% to –15%. Therefore, a stricter input voltage tolerance of +10 to –5% applies when using the drive with a single-phase supply. The average bus voltage with single-phase input is lower than the equivalent of a three-phase input. Therefore, the maximum output voltage (motor voltage) will be lower with a single-phase input. The minimum input voltage must be no less than 228Vac for 240 volt models and 456Vac for 480 volt models, to ensure motor voltage production of 207Vac and 415Vac, respectively. Thus, if full motor torque must be developed near base speed (full power) it will be necessary to maintain a rigid incoming line voltage so that adequate motor voltage can be produced. Operating a motor at reduced speed (reduced power), or using a motor with a base voltage that is lower than the incoming AC supply rating (ex. 208Vac motor with a 240Vac supply), will also minimize the effect of voltage deprivation. (240VAC Input →208V motor, 480VAC Input → 400V motor)

Product Warranty

Warranty Information

Fill in this warranty information form and keep this page for future reference or when warranty service may be required.

<table>
<tr><th>Product Name</th><td>Standard Inverter</td><th>Date of Installation</th><td></td></tr>
<tr><th>Model Name</th><td>RSI-xxx-SS-xC</td><th>Warranty Period</th><td></td></tr>
<tr><th rowspan="3">Customer Info</th><td>Name
(or company)</td><td colspan="2"></td></tr>
<tr><td>Address</td><td colspan="2"></td></tr>
<tr><td>Contact Info.</td><td colspan="2"></td></tr>
<tr><th rowspan="3">Retailer Info</th><td>Name</td><td colspan="2"></td></tr>
<tr><td>Address</td><td colspan="2"></td></tr>
<tr><td>Contact info.</td><td colspan="2"></td></tr>
</table>

Warranty Period

The product warranty covers product malfunctions, under normal operating conditions, for 24 months from the date of installation. If the date of installation is unknown, the product warranty is valid for 18 months from the date of manufacturing. Please note that the product warranty terms may vary depending on purchase or installation contracts.

Warranty Service Information

During the product warranty period, warranty service is provided for product malfunctions under normal operating conditions. For warranty service, contact Benshaw Service, 800-203-2416.

Non-Warranty

An inverter will not be covered under warranty for malfunctions due to the following:

- intentional abuse or negligence
- power source problems or from other appliances being connected to the product
- acts of nature (fire, flood, earthquake, etc.)
- modifications or repair by unauthorized persons
- missing authentic Benshaw name plates
- expired warranty period

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

Rev. No.	Date	Edition	Changes
0	Oct. 2016	First Release	890049-00-00, Software Ver. 2.05

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