Mechatronics Solutions

Current Vector Controlled, General-Purpose Inverter

# Varispeed F7

## Instruction Manual and Parameter Description

**Model: CIMR-F7C□□□□**


YEG -TOE-S616-55.1
based on YEC-TOE-S616-55.1

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## Warnings

**⚠ CAUTION**

Cables must not be connected or disconnected, nor signal tests carried out, while the power is switched on.

The Varispeed DC bus capacitor remains charged even after the power has been switched off. To avoid an electric shock hazard, disconnect the frequency inverter from the mains before carrying out maintenance. Then wait for at least 5 minutes after all LEDs have gone out.
Do not perform a withstand voltage test on any part of the Varispeed. The frequency inverter contains semiconductors, which are not designed for such high voltages.

Do not remove the digital operator while the mains supply is switched on. The printed circuit board must also not be touched while the inverter is connected to the power.

Never connect general LC/RC interference suppression filters, capacitors or overvoltage protection devices to the inverter input or output.

To avoid unnecessary overcurrent faults, etc, being displayed, the signaling contacts of any contactor or switch fitted between inverter and motor must be integrated into the inverter control logic (eg baseblock).

**This is absolutely imperative!**
This manual must be read thoroughly before connecting and operating the inverter. All safety precautions and instructions for use must be followed.

The inverter may must be operated with the appropriate line filters, following the installation instructions in this manual and with all covers closed and terminals covered.
Only then will adequate protection be provided. Please do not connect or operate any equipment with visible damage or missing parts. The operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this manual.

# Safety Precautions and Instructions for Use!

## ■ 1. General

Please read these safety precautions and instructions for use thoroughly before installing and operating this inverter. Also read all of the warning signs on the inverter and ensure they are never damaged or removed.

Live and hot inverter components may be accessible during operation. Removal of housing components, the digital operator or terminal covers runs the risk of serious injuries or damage in the event of incorrect installation or operation. The fact that frequency inverters control rotating mechanical machine components can give rise to other dangers.

The instructions in this manual must be followed. Installation, operation and maintenance may only be carried out by qualified personnel. For the purposes of the safety precautions, qualified personnel are defined as individuals who are familiar with the installation, starting, operation and maintenance of frequency inverters and have the proper qualifications for this work. Safe operation of these units is only possible if they are used properly for their intended purpose.

The DC bus capacitors can remain live for about 5 minutes after the inverter is disconnected from the power. It is therefore necessary to wait for this time before opening its covers. All of the main circuit terminals may still carry dangerous voltages.

Children and other unauthorized persons must not be allowed access to these inverters.

Keep these Safety Precautions and Instructions for Use readily accessible and supply them to all persons with any form of access to the inverters.

## ■ 2. Intended Use

Frequency inverters are intended for installation in electrical systems or machinery.

Their installation in machinery and systems must conform to the following product standards of the Low Voltage Directive:

| | |
|---|---|
| EN 50178, 1997-10, | Equipping of Power Systems with Electronic Devices |
| EN 60204-1, 1997-12 | Machine Safety and Equipping with Electrical Devices<br>Part 1: General Requirements (IEC 60204-1:1997)/<br>Please note: Includes Corrigendum of September 1998 |
| EN 61010-1, A2, 1995 | Safety Requirements for Information Technology Equipment<br>(IEC 950, 1991 + A1, 1992 + A2, 1993 + A3, 1995 + A4, 1996, modified) |

CE marking is carried out to EN 50178, using the line filters specified in this manual and following the appropriate installation instructions.

## ■ 3. Transportation and storage

The instructions for transportation, storage and proper handling must be followed in accordance with the technical data.

## ■ 4. Installation

Install and cool the inverters as specified in the documentation. The cooling air must flow in the specified direction. The inverter may therefore only be operated in the specified position (eg upright). Maintain the specified clearances. Protect the inverters against impermissible loads. Components must not be bent nor insulation clearances changed. To avoid damage being caused by static electricity, do not touch any electronic components or contacts.

## ■ 5. Electrical Connection

Carry out any work on live equipment in compliance with the national safety and accident prevention regulations. Carry out electrical installation in compliance with the relevant regulations. In particular, follow the installation instructions ensuring electromagnetic compatibility (EMC), eg shielding, grounding, filter arrangement and laying of cables. This also applies to equipment with the CE mark. It is the responsibility of the manufacturer of the system or machine to ensure conformity with EMC limits.

Your supplier or Yaskawa representative must be contacted when using leakage current circuit braker in conjunction with frequency inverters.

In certain systems it may be necessary to use additional monitoring and safety devices in compliance with the relevant safety and accident prevention regulations. The frequency inverter hardware must not be modified.

## ■ 6. Notes

The VARISPEED F7 frequency inverters are certified to CE, UL, and c-UL.

# EMC Compatibility

## 1. Introduction

This manual was compiled to help system manufacturers using YASKAWA frequency inverters design and install electrical switchgear. It also describes the measures necessary to comply with the EMC Directive. The manual's installation and wiring instructions must therefore be followed.

Our products are tested by authorized bodies using the standards listed below.

**Product standard:** **EN 61800-3:1996**
**EN 61800-3; A11:2000**

## 2. Measures to Ensure Conformity of YASKAWA Frequency inverters to the EMC Directive

YASKAWA frequency inverters do not necessarily have to be installed in a switch cabinet.

It is not possible to give detailed instructions for all of the possible types of installation. This manual therefore has to be limited to general guidelines.

All electrical equipment produces radio and line-borne interference at various frequencies. The cables pass this on to the environment like an aerial.

Connecting an item of electrical equipment (eg drive) to a supply without a line filter can therefore allow HF or LF interference to get into the mains.

The basic countermeasures are isolation of the wiring of control and power components, proper grounding and shielding of cables.

A large contact area is necessary for low-impedance grounding of HF interference. The use of grounding straps instead of cables is therefore definitely advisable.

Moreover, cable shields must be connected with purpose-made ground clips.

## 3. Laying Cables

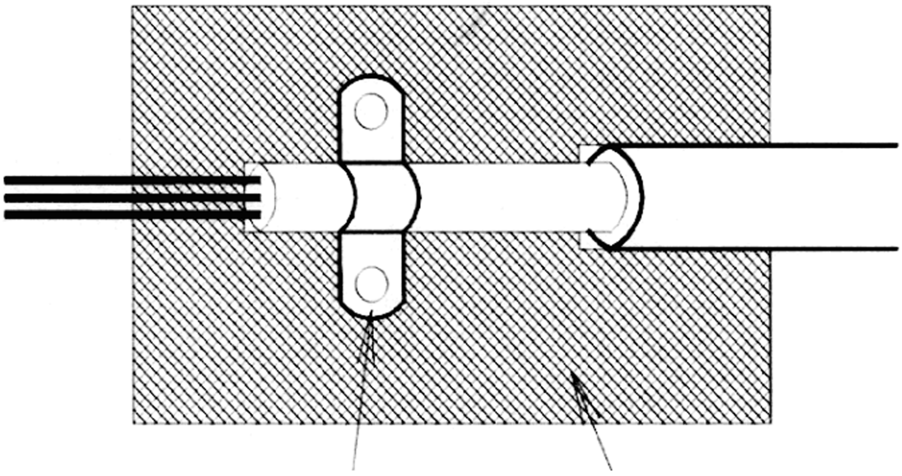
Measures Against Line-Borne Interference:

Line filter and frequency inverter must be mounted on the same metal plate. Mount the two components as close to each other as possible, with cables kept as short as possible.

Use a power cable with well-grounded shield. Use a shielded motor cable not exceeding 20 meters in length. Arrange all grounds so as to maximize the area of the end of the lead in contact with the ground terminal (eg metal plate).

Shielded Cable:

– Use a cable with braided shield.
– Ground the maximum possible area of the shield. It is advisable to ground the shield by connecting the cable to the ground plate with metal clips (see following figure).




The grounding surfaces must be highly conductive bare metal. Remove any coats of varnish and paint.

– Ground the cable shields at both ends.

– Ground the motor of the machine.

# Electromagnetic Compatibility (EMC)

## ■ Recommended Line Filters for Varispeed F7 made by Schaffner EMV AG

| Inverter Model | Line Filter (Schaffner) | | | | |
|---|---|---|---|---|---|
| Varispeed F7 | Model | EN 55011 Class* | Current (A) | Weight (kg) | Dimensions W x D x H |
| CIMR-F7C40P4 | FS 5972-10-07 | B, 50 m | 10 | 1.1 | 141 x 46 x 330 |
| CIMR-F7C40P7 | | B, 50 m | | | |
| CIMR-F7C41P5 | | B, 50 m | | | |
| CIMR-F7C42P2 | | B, 50 m | | | |
| CIMR-F7C43P7 | | B, 50 m | | | |
| CIMR-F7C44P0 | FS 5972-18-07 | B, 50 m | 18 | 1.3 | 141 x 46 x 330 |
| CIMR-F7C45P5 | | B, 50 m | | | |
| CIMR-F7C47P5 | FS 5972-21-07 | B, 50 m | 21 | 1.8 | 206 x 50 x 355 |
| CIMR-F7C4011 | FS 5972-35-07 | B, 50 m | 35 | 2.1 | 206 x 50 x 355 |
| CIMR-F7C4015 | FS 5972-60-07 | B, 50 m | 60 | 4.0 | 236 x 65 x 408 |
| CIMR-F7C4018 | | B, 50 m | | | |
| CIMR-F7C4022 | FS 5972-70-52 | B, 50 m | 70 | 3.4 | 80 x 185 x 329 |
| CIMR-F7C4030 | | B, 50 m | | | |
| CIMR-F7C4037 | FS 5972-100-35 | B, 50 m | 100 | 4.5 | 90 x 150 x 326 |
| CIMR-F7C4045 | | B, 50 m | | | |
| CIMR-F7C4055 | FS 5972-130-35 | B, 50 m | 130 | 4.7 | 90 x 180 x 366 |
| CIMR-F7C4075 | FS 5972-170-40 | B, 50 m | 170 | 6.0 | 120 x 170 x 451 |
| CIMR-F7C4090<br>CIMR-F7C4110 | FS 5972-250-37<br>or<br>FN 3359-250-28 | A, 50 m<br><br>A, 50 m | 250 | 11.7<br><br>7.0 | 130 x 240 x 610<br><br>230 x 125 x 300 |
| CIMR-F7C4132<br>CIMR-F7C4160 | FS 5972-400-99<br>or<br>FS 3359-410-99 | A, 50 m<br><br>A, 50 m | 400<br><br>410 | 18.5<br><br>10.5 | 300 x 160 x 610<br><br>260 x 115 x 386 |
| CIMR-F7C4185 | FS 5972-410-99 | A, 50 m | 410 | 10.5 | 260 x 115 x 386 |
| CIMR-F7C4220 | FS 5972-600-99 | A, 50 m | 600 | 11 | 260 x 135 x 386 |
| CIMR-F7C4300 | FS 5972-800-99 | A, 50 m | 600 | 31 | 300 x 160 x 716 |

Maximum Voltage : AC 480V 3phase
Ambient Temperature : 45°C (max.)

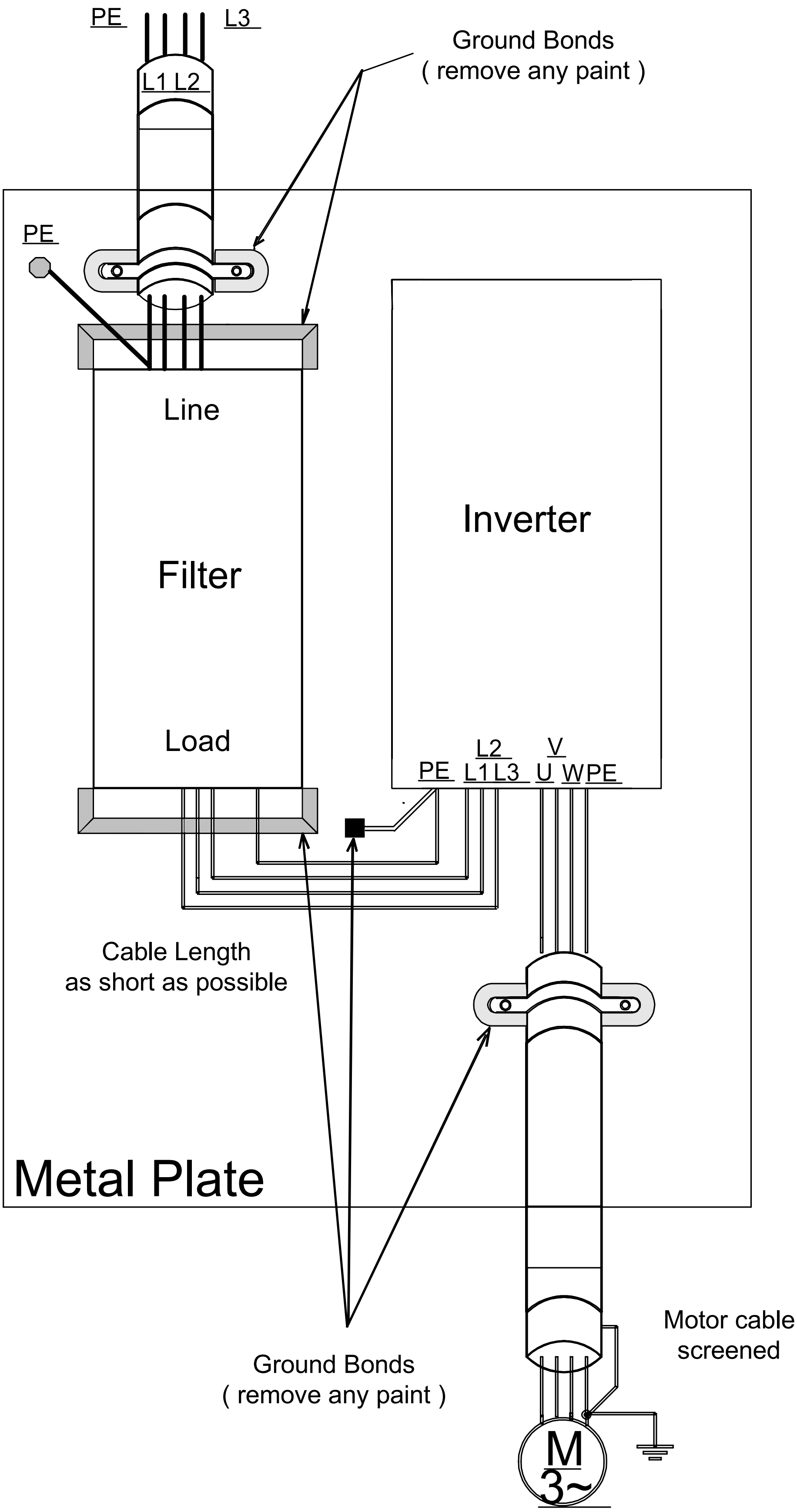
* Permissible emission of power drive systems for commercial and light environment (EN61800-3, A11) (general availability, 1st environment)

| Line Filters (Schaffner) | | | | | |
|---|---|---|---|---|---|
| **Varispeed F7** | **Type** | **EN 55011 Class** | **Current (A)** | **Weight (kg)** | **Dimensions W x D x H** |
| CIMR-F7C20P4 | FS 5972-10-07 | B* | 7 | 1.1 | 141 x 45 x 330 |
| CIMR-F7C20P7 | | B* | | | |
| CIMR-F7C21P5 | | B* | | | |
| CIMR-F7C22P2 | FS 5972-18-07 | B* | 18 | 1.7 | 141 x 46 x 330 |
| CIMR-F7C23P7 | FS 5973-35-07 | B* | 35 | 1.4 | 141 x 46 x 330 |
| CIMR-F7C25P5 | | B* | | | |
| CIMR-F7C27P5 | FS 5973-60-07 | B* | 60 | 3 | 206 x 60 x 355 |
| CIMR-F7C2011 | | B* | | | |
| CIMR-F7C2015 | FS 5973-100-07 | A | 100 | 4.9 | 236 x 80 x 408 |
| CIMR-F7C2018 | | A | | | |
| CIMR-F7C2022 | FS 5973-130-35 | A | 130 | 4.3 | 90 x 180 x 366 |
| CIMR-F7C2030 | | A | | | |
| CIMR-F7C2037 | FS 5973-160-40 | A | 160 | 6 | 120 x 170 x 451 |
| CIMR-F7C2045 | FS 5973-240-37 | A | 240 | 11 | 130 x 240 x 610 |
| CIMR-F7C2055 | | A | | | |
| CIMR-F7C2075 | FS 5973-500-37 | A | 500 | 19.5 | 300 x 160 x 564 |
| CIMR-F7C2090 | | A | | | |
| CIMR-F7C2110 | | A | | | |

* max. motor cable length: 10 m Class B, 50 m Class A

Rated Voltage: AC240V 3 ph.
Ambient Temperature: 45°C (max.)

■ **Installation inverters and EMC filters**



## Registered Trademarks

The following registered trademarks are used in this manual.

- DeviceNet is a registered trademark of the ODVA (Open DeviceNet Vendors Association, Inc.).
- InterBus is a registered trademark of Phoenix Contact Co.
- ControlNet is a registered trademark of ControlNet International, Ltd.
- LONworks is a registered trademark of the Echolon.

# 1

# Handling Inverters



This chapter describes the checks required upon receiving or installing an Inverter.

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and Front Cover ........................................................ 1-13

# Varispeed F7 Introduction

## ◆ Varispeed F7 Applications

The Varispeed F7 is ideal for the following applications.

- Fan, blower, and pump applications
- Conveyors, pushers, metal tooling machines, etc.

Settings must be adjusted to the application for optimum operation. Refer to *Fig 4 Trial Operation*.

## ◆ Varispeed F7 Models

The Varispeed F7 Series includes Inverters in two voltage classes: 200 V and 400 V. The maximum motor capacities vary from 0.55 to 300 kW (42 models).

Table 1.1  Varispeed F7 Models

| Voltage Class | Maximum Motor Capacity kW | Varispeed F7 | | Specifications (Always specify through the protective structure when ordering.) | |
|---|---|---|---|---|---|
| | | Output Capacity kVA | Basic Model Number | Open Chassis (IEC IP00) CIMR-F7C□□□□□□ | Enclosed Wall-mounted (IEC IP20, NEMA 1) CIMR-F7C□□□□□□ |
| 200 V class | 0.55 | 1.2 | CIMR-F7C20P4 | Remove the top and bottom covers from the Enclosed Wall-mounted model. | 20P41□ |
| | 0.75 | 1.6 | CIMR-F7C20P7 | | 20P71□ |
| | 1.5 | 2.7 | CIMR-F7C21P5 | | 21P51□ |
| | 2.2 | 3.7 | CIMR-F7C22P2 | | 22P21□ |
| | 3.7 | 5.7 | CIMR-F7C23P7 | | 23P71□ |
| | 5.5 | 8.8 | CIMR-F7C25P5 | | 25P51□ |
| | 7.5 | 12 | CIMR-F7C27P5 | | 27P51□ |
| | 11 | 17 | CIMR-F7C2011 | | 20111□ |
| | 15 | 22 | CIMR-F7C2015 | | 20151□ |
| | 18.5 | 27 | CIMR-F7C2018 | | 20181□ |
| | 22 | 32 | CIMR-F7C2022 | 20220□ | 20221□ |
| | 30 | 44 | CIMR-F7C2030 | 20300□ | 20301□ |
| | 37 | 55 | CIMR-F7C2037 | 20370□ | 20371□ |
| | 45 | 69 | CIMR-F7C2045 | 20450□ | 20451□ |
| | 55 | 82 | CIMR-F7C2055 | 20550□ | 20551□ |
| | 75 | 110 | CIMR-F7C2075 | 20750□ | 20751□ |
| | 90 | 130 | CIMR-F7C2090 | 20900□ | – |
| | 110 | 160 | CIMR-F7C2110 | 21100□ | – |

| Voltage Class | Maximum Motor Capacity kW | Varispeed F7 | | Specifications (Always specify through the protective structure when ordering.) | |
|---|---|---|---|---|---|
| | | Output Capacity kVA | Basic Model Number | Open Chassis (IEC IP00) CIMR-F7C□□□□□□ | Enclosed Wall-mounted (IEC IP20, NEMA 1) CIMR-F7C□□□□□□ |
| 400 V class | 0.55 | 1.4 | CIMR-F7C40P4 | Remove the top and bottom covers from the Enclosed Wall-mount model. | 40P41□ |
| | 0.75 | 1.6 | CIMR-F7C40P7 | | 40P71□ |
| | 1.5 | 2.8 | CIMR-F7C41P5 | | 41P51□ |
| | 2.2 | 4.0 | CIMR-F7C42P2 | | 42P21□ |
| | 3.7 | 5.8 | CIMR-F7C43P7 | | 43P71□ |
| | 4.0 | 6.6 | CIMR-F7C44P0 | | 44P01 |
| | 5.5 | 9.5 | CIMR-F7C45P5 | | 45P51□ |
| | 7.5 | 13 | CIMR-F7C47P5 | | 47P51□ |
| | 11 | 18 | CIMR-F7C4011 | | 40111□ |
| | 15 | 24 | CIMR-F7C4015 | | 40151□ |
| | 18.5 | 30 | CIMR-F7C4018 | | 40181□ |
| | 22 | 34 | CIMR-F7C4022 | 40220□ | 40221□ |
| | 30 | 46 | CIMR-F7C4030 | 40300□ | 40301□ |
| | 37 | 57 | CIMR-F7C4037 | 40370□ | 40371□ |
| | 45 | 69 | CIMR-F7C4045 | 40450□ | 40451□ |
| | 55 | 85 | CIMR-F7C4055 | 40550□ | 40551□ |
| | 75 | 110 | CIMR-F7C4075 | 40750□ | 40751□ |
| | 90 | 140 | CIMR-F7C4090 | 40900□ | 40901□ |
| | 110 | 160 | CIMR-F7C4110 | 41100□ | 41101□ |
| | 132 | 200 | CIMR-F7C4132 | 41320□ | 41321□ |
| | 160 | 230 | CIMR-F7C4160 | 41600□ | 41601□ |
| | 185 | 280 | CIMR-F7C4185 | 41850□ | – |
| | 220 | 390 | CIMR-F7C4220 | 42200□ | – |
| | 300 | 510 | CIMR-F7C4300 | 43000□ | – |

# Confirmations upon Delivery

## ◆ Checks

Check the following items as soon as the Inverter is delivered.

Table 1.2 Checks

| Item | Method |
|---|---|
| Has the correct model of Inverter been delivered? | Check the model number on the nameplate on the side of the Inverter. |
| Is the Inverter damaged in any way? | Inspect the entire exterior of the Inverter to see if there are any scratches or other damage resulting from shipping. |
| Are any screws or other components loose? | Use a screwdriver or other tools to check for tightness. |

If you find any irregularities in the above items, contact the agency from which you purchased the Inverter or your Yaskawa representative immediately.

## ◆ Nameplate Information

There is a nameplate attached to the side of each Inverter. The nameplate shows the model number, specifications, lot number, serial number, and other information on the Inverter.

### ■ Example Nameplate

The following nameplate is an example for a standard domestic European Inverter: 3-phase, 200 VAC, 0.55 kW, IEC IP20 and NEMA 1 standards

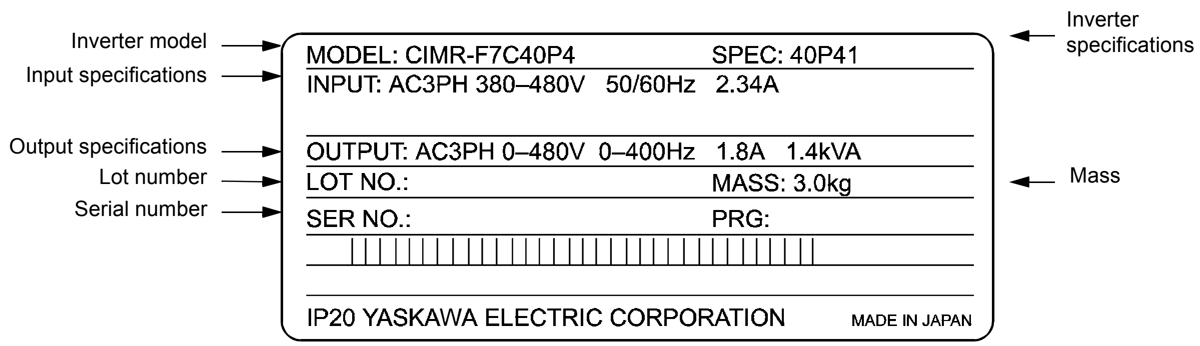



Fig 1.1 Nameplate

## ■Inverter Model Numbers

The model number of the Inverter on the nameplate indicates the specification, voltage class, and maximum motor capacity of the Inverter in alphanumeric codes.

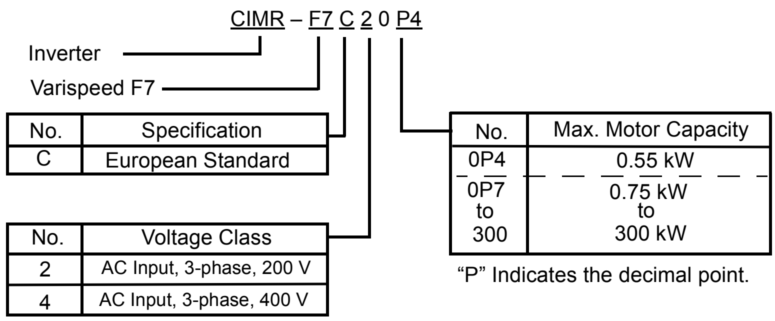



Fig 1.2 Inverter Model Numbers

1

## ■Inverter Specifications

The Inverter specifications ("SPEC") on the nameplate indicate the voltage class, maximum motor capacity, the protective structure, and the revision of the Inverter in alphanumeric codes.

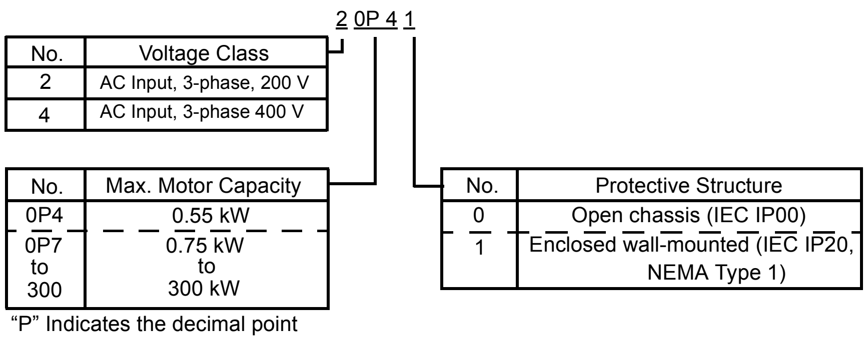



Fig 1.3 Inverter Specifications

## ◆ Component Names

### ■ Inverters of 18.5 kW or Less

The external appearance and component names of the Inverter are shown in *Fig 1.4*. The Inverter with the terminal cover removed is shown in *Fig 1.5*.

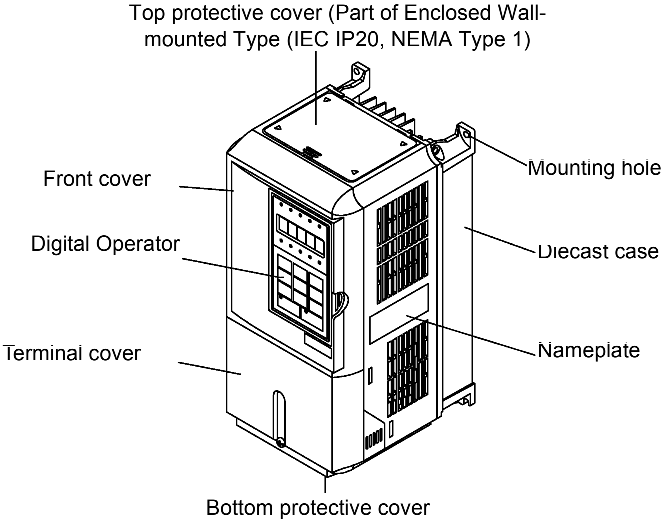



Fig 1.4 Inverter Appearance (18.5 kW or Less)

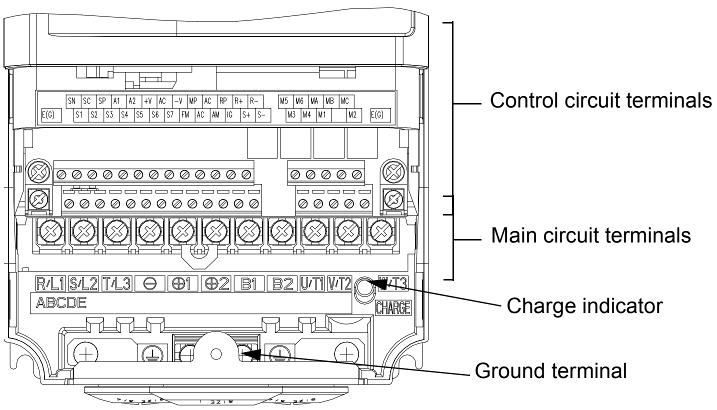



Fig 1.5 Terminal Arrangement (18.5 kW or Less)

## ■ Inverters of 22 kW or More

The external appearance and component names of the Inverter are shown in *Fig 1.6*. The Inverter with the terminal cover removed is shown in *Fig 1.7*.

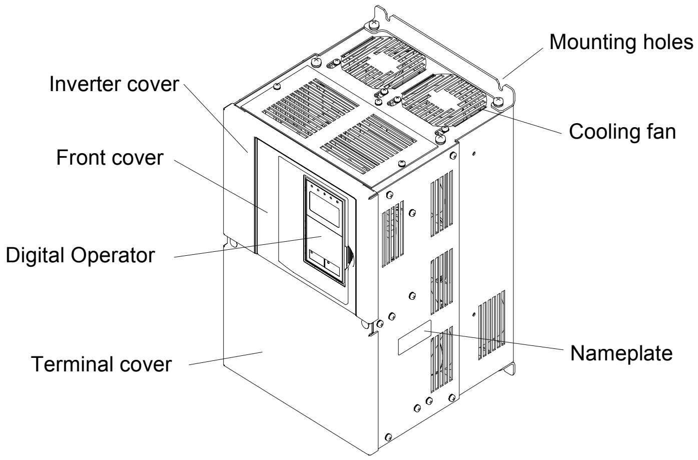



Fig 1.6 Inverter Appearance (22 kW or More)

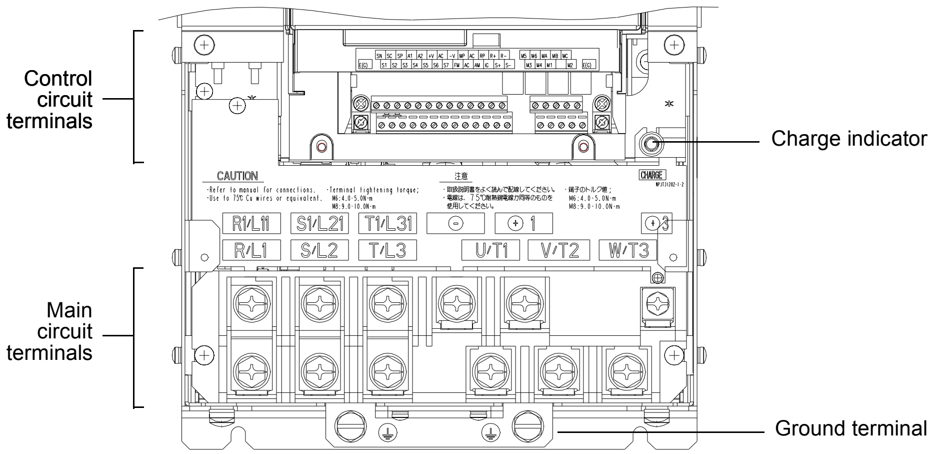


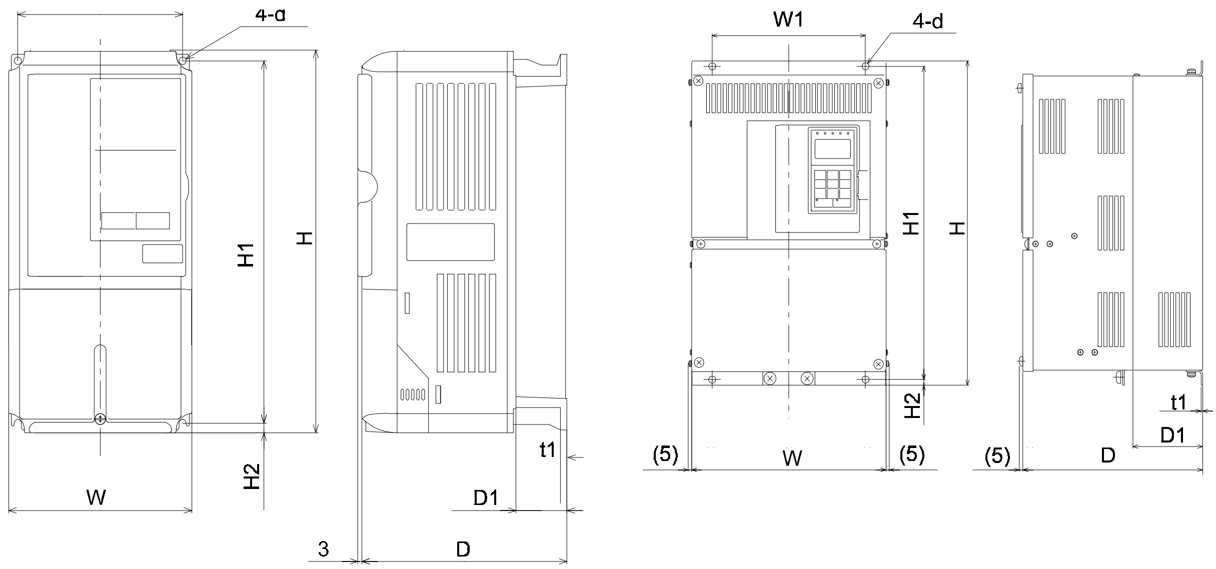

Fig 1.7 Terminal Arrangement (22 kW or More)

1

# Exterior and Mounting Dimensions

## ◆ Open Chassis Inverters (IP00)

Exterior diagrams of the Open Chassis Inverters are shown below.



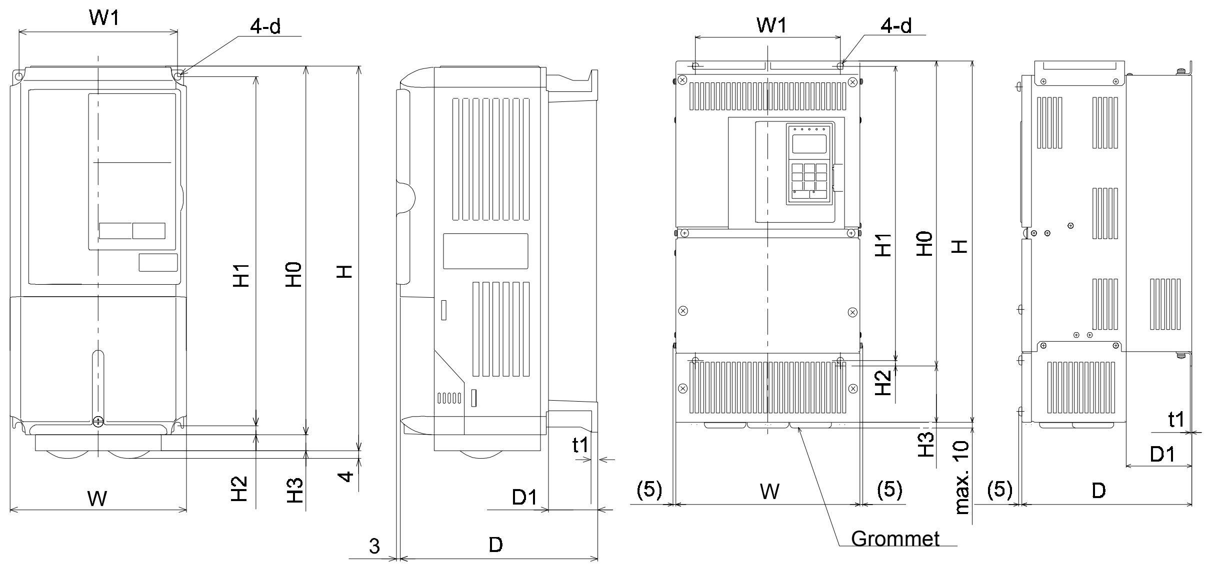

200 V/400 V Class Inverters of 0.55 to 18.5 kW

200 V Class Inverters of 22 or 30 kW
400 V Class Inverters of 22 to 55 kW

Fig 1.8  Exterior Diagrams of Open Chassis Inverters

## ◆ Enclosed Wall-mounted Inverters (NEMA1)

Exterior diagrams of the Enclosed Wall-mounted Inverters (NEMA1) are shown below.




200 V/400 V Class Inverters of 0.55 to 18.5 kW

200 V Class Inverters of 22 or 30 kW
400 V Class Inverters of 22 to 55 kW

Fig 1.9  Exterior Diagrams of Enclosed Wall-mounted Inverters

Table 1.3 Inverter Dimensions (mm) and Masses (kg)

| Voltage Class | Max. Applicable Motor Output [kW] | Dimensions (mm) | | | | | | | | | | | | | | | | | | | | | | Caloric Value(W) | | | Cooling Method |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Open Chassis (IP00) | | | | | | | | | Enclosed Wall-mounted (NEMA1) | | | | | | | | | | | | | | | | |
| | | W | H | D | W1 | H1 | H2 | D1 | t1 | Approx. Mass | W | H | D | W1 | H0 | H1 | H2 | H3 | D1 | t1 | Approx. Mass | Mounting Holes d* | External | Internal | Total Heat Generation | |
| 200 V (3-phase) | 0.55 | 140 | 280 | 157 | 126 | 266 | 7 | 39 | 5 | 3 | 140 | 280 | 157 | 126 | 280 | 266 | 7 | 0 | 39 | 5 | 3 | M5 | 20 | 39 | 59 | Natural |
| | 0.75 | | | | | | | | | | | | | | | | | | | | | | 27 | 42 | 69 | |
| | 1.5 | | | | | | | | | | | | | | | | | | | | | | 50 | 50 | 100 | |
| | 2.2 | | | | | | | | | | | | | | | | | | | | | | 70 | 59 | 129 | |
| | 3.7 | | | 177 | | | | 59 | | 4 | | | 177 | | | | | | 59 | | 4 | | 112 | 74 | 186 | Fan |
| | 5.5 | | | | | | | | | | | | | | | | | | | | | | 164 | 84 | 248 | |
| | 7.5 | 200 | 300 | 197 | 186 | 285 | 7.5 | 65.5 | 2.3 | 6 | 200 | 300 | 197 | 186 | 300 | 285 | 7.5 | | 65.5 | 2.3 | 6 | M6 | 219 | 113 | 332 | |
| | 11 | | | | | | | | | 7 | | 310 | | | | | | 10 | | | 7 | | 374 | 170 | 544 | |
| | 15 | 240 | 350 | 207 | 216 | 335 | | 78 | | 11 | 240 | 350 | 207 | 216 | 350 | 335 | | 0 | 78 | | 11 | | 429 | 183 | 612 | |
| | 18.5 | | | | | | | | | | | 380 | | | | | | 30 | | | | | 501 | 211 | 712 | |
| | 22 | 250 | 400 | 258 | 195 | 385 | | 100 | | 21 | 250 | 535 | 258 | 195 | 400 | 385 | | 135 | 100 | | 24 | | 586 | 274 | 860 | |
| | 30 | 275 | 450 | | 220 | 435 | | | | 24 | 275 | 615 | | 220 | 450 | 435 | | 165 | | | 27 | | 865 | 352 | 1217 | |
| | 37 | 375 | 600 | 300 | 250 | 575 | 13 | 100 | 3.2 | 57 | 380 | 890 | 300 | 250 | 600 | 575 | 13 | 210 | 100 | 3.2 | 62 | M10 | 1015 | 411 | 1426 | |
| | 45 | | | 330 | | | | 130 | | 63 | | | 330 | | | | | | 130 | | 68 | | 1266 | 505 | 1771 | |
| | 55 | 450 | 725 | 350 | 325 | 700 | | | | 86 | 455 | 1100 | 350 | 325 | 725 | 700 | | 305 | | | 94 | | 1588 | 619 | 2207 | |
| | 75 | | | | | | | | | 87 | | | | | | | | | | | 95 | | 2019 | 838 | 2857 | |
| | 90 | 500 | 850 | 360 | 370 | 820 | 15 | | 4.5 | 108 | --- | | | | | | | | | | | M12 | 2437 | 997 | 3434 | |
| | 110 | 575 | 885 | 380 | 445 | 855 | | 140 | | 150 | | | | | | | | | | | | | 2733 | 1242 | 3975 | |
| 400 V (3-phase) | 0.55 | 140 | 280 | 157 | 126 | 266 | 7 | 39 | 5 | 3 | 140 | 280 | 157 | 126 | 280 | 266 | 7 | 0 | 39 | 5 | 3 | M5 | 14 | 39 | 53 | Natural |
| | 0.75 | | | | | | | | | | | | | | | | | | | | | | 17 | 41 | 58 | |
| | 1.5 | | | | | | | | | | | | | | | | | | | | | | 36 | 48 | 84 | |
| | 2.2 | | | 177 | | | | 59 | | 4 | | | 177 | | | | | | 59 | | 4 | | 59 | 56 | 115 | Fan |
| | 3.7 | | | | | | | | | | | | | | | | | | | | | | 80 | 68 | 148 | |
| | 4.0 | | | | | | | | | | | | | | | | | | | | | | 70 | 91 | 161 | |
| | 5.5 | | | | | | | | | | | | | | | | | | | | | | 127 | 82 | 209 | |
| | 7.5 | 200 | 300 | 197 | 186 | 285 | 7.5 | 65.5 | 2.3 | 6 | 200 | 300 | 197 | 186 | 300 | 285 | 7.5 | | 65.5 | 2.3 | 6 | M6 | 193 | 114 | 307 | |
| | 11 | | | | | | | | | | | | | | | | | | | | | | 252 | 158 | 410 | |
| | 15 | 240 | 350 | 207 | 216 | 335 | | 78 | | 10 | 240 | 350 | 207 | 216 | 350 | 335 | | | 78 | | 10 | | 326 | 172 | 498 | |
| | 18.5 | | | | | | | | | | | | | | | | | | | | | | 426 | 208 | 634 | |
| | 22 | 275 | 450 | 258 | 220 | 435 | | 100 | | 21 | 275 | 535 | 258 | 220 | 450 | 435 | | 85 | 100 | | 24 | | 466 | 259 | 725 | |
| | 30 | | | | | | | | | | | | | | | | | | | | | | 678 | 317 | 995 | |
| | 37 | 325 | 550 | 283 | 260 | 535 | | 105 | | 36 | 325 | 635 | 283 | 260 | 550 | 535 | | | 105 | | 40 | | 784 | 360 | 1144 | |
| | 45 | | | | | | | | | | | 715 | | | | | | 165 | | | | | 901 | 415 | 1316 | |
| | 55 | | | | | | | | | | | | | | | | | | | | | | 1203 | 495 | 1698 | |
| | 75 | 450 | 725 | 350 | 325 | 700 | 13 | 130 | 3.2 | 88 | 455 | 1100 | 350 | 325 | 725 | 700 | 13 | 305 | 130 | 3.2 | 96 | M10 | 1399 | 575 | 1974 | |
| | 90 | | | | | | | | | 89 | | | | | | | | | | | 97 | | 1614 | 671 | 2285 | |
| | 110 | 500 | 850 | 360 | 370 | 820 | 15 | | 4.5 | 102 | 505 | 1245 | 360 | 370 | 850 | 820 | 15 | 395 | | 4.5 | 122 | M12 | 2097 | 853 | 2950 | |
| | 132 | | | | | | | | | 120 | | | | | | | | | | | 130 | | 2388 | 1002 | 3390 | |
| | 160 | 575 | 925 | 380 | 445 | 895 | | 140 | | 160 | 580 | 1325 | 380 | 445 | 925 | 895 | | 400 | 140 | | 170 | | 2791 | 1147 | 3938 | |
| | 185 | 710 | 1305 | 415 | 540 | 1270 | | 125,5 | | | – – | | | | | | | | | | | | | | | |
| | 220 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 300 | 916 | 1475 | 416 | 730 | 1440 | | | | | | | | | | | | | | | | | | | | |

* Same for Open Chassis and Enclosed Wall-mounted Inverters.

1

# Checking and Controlling the Installation Site

Install the Inverter in the installation site described below and maintain optimum conditions.

## ◆ Installation Site

Install the Inverter under the following conditions in a pollution degree 2 environment.

Table 1.4 Installation Site

| Type | Ambient Operating Temperature | Humidity |
|---|---|---|
| Enclosed wall-mounted | -10 to + 40 °C | 95% RH or less (no condensation) |
| Open chassis | -10 to + 45 °C | 95% RH or less (no condensation) |

Protection covers are attached to the top and bottom of the Inverter. Be sure to remove the protection covers before installing a 200 or 400 V Class Inverter with an output of 18.5 kW or less in a panel.

Observe the following precautions when mounting the Inverter.

- Install the Inverter in a clean location which is free from oil mist and dust. It can be installed in a totally enclosed panel that is completely shielded from floating dust.
- When installing or operating the Inverter, always take special care so that metal powder, oil, water, or other foreign matter does not get into the Inverter.
- Do not install the Inverter on combustible material, such as wood.
- Install the Inverter in a location free from radioactive materials and combustible materials.
- Install the Inverter in a location free from harmful gasses and liquids.
- Install the Inverter in a location without excessive oscillation.
- Install the Inverter in a location free from chlorides.
- Install the Inverter in a location not in direct sunlight.

## ◆ Controlling the Ambient Temperature

To enhance the reliability of operation, the Inverter should be installed in an environment free from extreme temperature increases. If the Inverter is installed in an enclosed environment, such as a box, use a cooling fan or air conditioner to maintain the internal air temperature below 45°C.

## ◆ Protecting the Inverter from Foreign Matter

Place a cover over the Inverter during installation to shield it from metal power produced by drilling.

Always remove the cover from the Inverter after completing installation. Otherwise, ventilation will be reduced, causing the Inverter to overheat.

# Installation Orientation and Space

Install the Inverter vertically so as not to reduce the cooling effect. When installing the Inverter, always provide the following installation space to allow normal heat dissipation.

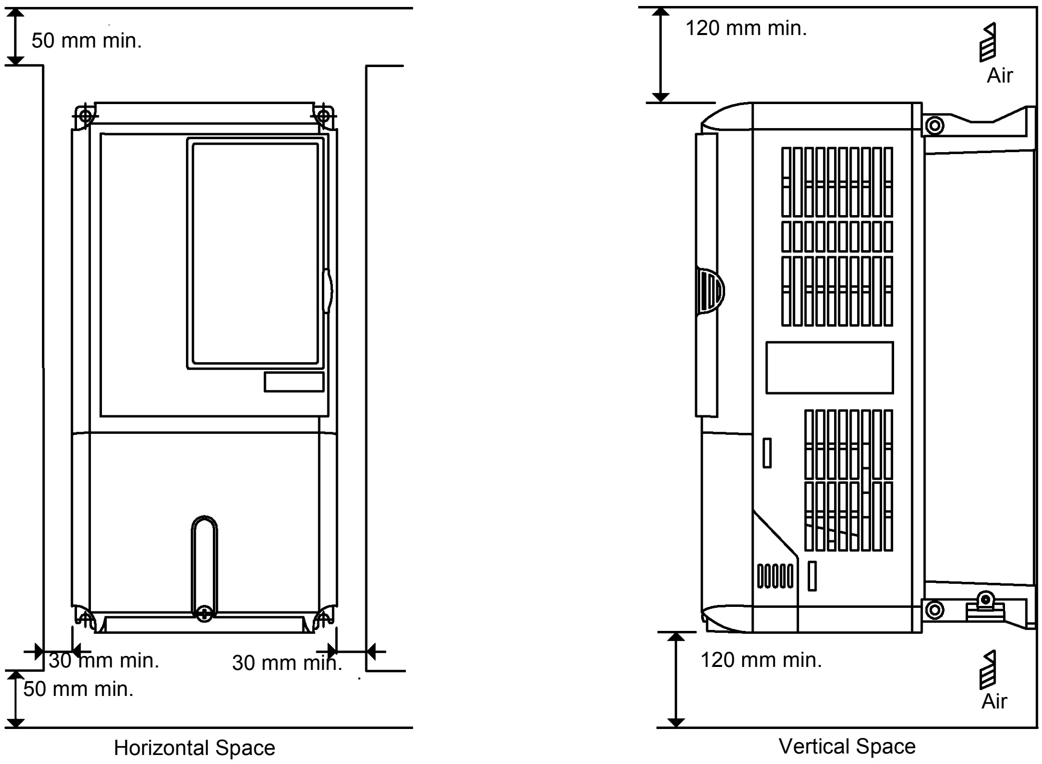



Fig 1.10 Inverter Installation Orientation and Space

**IMPORTANT**

1. The same space is required horizontally and vertically for both Open Chassis (IP00) and Enclosed Wall-mounted (IP20, NEMA 1) Inverters.
2. Always remove the protection covers before installing a 200 or 400 V Class Inverter with an output of 18.5 kW or less in a panel.
   Always provide enough space for suspension eye bolts and the main circuit lines when installing a 200 or 400 V Class Inverter with an output of 22 kW or more in a panel.

1

# Removing and Attaching the Terminal Cover

Remove the terminal cover to wire cables to the control circuit and main circuit terminals.

## ◆ Removing the Terminal Cover

### ■ Inverters of 18.5 kW or Less

Loosen the screw at the bottom of the terminal cover, press in on the sides of the terminal cover in the directions of arrows 1, and then lift up on the terminal in the direction of arrow 2.

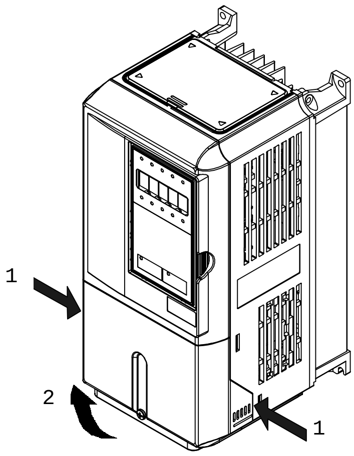



Fig 1.11 Removing the Terminal Cover (Model CIMR-F7C25P5 Shown Above)

### ■ Inverters of 22 kW or More

Loosen the screws on the left and right at the top of the terminal cover, pull out the terminal cover in the direction of arrow 1 and then lift up on the terminal in the direction of arrow 2.

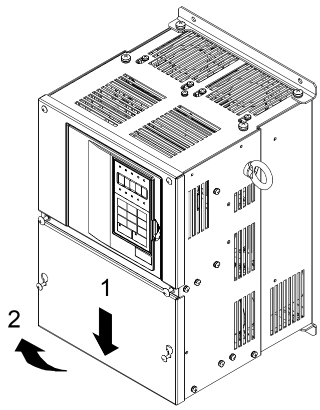



Fig 1.12 Removing the Terminal Cover (Model CIMR-F7C2022 Shown Above)

## ◆ Attaching the Terminal Cover

When wiring the terminal block has been completed, attach the terminal cover by reversing the removal procedure.

For Inverters with an output of 18.5 kW or less, insert the tab on the top of the terminal cover into the groove on the Inverter and press in on the bottom of the terminal cover until it clicks into place.

# Removing/Attaching the Digital Operator and Front Cover

## ◆ Inverters of 18.5 kW or Less

To attach optional cards or change the terminal card connector, remove the Digital Operator and front cover in addition to the terminal cover. Always remove the Digital Operator from the front cover before removing the front cover.

The removal and attachment procedures are described below.

### ■Removing the Digital Operator

Press the lever on the side of the Digital Operator in the direction of arrow 1 to unlock the Digital Operator and lift the Digital Operator in the direction of arrow 2 to remove the Digital Operator as shown in the following illustration.



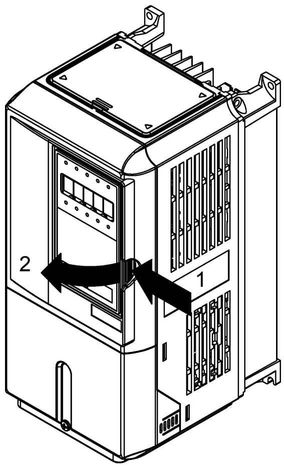



Fig 1.13 Removing the Digital Operator (Model CIMR-F7C45P5 Shown Above)

## ■Removing the Front Cover

Press the left and right sides of the front cover in the directions of arrows 1 and lift the bottom of the cover in the direction of arrow 2 to remove the front cover as shown in the following illustration.

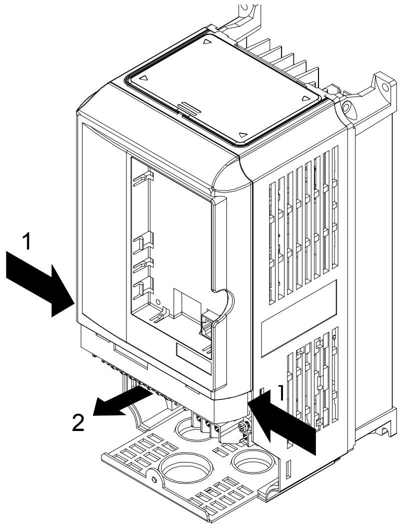



Fig 1.14 Removing the Front Cover (Model CIMR-F7C45P5 Shown Above)

## ■Mounting the Front Cover

After wiring the terminals, mount the front cover to the Inverter by performing the steps to remove the front cover in reverse order.

1. Do not mount the front cover with the Digital Operator attached to the front cover; otherwise, Digital Operator may malfunction due to imperfect contact.
2. Insert the tab of the upper part of the front cover into the groove of the Inverter and press the lower part of the front cover onto the Inverter until the front cover snaps shut.

## ■Mounting the Digital Operator

After attaching the terminal cover, mount the Digital Operator onto the Inverter using the following procedure.

1. Hook the Digital Operator at A (two locations) on the front cover in the direction of arrow 1 as shown in the following illustration.
2. Press the Digital Operator in the direction of arrow 2 until it snaps in place at B (two locations).

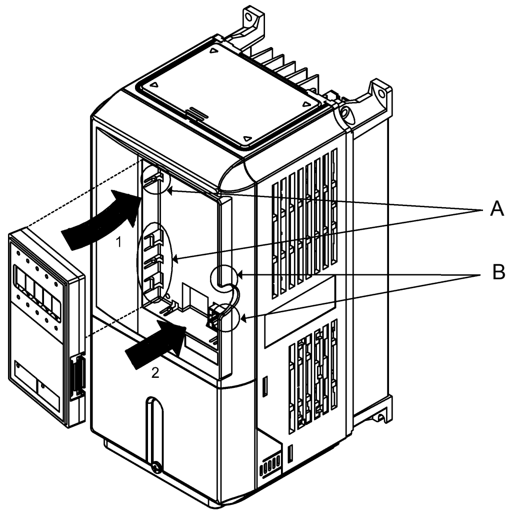



Fig 1.15  Mounting the Digital Operator



**IMPORTANT**

1. Do not remove or attach the Digital Operator or mount or remove the front cover using methods other than those described above, otherwise the Inverter may break or malfunction due to imperfect contact.
2. Never attach the front cover to the Inverter with the Digital Operator attached to the front cover. Imperfect contact can result.
   Always attach the front cover to the Inverter by itself first, and then attach the Digital Operator to the front cover.

## ◆ Inverters of 22 kW or More

For inverters with an output of 22 kW or more, remove the terminal cover and then use the following procedures to remove the Digital Operator and main cover.

### ■Removing the Digital Operator

Use the same procedure as for Inverters with an output of 18.5 kW or less.

### ■Removing the Front Cover

Lift up at the location label 1 at the top of the control circuit terminal card in the direction of arrow 2.

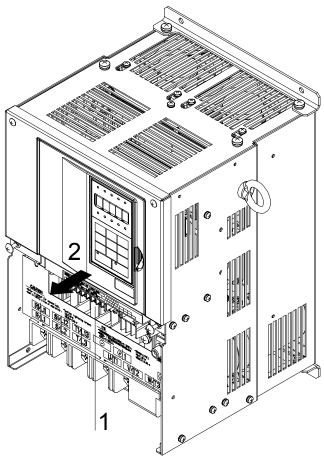



Fig 1.16 Removing the Front Cover (Model CIMR-F7C2022 Shown Above)

### ■ Attaching the Front Cover

After completing required work, such as mounting an optional card or setting the terminal card, attach the front cover by reversing the procedure to remove it.

1. Confirm that the Digital Operator is not mounted on the front cover. Contact faults can occur if the cover is attached while the Digital Operator is mounted to it.
2. Insert the tab on the top of the front cover into the slot on the Inverter and press in on the cover until it clicks into place on the Inverter.

### ■Attaching the Digital Operator

Use the same procedure as for Inverters with an output of 18.5 kW or less.

# 2

# Wiring



This chapter describes wiring terminals, main circuit terminal connections, main circuit terminal wiring specifications, control circuit terminals, and control circuit wiring specifications.

Connections to Peripheral Devices..............................2-2
Connection Diagram..................................................2-3
Terminal Block Configuration......................................2-5
Wiring Main Circuit Terminals.....................................2-6
Wiring Control Circuit Terminals ...............................2-21
Wiring Check ...........................................................2-28
Installing and Wiring Option Cards ............................2-29

# Connections to Peripheral Devices

Examples of connections between the Inverter and typical peripheral devices are shown in *Fig 2.1*.

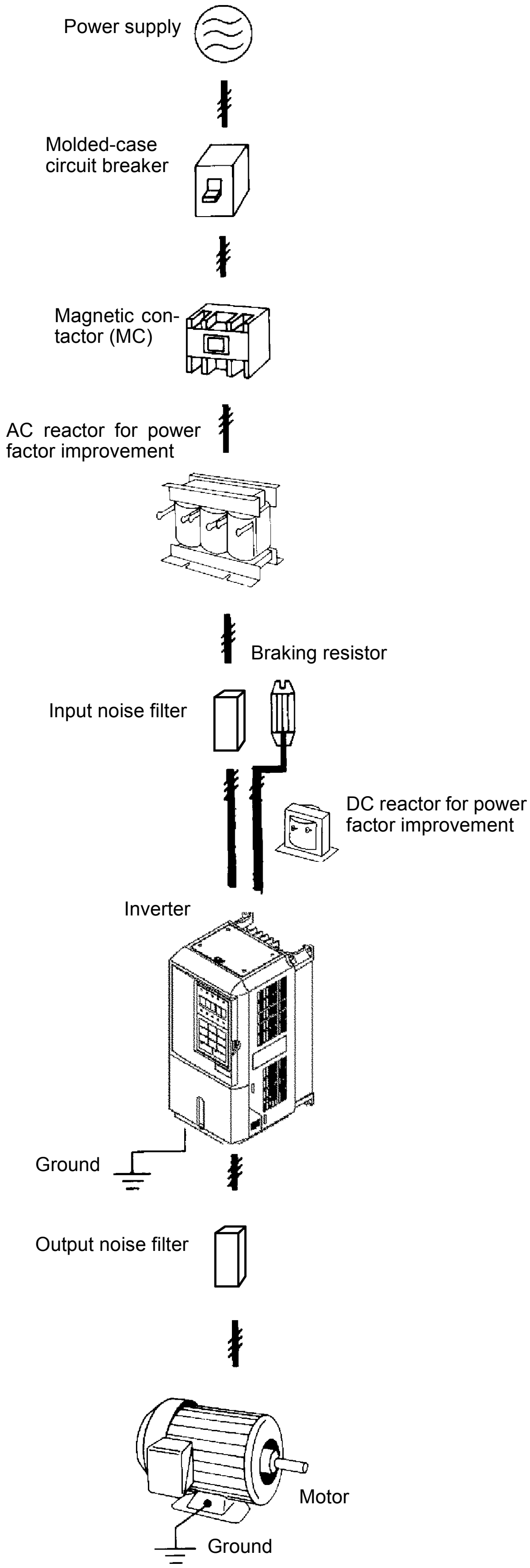



Fig 2.1 Example Connections to Peripheral Devices

# Connection Diagram

The connection diagram of the Inverter is shown in *Fig 2.2*.

When using the Digital Operator, the motor can be operated by wiring only the main circuits.

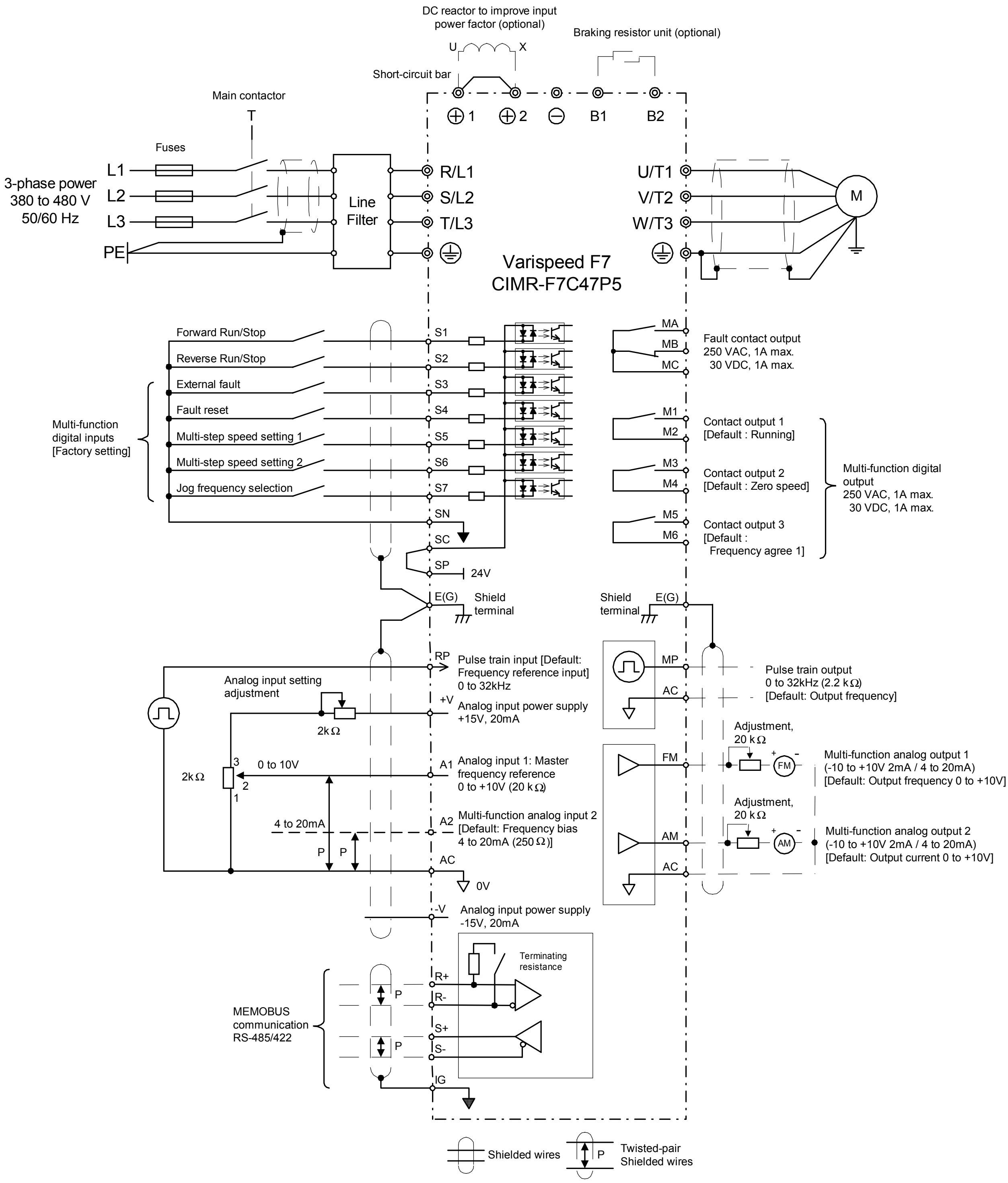



Fig 2.2  Connection Diagram (Model CIMR-F7C47P5 Shown Above)

## ◆ Circuit Descriptions

**IMPORTANT**

1. Control circuit terminals are arranged as shown below.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SN | SC | SP | A1 | A2 | +V | AC | -V | MP | AC | RP | R+ | R- | M5 | M6 | MA | MB | MC | |
| E(G) | S1 | S2 | S3 | S4 | S5 | S6 | S7 | FM | AC | AM | IG | S+ | S- | M3 | M4 | M1 | | M2 | E(G) |

2. The output current capability of the +V terminal is 20 mA.
   Disable the stall prevention during deceleration (L3-04 = 0) or set it to enabled with Braking Resistor Unit (L3-04 = 3) when using a Braking Option. If this user constant is not changed to disable stall prevention, the system may not stop within set deceleration time.
   Set parameter L8-01 to 1 when using a breaking resistor that is to be mounted to the backside of the inverters heatsink (ERF-type). When using a Braking Resistor Unit, a shutoff control circuit for the power supply has to be installed using a thermal overload relay trip contact.
3. Main circuit terminals are indicated with double circles and control circuit terminals are indicated with single circles.
4. The wiring of the digital inputs S1 to S7 is shown for the connection of contacts or NPN transistors (0V common and sinking mode). This is the default setting.
   For the connection of PNP transistors or for using a 24V external power supply, refer to *Table 2.14*.
5. The master speed frequency reference can be input either at terminal A1 or at terminal A2 by changing the setting of parameter H3-13. The default setting is terminal A2.
6. The multi-function analog outputs are dedicated meter outputs for analog frequency meters, ampmeters, voltmeters, wattmeters, etc. Do not use these outputs for feedback control or for any other control purposes.
7. DC reactors to improve the input power factor are built into 200 V Class Inverters from 22 up to 110 kW and 400 V Class Inverters from 22 up to 300 kW. A DC reactor is an option only for Inverters of 18.5 kW or less. Remove the short circuit bar when connecting a DC reactor.

# Terminal Block Configuration

The terminal arrangements are shown in *Fig 2.3* and *Fig 2.4*.

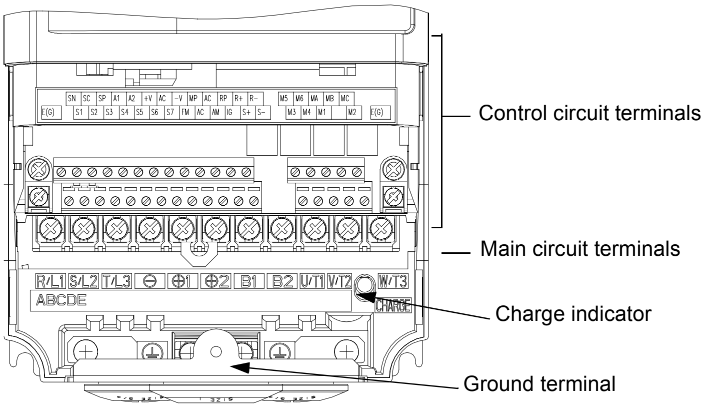



Fig 2.3  Terminal Arrangement (200 V/400 V Class Inverter of 0.4 kW)

2

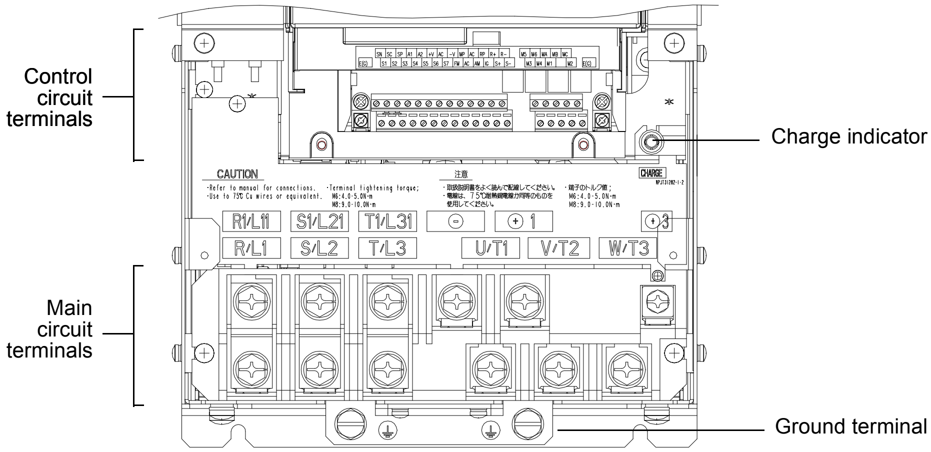



Fig 2.4  Terminal Arrangement (200 V/400 V Class Inverter of 22 kW or more)

# Wiring Main Circuit Terminals

## ◆ Applicable Wire Sizes and Closed-loop Connectors

Select the appropriate wires and crimp terminals from *Table 2.1* to *Table 2.3*. Refer to instruction manual TOE-C726-2 for wire sizes for Braking Resistor Units and Braking Units.

Table 2.1 200 V Class Wire Sizes

| Inverter Model CIMR-□ | Terminal Symbol | Terminal Screws | Tightening Torque (N•m) | Possible Wire Sizes $mm^2$(AWG) | Recommended Wire Size $mm^2$ (AWG) | Wire Type |
|---|---|---|---|---|---|---|
| F7C20P4 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C20P7 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C21P5 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C22P2 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C23P7 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 3.5 to 5.5 (12 to 10) | 3.5 (12) | |
| | ⏚ | | | | | |
| F7C25P5 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 5.5 (10) | 5.5 (10) | |
| | ⏚ | | | | | |
| F7C27P5 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M5 | 2.5 | 8 to 14 (8 to 6) | 8 (8) | |
| | ⏚ | | | | | |
| F7C2011 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M5 | 2.5 | 14 to 22 (6 to 4) | 14 (6) | Power cables, e.g., 600 V vinyl power cables |
| | ⏚ | | | | | |
| F7C2015 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, U/T1, V/T2, W/T3 | M6 | 4.0 to 5.0 | 30 to 38 (4 to 2) | 30 (4) | |
| | B1, B2 | M5 | 2.5 | 8 to 14 (8 to 6) | - | |
| | ⏚ | M6 | 4.0 to 5.0 | 22 (4) | 22 (4) | |
| F7C2018 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, U/T1, V/T2, W/T3 | M8 | 9.0 to 10.0 | 30 to 38 (3 to 2) | 30 (3) | |
| | B1, B2 | M5 | 2.5 | 8 to 14 (8 to 6) | - | |
| | ⏚ | M6 | 4.0 to 5.0 | 22 (4) | 22 (4) | |
| F7C2022 | R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M8 | 9.0 to 10.0 | 30 to 60 (3 to 1) | 30 (3) | |
| | ⊕3 | M6 | 4.0 to 5.0 | 8 to 22 (8 to 4) | - | |
| | ⏚ | M8 | 9.0 to 10.0 | 22 to 38 (4 to 2) | 22 (4) | |
| F7C2030 | R/L1, S/L2, T/L3, ⊖, ⊕1 U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M8 | 9.0 to 10.0 | 50 to 60 (1 to 1/0) | 50 (1) | |
| | ⊕3 | M6 | 4.0 to 5.0 | 8 to 22 (8 to 4) | - | |
| | ⏚ | M8 | 9.0 to 10.0 | 22 to 38 (4 to 2) | 22 (4) | |

| Inverter Model CIMR-☐ | Terminal Symbol | Terminal Screws | Tightening Torque (N•m) | Possible Wire Sizes $mm^2$(AWG) | Recommended Wire Size $mm^2$ (AWG) | Wire Type |
|---|---|---|---|---|---|---|
| F7C2037 | R/L1, S/L2, T/L3, ⊖, ⊕1 U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M10 | 17.6 to 22.5 | 60 to 100 (2/0 to 4/0) | 60 (2/0) | Power cables, e.g., 600 V vinyl power cables |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 22 (10 to 4) | – | |
| | ⏚ | M10 | 17.6 to 22.5 | 30 to 60 (2 to 2/0) | 30 (2) | |
| | r/l1, Δ/l2 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C2045 | R/L1, S/L2, T/L3, ⊖, ⊕1 U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M10 | 17.6 to 22.5 | 80 to 100 (3/0 to 4/0) | 80 (3/0) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 22 (10 to 4) | – | |
| | ⏚ | M10 | 17.6 to 22.5 | 38 to 60 (1 to 2/0) | 38 (1) | |
| | r/l1, Δ/l2 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C2055 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 50 to 100 (1/0 to 4/0) | 50 × 2P (1/0 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M10 | 17.6 to 22.5 | 100 (4/0) | 100 (4/0) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 60 (10 to 2/0) | – | |
| | ⏚ | M10 | 17.6 to 22.5 | 30 to 60 (3 to 4/0) | 50 (1/0) | |
| | r/l1, Δ/l2 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C2075 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 80 to 125 (3/0 to 250) | 80 × 2P (3/0 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M10 | 17.6 to 22.5 | 80 to 100 (3/0 to 4/0) | 80 × 2P (3/0 × 2P) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 60 (10 to 2/0) | – | |
| | ⏚ | M10 | 17.6 to 22.5 | 100 to 200 (3/0 to 400) | 100 (3/0) | |
| | r/l1, Δ/l2 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C2090 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 150 to 200 (250 to 400) | 150 × 2P (250 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M12 | 31.4 to 39.2 | 100 to 150 (4/0 to 300) | 100 × 2P (4/0 × 2P) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 60 (10 to 2/0) | – | |
| | ⏚ | M12 | 31.4 to 39.2 | 60 to 150 (2/0 to 300) | 60 × 2P (2/0 × 2P) | |
| | r/l1, Δ/l2 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C2110 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 200 to 325 (350 to 600) | 200 × 2P, or 50 × 4P (350 × 2P, or 1/0 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M12 | 31.4 to 39.2 | 150 to 325 (300 to 600) | 150 × 2P, or 50 × 4P (300 × 2P, or 1/0 × 4P) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 60 (10 to 2/0) | – | |
| | ⏚ | M12 | 31.4 to 39.2 | 150 (300) | 150 × 2P (300 × 2P) | |
| | r/l1, Δ/l2 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |

* The wire thickness is set for copper wires at 75°C

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Table 2.2  400 V Class Wire Sizes

| Inverter Model CIMR-☐ | Terminal Symbol | Terminal Screws | Tightening Torque (N•m) | Possible Wire Sizes mm$^2$ (AWG) | Recommended Wire Size mm$^2$ (AWG) | Wire Type |
|---|---|---|---|---|---|---|
| F7C40P4 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | Power cables, e.g., 600 V vinyl power cables |
| | ⏚ | | | | | |
| F7C40P7 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C41P5 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C42P2 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 2 (14) | |
| | ⏚ | | | | | |
| F7C43P7 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 3.5 (12) | |
| | ⏚ | | | | 2 (14) | |
| F7C44P0 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 2 to 5.5 (14 to 10) | 3.5 (12) | |
| | ⏚ | | | | 2 (14) | |
| F7C45P5 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 3.5 to 5.5 (12 to 10) | 3.5 (12) | |
| | ⏚ | | | 2 to 5.5 (14 to 10) | 2 (14) | |
| F7C47P5 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M4 | 1.2 to 1.5 | 5.5(10) | 5.5 (10) | |
| | ⏚ | | | 3.5 to 5.5 (12 to 10) | 3.5 (12) | |
| F7C4011 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M5 | 2.5 | 5.5 to 14 (10 to 6) | 8 (8) | |
| | ⏚ | | | | 5.5 (10) | |
| F7C4015 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, B1, B2, U/T1, V/T2, W/T3 | M5 | 2.5 | 8 to 14 (8 to 6) | 8 (8) | |
| | ⏚ | M5 (M6) | 2.5 (4.0 to 5.0) | 5.5 to 14 (10 to 6) | 5.5 (10) | |
| F7C4018 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕2, U/T1, V/T2, W/T3 | M6 | 4.0 to 5.0 | 8 to 38 (8 to 2) | 8 (8) | |
| | B1, B2 | M5 | 2.5 | 8 (8) | 8 (8) | |
| | ⏚ | M6 | 4.0 to 5.0 | 8 to 22 (8 to 4) | 8 (8) | |
| F7C4022 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕3, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M6 | 4.0 to 5.0 | 14 to 22 (6 to 4) | 14 (6) | |
| | ⏚ | M8 | 9.0 to 10.0 | 14 to 38 (6 to 2) | 14 (6) | |
| F7C4030 | R/L1, S/L2, T/L3, ⊖, ⊕1, ⊕3, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M6 | 4.0 to 5.0 | 22 (4) | 22 (4) | |
| | ⏚ | M8 | 9.0 to 10.0 | 22 to 38 (4 to 2) | 22 (4) | |
| F7C4037 | R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M8 | 9.0 to 10.0 | 22 to 60 (4 to 1/0) | 38 (2) | |
| | ⊕3 | M6 | 4.0 to 5.0 | 8 to 22 (8 to 4) | - | |
| | ⏚ | M8 | 9.0 to 10.0 | 22 to 38 (4 to 2) | 22 (4) | |

| Inverter Model CIMR-☐ | Terminal Symbol | Terminal Screws | Tightening Torque (N•m) | Possible Wire Sizes $mm^2$ (AWG) | Recommended Wire Size $mm^2$ (AWG) | Wire Type |
|---|---|---|---|---|---|---|
| F7C4045 | R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M8 | 9.0 to 10.0 | 38 to 60 (2 to 1/0) | 38 (2) | |
| | ⊕3 | M6 | 4.0 to 5.0 | 8 to 22 (8 to 4) | - | |
| | ⏚ | M8 | 9.0 to 10.0 | 22 to 38 (4 to 2) | 22 (4) | |
| F7C4055 | R/L1, S/L2, T/L3, ⊖, ⊕1, U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M8 | 9.0 to 10.0 | 50 to 60 (1 to 1/0) | 50 (1) | Power cables, e.g., 600 V vinyl power cables |
| | ⊕3 | M6 | 4.0 to 5.0 | 8 to 22 (8 to 4) | - | |
| | ⏚ | M8 | 9.0 to 10.0 | 22 to 38 (4 to 2) | 22 (4) | |
| F7C4075 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 60 to 100 (2/0 to 4/0) | 60 (2/0) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M10 | 17.6 to 22.5 | 50 to 100 (1/0 to 4/0) | 50 (1/0) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 5.5 to 22 (10 to 4) | - | |
| | ⏚ | M12 | 31.4 to 39.2 | 38 to 60 (2 to 2/0) | 38 (2) | |
| | r/l1, Δ200/$_{l2}$200, Δ400/$_{l2}$400 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C4090 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 80 to 100 (3/0 to 4/0) | 100 (4/0) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L31 | M10 | 17.6 to 22.5 | 80 to 100 (3/0 to 4/0) | 100 (4/0) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 8 to 22 (8 to 4) | - | |
| | ⏚ | M12 | 31.4 to 39.2 | 50 to 100 (1 to 4/0) | 50 (1) | |
| | r/l1, Δ200/$_{l2}$200, Δ400/$_{l2}$400 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C4110 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 50 to 100 (1/0 to 4/0) | 50 × 2P (1/0 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L33 | M12 | 31.4 to 39.2 | 50 to 100 (1/0 to 4/0) | 50 × 2P (1/0 × 2P) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 8 to 60 (8 to 2/0) | - | |
| | ⏚ | M12 | 31.4 to 39.2 | 60 to 150 (2/0 to 300) | 600 (2/0) | |
| | r/l1, Δ200/$_{l2}$200, Δ400/$_{l2}$400 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C4132 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 80 to 100 (3/0 to 4/0) | 80 × 2P (3/0 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L33 | M12 | 31.4 to 39.2 | 60 to 100 (2/0 to 4/0) | 60 × 2P (2/0 × 2P) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 8 to 60 (8 to 2/0) | - | |
| | ⏚ | M12 | 31.4 to 39.2 | 100 to 150 (4/0 to 300) | 100 (4/0) | |
| | r/l1, Δ200/$_{l2}$200, Δ400/$_{l2}$400 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C4160 | R/L1, S/L2, T/L3, ⊖, ⊕1 | M12 | 31.4 to 39.2 | 100 to 200 (4/0 to 400) | 100 × 2P (4/0 × 2P) | |
| | U/T1, V/T2, W/T3, R1/L11, S1/L21, T1/L33 | M12 | 31.4 to 39.2 | 80 to 200 (3/0 to 400) | 80 × 2P (3/0 × 2P) | |
| | ⊕3 | M8 | 8.8 to 10.8 | 80 to 60 (8 to 2/0) | - | |
| | ⏚ | M12 | 31.4 to 39.2 | 50 to 150 (1/0 to 300) | 50 × 2P (1/0 × 2P) | |
| | r/l1, Δ200/$_{l2}$200, Δ400/$_{l2}$400 | M4 | 1.3 to 1.4 | 0.5 to 5.5 (20 to 10) | 1.25 (16) | |
| F7C4185 | Under development | | | | | |
| F7C4220 | | | | | | |
| F7C4300 | | | | | | |

* The wire thickness is set for copper wires at 75°C.

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Table 2.3  Lug Sizes (JIS C2805) (200 V Class and 400 V Class)

| Wire Thickness ($mm^2$) | Terminal Screws | Size |
|---|---|---|
| 0.5 | M3.5 | 1.25 / 3.5 |
| | M4 | 1.25 / 4 |
| 0.75 | M3.5 | 1.25 / 3.5 |
| | M4 | 1.25 / 4 |
| 1.25 | M3.5 | 1.25 / 3.5 |
| | M4 | 1.25 / 4 |
| 2 | M3.5 | 2 / 3.5 |
| | M4 | 2 / 4 |
| | M5 | 2 / 5 |
| | M6 | 2 / 6 |
| | M8 | 2 / 8 |
| 3.5/5.5 | M4 | 5.5 / 4 |
| | M5 | 5.5 / 5 |
| | M6 | 5.5 / 6 |
| | M8 | 5.5 / 8 |
| 8 | M5 | 8 / 5 |
| | M6 | 8 / 6 |
| | M8 | 8 / 8 |
| 14 | M6 | 14 / 6 |
| | M8 | 14 / 8 |
| 22 | M6 | 22 / 6 |
| | M8 | 22 / 8 |
| 30/38 | M8 | 38 / 8 |
| 50/60 | M8 | 60 / 8 |
| | M10 | 60 / 10 |
| 80 | M10 | 80 / 10 |
| 100 | | 100 / 10 |
| 100 | M12 | 100 / 12 |
| 150 | | 150 / 12 |
| 200 | | 200 / 12 |
| 325 | M12 x 2 | 325 / 12 |
| | M16 | 325 / 16 |

**IMPORTANT**

Determine the wire size for the main circuit so that line voltage drop is within 2% of the rated voltage. Line voltage drop is calculated as follows:

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

## ◆ Main Circuit Terminal Functions

Main circuit terminal functions are summarized according to terminal symbols in *Table 2.4*. Wire the terminals correctly for the desired purposes.

Table 2.4 Main Circuit Terminal Functions (200 V Class and 400 V Class)

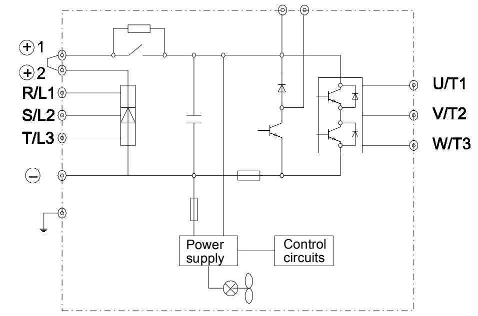
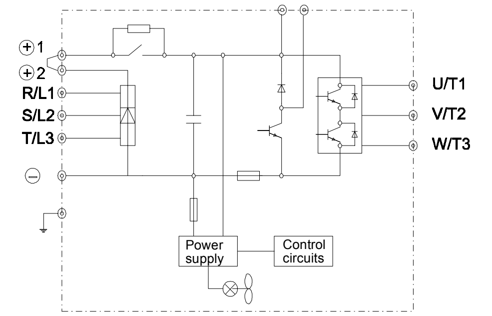
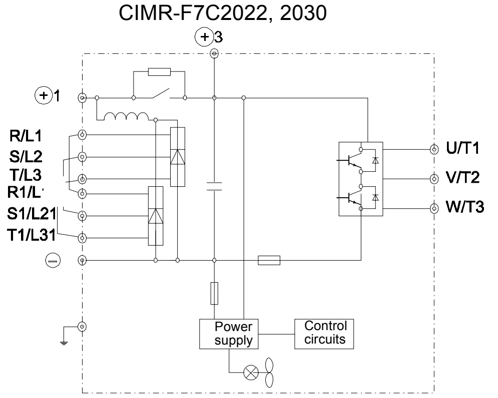
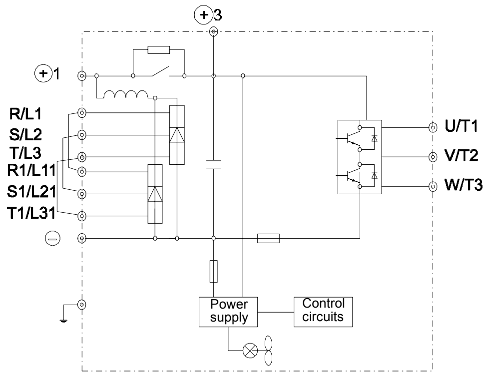
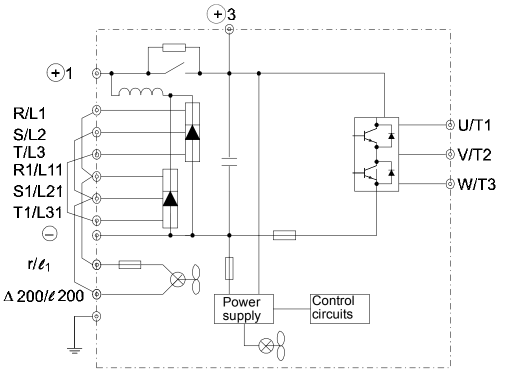
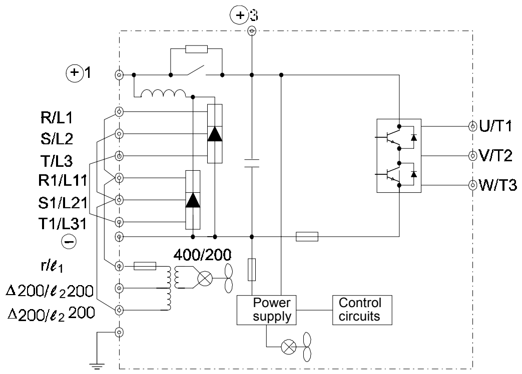
| Purpose | Terminal Symbol | Model: CIMR-F7C□□□□ | |
|---|---|---|---|
| | | 200 V Class | 400 V Class |
| Main circuit power input | R/L1, S/L2, T/L3 | 20P4 to 2110 | 40P4 to 4300 |
| | R1/L11, S1/L21, T1/L31 | 2022 to 2110 | 4022 to 4300 |
| Inverter outputs | U/T1, V/T2, W/T3 | 20P4 to 2110 | 40P4 to 4300 |
| DC bus terminals | ⊕1, ⊖ | 20P4 to 2110 | 40P4 to 4300 |
| Braking Resistor Unit connection | B1, B2 | 20P4 to 2011 | 40P4 to 4018 |
| DC reactor connection | ⊕1, ⊕2 | 20P4 to 2018 | 40P4 to 4018 |
| Braking Unit connection | ⊕3, ⊖ | 2022 to 2110 | 4022 to 4300 |
| Ground | ⏚ | 20P4 to 2110 | 40P4 to 4300 |

2

## ◆ Main Circuit Configurations

The main circuit configurations of the Inverter are shown in *Table 2.5*.

Table 2.5 Inverter Main Circuit Configurations

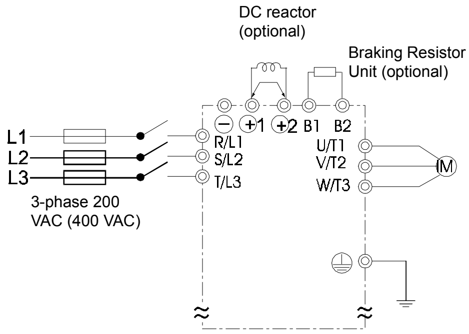
| 200 V Class | 400 V Class |
|---|---|
| CIMR-F7C20P4 to 4018<br> | CIMR-F7C40P4 to 4018<br> |
| CIMR-F7C2022, 2030<br> | CIMR-F7C4022 to 4055<br> |
| CIMR-F7C2037 to 2110<br> | CIMR-F7C4075 to 4300<br> |

Note: Consult your Yaskawa representative before using 12-phase rectification.

## ◆ Standard Connection Diagrams

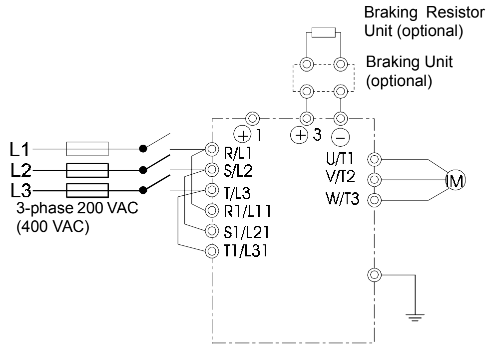
Standard Inverter connection diagrams are shown in *Fig 2.5*. These are the same for both 200 V Class and 400 V Class Inverters. The connections depend on the Inverter capacity.

### ■CIMR-F7C20P4 to 2018 and 40P4 to 4018



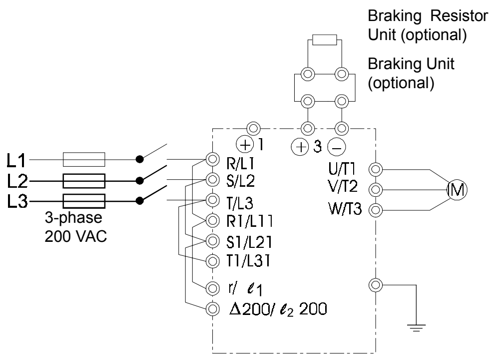

Be sure to remove the short-circuit bar before connecting the DC reactor.

### ■CIMR-F7C2022, 2030, and 4022 to 4055

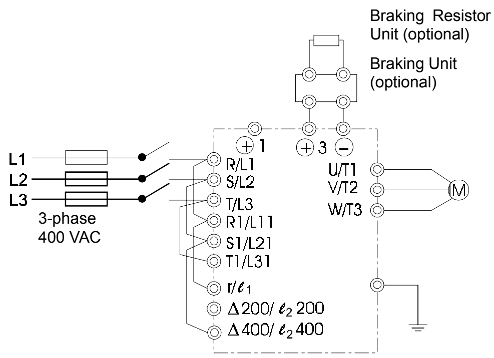



The DC reactor is built in.

### ■CIMR-F7C2037 to 2110




### ■CIMR-F7C4075 to 4300




Control power is supplied internally from the DC bus at all inverter models.

Fig 2.5 Main Circuit Terminal Connections

2

## ◆ Wiring the Main Circuits

This section describes wiring connections for the main circuit inputs and outputs.

### ■Wiring Main Circuit Inputs

Observe the following precautions for the main circuit power supply input.

#### Installing Fuses

To protect the inverter, it is recommended to use semiconductor fuses like they are shown in the table below.

Table 2.6 Input Fuses

| Inverter Type | FUSE | | |
|---|---|---|---|
| | Voltage (V) | Current (A) | $I^2t$ ($A^2s$) |
| 20P4 | 240 | 10 | 12~25 |
| 20P7 | 240 | 10 | 12~25 |
| 21P5 | 240 | 15 | 23~55 |
| 22P2 | 240 | 20 | 34~98 |
| 23P7 | 240 | 30 | 82~220 |
| 25P5 | 240 | 40 | 220~610 |
| 27P5 | 240 | 60 | 290~1300 |
| 2011 | 240 | 80 | 450~5000 |
| 2015 | 240 | 100 | 1200~7200 |
| 2018 | 240 | 130 | 1800~7200 |
| 2022 | 240 | 150 | 870~16200 |
| 2030 | 240 | 180 | 1500~23000 |
| 2037 | 240 | 240 | 2100~19000 |
| 2045 | 240 | 300 | 2700~55000 |
| 2055 | 240 | 350 | 4000~55000 |
| 2075 | 240 | 450 | 7100~64000 |
| 2090 | 240 | 550 | 11000~64000 |
| 2110 | 240 | 600 | 13000~83000 |
| 40P4 | 480 | 5 | 6~55 |
| 40P7 | 480 | 5 | 6~55 |
| 41P5 | 480 | 10 | 10~55 |
| 42P2 | 480 | 10 | 18~55 |
| 43P7 | 480 | 15 | 34~72 |
| 44P0 | 480 | 20 | 50~570 |
| 45P5 | 480 | 25 | 100~570 |
| 47P5 | 480 | 30 | 100~640 |
| 4011 | 480 | 50 | 150~1300 |
| 4015 | 480 | 60 | 400~1800 |
| 4018 | 480 | 70 | 700~4100 |
| 4022 | 480 | 80 | 240~5800 |
| 4030 | 480 | 100 | 500~5800 |
| 4037 | 480 | 125 | 750~5800 |
| 4045 | 480 | 150 | 920~13000 |
| 4055 | 480 | 150 | 1500~13000 |
| 4075 | 480 | 250 | 3000~55000 |
| 4090 | 480 | 300 | 3800~55000 |
| 4110 | 480 | 350 | 5400~23000 |
| 4132 | 480 | 400 | 7900~64000 |
| 4160 | 480 | 450 | 14000~250000 |
| 4185 | 480 | 600 | 20000~250000 |
| 4220 | 480 | 700 | 34000~400000 |
| 4300 | 480 | 900 | 52000~920000 |

### Installing a Moulded-case Circuit Breaker

When connecting the power input terminals (R/L2, S/L2, and T/L3) to the power supply using a moulded-case circuit breaker (MCCB) observe that the circuit breaker is suitable for the Inverter.

- Choose an MCCB with a capacity of 1.5 to 2 times of the inverter's rated current.
- For the MCCB's time characteristics, be sure to consider the inverter's overload protection (one minute at 150% of the rated output current).

### Installing a Ground Fault Interrupter

Inverter outputs use high-speed switching, so high-frequency leakage current is generated. If a ground fault interrupter should be used, select an interrupter that detects only the leakage current which is in the frequency range that is hazardous to humans but not high-frequency leakage currents.

- For the special-purpose ground fault interrupter for Inverters, choose a ground fault interrupter with a sensitivity amperage of at least 30 mA per Inverter.
- When using a general ground fault interrupter, choose a ground fault interrupter with a sensitivity amperage of 200 mA or more per Inverter and with an operating time of 0.1 s or more.

### Installing a Magnetic Contactor



If the power supply for the main circuit is to be shut off by a control circuit, a magnetic contactor can be used.

The following things should be considered:

- The Inverter can be started and stopped by opening and closing the magnetic contactor on the primary side. Frequently opening and closing the magnetic contactor, however, may cause the Inverter to break down. Start and stop the Inverter at most once every 30 minutes.
- When the Inverter is operated with the Digital Operator, automatic operation cannot be performed after recovery from a power interruption.
- If a Braking Resistor Unit is used, design the control circuit so that the magnetic contactor is turned OFF by the contact of the Unit's thermal overload relay.

### Connecting Input Power Supply to the Terminal Block

Input power supply can be connected to any terminal R, S or T on the terminal block; the phase sequence of input power supply is irrelevant to the output phase sequence.

### Installing an AC Reactor

If the Inverter is connected to a large-capacity power transformer (600 kW or more) or a phase advancing capacitor is switched, an excessive peak current may flow through the input power circuit, causing the inverter unit to break down.

To prevent this, install an optional AC Reactor on the input side of the Inverter or a DC reactor to the DC reactor connection terminals.

This also improves the power factor on the power supply side.

### Installing a Surge Absorber

Always use a surge absorber or diode for inductive loads near the Inverter. These inductive loads include magnetic contactors, electromagnetic relays, solenoid valves, solenoids, and magnetic brakes.

## ■Wiring the Output Side of Main Circuit

Observe the following precautions when wiring the main output circuits.

### Connecting the Inverter and Motor

Connect output terminals U/T1, V/T2, and W/T3 respective to the motor lead wires U, V, and W.

Check that the motor rotates forward with the forward run command. Switch over any two of the output terminals to each other and reconnect if the motor rotates in reverse with the forward run command.

### Never Connect a Power Supply to Output Terminals

Never connect a power supply to output terminals U/T1, V/T2, and W/T3. If voltage is applied to the output terminals, the internal circuits of the Inverter will be damaged.

### Never Short or Ground Output Terminals

If the output terminals are touched with bare hands or the output wires come into contact with the Inverter casing, an electric shock or grounding may occur. This is extremely hazardous. Do not short the output wires.

### Do Not Use a Phase Advancing Capacitor

Never connect a phase advancing capacitor to an output circuit. The high-frequency components of the Inverter output may overheat and be damaged and may cause other parts to burn.

### Do Not Use an Electromagnetic Switch

Never connect an electromagnetic switch (MC) between the Inverter and motor and turn it ON or OFF during operation. If the MC is turned ON while the Inverter is operating, a large inrush current will be created and the inverter’s overcurrent protection will operate.

When using a MC to switch for instance between two motors, stop the Inverter output before operating the MC.

### Installing a Thermal Overload Relay Contact

This Inverter has an electronic thermal protection function to protect the motor from overheating. If, however, more than one motor is operated with one Inverter or a multi-polar motor is used, always install a thermal relay (THR) between the Inverter and the motor and set L1-01 to 0 (no motor protection). The control circuit should be designed so that the contacts of the thermal overload relay turn OFF the magnetic contactor on the main circuit inputs.

### Cable Length between Inverter and Motor

If the cable between the Inverter and the motor is long, the high-frequency leakage current will increase, causing the Inverter output current to increase as well. This may affect peripheral devices. To prevent this, adjust the carrier frequency (set in C6-01, C6-02) as shown in *Table 2.7*. (For details, refer to *Chapter 5 User Constants*.)

Table 2.7 Cable Length between Inverter and Motor

| Cable length | 50 m max. | 100 m max. | More than 100 m |
|---|---|---|---|
| Carrier frequency | 15 kHz max. | 10 kHz max. | 5 kHz max. |

## ■Ground Wiring

Observe the following precautions when wiring the ground line.

- Always use the ground terminal of the 200 V Inverter with a ground resistance of less than 100 Ω and that of the 400 V Inverter with a ground resistance of less than 10 Ω.
- Do not share the ground wire with other devices, such as welding machines or power tools.
- Always use a ground wire that complies with technical standards on electrical equipment and minimize the length of the ground wire.
  Leakage current flows through the Inverter. Therefore, if the distance between the ground electrode and the ground terminal is too long, potential on the ground terminal of the Inverter will become unstable.
- When using more than one Inverter, be careful not to loop the ground wire.

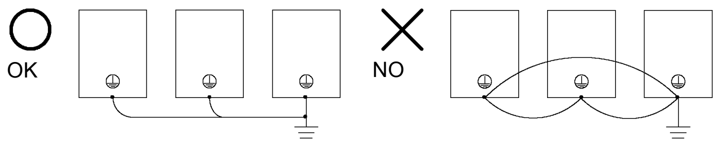



Fig 2.6 Ground Wiring

## ■Connecting a Braking Resistor (ERF)

A Braking Resistor mounted to the Inverter can be used with 200 V and 400 V Class Inverters with outputs from 0.4 to 11 kW.

Connect the braking resistor as shown in *Fig 2.7*.

Table 2.8

| | |
|---|---|
| L8-01 (Protection selection for internal DB resistor) | 1 (Enable overheat protection) |
| L3-04 (Stall prevention selection during deceleration) (Select either of them.) | 0 (Disable stall prevention function) |
| | 3 (Enable stall prevention function with braking resistor) |

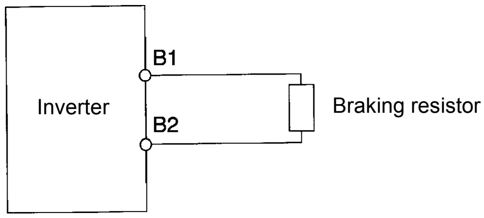



Fig 2.7  Connecting the Braking Resistor

IMPORTANT

The braking resistor connection terminals are B1 and B2. Do not connect the resistor to any other terminals.  Otherwise the resistor and other equipment may get damaged

## ■Connecting a Braking Resistor Unit (LKEB) and Braking Unit (CDBR)

Connect a Braking Resistor Unit and Braking Unit to the Inverter as shown in the *Fig 2.8*.

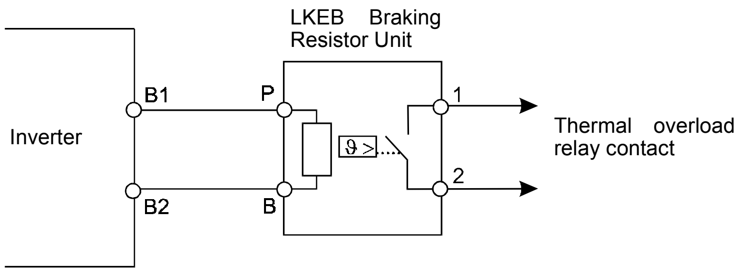
Table 2.9

| | |
|---|---|
| L8-01 (Protection selection for internal DB resistor) | 0 (Disable overheat protection) |
| L3-04 (Stall prevention selection during deceleration) (Select either of them.) | 0 (Disable stall prevention function) |
| | 3 (Enable stall prevention function with braking resistor) |

The Braking Resistor Unit will not work if L3-04 is set to 1 (i.e., if stall prevention is enabled for deceleration). Hence the deceleration time may be longer than the set time (C1-02/04/06/08).

To prevent the braking unit/braking resistor unit from overheating, design the control circuit to turn OFF the power supply using the thermal overload relay contacts of the Unit as shown in *Fig 2.8*.

### 200 V and 400 V Class Inverters with 0.4 to 18.5 kW Output Capacity




### 200 V and 400 V Class Inverters with 22 kW or higher Output Capacity

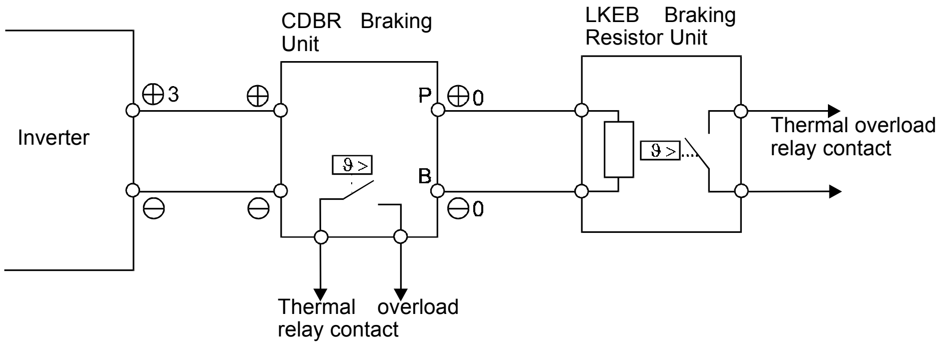



Fig 2.8 Connecting the Braking Resistor Unit and Braking Unit

### Connecting Braking Units in Parallel

When connecting two or more Braking Units in parallel, use the wiring and jumper settings like shown in *Fig 2.9*. There is a jumper for selecting whether each Braking Unit is to be a master or slave. Select “Master” for the first Braking Unit only, and select “Slave” for all other Braking Units (i.e., from the second Unit onwards).

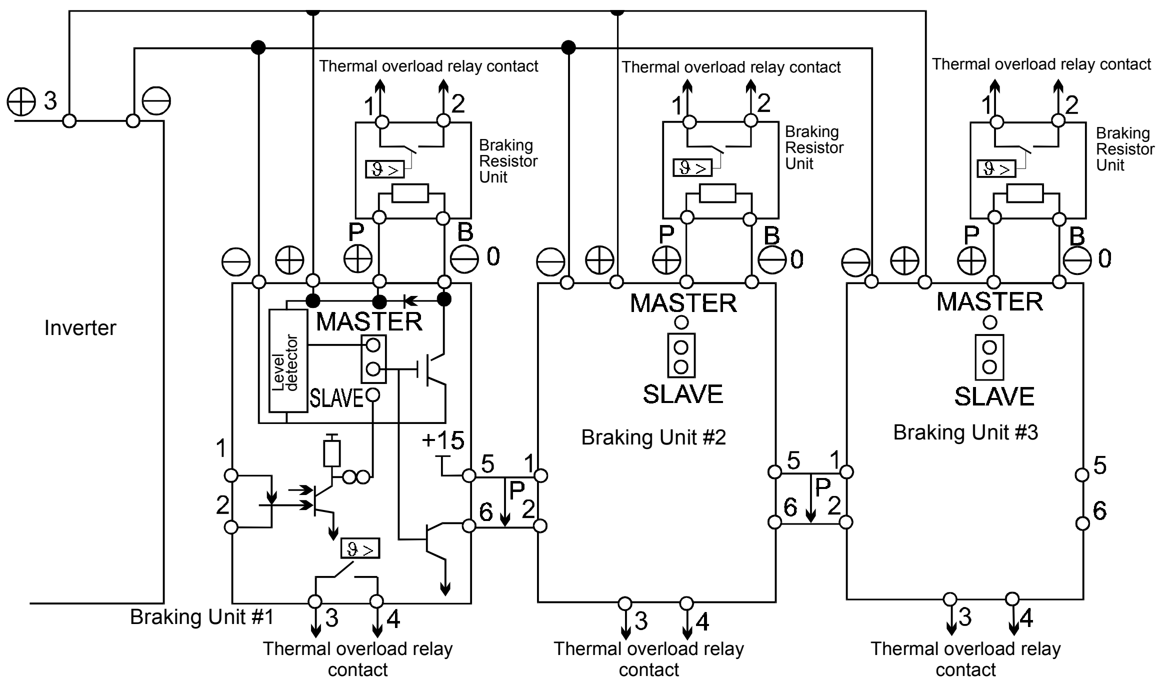



Fig 2.9  Connecting Braking Units in Parallel

### Breaking Unit Application Precautions

When using a Braking Resistor Unit, design the control circuit to detect overheating of the braking resistor.

# Wiring Control Circuit Terminals

## ◆ Wire Sizes

For remote operation using analog signals, keep the control line length between the Analog Operator or operation signals and the Inverter to 50 m or less, and separate the lines from main power lines or other control circuits to reduce induction from peripheral devices.

When setting frequencies from an external frequency source (and not from a Digital Operator), used shielded twisted-pair wires and ground the shield for the largest area of contact between shield and ground. See the figure below for details on the wiring.

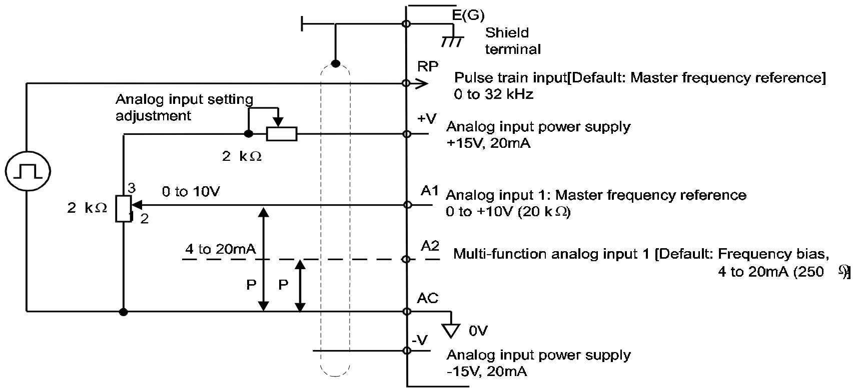



Fig 2.10

Terminal numbers and wire sizes are shown in *Table 2.10*.

Table 2.10 Terminal Numbers and Wire Sizes (Same for all Models)

| Terminals | Terminal Screws | Tightening Torque (N•m) | Possible Wire Sizes $mm^2$(AWG) | Recommended Wire Size $mm^2$(AWG) | Wire Type |
|---|---|---|---|---|---|
| FM, AC, AM, SC, SP, SN, A1, A2, +V, –V, S1, S2, S3, S4, S5, S6, S7 MA, MB, MC, M1, M2, M3, M4, M5, M6 MP, RP, R+, R-, S+, S-, IG | Phoenix type | 0.5 to 0.6 | Single wire*3: 0.14 to 2.5 Stranded wire: 0.14 to 1.5 (26 to 14) | 0.75 (18) | • Shielded, twisted-pair wire*1 • Shielded, polyethylene-covered, vinyl sheath cable (KPEV-S by Hitachi Electrical Wire or equivalent) |
| E (G) | M3.5 | 0.8 to 1.0 | 0.5 to 2*2 (20 to 14) | 1.25 (12) | |

* 1. Use shielded twisted-pair cables to input an external frequency reference.
* 2. Refer to *Table 2.3 Lug Sizes* for suitable lug sizes for the wires.
* 3. We recommend using straight solderless terminal on signal lines to simplify wiring and improve reliability.

## ■ Straight Solderless Terminals for Signal Lines

Models and sizes of straight solderless terminal are shown in the following table.

Table 2.11 Straight Solderless Terminal Sizes

| Wire Size mm$^2$ (AWG) | Model | d1 | d2 | L | Manufacturer |
|---|---|---|---|---|---|
| 0.25 (24) | AI 0.25 - 8YE | 0.8 | 2 | 12.5 | Phoenix Contact |
| 0.5 (20) | AI 0.5 - 8WH | 1.1 | 2.5 | 14 | |
| 0.75 (18) | AI 0.75 - 8GY | 1.3 | 2.8 | 14 | |
| 1.25 (16) | AI 1.5 - 8BK | 1.8 | 3.4 | 14 | |
| 2 (14) | AI 2.5 - 8BU | 2.3 | 4.2 | 14 | |

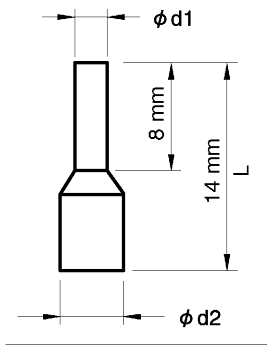



Fig 2.11 Straight Solderless Terminal Sizes

## ■Wiring Method

Use the following procedure to connect wires to the terminal block.

1. Loosen the terminal screws with a thin-slot screwdriver.
2. Insert the wires from underneath the terminal block.
3. Tighten the terminal screws firmly.

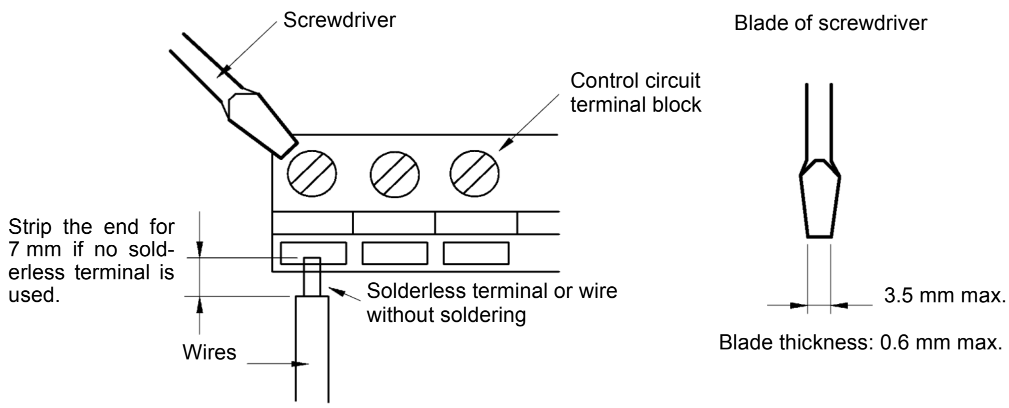



Fig 2.12 Connecting Wires to Terminal Block

## ◆ Control Circuit Terminal Functions

The functions of the control circuit terminals are shown in *Table 2.12*. Use the appropriate terminals for the correct purposes.

Table 2.12 Control Circuit Terminals with default settings

| Type | No. | Signal Name | Function | | Signal Level |
|---|---|---|---|---|---|
| Digital input signals | S1 | Forward run/stop command | Forward run when ON; stopped when OFF. | | 24 VDC, 8 mA<br>Photocoupler isolation |
| | S2 | Reverse run/stop command | Reverse run when ON; stopped when OFF. | | |
| | S3 | External fault input[*1] | Fault when ON. | Functions are selected by setting H1-01 to H1-05. | |
| | S4 | Fault reset[*] | Reset when ON | | |
| | S5 | Multi-step speed reference 1[*1]<br>(Master/auxiliary switch) | Auxiliary frequency reference when ON. | | |
| | S6 | Multi-step speed reference 2[*1] | Multi-step setting 2 when ON. | | |
| | S7 | Jog frequency reference[*1] | Jog frequency when ON. | | |
| | SC | Digital input common | – | | – |
| | SN | Digital Input Neutral | – | | – |
| | SP | Digital Input Power Supply | +24VDC power supply for digital inputs | | 24 VDC, 250 mA max. [*2] |
| Analog input signals | +V | 15 V power output | 15 V power supply for analog references | | 15 V<br>(Max. current: 20 mA) |
| | –V | –15 V power output | –15 V power supply for analog references | | –15 V<br>(Max. current: 20 mA) |
| | A1 | Frequency reference | –10 to +10 V/100% | | –10 to +10 V(20 kΩ) |
| | A2 | Multi-function analog input | 4 to 20 mA/100%<br>–10 V to +10 V/100% | Function is selected by setting H3-09. | 4 to 20 mA(250Ω)<br>–10 V to +10 V(20kΩ) |
| | AC | Analog reference common | – | | – |
| | E(G) | Shield wire, optional ground line connection point | – | | – |
| Sequence output signals | M1<br>M2 | Running signal<br>(1NO contact) | Operating when ON. | Multi-function contact outputs | Dry contacts<br>Contact capacity:<br>1 A max. at 250 VAC<br>1 A max. at 30 VDC[*3] |
| | M3<br>M4 | Zero speed | Zero level (b2-01) or below when ON | | |
| | M5<br>M6 | Speed agreement detection | Within ±2 Hz of set frequency when ON. | | |
| | MA<br>MB<br>MC | Fault output signal (SPDT) | Fault when CLOSED across MA and MC<br>Fault when OPEN across MB and MC | | Dry contacts<br>Contact capacity:<br>1 A max. at 250 VAC<br>1 A max. at 30 VDC[*3] |
| Analog output signals | FM | Multi-function analog output (frequency output) | –10 to +10 V/100% frequency | Multi-function analog output 1 | –10 to +10 V max. ±5%<br>2 mA max. |
| | AC | Analog common | – | | |
| | AM | Multi-function analog output (current monitor) | 5 V/Inverter's rated current | Multi-function analog output 2 | |

Table 2.12  Control Circuit Terminals with default settings (Continued)

| Type | No. | Signal Name | Function | Signal Level |
|---|---|---|---|---|
| Pulse I/O | RP | Pulse input*4 | H6-01 (Frequency reference input) | 0 to 32 kHz (3 kΩ)<br>High level voltage 3.5 to 13.2 V |
| | MP | Pulse monitor | H6-06 (Output frequency) | 0 to 32 kHz<br>+5 V output (2.2 kΩ) |
| RS-485/422 | R+ | MEMOBUS communications input | For 2-wire RS-485, short R+ and S+ as well as R- and S-. | Differential input, PHC isolation |
| | R- | | | |
| | S+ | MEMOBUS communications output | | Differential input, PHC isolation |
| | S- | | | |
| | IG | Signal common | – | – |

* 1. The default settings are given for terminals S3 to S7. For a 3-wire sequence, the default settings are a 3-wire sequence for S5, multi-step speed setting 1 for S6 and multi-step speed setting 2 for S7.
* 2. Do not use this power supply for supplying any external equipment.
* 3. When driving a reactive load, such as a relay coil with DC power supply, always insert a flywheel diode as shown in *Fig 2.13*.
* 4. Pulse input specifications are given in the following table.

| | |
|---|---|
| Low level voltage | 0.0 to 0.8 V |
| High level voltage | 3.5 to 13.2 V |
| H duty | 30% to 70% |
| Pulse frequency | 0 to 32 kHz |

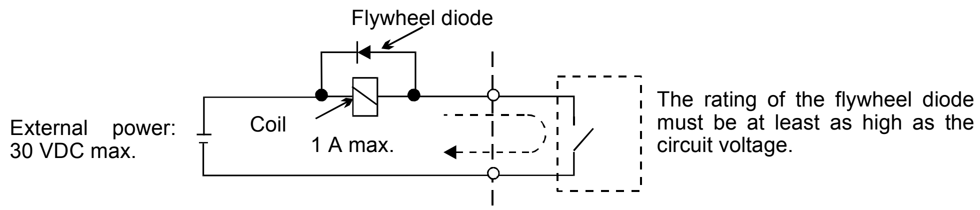
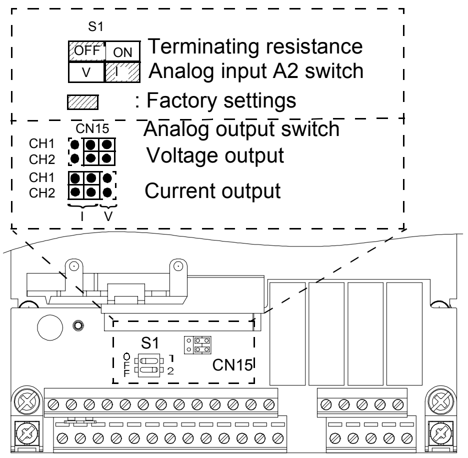



Fig 2.13  Flywheel Diode Connection

## ■Jumper CN15 and DIP Switch S1

The jumper CN 15 and DIP switch S1 are described in this section.




Note: Refer to *Table 2.13* for S1 functions.

Fig 2.14  Jumper CN15 and DIP Switch S1

The functions of DIP switch S1 and jumper CN15 are shown in the following table.

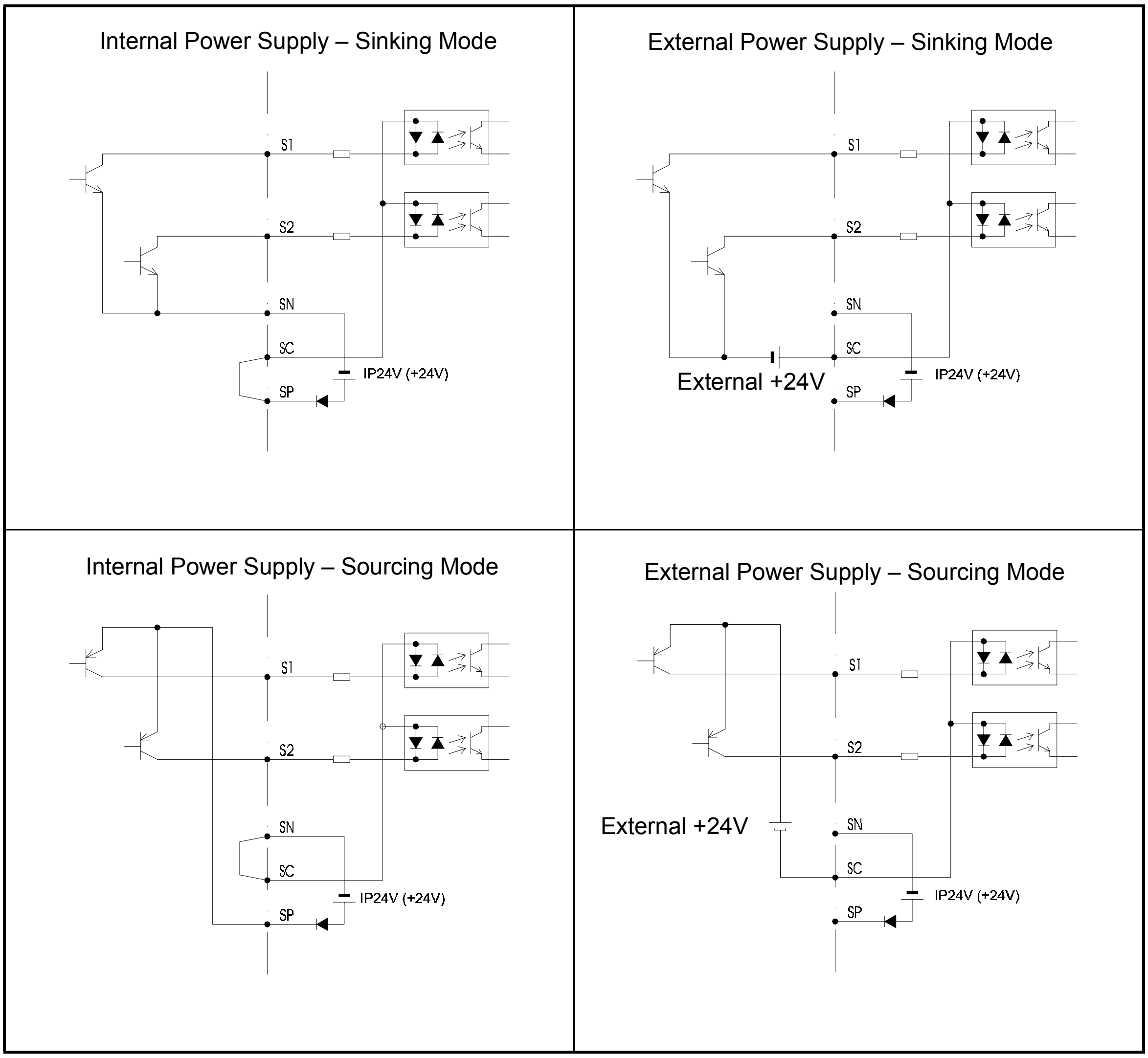
Table 2.13 DIP Switch S1 and jumper CN15

| Name | Function | Setting |
|---|---|---|
| S1-1 | RS-485 and RS-422 terminating resistance | OFF: No terminating resistance<br>ON: Terminating resistance of 110 Ω |
| S1-2 | Input method for analog input A2 | V: 0 to 10 V (internal resistance: 20 kΩ)<br>I: 4 to 20 mA (internal resistance: 250 Ω) |
| CN15-CH1 | Multifunction analog output FM voltage/current switch | I: Current output<br>V: Voltage output |
| CN15-CH2 | Multifunction analog output AM voltage/current switch | I: Current output<br>V: Voltage output |

## ■ Sinking/Sourcing Mode

The input terminal logic can be switched between sinking mode (0-V common) and sourcing mode (+24V common) by using the terminals SN, SC, and SP. An external power supply is also supported, providing more freedom in signal input methods.

Table 2.14 Sinking/Sourcing Mode and Input Signals




2

## ◆ Control Circuit Terminal Connections

Connections to Inverter control circuit terminals are shown in *Fig 2.15*.

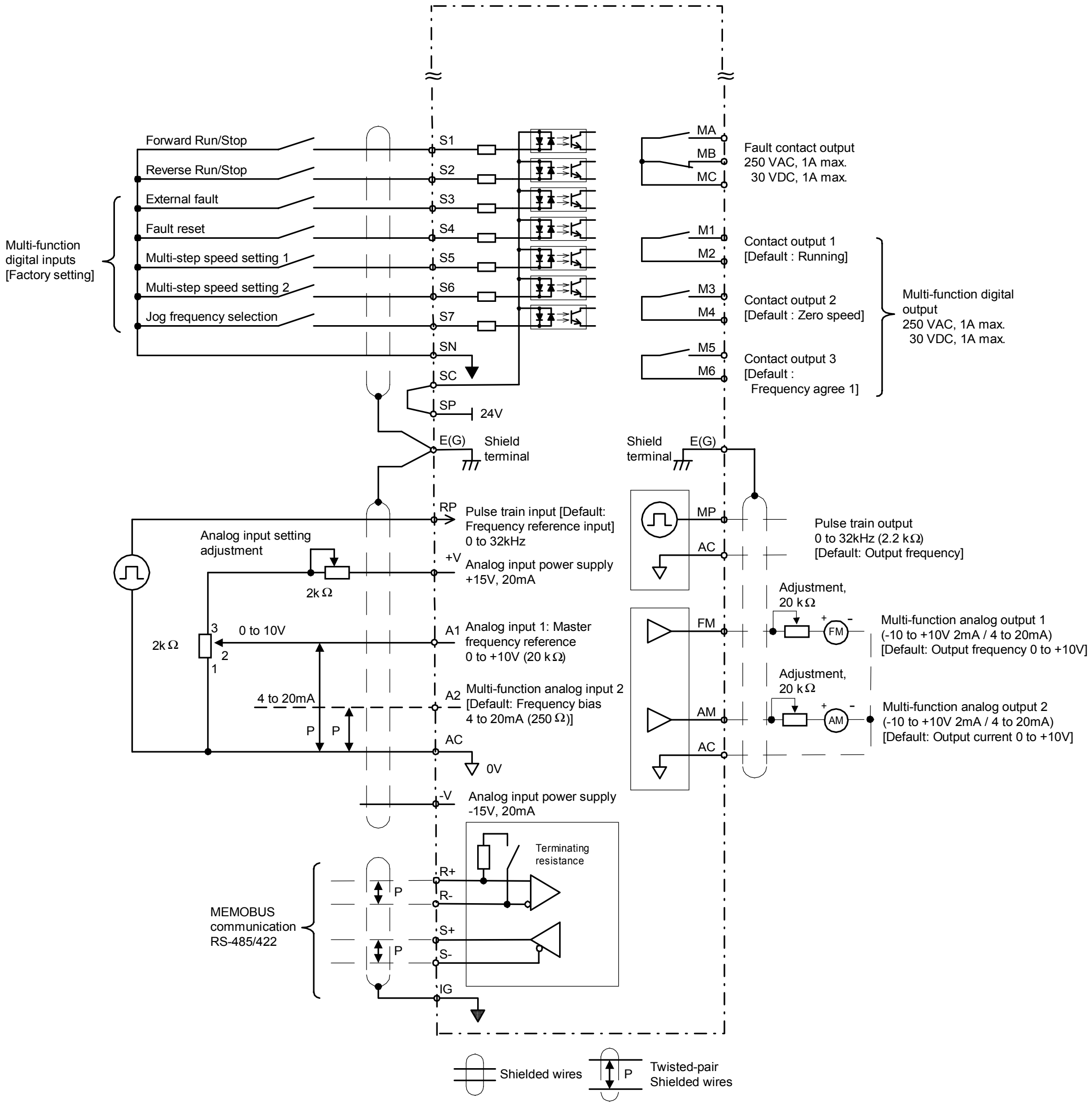



Fig 2.15  Control Circuit Terminal Connections

## ◆ Control Circuit Wiring Precautions

Observe the following precautions when wiring control circuits.

- Separate control circuit wiring from main circuit wiring (terminals R/L1, S/L2, T/L3, B1, B2, U/T1, V/T2, W/T3, ⊖, ⊕1, ⊕2, and ⊕3) and other high-power lines.
- Separate wiring for control circuit terminals MA, MB, MC, M1, M2, M3, M4, M5, and M6 (contact outputs) from wiring to other control circuit terminals.
- If using an optional external power supply, it shall be a UL Listed Class 2 power supply source.
- Use twisted-pair or shielded twisted-pair cables for control circuits to prevent operating faults.
- Ground the cable shields so as to maximise the contact area of the shield and ground.
- Cable shields have to be grounded on both cable ends.

# Wiring Check

## ◆ Checks

Check all wiring after wiring has been completed. Do not perform continuity check on control circuits. Perform the following checks on the wiring.

- Is all wiring correct?
- Have no wire clippings, screws, or other foreign material been left?
- Are all screws tight?
- Are any wire ends contacting other terminals?

# Installing and Wiring Option Cards

## ◆ Option Card Models and Specifications

Up to two Option Cards can be mounted in the Inverter. You can mount up one card into each of the two places on the controller card (A, and C) shown in *Fig 2.16*.

*Table 2.15* lists the type of Option Cards and their specifications.

Table 2.15 Option Card Specifications

| Card | Model | Specifications | Mounting Location |
|---|---|---|---|
| PG Speed Control Cards | PG-A2 | One phase (phase A or B), +12V or open collector input, max. response frequency: 30 kHz | A |
| | PG-B2 | Two phase (phase A and B), +12V inputs, max. response frequency: 30 kHz | A |
| | PG-D2 | One phase (phase A or B), line driver input (RS422), max. response frequency: 300 kHz | A |
| | PG-X2 | Three phase (phase A, B, Z), line driver inputs (RS422), max. response frequency: 300 kHz | A |
| DeviceNet communications card | SI-N | Option card for DeviceNet fieldbus | C |
| Profibus-DP communications card | SI-P | Option card for Profibus-DP fieldbus | C |
| InterBus-S communications card | SI-R | Option card for InterBus-S fieldbus | C |

## ◆ Installation

Before mounting an Option Card, remove the terminal cover and be sure that the charge indicator inside the Inverter does not light anymore. After that remove the Digital Operator and front cover and then mount the Option Card.

Refer to documentation provided with the Option Card for actual mounting instructions for option slots A and C.

## ■ Preventing A and C Option Card Connectors from Rising

After installing an Option Card into slot A or C, insert an Option Clip to prevent the side with the connector from rising. The Option Clip can be easily removed by holding onto the protruding portion of the Clip and pulling it out.

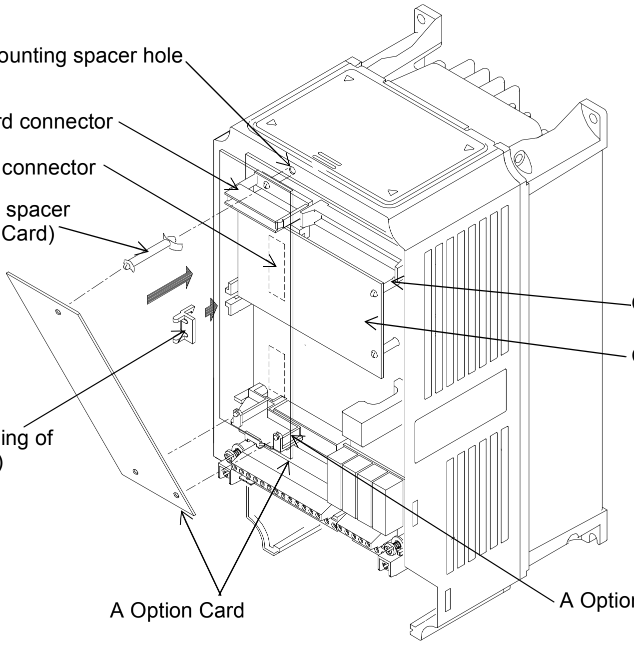



Fig 2.16 Mounting Option Cards

# ◆ PG Speed Control Card Terminals and Specifications

## ■PG-A2

The terminal specifications for the PG-A2 are given in the following table.

Table 2.16 PG-A2 Terminal Specifications

| Terminal | No. | Contents | Specifications |
|---|---|---|---|
| TA1 | 1 | Power supply for pulse generator | 12 VDC (±5%), 200 mA max. |
| | 2 | | 0 VDC (GND for power supply) |
| | 3 | +12 V/open collector selection terminal | Terminal for switching between12 V voltage input and open collector input. For open collector input, short across 3 and 4. |
| | 4 | | |
| | 5 | Pulse input terminals | H: +4 to 12 V; L: +1 V max. (Maximum response frequency: 30 kHz) |
| | 6 | | GND for pulse input |
| | 7 | Pulse monitor output terminals | 12 VDC (±10%), 20 mA max. |
| | 8 | | GND for pulse output |
| TA2 | (E) | Shield connection terminal | – |

## ■PG-B2

The terminal specifications for the PG-B2 are given in the following table.

Table 2.17  PG-B2 Terminal Specifications

| Terminal | No. | Contents | Specifications |
|---|---|---|---|
| TA1 | 1 | Power supply for pulse generator | 12 VDC (±5%), 200 mA max. |
| | 2 | | 0 VDC (GND for power supply) |
| | 3 | Pulse input terminals phase A | H: +8 to 12 V<br>L: +1 V max.<br>(Maximum response frequency: 30 kHz) |
| | 4 | | GND pulse input phase A |
| | 5 | Pulse input terminals phase B | H: +8 to 12 V<br>L: +1 V max.<br>(Maximum response frequency: 30 kHz) |
| | 6 | | GND pulse input phase B |
| TA2 | 1 | Pulse monitor output terminals phase A | Open collector output, 24 VDC, 30 mA max. |
| | 2 | | |
| | 3 | Pulse monitor output terminals phase B | Open collector output, 24 VDC, 30 mA max. |
| | 4 | | |
| TA3 | (E) | Shield connection terminal | - |

## ■PG-D2

The terminal specifications for the PG-D2 are given in the following table.

Table 2.18  PG-D2 Terminal Specifications

| Terminal | No. | Contents | Specifications |
|---|---|---|---|
| TA1 | 1 | Power supply for pulse generator | 12 VDC (±5%), 200 mA max.* |
| | 2 | | 0 VDC (GND for power supply) |
| | 3 | | 5 VDC (±5%), 200 mA max.* |
| | 4 | Pulse input terminal phase A/B (+) | Line driver input (RS-422 level input)<br>Maximum response frequency: 300 kHz |
| | 5 | Pulse input terminal phase A/B (–) | |
| | 6 | Common terminal | – |
| | 7 | Pulse monitor output terminal phase A/B (+) | Line driver output (RS-422 level output) |
| | 8 | Pulse monitor output terminal phase A/B (–) | |
| TA2 | (E) | Shield connection terminal | – |

* 5 VDC and 12 VDC cannot be used at the same time.

■PG-X2

The terminal specifications for the PG-X2 are given in the following table.

Table 2.19 PG-X2 Terminal Specifications

| Terminal | No. | Contents | Specifications |
|---|---|---|---|
| TA1 | 1 | Power supply for pulse generator | 12 VDC (±5%), 200 mA max.* |
| | 2 | | 0 VDC (GND for power supply) |
| | 3 | | 5 VDC (±5%), 200 mA max.* |
| | 4 | Pulse input terminal phase A (+) | Line driver input (RS422 level) (maximum response frequency: 300 kHz) |
| | 5 | Pulse input terminal phase A (–) | |
| | 6 | Pulse input terminal phase B (+) | |
| | 7 | Pulse input terminal phase B (–) | |
| | 8 | Pulse input terminal phase Z (+) | |
| | 9 | Pulse input terminal phase Z (–) | |
| | 10 | Common terminal inputs | – |
| TA2 | 1 | Pulse monitor output terminal phase A (+) | Line driver output (RS422 level output) |
| | 2 | Pulse monitor output terminal phase A (–) | |
| | 3 | Pulse monitor output terminal phase B (+) | |
| | 4 | Pulse monitor output terminal phase B (–) | |
| | 5 | Pulse monitor output terminal phase Z (+) | |
| | 6 | Pulse monitor output terminal phase Z (–) | |
| | 7 | Common terminal monitor outputs | – |
| TA3 | (E) | Shield connection terminal | – |

* 5 VDC and 12 VDC cannot be used at the same time.

## ◆ Wiring

### ■ Wiring the PG-A2

Wiring examples for the PG-A2 are provided in the following illustrations.

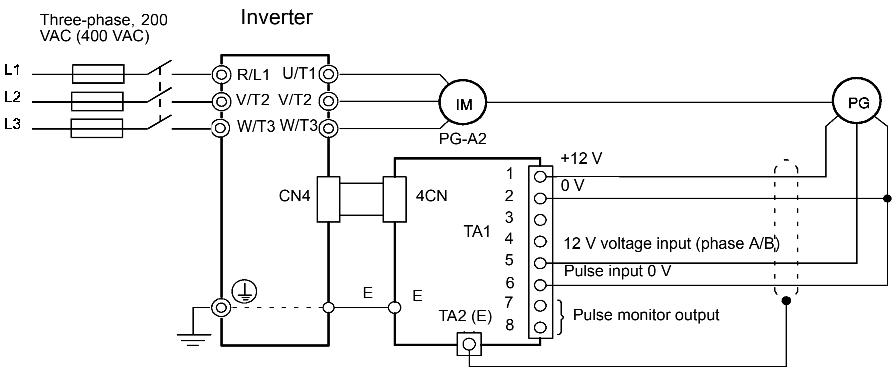
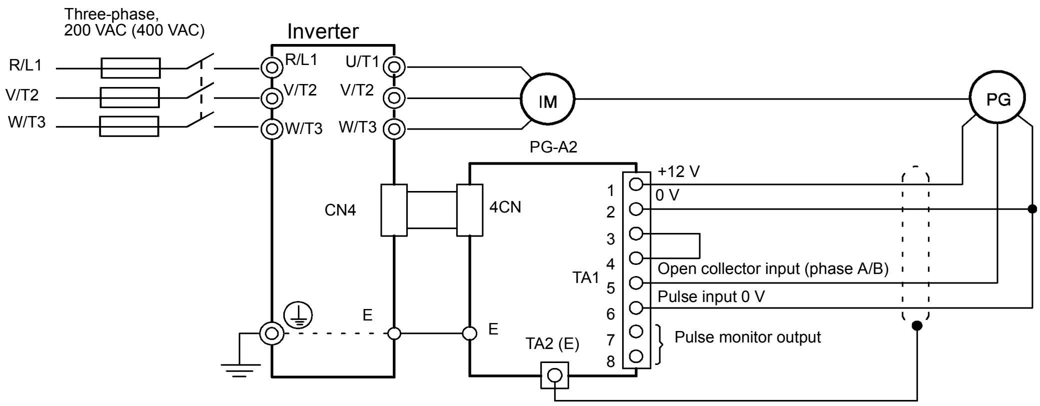



Fig 2.17 Wiring a 12 V Voltage Input




- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.

Fig 2.18 Wiring an Open-collector Input

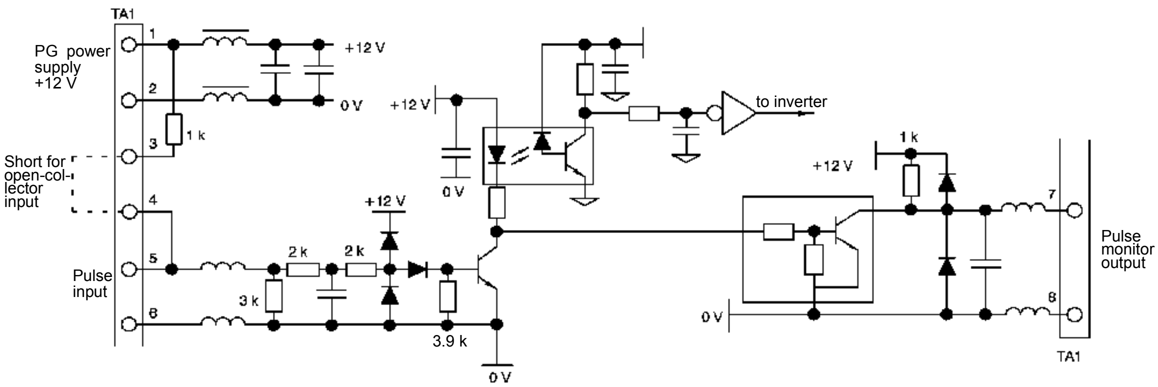
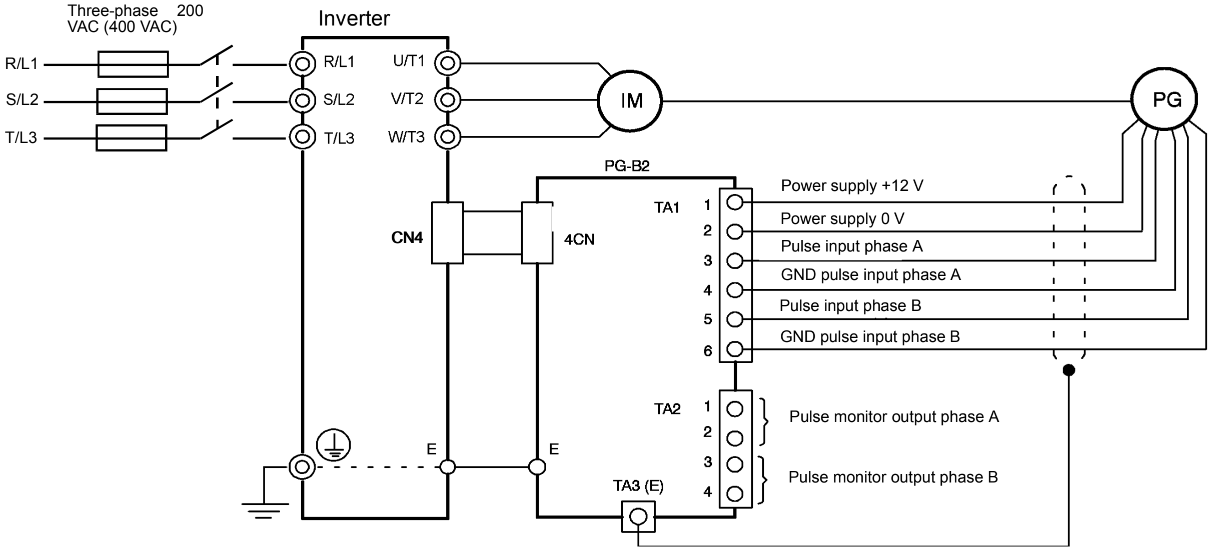



Fig 2.19 I/O Circuit Configuration of the PG-A2

## ■ Wiring the PG-B2

Wiring examples for the PG-B2 are provided in the following illustrations.




- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.
- The direction of rotation of the PG can be set in user constant F1-05. The factory preset if for forward rotation, A-phase advancement.

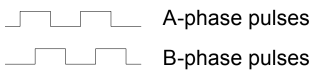
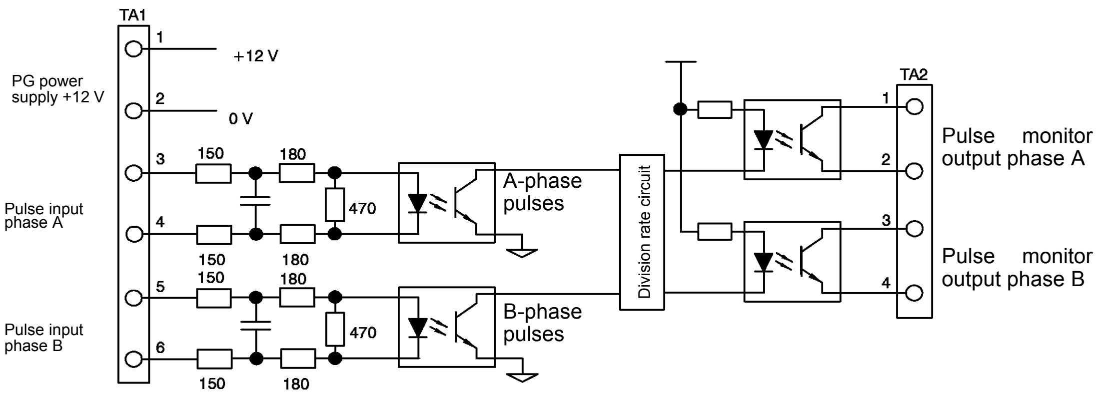



Fig 2.20 PG-B2 Wiring

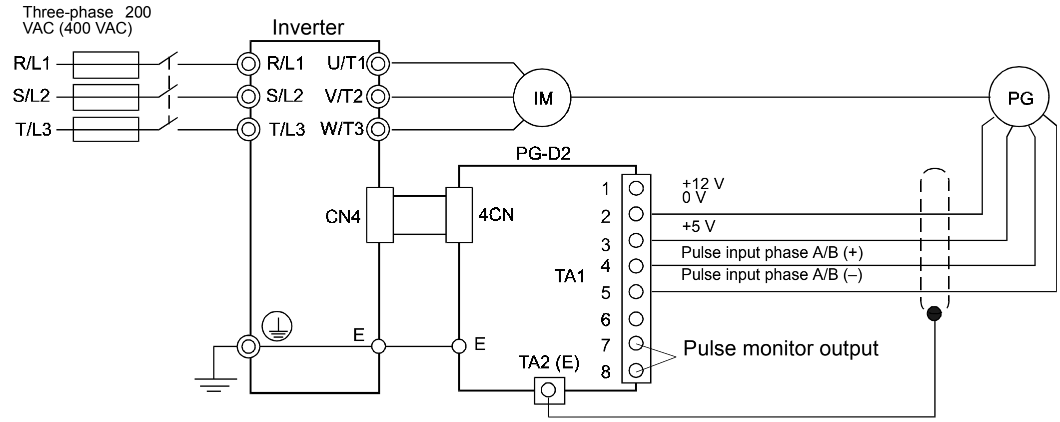



- When connecting to a voltage-output-type PG (encoder), select a PG that has an output impedance with a current of at least 12 mA to the input circuit photocoupler (diode).
- The pulse monitor dividing ratio can be changed using constant F1-06.

Fig 2.21 I/O Circuit Configuration of the PG-B2

## ■Wiring the PG-D2

Wiring examples for the PG-D2 are provided in the following illustrations.

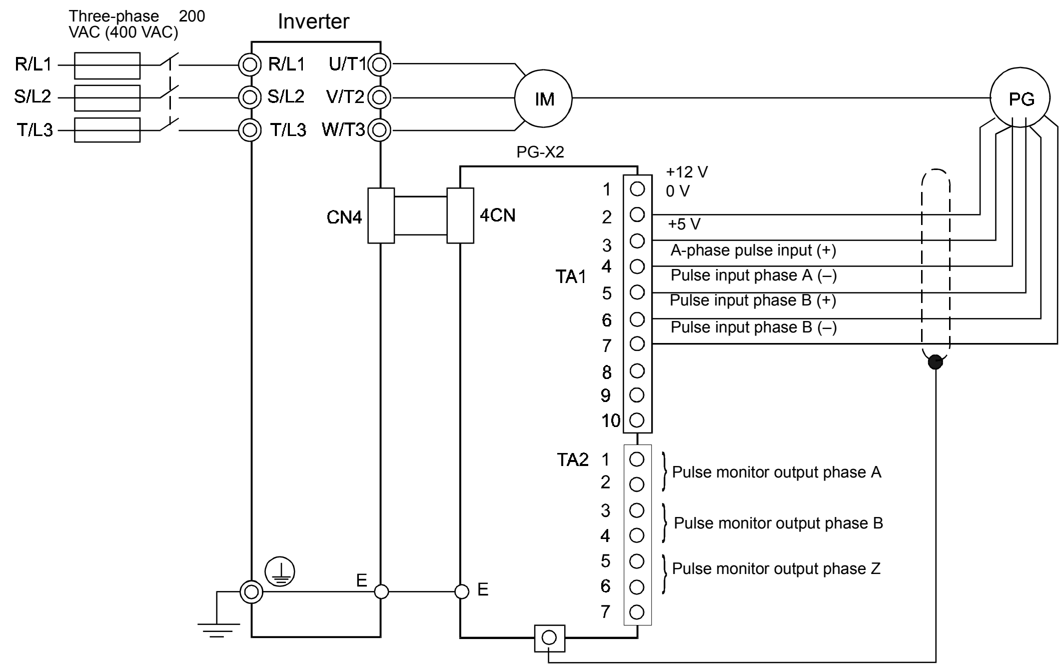



- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.

Fig 2.22 PG-D2 Wiring

## ■Wiring the PG-X2

Wiring examples for the PG-X2 are provided in the following illustrations.




- Shielded twisted-pair wires must be used for signal lines.
- Do not use the pulse generator's power supply for anything other than the pulse generator (encoder). Using it for another purpose can cause malfunctions due to noise.
- The length of the pulse generator's wiring must not be more than 100 meters.
- The direction of rotation of the PG can be set in user constant F1-05 (PG Rotation). The factory preset if for motor forward rotation, A-phase advancement.

Fig 2.23 PG-X2 Wiring

## ◆ Wiring Terminal Blocks

Use not more than 100 meters of wiring for PG (encoder) signal lines, and keep them separate from power lines.

Use shielded, twisted-pair wires for pulse inputs and pulse output monitor wires, and connect the shield to the shield connection terminal.

### ■Wire Sizes (Same for All Models)

Terminal wire sizes are shown in *Table 2.20*.

Table 2.20 Wire Sizes

| Terminal | Terminal Screws | Wire Thickness ($mm^2$) | Wire Type |
|---|---|---|---|
| Pulse generator power supply<br>Pulse input terminal<br>Pulse monitor output terminal | - | Stranded wire: 0.5 to 1.25<br>Single wire: 0.5 to 1.25 | • Shielded, twisted-pair wire<br>• Shielded, polyethylene-covered, vinyl sheath cable<br>(KPEV-S by Hitachi Electric Wire or equivalent) |
| Shield connection terminal | M3.5 | 0.5 to 2 | |

### ■Straight Solderless Terminals

We recommend using straight solderless terminal on signal lines to simplify wiring and improve reliability.

Refer to *Table 2.11 Straight Solderless Terminal Sizes* for specifications.

### ■Closed-loop Connector Sizes and Tightening Torque

The lug connectors and tightening torques for various wire sizes are shown in *Table 2.21*.

Table 2.21 Closed-loop Connectors and Tightening Torques

| Wire Thickness [$mm^2$] | Terminal Screws | Crimp Terminal Size | Tightening Torque (N • m) |
|---|---|---|---|
| 0.5 | M3.5 | 1.25 - 3.5 | 0.8 |
| 0.75 | | 1.25 - 3.5 | |
| 1.25 | | 1.25 - 3.5 | |
| 2 | | 2 - 3.5 | |

### ■Wiring Method and Precautions

The wiring method is the same as the one used for straight solderless terminals. Refer to *page 2-22*. Observe the following precautions when wiring.

- Separate the control signal lines for the PG Speed Control Card from main power lines and other control circuits.
- Connect the shield when connecting to a PG. The shield must be connected to prevent operational errors caused by noise. Also, do not use any lines that are more than 100 m long.
- Connect the shield (green grounding cable of the option card) to the shield terminal (E).
- Do not solder the ends of wires. Doing so may cause contact faults.
- When not using straight solderless terminals, strip the wires to a length of approximately 5.5 mm.

## ◆ Selecting the Number of PG (Encoder) Pulses

The setting for the number of PG pulses depends on the model of PG Speed Control Card being used. Set the correct number for your model.

### ■PG-A2/PG-B2

The maximum response frequency is 32,767 Hz.

Use a PG that outputs a maximum frequency of approximately 20 kHz for the nominal speed of the motor.

$$\frac{\text{Motor speed at maximum output frequency (min}^{-1}\text{)}}{60} \text{ x PG rating (p/rev) = 20,000 Hz}$$

Some examples of PG output frequency (number of pulses) for the maximum frequency output are shown in *Table 2.22*.

Table 2.22 PG Pulse Selection Examples

| Motor's Nominal Speed (min$^{-1}$) | PG Rating (p/rev) | PG Output Frequency for Maximum Output Frequency (Hz) |
|---|---|---|
| 1800 | 600 | 18,000 |
| 1500 | 800 | 20,000 |
| 1200 | 1000 | 20,000 |
| 900 | 1200 | 18,000 |

Note 1. The motor speed at maximum frequency output is expressed as the sync rotation speed.
2. The PG power supply is 12 V.
3. A separate power supply is required if the PG power consumption is greater than 200 mA. (If momentary power loss must be handled, use a backup capacitor or other method.)

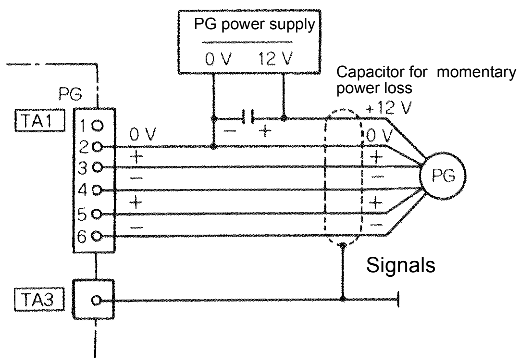



Fig 2.24 PG-B2 Connection Example

## ■PG-D2/PG-X2

There are 5 V and 12 V PG power supplies.
Check the PG power supply specifications before connecting.

The maximum response frequency is 300 kHz.

Use the following equation to calculate the output frequency of the PG ($f_{PG}$).

$$f_{PG}\ (\text{Hz}) = \frac{\text{Motor speed at maximum output frequency}\ (\text{min}^{-1})}{60} \times \text{PG rating (p/rev)}$$

A separate power supply is required if the PG power supply consumption is higher than 200 mA. (If momentary power loss must be handled, use a backup capacitor or other method.)

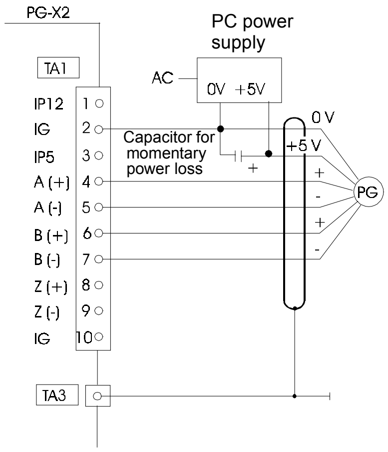



Fig 2.25 PG-X2 Connection Example (for 12 V PG power supply)

# 3

# Digital Operator and Modes

This chapter describes Digital Operator displays and functions, and provides an overview of operating modes and switching between modes.

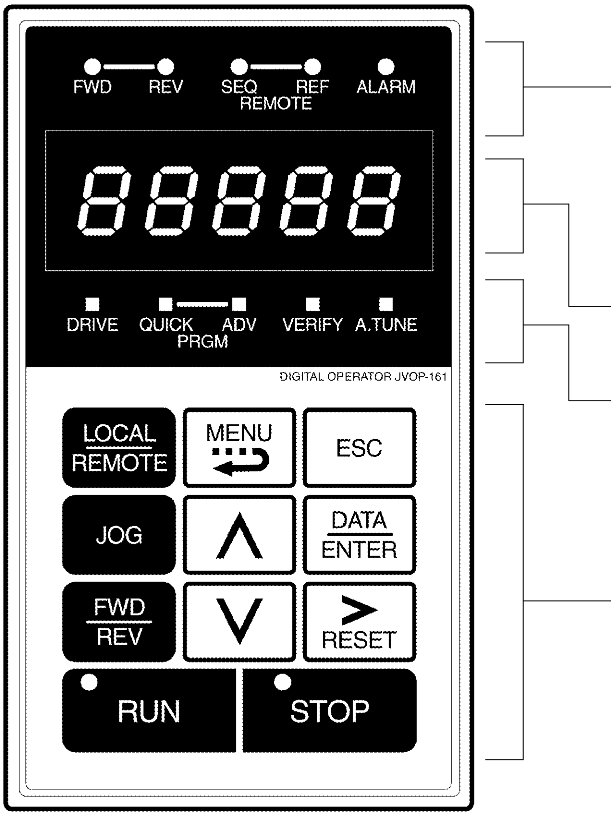
Digital Operator ........................................................ 3-2
Modes .................................................................... 3-4

# Digital Operator

This section describes the displays and functions of the Digital Operator.

## ◆ Digital Operator Display

The key names and functions of the Digital Operator are described below.




Drive Mode Indicators

FWD: Lights up when a forward run command is input.
REV: Lights up when a reverse run command is input.
SEQ: Lights up when the run command from the control circuit terminal is enabled.
REF: Lights up when the frequency reference from control circuit terminals A1 and A2 is enabled.
ALARM: Lights up when an error or alarm has occurred.

Data Display

Displays monitor data, constant numbers, and settings.

Mode Display

DRIVE: Lights up in Drive Mode.
QUICK: Lights up in Quick Programming Mode.
ADV: Lights up in Advanced Programming Mode.
VERIFY: Lights up in Verify Mode.
A. TUNE: Lights up in Autotuning Mode.

Keys

Execute operations such as setting user constants, monitoring, jogging, and autotuning.

Fig 3.1 Digital Operator Component Names and Functions

## ◆ Digital Operator Keys

The names and functions of the Digital Operator Keys are described in *Table 3.1*.

Table 3.1 Key Functions

| Key | Name | Function |
|---|---|---|
| LOCAL REMOTE | LOCAL/REMOTE Key | Switches between operation via the Digital Operator (LOCAL) and control circuit terminal operation (REMOTE).<br>This Key can be enabled or disabled by setting user constant o2-01. |
| MENU | MENU Key | Selects modes. |
| ESC | ESC Key | Returns to the status before the DATA/ENTER Key was pressed. |

Table 3.1 Key Functions (Continued)

| Key | Name | Function |
|---|---|---|
| JOG | JOG Key | Enables jog operation when the Inverter is being operated from the Digital Operator. |
| FWD/REV | FWD/REV Key | Selects the rotation direction of the motor when the Inverter is being operated from the Digital Operator. |
| > RESET | Shift/RESET Key | Sets the active digit when programming user constants.<br>Also acts as the Reset key when a fault has occurred. |
| ∧ | Increment Key | Selects menu items, sets user constant numbers, and increments set values.<br>Used to move to the next item or data. |
| ∨ | Decrement Key | Selects menu items, sets user constant numbers, and decrements set values.<br>Used to move to the previous item or data. |
| DATA/ENTER | DATA/ENTER Key | Pressed to enter menu items, user constants, and set values.<br>Also used to switch from one screen to another. |
| RUN | RUN Key | Starts the Inverter operation when the Inverter is being controlled by the Digital Operator. |
| STOP | STOP Key | Stops Inverter operation.<br>This key can be enabled or disabled when operating from the control circuit terminal by setting user constant o2-02. |

Note: Except in diagrams, Keys are referred to the Key names listed in the above table.

There are indicators on the upper left of the RUN and STOP keys on the Digital Operator. These indicators will light and flash to indicate operating status.

The RUN key indicator will flash and the STOP key indicator will light during initial excitation or DC brake. The relationship between the indicators on the RUN and STOP keys and the Inverter status is shown in *Fig 3.2*.

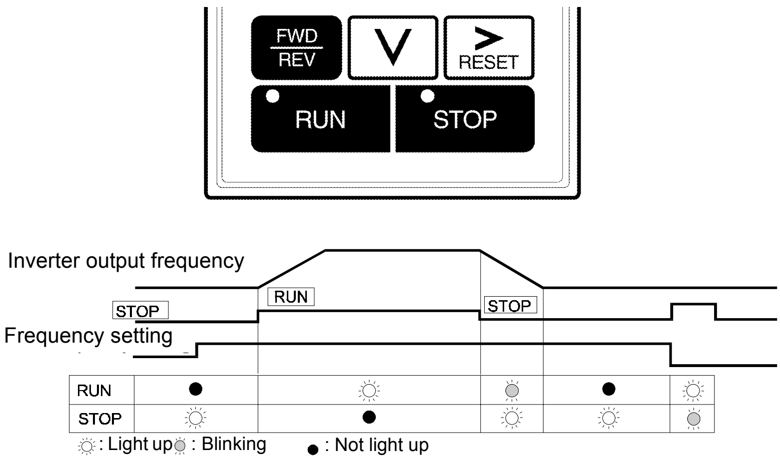



Fig 3.2 RUN and STOP Indicators

# Modes

This section describes the Inverter's modes and switching between modes.

## ◆ Inverter Modes

The Inverter's user constants and monitoring functions are organized in groups called modes that make it easier to read and set user constants.The Inverter is equipped with 5 modes.

The 5 modes and their primary functions are shown in the *Table 3.2*.

Table 3.2 Modes

| Mode | Primary function(s) |
|---|---|
| Drive mode | The Inverter can be run in this mode.<br>Use this mode when monitoring values such as frequency references or output current, displaying fault information, or displaying the fault history. |
| Quick programming mode | Use this mode to read and set the basic user constants to operate the Inverter. |
| Advanced programming mode | Use this mode to reference and set all user constants. |
| Verify mode | Use this mode to read/set user constants that have been changed from their factory-set values. |
| Autotuning mode* | Use this mode when running a motor with unknown motor constants in the vector control mode. The motor constants are measured/calculated and set automatically.<br>This mode can also be used to measure only the motor line-to-line resistance. |

* Always perform autotuning with the motor before operating in vector control mode.

## ◆ Switching Modes

The mode selection display will appear when the MENU key is pressed from a monitor or setting display. Press the MENU key from the mode selection display to switch between the modes.

Press the DATA/ENTER key from the mode selection display to monitor data and from a monitor display to access the setting display.

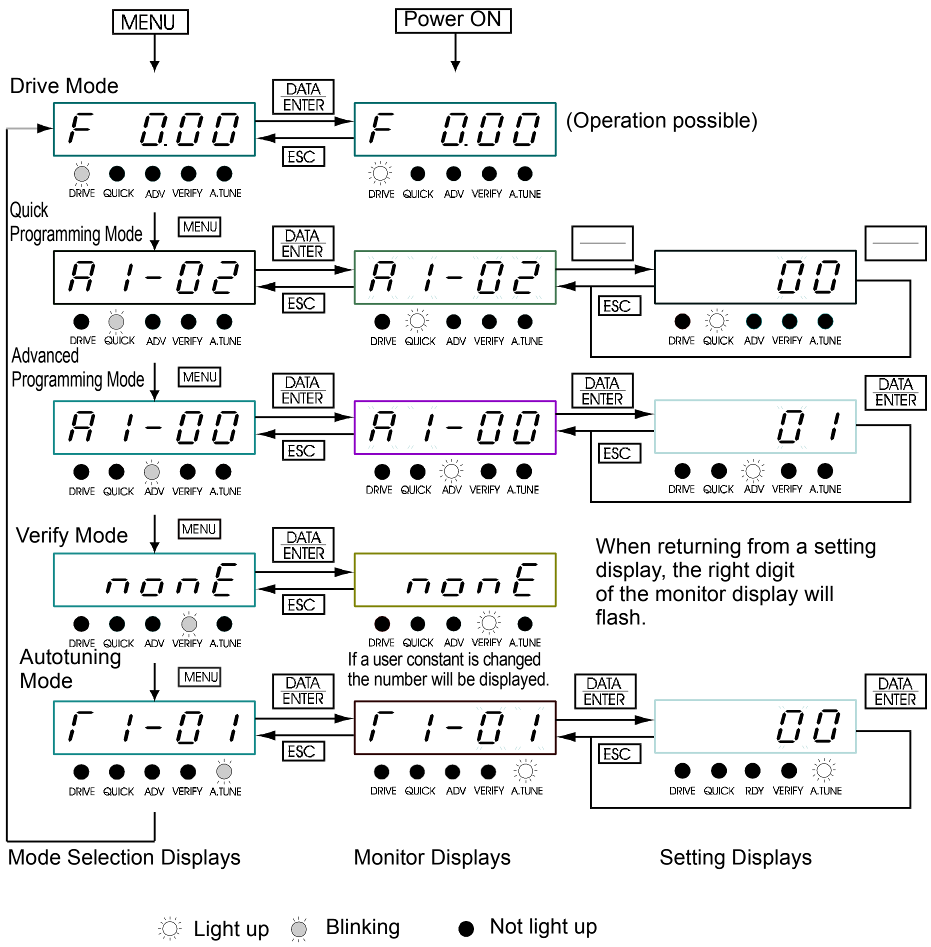



Fig 3.3 Mode Transitions

## ◆ Drive Mode

Drive mode is the mode in which the Inverter can be operated. The following monitor displays are possible in drive mode: The frequency reference, output frequency, output current, and output voltage, as well as fault information and the fault history.

When b1-01 (Reference selection) is set to 0, the frequency can be changed from the frequency setting display. Use the Increment, Decrement, and Shift/RESET keys to change the frequency. The user constant will be written and the monitor display will be returned to when the DATA/ENTER key is pressed after changing the setting.

### ■Example Operations

Key operations in drive mode are shown in the following figure.

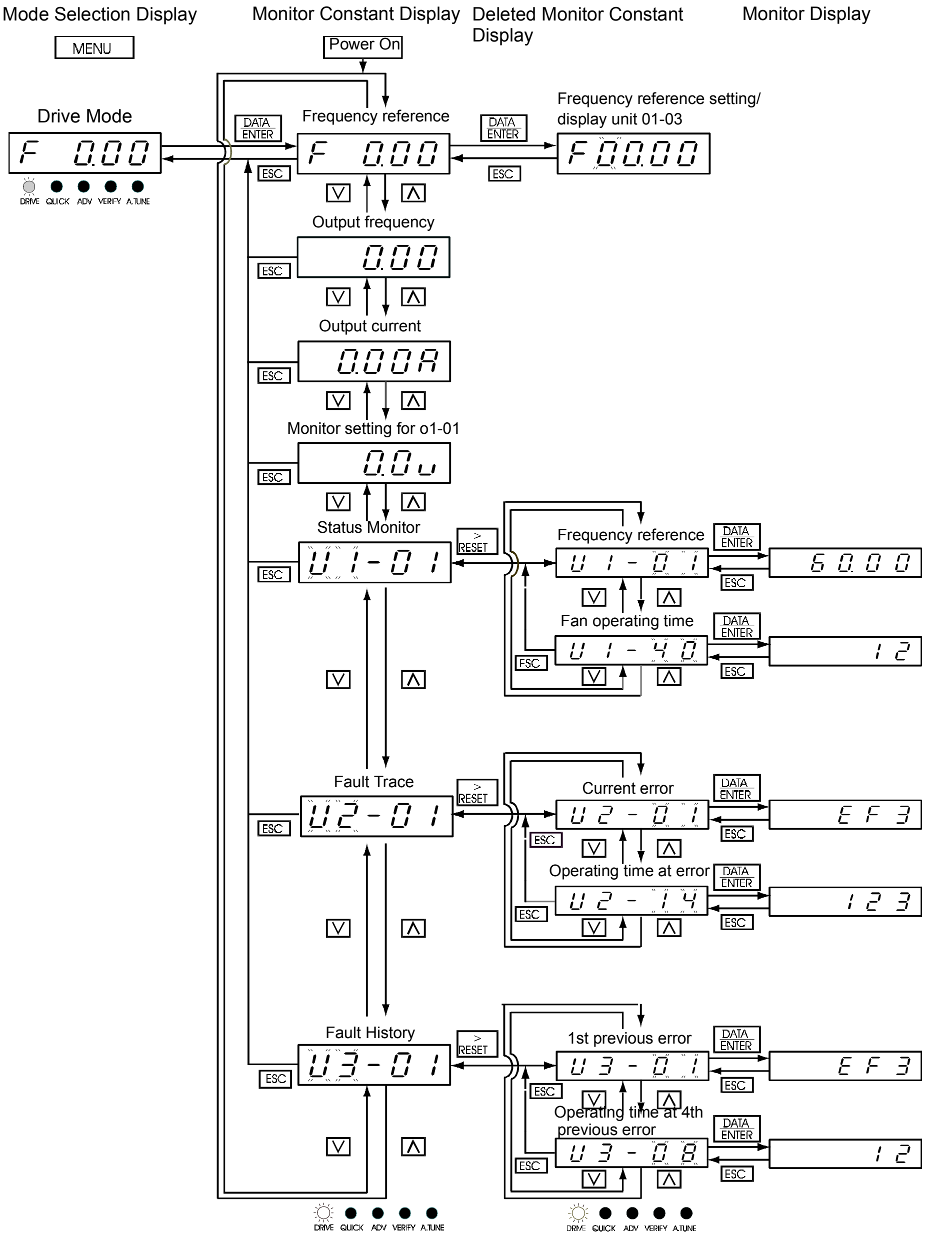



Fig 3.4  Operations in Drive Mode

**IMPORTANT**

The display for the first monitor constant (frequency reference) will be displayed when power is turned ON. The monitor item displayed at startup can be set in o1-02 (Monitor Selection after Power Up).

Operation cannot be started from the mode selection display.

## ◆ Quick Programming Mode

In quick programming mode, the constants required for Inverter trial operation can be monitored and set.

Constants can be changed from the setting displays. Use the Increment, Decrement, and Shift/RESET keys to change the frequency. The user constant will be written and the monitor display will be returned to when the DATA/ENTER key is pressed after changing the setting.

Refer to *Chapter 5 User Constants5-1* for details on the constants displayed in quick programming mode.

### ■Example Operations

Key operations in quick programming mode are shown in the following figure.

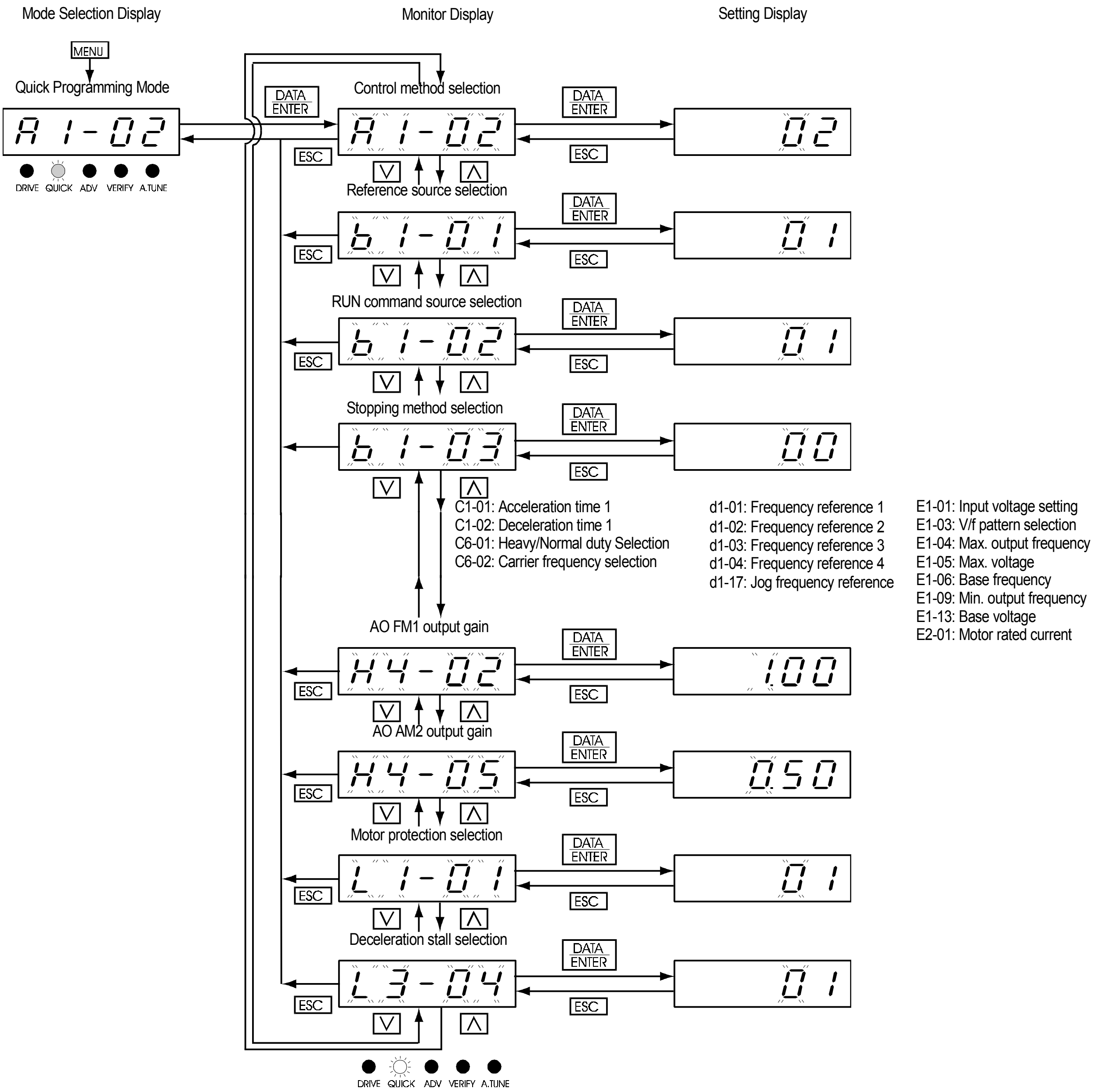



Fig 3.5  Operations in Quick Programming Mode

3

## ◆ Advanced Programming Mode

In advanced programming mode all Inverter constants can be monitored and set.

Constants can be changed from the setting displays. Use the Increment, Decrement, and Shift/RESET keys to change the constant. The user constant will be written and the display will return to monitor display when the DATA/ENTER key is pressed after changing the setting.

Refer to *Chapter 5 User Constants5-1* for details on the constants.

### ■Example Operations

Key operations in advanced programming mode are shown in the following figure.

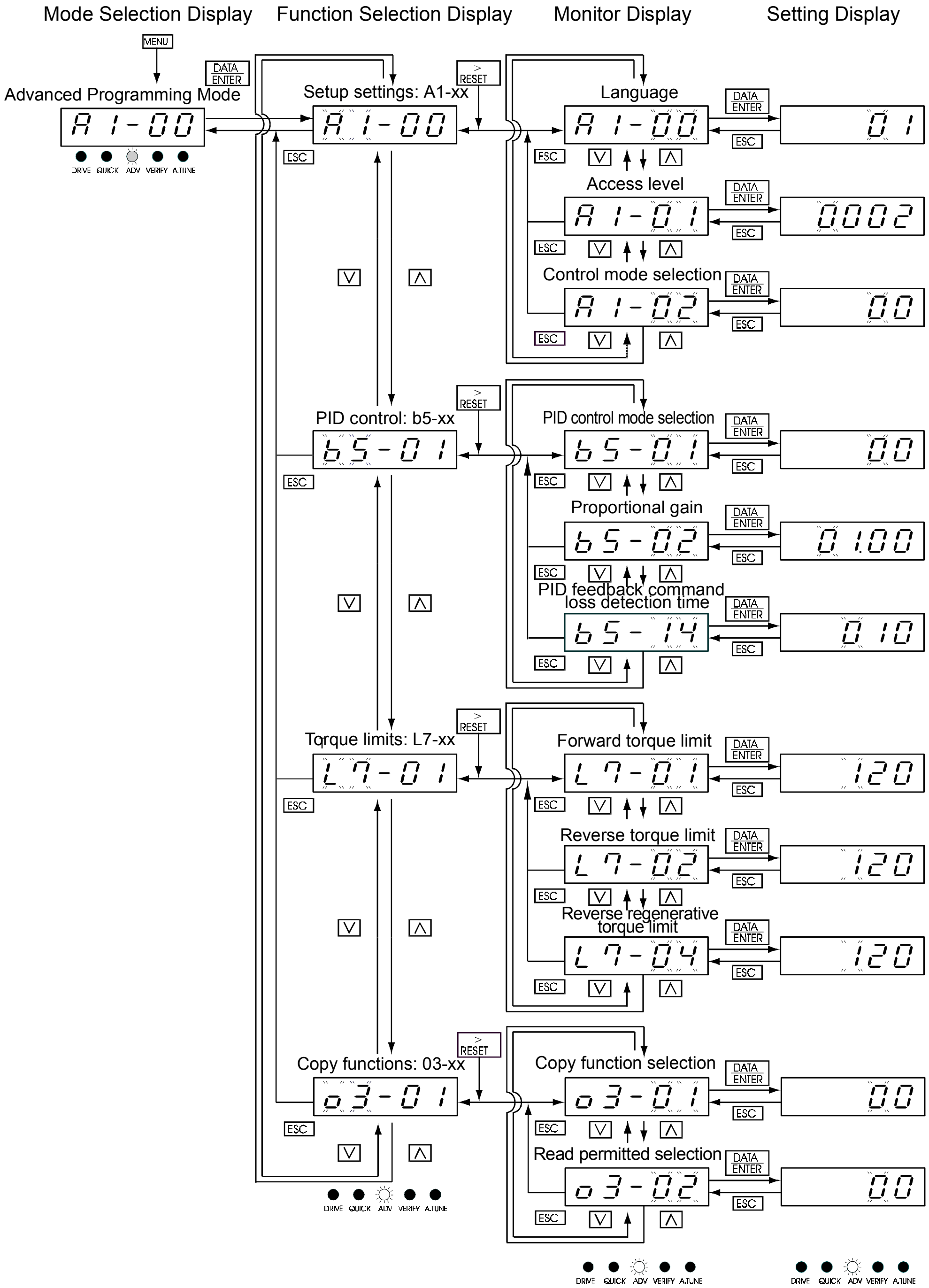



Fig 3.6 Operations in Advanced Programming Mode

## ■Setting User Constants

Here the procedure to change C1-01 (Acceleration Time 1) from 10 s to 20 s is shown.

Table 3.3  Setting User Constants in Advanced Programming Mode

| Step No. | Digital Operator Display | Description |
|---|---|---|
| 1 | F 0.00<br>DRIVE QUICK ADV VERIFY A.TUNE | Power supply turned ON. |
| 2 | F 0.00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press MENU key to enter drive mode. |
| 3 | A1-02<br>DRIVE QUICK ADV VERIFY A.TUNE | Press MENU key to enter quick programming mode. |
| 4 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press MENU key to enter advanced programming mode. |
| 5 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press DATA/ENTER to access monitor display. |
| 6 | C1-01<br>DRIVE QUICK ADV VERIFY A.TUNE | Press Increment or Decrement key to display C1-01 (Acceleration Time 1). |
| 7 | 0 10.00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press DATA/ENTER key to access setting display. The setting of C1-01 (10.00) is displayed. |
| 8 | 0 10.00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press Shift/RESET key to move the flashing digit to the right. |
| 9 | 020.00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press Increment key to change set value to 20.00 s. |
| 10 | End → 020.00 | Press DATA/ENTER key to enter the set data. “END” is displayed for 0.5 s and then the entered value is displayed for 0.5 s. |
| 11 | C1-01<br>DRIVE QUICK ADV VERIFY A.TUNE | The monitor display for C1-01 returns. |

3

## ◆ Verify Mode

Verify mode is used to display any constants that have been changed from their default settings in a programming mode or by autotuning. “None” will be displayed if no settings have been changed.

Even in verify mode, the same procedures can be used to change settings as they are used in the programming modes. Use the Increment, Decrement, and Shift/RESET keys to change the settings. The user constant will be written and the monitor display will be returned to when the DATA/ENTER key is pressed.

### ■Example Operations

An example of key operations is given below for when the following settings have been changed from their default settings: b1-01 (Reference Selection), C1-01 (Acceleration Time 1), E1-01 (Input Voltage Setting), and E2-01 (Motor Rated Current).

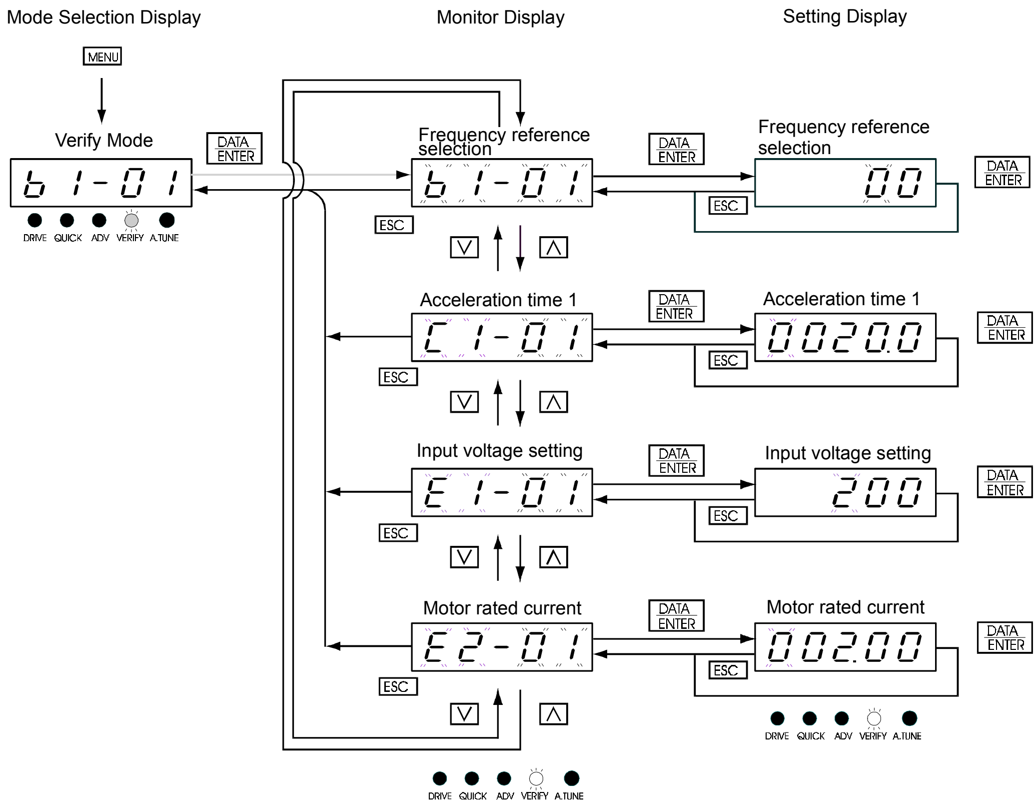



Fig 3.7 Operations in Verify Mode

## ◆ Autotuning Mode

Autotuning automatically measures and sets the required motor constants for the best performance in all control modes. Always perform autotuning before starting operation when using vector control.

When V/f control has been selected, only stationary autotuning for line-to-line resistance can be selected.

When the motor cannot be disconnected from the load, and vector control shall be used perform stationary autotuning.

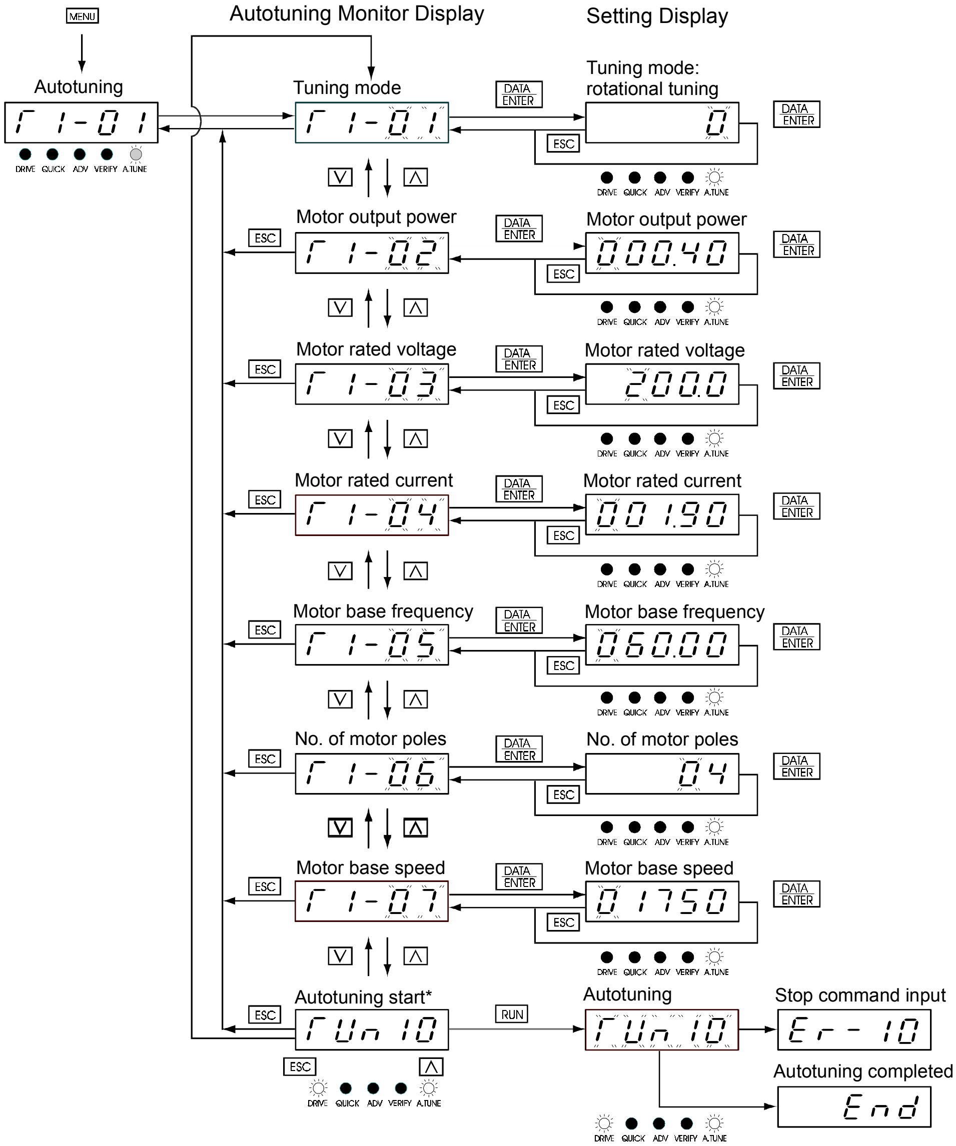
### ■Example of Operation

Set the motor rated output power (in kW), rated voltage, rated current, rated frequency, rated speed, and number of poles specified on the nameplate of the motor and then press the RUN key. The motor is automatically run and the measured motor constants are set.

Always set the above items. Otherwise autotuning cannot be started otherwise, e.g. it cannot be started from the motor rated voltage display.

Constants can be changed from the setting displays. Use the Increment, Decrement, and Shift/RESET keys to change the setting. The user constant will be written and the display will be returned to monitor display when the DATA/ENTER key is pressed.

The following example shows autotuning for open-loop vector control.




* TUn10 will be displayed during rotational autotuning and TUn11 will be displayed during stationary autotuning. The DRIVE indicator will light when autotuning starts.

Fig 3.8 Operation in Autotuning Mode

**IMPORTANT**

If a fault occurs during autotuning, refer to *Chapter 7 Troubleshooting*.

# 4

# Trial Operation

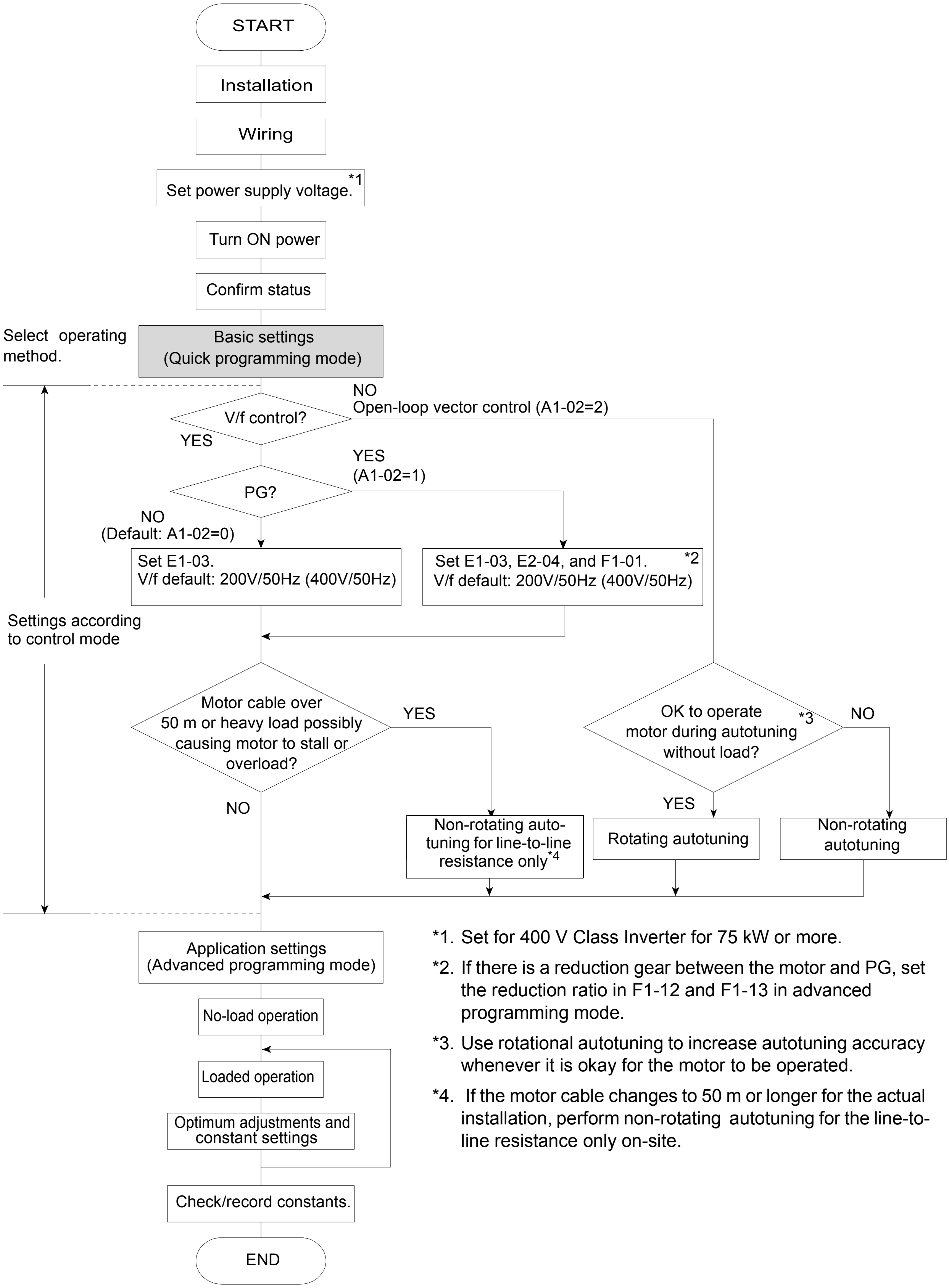
This chapter describes the procedures for trial operation of the Inverter and provides an example of trial operation.



Trial Operation Procedure............................................4-2
Trial Operation ............................................................4-3
Adjustment Suggestions ............................................4-14

# Trial Operation Procedure

Perform trial operation according to the following flowchart. When setting the basic user constants, always set C6-01 (Heavy/Normal Duty Selection) according to the application.




*1. Set for 400 V Class Inverter for 75 kW or more.

*2. If there is a reduction gear between the motor and PG, set the reduction ratio in F1-12 and F1-13 in advanced programming mode.

*3. Use rotational autotuning to increase autotuning accuracy whenever it is okay for the motor to be operated.

*4. If the motor cable changes to 50 m or longer for the actual installation, perform non-rotating autotuning for the line-to-line resistance only on-site.

Fig 4.1 Trial Operation Flowchart

# Trial Operation

The procedure for the trial operation is described in order in this section.

## ◆ Application Confirmation

First, confirm the application before using the Inverter.

- Fan, blower, pump
- Other equipment

For any Inverter application other than a fan, blower, or pump (with quadratic torque characteristic), set C6-01 (Heavy/Normal Duty Selection) to 0 (Heavy Duty: low carrier, constant torque). The default setting is 1 (Normal Duty: high carrier, variable torque).

## ◆ Setting the Power Supply Voltage Jumper (400 V Class Inverters of 75 kW or Higher)

Set the power supply voltage jumper after setting E1-01 (Input Voltage Setting) for 400 V Class Inverters of 75 kW or higher. Insert the jumper into the voltage connector nearest to the actual power supply voltage.

The jumper is factory-set to 440 V when shipped. If the power supply voltage is not 440 V, use the following procedure to change the setting.

1. Turn OFF the power supply and wait for at least 5 minutes.
2. Confirm that the CHARGE  indicator has gone out.
3. Remove the terminal cover.
4. Insert the jumper at the position for the voltage supplied to the Inverter (see *Fig 4.2*).
5. Return the terminal cover to its original position.

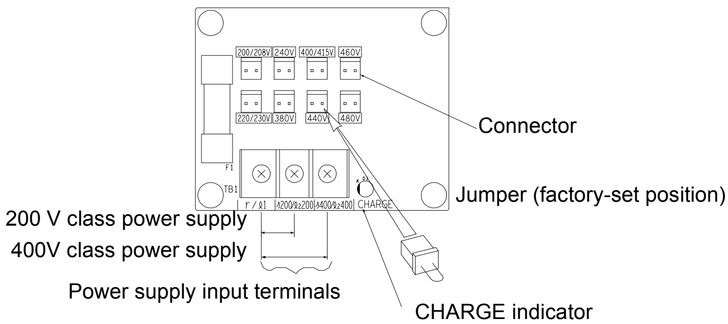



Fig 4.2  Large-capacity Inverter Connections

## ◆ Power ON

Confirm all of the following items and then turn ON the power supply.

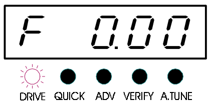
- Check that the power supply is of the correct voltage.
  200 V class: 3-phase 200 to 240 VDC, 50/60 Hz
  400 V class: 3-phase 380 to 480 VDC, 50/60 Hz
- Make sure that the motor output terminals (U, V, W) and the motor are connected correctly.
- Make sure that the Inverter control circuit terminal and the control device are wired correctly.

- Set all Inverter control circuit terminals to OFF.
- When using a PG Speed Control Card, make sure that it is wired correctly.
- Make sure that the motor is not connected to the mechanical system (no-load status) if possible.

## ◆ Checking the Display Status

If the Digital Operator's display at the time the power is connected is normal, it will read as follows:

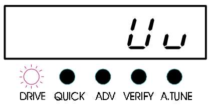
Display for normal operation




The frequency reference monitor is displayed in the data display section.

When a fault has occurred, the details of the fault will be displayed instead of the above display. In that case, refer to *Chapter 7 Troubleshooting*. The following display is an example of a display for faulty operation.

Display for fault operation




The display will differ depending on the type of fault.
A low voltage alarm is shown at left.

## ◆ Basic Settings

Switch to the quick programming mode (the QUICK indicator on the Digital Operation should light) and then set the following user constants.

Refer to *Chapter 3 Digital Operator and Modes* for Digital Operator operating procedures and to *Chapter 5 User Constants* and *Chapter 6 Constant Settings by Function* for details on the user constants.

Table 4.1 Basic Constant Settings

● : Must be set. O : Set as required.

| Class | Constant Number | Name | Description | Setting Range | Factory Setting | Page |
|---|---|---|---|---|---|---|
| ● | A1-02 | Control method selection | Sets the control method for the Inverter.<br>0: V/f control<br>1: V/f control with PG<br>2: Open-loop vector control | 0 to 2 | 0 | 5-7 |
| ● | b1-01 | Reference selection | Sets the frequency reference input method.<br>0: Digital Operator<br>1: Control circuit terminal multifunction (analog input)<br>2: MEMOBUS communications<br>3: Option Card<br>4: Pulse train input | 0 to 4 | 1 | 5-9<br>6-6<br>6-69<br>6-88 |
| ● | b1-02 | Operation method selection | Sets the run command input method.<br>0: Digital Operator<br>1: Control circuit terminal (digital multi-function input)<br>2: MEMOBUS communications<br>3: Option Card | 0 to 3 | 1 | 5-9<br>6-11<br>6-69<br>6-88 |
| O | b1-03 | Stopping method selection | Selects stopping method when stop command is sent.<br>0: Deceleration to stop<br>1: Coast to stop<br>2: DC braking stop<br>3: Coast to stop with timer | 0 to 3 | 0 | 5-9<br>6-13 |
| ● | C1-01 | Acceleration time 1 | Sets the acceleration time in seconds for the output frequency to climb from 0% to 100%. | 0.0 to 6000.0 | 10.0 s | 5-17<br>6-18 |
| ● | C1-02 | Deceleration time 1 | Sets the deceleration time in seconds for the output frequency to fall from 100% to 0%. | 0.0 to 6000.0 | 10.0 s | 5-17<br>6-18 |
| ● | C6-01 | Heavy /Normal Duty selection | Set to Heavy Duty (low carrier frequency, maximum current overload: 150% for 1 min.) or Normal Duty (high carrier frequency, maximum current overload:120% for 1 min.).<br>0: Heavy Duty<br>1: Normal Duty | 0 or 1 | 1 | 5-22<br>6-2 |
| O | C6-02 | Carrier frequency selection | Sets the carrier frequency. The factory setting and setting range depends on the setting of C6-01. | 0 to F | Depends on setting of C6-01. | 5-22 |

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Table 4.1 Basic Constant Settings (Continued)

●: Must be set. O: Set as required.

| Class | Constant Number | Name | Description | Setting Range | Factory Setting | Page |
|---|---|---|---|---|---|---|
| O | d1-01 to d1-04 and d1-17 | Frequency references 1 to 4 and jog frequency reference | Sets the required speed references for multi-step speed operation or jogging. | 0 to 400.00 Hz | d1-01 to d1-04: 0.00 Hz<br>d1-17: 6.00 Hz | 5-23<br>6-9 |
| ● | E1-01 | Input voltage setting | Sets the Inverter's nominal input voltage in volts. | 155 to 255 V (200 V class)<br>310 to 510 V (400 V class) | 200 V (200 V class)<br>400 V (400 V class) | 5-27<br>6-116 |
| ● | E2-01 | Motor rated current | Sets the motor rated current. | 10% to 200% of Inverter's rated current | Setting for general-purpose motor of same capacity as Inverter | 5-29<br>6-51<br>6-114 |
| O | H4-02 and H4-05 | FM and AM terminal output gain | Can be used to adjust the analog output when an instrument is connected to the FM or AM terminal. | 0.00 to 2.50 | H4-02: 1.00<br>H4-05: 0.50 | 5-42 |
| ● | L1-01 | Motor protection selection | Used to enable or disable the motor overload protection function.<br>0: Disabled<br>1: Protection for general purpose motor (fan cooled)<br>2: Protection for frequency converter motor (externally cooled)<br>3: Protection for special vector control motor | 0 to 3 | 1 | 5-45<br>6-51 |
| O | L3-04 | Stall prevention selection during deceleration | If using the dynamic brake option (braking resistor, Braking Resistor Units, and Braking Units), be sure to set constant L3-04 to 0 (disabled) or 3 (enabled with braking resistor). | 0 to 3 | 1 | 5-48<br>6-23 |

**IMPORTANT**

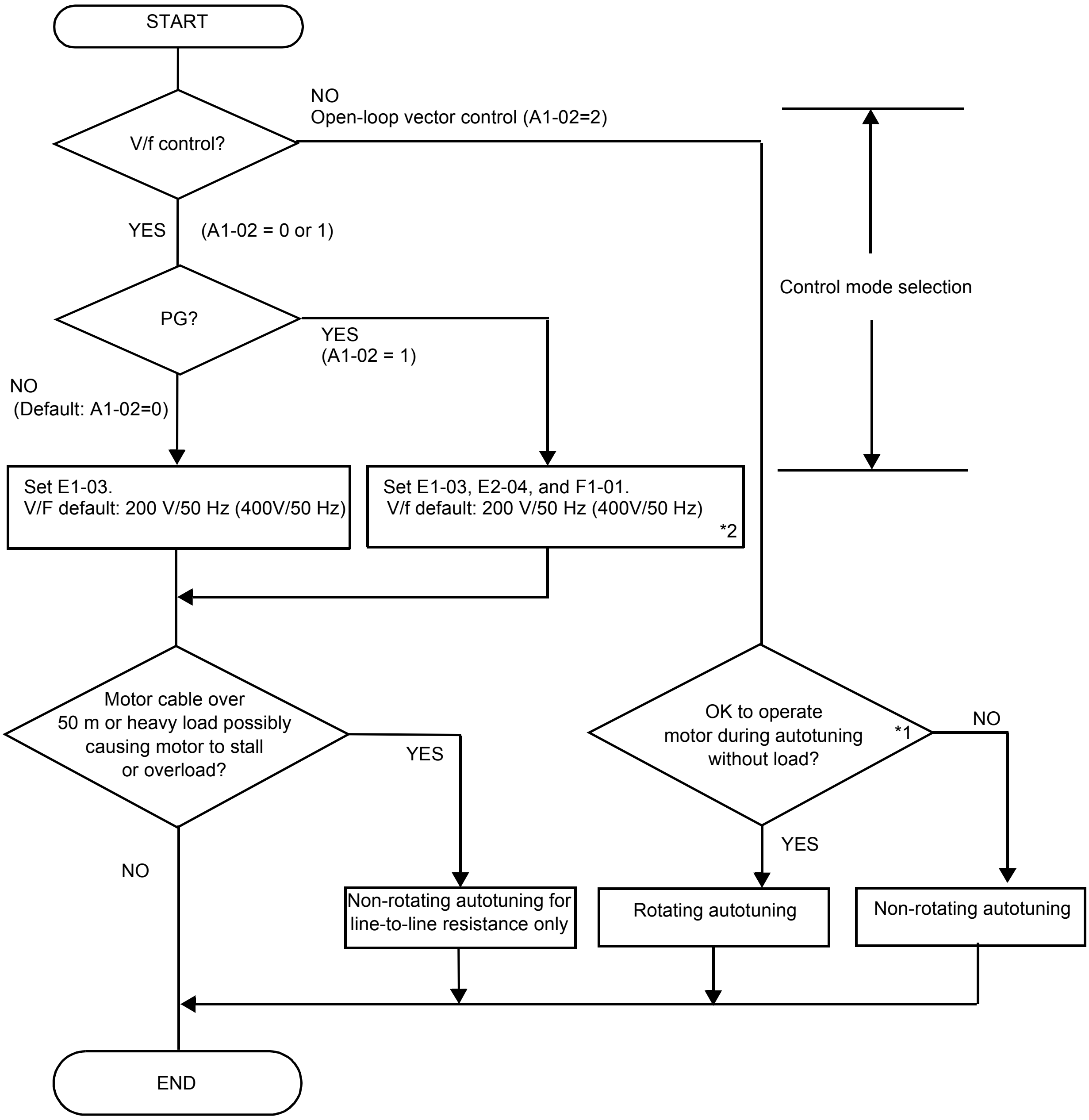
When C6-01 is set to 0 (Heavy Duty), low carrier frequency will be applied and the Inverter overload capability will be 150% of the inverter rated current for one minute. When C6-01 is set to 1 (Normal Duty), high carrier frequency will be applied and the inverter overload capability will be 120% of the inverter rated current for one minute.

## ◆ Settings for the Control Methods

Autotuning methods depend on the control method set for the Inverter. Make the settings required by the control method.

### ■Overview of Settings

Make the required settings in quick programming mode and autotuning mode according to the following flowchart.




Note: If the motor cable changes to 50 m or longer for the actual installation, perform non-rotating autotuning for the line-to-line resistance only on-site.
* 1. Use rotating autotuning to increase autotuning accuracy whenever it is possible to disconnect motor and load.
* 2. If there is a reduction gear between the motor and PG, set the reduction ratio in F1-12 and F1-13.

Fig 4.3  Settings According to the Control Method

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## ■Setting the Control Method

Any of the following three control methods can be set.

- V/f control without PG (normal variable control)
- V/f control with PG (simple speed feedback control)
- Open-loop vector control (high-performance control without PG)

### V/f Control without PG (A1-02 = 0)

- Set either one of the fixed patterns (0 to E) in E1-03 (V/f Pattern Selection) or set F in E1-03 to specify a user-set pattern as required for the motor and load characteristics in E1-04 to E1-13 in advanced programming mode.

| | |
|---|---|
| Simple operaton of a general-purpose motor at 50 Hz: | E1-03 = 0 or F (default) |
| Simple operaton of a general-purpose motor at 60 Hz: | E1-03 = 1<br>If E1-03 = F, the default setting in the user setting from E1-04 to E1-13 are for 50 Hz |

- It is recommended to perform non-rotating autotuning for the line-to-line resistance if the motor cable is 50 m or longer for the actual installation or the load is heavy enough to produce stalling. Refer to the following section on *Autotuning* for details on non-rotating autotuning.

### V/f Control with PG (A1-02=1)

- Set either one of the fixed patterns (0 to E) in E1-03 (V/f Pattern Selection) or set F in E1-03 to specify a user-set pattern as required for the motor and load characteristics in E1-04 to E1-13 in advanced programming mode.

| | |
|---|---|
| Simple operaton of a general-purpose motor at 50 Hz: | E1-03 = 0 or F (default) |
| Simple operaton of a general-purpose motor at 60 Hz: | E1-03 = 1<br>If E1-03 = F, the default setting in the user setting from E1-04 to E1-13 are for 50 Hz |

- Set the number of motor poles in E2-04 (Number of Motor Poles)
- Set the number of pulses per rotation in F1-01 (PG Constant). If there is a reduction gear between the motor and PG, set the reduction ratio in F1-12 and F1-13 in advanced programming mode.
- It is recommended to perform non-rotating autotuning for the line-to-line resistance if the motor cable is 50 m or longer for the actual installation or the load is heavy enough to produce stalling. Refer to the following section on *Autotuning* for details on non-rotating autotuning.

### Open-loop Vector Control (A1-02 = 2)

Always perform autotuning. If the motor can be operated, perform rotating autotuning. If the motor cannot be operated, perform stationary autotuning. Refer to the following section on *Autotuning* for details on autotuning.

## ◆ Autotuning

Use the following procedure to perform autotuning to automatically set motor constants when using the open-loop vector control method, when the cable length is long, etc.

### ■ Setting the Autotuning Mode

One of the following three autotuning modes can be set.

- Rotating autotuning
- Non-rotating autotuning
- Non-rotating autotuning for line-to-line resistance only

#### Rotating Autotuning (T1-01 = 0)

Rotating autotuning is used for open-vector control only. Set T1-01 to 0, input the data from the nameplate, and then press the RUN key on the Digital Operator. The Inverter will stop the motor for approximately 1 minute and then set the required motor constants automatically while operating the motor for approximately 1 minute

**IMPORTANT**

1. Always disconnect the motor from the machine and confirm that it is safe to operate the motor before performing rotational autotuning.
2. If the motor and load cannot be disconnected perform non-rotating autotuning, but always use rotating autotuning whenever it is possible to operate the motor to increase performance.



#### Non-rotating Autotuning (T1-01 = 1)

Non-rotating autotuning is used for open-vector control only. Set T1-01 to 1, input the data from the name-plate, and then press the RUN key on the Digital Operator. The inverter will supply power to the non-rotating motor for approximately 1 minute and some of the motor constants will be set automatically. The remaining motor constants will be set automatically during the first time operation.

**IMPORTANT**

1. Power will be supplied to the motor when non-rotating autotuning is performed but the motor will not turn. Do not touch the motor until autotuning has been completed.
2. When performing non-rotating autotuning connected to a conveyor or other machine, ensure that the holding brake is not activated during autotuning.
3. Try to keep the motor load ratio to 50% or less when the system is operated the first time after perform-ing non-rotating autotuning.

#### Non-rotating Autotuning for Line-to-Line Resistance (T1-01 = 2)

Non-rotating autotuning for line-to-line resistance can be used in any control method. This is the only possible autotuning for V/f control and V/f control with PG.

Autotuning can be used to prevent control errors when the motor cable is long, the cable length has changed or when the motor and inverter have different capacities.

To perform autotuning in V/f control or V/f control with PG, set T1-02 (Motor rated power) and T1-04 (Motor rated current) and then press the RUN key on the Digital Operator. The Inverter will supply power to the non-rotating motor for approximately 20 seconds and the Motor line-to-line resistance (E2-05) and cable resistance will be automatically measured

**IMPORTANT**

1. Power will be supplied to the motor when stationary autotuning for line-to-line resistance is performed but the motor will not turn. Do not touch the motor until autotuning has been completed.
2. When performing non-rotating autotuning connected to a conveyor or other machine, ensure that the holding brake is not activated during autotuning.

## ■ Constant Settings for Autotuning

The following constants must be set before autotuning.

Table 4.2 Constant Settings before Autotuning

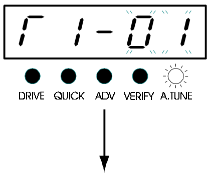
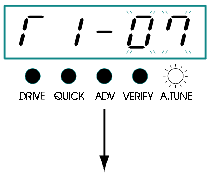
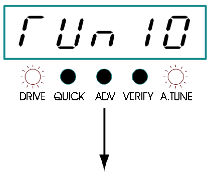
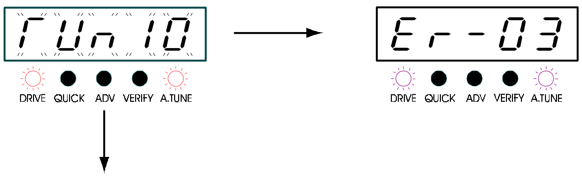
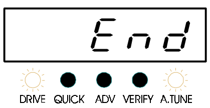
| Constant Number | Name | Display | Setting Range | Factory Setting | Data Displays during Autotuning | | |
|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector |
| T1-00*1 | Motor 1/2 selection | Set the location where the autotuned motor constants are to be stored.<br>1: E1 to E2 (motor 1)<br>2: E3 to E4 (motor 2) | 1 or 2 | 1 | Yes | Yes | Yes |
| T1-01 | Autotuning mode selection | Set the autotuning mode.<br>0: Rotating autotuning<br>1: Non-rotating autotuning<br>2: Non-rotating autotuning for line-to-line resistance only | 0 to 2 | 2 (V/f and V/f with PG)<br>0 (open-loop vector)*2 | Yes (only 2) | Yes (only 2) | Yes |
| T1-02 | Motor rated power | Set the output power of the motor in Kilowatts. | 10% to 200% of Inverter rated output *3 | Same as Inverter rated output | Yes | Yes | Yes |
| T1-03 | Motor rated voltage | Set the rated voltage of the motor in Volts.*4 | 0 to 255.0 V (200 V class)<br>0 to 510.0 V (400 V class) | 200.0 V (200 V class)<br>400.0 V (400 V class) | – | – | Yes |
| T1-04 | Motor rated current | Set the rated current of the motor in Amps. | 10% to 200% of Inverter rated current*3 | Same as general-purpose motor with same capacity as Inverter | Yes | Yes | Yes |
| T1-05 | Motor rated frequency | Set the base frequency of the motor in Hertz.*4 | 0 to 400.0 Hz *5 | 50.0 Hz | – | – | Yes |
| T1-06 | Number of motor poles | Set the number of motor poles. | 2 to 48 poles | 4 poles | – | – | Yes |
| T1-07 | Motor rated speed | Set the base speed of the motor in r/min. | 0 to 24000 | 1450 r/min | – | – | Yes |

* 1. Not normally displayed. Displayed only, when a motor switch command is set for a multi-function digital input (one of H1-01 to H1-05 set to 16).
* 2. Only setting 2 (non-rotating autotuning for line-to-line resistance only) is possible for V/f control or V/f control with PG.
* 3. Stable vector control will be possible when the setting is between 50% and 100%.
* 4. For an inverter motor or vector control motor, the voltage and frequency may be lower than for a general-purpose motor. Always confirm setting on the nameplate or in test reports. Also, if you know the no-load values, set the no-load voltage in T1-03 and the no-load frequency in T1-05 to obtain better accuracy.
* 5. The setting range depends on the Inverter capacity and the setting of C6-01 (Heavy/Normal Duty Selection).

## ■Digital Operator Displays during Autotuning

The following displays will appear on the Digital Operator during autotuning.

Table 4.3 Digital Operator Displays during Autotuning

| Digital Operator Display | Description |
|---|---|
| Autotuning mode selection: T1-01<br><br> | Using the same procedures as for the programming modes check and set the T1 constants according to information on the previous page.<br>Be sure that T1-01 (Autotuning Mode Selection) is set correctly and check safety around the motor and machine. |
| Motor base speed: T1-07<br>(For rotational autotuning)<br><br> | The autotuning start display will appear when all settings through T1-07 have been completed. The A.TUNE and DRIVE indicators will light. |
| Autotuning started: TUn10<br><br> | Autotuning will start when the RUN key is pressed from the autotuning start display.<br>The left digit in TUn□□ is the Motor 1/2 Selection (T1-00) and the right digit is the Autotuning Mode Selection (T1-01). |
| Autotuning                Stop command input<br><br> | If the STOP key is pressed or a measurement error occurs during autotuning, and error message will be display and autotuning will be stopped.<br>Refer to *Errors during Autotuning* on page *7-13*. |
| Autotuning completed<br><br> | END will be displayed after approximately 1 minute, indicating that autotuning has been completed. |

4

## ◆ Application Settings

User constants can be set as required in advanced programming mode (i.e. the ADV indicator lights on the Digital Operator). All the constants that can be set in quick programming mode can also be displayed and set in advanced programming mode.

### ■Setting Examples

The following are examples of settings for applications.

- When using an Inverter-mounted braking resistor (ERF), set L8-01 to 1 to enable ERF braking resistor overheating protection.
- To prevent the machine from being operated in reverse, set b1-04 to 1 to disable reverse operation.
- To increase the speed of a 50 Hz motor by 10%, set E1-04 to 55.0 Hz.
- To use a 0 to 10 V analog signal for a 50 Hz motor for variable-speed operation between 0 and 45 Hz (0% to 90% speed deduction), set H3-02 to 90.0%.
- To limit the speed range between 20% and 80% set d2-01 to 80.0% and set d2-02 to 20.0%.

## ◆ No-load Operation

This section describes trial operation in which the motor is in no-load state, that means the machine is not connected to the motor. To avoid failures caused due to the wiring of the control circuit it's recommended to use the LOCAL mode.  Press the LOCAL/REMOTE key on the Digital Operator to change to LOCAL mode (the SEQ and REF indicators on the Digital Operator should be OFF).

Always confirm safety around the motor and machine before starting Inverter operation from the Digital Operator. Confirm that the motor works normally and that no errors are displayed at the Inverter.  For applications, at which the machine can be driven in one direction only, check the motor rotation direction.

Operation with Jog frequency reference (d1-17, default: 6.00 Hz) can be started and stopped by pressing and releasing the JOG key on the Digital Operator. If the external control circuit prevents operation from the Digital Operator, confirm that emergency stop circuits and machine safety mechanisms are functioning, and then start operation in REMOTE mode (i.e., with a signal from the control signal terminal). The safety precautions must always be taken before starting the inverter and the motor connected.

Both, a RUN command (forward or reverse) and a frequency reference (or multi-step speed command) must be provided to start Inverter operation.

## ◆ Loaded Operation

### ■Connecting the Load

- After confirming that the motor has stopped completely, connect the mechanical system.
- Be sure to tighten all the screws when connecting the motor shaft to the mechanical system.

### ■Operation using the Digital Operator

- Use the Digital Operator to start operation in LOCAL mode in the same way as in no-load operation.
- If fault occurs during operation, make sure that the STOP key on the Digital Operator is easily accessible.
- At first, set the frequency reference to a low speed, e.g. to one tenth of the normal operating speed.

### ■ Checking Operating Status

- Having checked that the operating direction is correct and that the machine is operating smoothly at slow speed, increase the frequency reference.
- After changing the frequency reference or the rotation direction, check that there is no oscillation or abnormal sound from the motor. Check the monitor display to ensure that U1-03 (Output Current) is not too high.
- Refer to *Adjustment Suggestions* on page *4-14* if hunting, vibration, or other problems originated by the control system occur.

## ◆ Check and Recording User Constants

Use verify mode (i.e., when the VERIFY indicator on the Digital Operator lights up) to check user constants that have been changed for trial operation and record them in a user constant table.

Any user constants that have been changed by autotuning will also be displayed in verify mode.

If required, the copy function in constants o3-01 and o3-02 displayed in advanced programming mode can be used to copy the changed settings from the inverter to a recording area in the Digital Operator. If changed settings are saved in the Digital Operator, they can be easily copied back to the Inverter to speed up system recovery if for any reason the inverter has to be replaced.

The following functions can also be used to manage user constants.

- Recording user constants
- Setting access levels for user constants
- Setting a password

### ■ Recording User Constants (o2-03)

If o2-03 is set to 1 after completing trial operation, the settings of user constants will be saved in a separate memory area in the inverter. When the Inverter settings have been changed for any reason, the user constants can be initialized to the settings saved in the separate memory area by setting A1-03 (Initialize) to 1110.

### ■User Constant Access Levels (A1-01)

A1-01 can be set to 0 (monitoring-only) to prevent user constants from being changed. A1-01 can also be set to 1 (User-specified Constants) to display only constants required by the machine or application in a programming mode. These constants can be determined by setting the A2-XX constants.

### ■Password (A1-04 and A1-05)

When the access level is set to monitoring-only (A1-01 = 0), a password can be set so that user constants will be displayed only when the correct password has been input.

# Adjustment Suggestions

If hunting, vibration, or other problems originated by the control system occur during trial operation, adjust the constants listed in the following table according to the control method. This table lists only the most commonly used user constants.

Table 4.4 Adjusted User Constants

| Control Method | Name (Constant Number) | Performance | Factory Setting | Recom-mended Setting | Adjustment Method |
|---|---|---|---|---|---|
| V/f control (A1-02 = 0 or 1) | Hunting-prevention gain (N1-02) | Controlling hunting and vibration in middle-range speeds (10 to 40 Hz) | 1.00 | 0.50 to 2.00 | • Reduce the setting if torque is insufficient for heavy loads.<br>• Increase the setting if hunting or vibration occurs for light loads. |
| | Carrier frequency selection (C6-02) | • Reducing motor magnetic noise<br>• Controlling hunting and vibration at low speeds | Depends on capacity | 0 to default | • Increase the setting if motor magnetic noise is high.<br>• Reduce the setting if hunting or vibration occurs at low to middle-range speeds. |
| | Torque compensation primary delay time constant (C4-02) | • Increasing torque and speed response<br>• Controlling hunting and vibration | Depends on capacity | 200 to 1000 ms | • Reduce the setting if torque or speed response is low.<br>• Increase the setting if hunting or vibration occurs. |
| | Torque compensation gain (C4-01) | • Improving torque at low speeds (10 Hz or lower)<br>• Controlling hunting and vibration | 1.00 | 0.50 to 1.50 | • Increase the setting if torque is insufficient at low speeds.<br>• Reduce the setting if hunting or vibration occurs for light loads. |
| | Middle output frequency voltage (E1-08)<br>Minimum output frequency voltage (E1-10) | • Improving torque at low speeds<br>• Controlling shock at startup | Depends on capacity and voltage | Default to Default + 3 to 5 V* | • Increase the setting if torque is insufficient at low speeds.<br>• Reduce the setting if shock at startup is large. |
| Open-loop vector control (A1-02 = 2) | Speed feedback detection control (AFR) gain (N2-01) | • Increasing torque and speed response<br>• Controlling hunting and vibration in middle-range speeds (10 to 40 Hz) | 1.00 | 0.50 to 2.00 | • Reduce the setting if torque or speed response is low.<br>• Increase the setting if hunting or vibration occurs. |
| | Torque compensation primary delay time constant (C4-02) | • Increasing torque and speed response<br>• Controlling hunting and vibration | 20 ms | 20 to 100 ms | • Reduce the setting if torque or speed response is low.<br>• Increase the setting if hunting or vibration occurs. |
| | Slip compensation primary delay time (C3-02) | • Increasing speed response<br>• Improving speed stability | 200 ms | 100 to 500 ms | • Reduce the setting if speed response is low.<br>• Increase the setting if the speed is not stable. |
| | Slip compensation gain (C3-01) | • Improving speed accuracy | 1.0 | 0.5 to 1.5 | • Increase the setting if speed response is low.<br>• Reduce the setting if the speed is too high. |

Table 4.4 Adjusted User Constants (Continued)

| Control Method | Name (Constant Number) | Performance | Factory Setting | Recom-mended Setting | Adjustment Method |
|---|---|---|---|---|---|
| Open-loop vector con-trol (A1-02 = 2) | Carrier frequency selection (C6-02) | • Reducing motor magnetic noise<br>• Controlling hunting and vibration at low speeds (10 Hz or less) | Depends on capac-ity | 0 to default | • Increase the setting if motor magnetic noise is high.<br>• Reduce the setting if hunt-ing or vibration occurs at low speeds. |
| | Middle output fre-quency voltage (E1-08)<br>Minimum output fre-quency voltage (E1-10) | • Improving torque at low speeds<br>• Controlling shock at startup | Depends on capac-ity and voltage | Default to Default + 3 to 5 V* | • Increase the setting if torque or speed response is low.<br>• Reduce the setting if shock at startup is large. |

* The setting is given for 200 V Class Inverters. Double the voltage for 400 V Class Inverters.

- Do not change the Torque Compensation Gain (C4-01) from its default setting of 1.00 when using open-loop vector control.
- If speeds are inaccurate during regeneration in open-loop vector control, enable Slip Compensation during regeneration (C3-04 = 1).
- Use slip compensation to improve speed control during V/f control (A1-02 = 0).
  Set the Motor Rated Current (E2-01), Motor Rated Slip (E2-02), and Motor No-load Current (E2-03), and then adjust the Slip Compensation Gain (C3-01) to between 0.5 and 1.5. The default setting for V/f control is C3-01 = 0.0 (slip compensation disabled).
- To improve speed response and stability in V/f control with a PG (A1-02 = 1), set the ASR constants (C5-01 to C5-05) to between 0.5 and 1.5 times the default. (Normally it is not necessary to adjust this setting.)

The following user constants will also affect the control system indirectly.

Table 4.5 Constants Affecting Control and Applications Indirectly

| Name (Constant Number) | Application |
|---|---|
| Heavy/Normal Duty selection (C6-01) | Sets the maximum torque and overload capability to 120% or 150%. |
| DWELL function (b6-01 to b6-04) | Used for heavy loads or large machine backlashes. |
| Acceleration/deceleration times (C1-01 to C1-11) | Adjust torque during acceleration and deceleration. |
| S-curve characteristics (C2-01 to C2-04) | Used to prevent shock when completing acceleration. |
| Jump frequencies (d3-01 to d3-04) | Used to avoid resonance points during acceleration or deceleration. |
| Analog input filter time constant (H3-12) | Used to prevent fluctuations in analog input signals caused by noise. |
| Stall prevention (L3-01 to L3-06) | Used to prevent OV (overvoltage errors) and motor stalling for heavy loads or rapid acceleration/deceleration. Stall prevention is enabled by default and the setting normally has not to be changed. When using a braking resistor, however, disable stall prevention during deceleration by setting L3-04 to 0 or set it to 3 (enabled with braking resistor). |
| Torque limits (L7-01 to L7-04) | Set the maximum torque during vector control. If a setting is reduced, stalling can occur under heavy loads. |

# 5

# User Constants

This chapter describes all user constants that can be set in the Inverter.

User Constant Descriptions ........................................5-2
Digital Operation Display Functions and Levels ..........5-3
User Constant Tables .................................................5-7

# User Constant Descriptions

This section describes the contents of the user constant tables.

## ◆ Description of User Constant Tables

User constant tables are structured as shown below. Here, b1-01 (Frequency Reference Selection) is used as an example.

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector | | |
| b1-01 | Reference selection | Sets the frequency reference input method.<br>0: Digital Operator<br>1: Control circuit terminal (analog input)<br>2: MEMOBUS communica-tions<br>3: Option Card<br>4: Pulse train input | 0 to 4 | 1 | No | Q | Q | Q | 180H | - |

- Constant Number: The number of the user constant.
- Name: The name of the user constant.
- Description: Details on the function or settings of the user constant.
- Setting Range: The setting range for the user constant.
- Factory Setting: The factory setting (each control method has its own factory setting. Therefore the factory setting changes when the control method is changed.)
  Refer to page 5-67 for factory settings that are changed by setting the control method.
- Change during Operation: Indicates whether or not the constant can be changed while the Inverter is in operation.
  - Yes: Changes are possible during operation.
  - No: Changes are not possible during operation.
- Control Methods: Indicates the control methods in which the user constant can be monitored or set.
  - Q: The item can be monitored and set as well in quick programming mode as in advanced programming mode.
  - A: The item can be monitored and set in advanced programming mode only.
  - No: The item cannot be monitored or set in this control method.
- MEMOBUS Register: The register number used for MEMOBUS communications.
- Page: Reference page for more detailed information about the constant.

# Digital Operation Display Functions and Levels

The following figure shows the Digital Operator display hierarchy for the Inverter.

MENU

- **Drive Mode**: Inverter can be operated and its status can be displayed.
- **Quick Programming Mode**: Minimum constants required for operation can be monitored or set.
- **Advanced Programming Mode**: All constants can be monitored or set.
- **Verify Mode**: Constants changed from the default settings can be monitored or set.
- **Autotuning Mode**: Automatically sets motor constants for open-loop vector control or measures the line-to-line resistance for V/f control.

| No. | Function | Page |
|---|---|---|
| U1 | Status Monitor Constants | 5-61 |
| U2 | Fault Trace | 5-65 |
| U3 | Fault History | 5-66 |
| A1 | Initialize Mode | 5-7 |
| A2 | User-specified Setting Mode | 5-8 |
| b1 | Operation Mode Selections | 5-9 |
| b2 | DC Injection Braking | 5-10 |
| b3 | Speed Search | 5-11 |
| b4 | Timer Function | 5-12 |
| b5 | PID Control | 5-13 |
| b6 | Dwell Functions | 5-15 |
| b8 | Energy Saving | 5-16 |
| C1 | Acceleration/Deceleration | 5-17 |
| C2 | S-curve Acceleration/Deceleration | 5-18 |
| C3 | Motor Slip Compensation | 5-19 |
| C4 | Torque Compensation | 5-20 |
| C5 | Speed Control (ASR) | 5-21 |
| C6 | Carrier Frequency | 5-22 |
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| d4 | Reference Frequency Hold | 5-25 |
| d6 | Field Weakening | 5-26 |
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| E2 | Motor Setup | 5-29 |
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| E4 | Motor 2 Setup | 5-31 |
| F1 | PG Option Setup | 5-32 |
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| L1 | Motor Overload | 5-45 |
| L2 | Power Loss Ridethrough | 5-46 |
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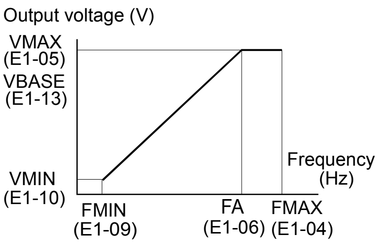
| L5 | Fault Restart | 5-51 |
| L6 | Torque Detection | 5-52 |
| L7 | Torque Limits | 5-53 |
| L8 | Hardware Protection | 5-53 |
| N1 | Hunting Prevention Function | 5-55 |
| N2 | Automatic Frequency Regulator | 5-55 |
| N3 | High-slip Braking | 5-56 |
| o1 | Monitor Select | 5-56 |
| o2 | Multi-function Selections | 5-58 |
| o3 | Copy Function | 5-59 |
| T | Motor Autotuning | 5-60 |

## ◆ User Constants Setable in Quick Programming Mode

The minimum user constants required for Inverter operation can be monitored and set in quick programming mode. The user constants displayed in quick programming mode are listed in the following table. These, and all other user constants, are also displayed in advanced programming mode.

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods: V/f | Control Methods: V/f with PG | Control Methods: Open Loop Vector | MEMOBUS Register |
|---|---|---|---|---|---|---|---|---|---|
| A1-02 | Control method selection | Sets the control method for the Inverter.<br>0: V/f control<br>1: V/f control with PG<br>2: Open-loop vector control | 0 to 2 | 0 | No | Q | Q | Q | 102H |
| b1-01 | Reference source selection | Sets the frequency reference input method.<br>0: Digital Operator<br>1: Control circuit terminal (analog input)<br>2: MEMOBUS communications<br>3: Option Card<br>4: Pulse train input | 0 to 4 | 1 | No | Q | Q | Q | 180H |
| b1-02 | RUN command source selection | Sets the run command input method<br>0: Digital Operator<br>1: Control circuit terminal (digital multifunction inputs)<br>2: MEMOBUS communications<br>3: Option Card | 0 to 3 | 1 | No | Q | Q | Q | 181H |
| b1-03 | Stopping method selection | Select stopping method when stop command is input.<br>0: Deceleration to stop<br>1: Coast to stop<br>2: DC braking stop (Stops faster than coast to stop, without regenerative operation.)<br>3: Coast to stop with timer (Run commands are disregarded during deceleration time.) | 0 to 3 | 0 | No | Q | Q | Q | 182H |
| C1-01 | Acceleration time 1 | Sets the acceleration time to accelerate from 0 Hz to the maximum output frequency. | 0.0 to 6000.0 *1 | 10.0 s | Yes | Q | Q | Q | 200H |
| C1-02 | Deceleration time 1 | Sets the deceleration time to decelerate from the maximum output frequency to 0 Hz. | | | Yes | Q | Q | Q | 201H |
| C6-01 | Heavy/Normal Duty selection | 0: Heavy Duty (low carrier, constant torque, 150% current overload for 1 min.)<br>1: Normal Duty (high carrier, variable torque, 120% current overload for 1 min.) | 0 or 1 | 1 | No | Q | Q | Q | 223H |
| C6-02 | Carrier frequency selection | Selects the carrier frequency.<br>Select F to enable detailed settings using constants C6-03 to C6-05. | 0 to F | 6 *2 | No | Q | Q | Q | 224H |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Regis-ter |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector | |
| d1-01 | Frequency reference 1 | Sets the master frequency reference. | | 0.00 Hz | Yes | Q | Q | Q | 280H |
| d1-02 | Frequency reference 2 | Sets the frequency reference when multi-step speed command 1 is ON for a multi-function input. | | 0.00 Hz | Yes | Q | Q | Q | 281H |
| d1-03 | Frequency reference 3 | Sets the frequency reference when multi-step speed command 2 is ON for a multi-function input. | 0 to 400.00 | 0.00 Hz | Yes | Q | Q | Q | 282H |
| d1-04 | Frequency reference 4 | Sets the frequency reference when multi-step speed command 1 and 2 are ON for a multi-function input. | | 0.00 Hz | Yes | Q | Q | Q | 283H |
| d1-17 | Jog frequency reference | Sets the frequency reference when multi-function inputs „Jog Frequency Command“, „FJOG command“, or „RJOG command“ is ON. | | 6.00 Hz | Yes | Q | Q | Q | 292H |
| E1-01 | Input voltage setting | Sets the inverter input voltage. This set value will be the basis for the protection functions. | 155 to 255 *3 | 200 V *3 | No | Q | Q | Q | 300H |
| E1-03 | V/f pattern selection | 0 to E: Select from 15 preset patterns.<br>F: Custom user-set pattern (Applicable for the setting of E1-04 to E1-10). | 0 to F | F | No | Q | Q | No | 302H |
| E1-04 | Max. output frequency (FMAX) | <br> | 40.0 to 400.0 *4 | 50.0 Hz | No | Q | Q | Q | 303H |
| E1-05 | Max. voltage (VMAX) | | 0.0 to 255.0 *3 | 200.0 V *3 | No | Q | Q | Q | 304H |
| E1-06 | Base frequency (FA) | | 0.0 to 400.0 *4 | 50.0 Hz *5 | No | Q | Q | Q | 305H |
| E1-09 | Min. output frequency (FMIN) | | 0.0 to 400.0 *4 | 1.3 Hz *5 | No | Q | Q | Q | 308H |
| E1-13 | Base voltage (VBASE) | Sets the output voltage at the base frequency (E1-06). | 0.0 to 255.0 *3 | 0.0 V *6 | No | A | A | Q | 30CH |
| E2-01 | Motor rated current | Sets the motor rated current in Amps. This set value becomes the base value for motor protection and torque limit. It is an input data for autotuning. | 0.32 to 6.40 *8 | 1.90 A *7 | No | Q | Q | Q | 30EH |
| E2-04 | Number of motor poles | Sets the number of motor poles. It is an input data for autotuning. | 2 to 48 | 4 | No | No | Q | No | 311H |
| F1-01 | PG constant | Sets the number of PG pulses (pulse generator or encoder). | 0 to 60000 | 1024 | No | No | Q | No | 380H |
| H4-02 | Gain (terminal FM) | Sets the multi-function analog output 1 (terminal FM) gain.<br>Sets the percentage of the monitor item that is equal to 10V/20mA output at terminal FM. Note that the maximum output voltage/current is 10V/20mA. | 0 to 1.000% | 100% | Yes | Q | Q | Q | 41EH |

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| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector | |
| H4-05 | Gain (terminal AM) | Sets the multi-function analog output 2 (terminal AM) gain.<br>Sets the percentage of the monitor item that is equal to 10V/20mA output at terminal AM. Note that the maximum output voltage/current is 10V/20mA. | 0 to 1.000% | 50% | Yes | Q | Q | Q | 421H |
| L1-01 | Motor protection selection | Set to enable or disable the motor overload protection function using the electronic thermal relay.<br>0: Disabled<br>1: Protection for general purpose motor (fan cooled)<br>2: Protection for frequency converter motor (external cooled)<br>3: Protection for special vector control motor<br>When the inverter power supply is turned off, the thermal value is reset, so even if this constant is set to 1, protection may not be effective.<br>When several motors are connected to one Inverter, set to 0 and ensure that each motor is equipped with a protection device. | 0 to 3 | 1 | No | Q | Q | Q | 480H |
| L3-04 | Stall prevention selection during deceleration | 0: Disabled (Deceleration as set. If deceleration time is too short, a main circuit overvoltage may result.)<br>1: Enabled (Deceleration is stopped when the DC bus voltage exceeds the stall prevention level. Deceleration restarts when voltage falls below the stall level again.)<br>2: Intelligent deceleration mode (Deceleration rate is automatically adjusted so that in Inverter can decelerate in the shortest possible time. The set deceleration time is disregarded.)<br>3: Enabled (with Braking Resistor Unit)<br>When a braking option (Braking Resistor, Braking Resistor Unit, Braking Unit) is used, always set to 0 or 3. | 0 to 3 | 1 | No | Q | Q | Q | 492H |

* 1. The setting ranges for acceleration/deceleration times depends on the setting of C1-10 (Acceleration/deceleration Time Setting Unit). If C1-10 is set to 0, the setting range is 0.00 to 600.00 (s).
* 2. The factory setting depends on the Inverter capacity.
* 3. These are values for a 200 V class Inverter. Values for a 400 V class Inverter are double.
* 4. The upper setting limit will be 150.0 Hz when C6-01 is set to 0.
* 5. The factory setting will change when the control method is changed. (V/f control factory settings are given.)
* 6. After autotuning, E1-13 will contain the same value as E1-05.
* 7. The factory setting depends on the Inverter capacity. (The value for a 200 V Class Inverter for 0.4 kW is given.)
* 8. The setting range is from 10% to 200% of the Inverter rated output current. (The value for a 200 V Class Inverter for 0.4 kW is given.)

# User Constant Tables

## ◆ A: Setup Settings

### ■ Initialize Mode: A1

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| A1-00 | Language selection for Digital Operator display | Used to select the language displayed on the Digital Operator (JVOP-160 only).<br>0: English<br>1: Japanese<br>2: German<br>3: French<br>4: Italian<br>5: Spanish<br>6: Portuguese<br>This constant is not initialized by the initialize operation. | 0 to 6 | 0 | Yes | A | A | A | 100H | – |
| A1-01 | Constant access level | Used to set the constant access level (set/read.)<br>0: Monitoring only (Monitoring drive mode and setting A1-01 and A1-04.)<br>1: Used to select user constant (Only constants set in A2-01 to A2-32 can be read and set.)<br>2: Advanced (Constants can be read and set in both, quick programming mode (Q) and advanced programming (A) mode.) | 0 to 2 | 2 | Yes | A | A | A | 101H | 6-134<br>6-135 |
| A1-02 | Control method selection | Used to select the control method for the Inverter<br>0: V/f control<br>1: V/f with PG feedback<br>2: Open loop vector<br>This constant is not initialized by the initialize operation. | 0 to 2 | 0 | No | Q | Q | Q | 102H | 4-5<br>4-7<br>4-14 |

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| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| A1-03 | Initialize | Used to initialize the constants using the specified method.<br>0: No initializing<br>1110: Initializes using the user constants that have been stored before using o2-03 parameter<br>2220: Initializes using a two-wire sequence. (Initializes to the factory setting.)<br>3330: Initializes using a three-wire sequence. | 0 to 3330 | 0 | No | A | A | A | 103H | – |
| A1-04 | Password | Password input when a password has been set in A1-05. This function write-protects constants of the initialize mode.<br>If the password is changed, A1-01 to A1-03 and A2-01 to A2-32 constants can only be changed after inputting the right password. | 0 to 9999 | 0 | No | A | A | A | 104H | 6-134 |
| A1-05 | Password setting | Used to set a four digit number as the password.<br>Usually this constant is not displayed. When the password (A1-04) is displayed, hold down the RESET key and press the Menu key and A1-05 will be displayed. | 0 to 9999 | 0 | No | A | A | A | 105H | 6-134 |

## ■User-set Constants: A2

The constants set by the user are listed in the following table.

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| A2-01 to A2-32 | User specified constants | Used to select the function for each of the user specified constants. User constants are the only accessable constants if Constant Access Level is set to user constants (A1-01=1) | b1-01 to o2-08 | – | No | A | A | A | 106H to 125H | 6-135 |

## ◆ Application Constants: b

### ■Operation Mode Selections: b1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b1-01 | Reference source selection | Sets the frequency reference input method.<br>0: Digital Operator<br>1: Control circuit terminal (analog input)<br>2: MEMOBUS communications<br>3: Option Card<br>4: Pulse train input | 0 to 4 | 1 | No | Q | Q | Q | 180H | 6-6<br>6-69 |
| b1-02 | RUN command source selection | Sets the run command input method.<br>0: Digital Operator<br>1: Control circuit terminal (digital multifunktion inputs)<br>2: MEMOBUS communications<br>3: Option Card | 0 to 3 | 1 | No | Q | Q | Q | 181H | 6-11<br>6-69 |
| b1-03 | Stopping method selection | Used to set the stopping method used when a stop command is input.<br>0: Deceleration to stop<br>1: Coast to stop<br>2: DC injection braking stop (Stops faster than coast to stop, no regenerative operation.)<br>3: Coast to stop with timer (Run commands are disregarded during deceleration.) | 0 to 3 | 0 | No | Q | Q | Q | 182H | 6-13 |
| b1-04 | Prohibition of reverse operation | 0: Reverse enabled<br>1: Reverse disabled | 0 to 2 | 0 | No | A | A | A | 183H | 6-55 |
| | | 2: Output Phase Rotation (both rotational directions are enabled) | | | | A | No | No | | |
| b1-06 | Control input scan | Used to set the responsiveness of the control inputs (forward/reverse and multi-function inputs.)<br>0: Two scans every 2 ms (Use for fast responses.)<br>1: Two scans every 5 ms (Use for possible malfunction due to noise.) | 0 or 1 | 1 | No | A | A | A | 185H | – |

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| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b1-07 | Operation selection after switching to remote mode | Used to set the operation mode by switching to the Remote mode using the Local/Remote Key.<br>0: Run signals that are input during mode switching are disregarded. (Input Run signals after switching the mode.)<br>1: Run signals become effective immediately after switching to the Remote mode. | 0 or 1 | 0 | No | A | A | A | 186H | - |
| b1-08 | Run command selection in programming modes | Used to set an operation interlock in programming modes.<br>0: Cannot operate.<br>1: Can operate (Disabled when Digital Operator is set to select run command (when b1-02 = 0)). | 0 or 1 | 0 | No | A | A | A | 187H | - |

## ■DC Injection Braking: b2

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b2-01 | Zero speed level (DC injection braking starting frequency) | Used to set the frequency at which DC injection braking starts in units of Hz when b1-03 is set to 0 (deceleration to stop).<br>When b2-01 is less than E1-09, E1-09 becomes the DC injection braking starting frequency. | 0.0 to 10.0 | 0.5 Hz | No | A | A | A | 189H | 6-13 |
| b2-02 | DC injection braking current | Sets the DC injection braking current as a percentage of the inverter rated current. | 0 to 100 | 50% | No | A | A | A | 18AH | 6-13<br>6-16 |
| b2-03 | DC injection braking time at start | Used to set the time to perform DC injection braking at start in units of 1 second.<br>Used to stop coasting motor and restart it. When the set value is 0, DC injection braking at start is not performed. | 0.00 to 10.00 | 0.00 s | No | A | A | A | 18BH | 6-16 |
| b2-04 | DC injection braking time at stop | Used to set the time to perform DC injection braking at stop in units of 1 second.<br>Used to prevent coasting after the stop command is input. When the set value is 0.00, DC injection braking at stop is not performed. | 0.00 to 10.00 | 0.50 s | No | A | A | A | 18CH | 6-13<br>6-17 |

## ■Speed Search: b3

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Regis-ter | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b3-01 | Speed search selection (current detection or speed cal-culation) | Enables/disables the speed search function for the RUN command and sets the speed search method.<br>0:Disabled, speed calculation<br>1: Enabled, speed calculation<br>2: Disabled, current detection<br>3: Enabled, current detection<br><br>Speed Calculation:<br>When the search is started, the motor speed is calculated and acceleration/deceleration is performed from the calculated speed to the specified frequency (motor direction is also searched).<br><br>Current Detection:<br>The speed search is started from the frequency when power was momentarily lost and the maximum frequency, and the speed is detected at the search current level. | 0 to 3 | 2* | No | A | A | A | 191H | 6-57 |
| b3-02 | Speed search operating current (current detection) | Sets the speed search operation current as a percentage, taking the Inverter rated current as 100%.<br>Usually not necessary to set. When restarting is not possible with the factory settings, reduce the value. | 0 to 200 | 120%* | No | A | No | A | 192H | 6-57 |
| b3-03 | Speed search decelera-tion time (current detection) | Sets the output frequency deceleration time during speed search in 1-second units.<br>Sets the time for deceleration from the maximum output fre-quency to the minimum output frequency. | 0.1 to 10.0 | 2.0 s | No | A | No | A | 193H | 6-57 |
| b3-05 | Speed search wait time (cur-rent detec-tion or speed cal-culation) | When a speed search is per-formed after recovering from a momentary power loss, the search operation is delayed for the time set here.<br>If e.g. a contactor is used at the output side of the inverter set this constant to the contactor delay time or more. | 0.0 to 20.0 | 0.2 s | No | A | A | A | 195H | 6-57 |

* The factory setting will change when the control method is changed. (Open Loop Vector factory settings are given.)

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## ■Timer Function: b4

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b4-01 | Timer function ON-delay time | Sets the timer function output ON-delay time (dead time) for the timer function input, in 1-second units. Enabled when a timer function is set in H1-☐☐ and H2-☐☐. | 0.0 to 3000.0 | 0.0 s | No | A | A | A | 1A3H | 6-101 |
| b4-02 | Timer function OFF-delay time | Sets the timer function output OFF-delay time (dead band) for the timer function input, in 1-second units. Enabled when a timer function is set in H1-☐☐ and H2-☐☐ | 0.0 to 3000.0 | 0.0 s | No | A | A | A | 1A4H | 6-101 |

## ■PID Control: b5

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| b5-01 | PID control mode selection | 0: Disabled<br>1: Enabled (Deviation is D-controlled.)<br>2: Enabled (Feedback value is D-controlled.)<br>3: PID control enabled (frequency reference + PID output, D control of deviation)<br>4: PID control enabled (frequency reference + PID output, D control of feedback value). | 0 to 4 | 0 | No | A | A | A | 1A5H | 6-103 |
| b5-02 | Proportional gain (P) | Sets P-control proportional gain.<br>P-control is not performed when the setting is 0.00. | 0.00 to 25.00 | 1.00 | Yes | A | A | A | 1A6H | 6-103 |
| b5-03 | Integral (I) time | Sets I-control integral time in 1-second units.<br>I-control is not performed when the setting is 0.0. | 0.0 to 360.0 | 1.0 s | Yes | A | A | A | 1A7H | 6-103 |
| b5-04 | Integral (I) limit | Sets the I-control limit as a percentage of the maximum output frequency. | 0.0 to 100.0 | 100.0% | Yes | A | A | A | 1A8H | 6-103 |
| b5-05 | Differential (D) time | Sets D-control differential time in 1-second units.<br>D-control is not performed when the setting is 0.00. | 0.00 to 10.00 | 0.00 s | Yes | A | A | A | 1A9H | 6-103 |
| b5-06 | PID limit | Sets the limit after PID-control as a percentage of the maximum output frequency. | 0.0 to 100.0 | 100.0% | Yes | A | A | A | 1AAH | 6-103 |
| b5-07 | PID offset adjustment | Sets the offset after PID-control as a percentage of the maximum output frequency. | -100.0 to +100.0 | 0.0% | Yes | A | A | A | 1ABH | 6-103 |
| b5-08 | PID delay time constant | Sets the time constant for low pass filter for PID-control outputs in 1-second units.<br>Usually not necessary to set. | 0.00 to 10.00 | 0.00 s | Yes | A | A | A | 1ACH | 6-103 |
| b5-09 | PID output characteristics selection | Selects forward/reverse direction for PID output.<br>0: PID output is forward.<br>1: PID output is reverse | 0 or 1 | 0 | No | A | A | A | 1ADH | 6-103 |
| b5-10 | PID output gain | Sets output gain. | 0.0 to 25.0 | 1.0 | No | A | A | A | 1AEH | 6-103 |
| b5-11 | PID reverse output selection | 0: Limit to 0 when PID output is negative.<br>1: Reverses when PID output is negative.<br>Limit to 0 is also active when reverse prohibit is selected by using b1-04. | 0 or 1 | 0 | No | A | A | A | 1AFH | 6-103 |

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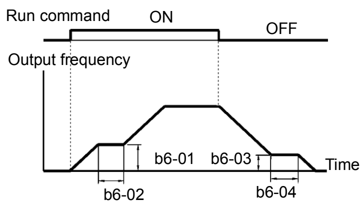
| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b5-12 | Selection of PID feed-back signal loss detec-tion | 0: No detection of PID feedback loss.<br>1: Detection of PID feedback loss. Operation continues during detection, the fault contact is not operated.<br>2: Detection of PID feedback loss. The motor coasts to stop at detection, and the fault contact operates. | 0 to 2 | 0 | No | A | A | A | 1B0H | 6-103 |
| b5-13 | PID feed-back loss detection level | Sets the PID feedback loss detection level as percentage using the maximum output frequency as 100%. | 0 to 100 | 0% | No | A | A | A | 1B1H | 6-103 |
| b5-14 | PID feed-back loss detection time | Sets the PID feedback loss detection level in s units. | 0.0 to 25.5 | 1.0 s | No | A | A | A | 1B2H | 6-103 |
| b5-15 | PID sleep function operation level | Sets the PID sleep function start level as a frequency. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A | 1B3H | 6-103 |
| b5-16 | PID sleep operation delay time | Sets the delay time until the PID sleep function starts in seconds. | 0.0 to 25.5 | 0.0 s | No | A | A | A | 1B4H | 6-103 |
| b5-17 | Accel/decel time for PID reference | Sets the accel/decel time for PID reference in seconds. | 0.0 to 25.5 | 0.0 s | No | A | A | A | 1B5H | 6-103 |
| b5-18 | PID Set-point Selec-tion | 0: Disabled<br>1: Enabled | 0 to 1 | 0 | No | A | A | A | 1DCH | 6-103 |
| b5-19 | PID Setpoint | PID-target value | 0 to 100.0% | 0 | No | A | A | A | 1OOH | 6-103 |

## ■Dwell Functions: b6




| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods: V/f | Control Methods: V/f with PG | Control Methods: Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| b6-01 | Dwell frequency at start | The dwell function is used to output frequency temporarily when driving a motor with a heavy load. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A | 1B6H | 6-21 |
| b6-02 | Dwell time at start | | 0.0 to 10.0 | 0.0 s | No | A | A | A | 1B7H | 6-21 |
| b6-03 | Dwell frequency at stop | | 0.0 to 400.0 | 0.0 Hz | No | A | A | A | 1B8H | 6-21 |
| b6-04 | Dwell time at stop | | 0.0 to 10.0 | 0.0 s | No | A | A | A | 1B9H | 6-21 |

## ■Energy Saving: b8

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| b8-01 | Energy-saving mode selection | Select whether to enable or disable energy-saving control.<br>0: Disable<br>1: Enable | 0 or 1 | 0 | No | A | A | A | 1CCH | 6-111 |
| b8-02 | Energy-saving gain | Sets the energy-saving gain in open loop vector control. | 0.0 to 10.0 | 0.7 *1 | Yes | No | No | A | 1CDH | 6-111 |
| b8-03 | Energy-saving filter time constant | Sets the energy-saving filter time constant in open loop vector control. | 0.00 to 10.0 | 0.50 s *2 | Yes | No | No | A | 1CEH | 6-111 |
| b8-04 | Energy-saving coefficient | Sets the energy-saving coefficient depending on the setting in E2-11 (motor rated current).<br>Adjust the value in 5% steps until the output power becomes minimal. | 0.0 to 655.00 | *3 | No | A | A | No | 1CFH | 6-111 |
| b8-05 | Power detection filter time constant | Sets the time constant for output power detection. | 0 to 2000 | 20 ms | No | A | A | No | 1D0H | 6-111 |
| b8-06 | Search operation voltage limiter | Sets the limit value of the voltage control range during search operation.<br>Set to 0 to disable the search operation. 100% is the motor rated voltage. | 0 to 100 | 0% | No | A | A | No | 1D1H | 6-111 |

* 1. The factory setting is 1.0 when using V/f control with PG.
* 2. The factory setting is 2.00 s when Inverter capacity is 55 kW min.
* 3. The factory settings depend on the Inverter capacity.

## ◆ Tuning Constants: C

### ■Acceleration/Deceleration: C1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| C1-01 | Acceleration time 1 | Sets the acceleration time to accelerate from 0 Hz to the maximum output frequency. | 0.0 to 6000.0* | 10.0 s | Yes | Q | Q | Q | 200H | 4-5<br>6-18 |
| C1-02 | Deceleration time 1 | Sets the deceleration time to decelerate from the maximum output frequency to 0 Hz. | | | Yes | Q | Q | Q | 201H | 4-5<br>6-18 |
| C1-03 | Acceleration time 2 | Sets the acceleration time when the multi-function input “accel/decel time 1” is set to ON. | | | Yes | A | A | A | 202H | 6-18 |
| C1-04 | Deceleration time 2 | Sets the deceleration time when the multi-function input “accel/decel time 1” is set to ON. | | | Yes | A | A | A | 203H | 6-18 |
| C1-05 | Acceleration time 3 | Sets the acceleration time when the multi-function input “accel/decel time 2” is set to ON. | | | No | A | A | A | 204H | 6-18 |
| C1-06 | Deceleration time 3 | Sets the deceleration time when the multi-function input “accel/decel time 2” is set to ON. | | | No | A | A | A | 205H | 6-18 |
| C1-07 | Acceleration time 4 | Sets the acceleration time when the multi-function input “accel/decel time 1” and “accel/decel time 2” are set to ON. | | | No | A | A | A | 206H | 6-18 |
| C1-08 | Deceleration time 4 | Sets the deceleration time when the multi-function input “accel/decel time 1” and “accel/decel time 2” are set to ON. | | | No | A | A | A | 207H | 6-18 |
| C1-09 | Emergency stop time | Sets the deceleration time when the multi-function input “Emergency (fast) stop” is set to ON. | | | No | A | A | A | 208H | 6-17 |
| C1-10 | Accel/decel time setting unit | 0: 0.01-second units<br>1: 0.1-second units | 0 or 1 | 1 | No | A | A | A | 209H | 6-18<br>6-19 |

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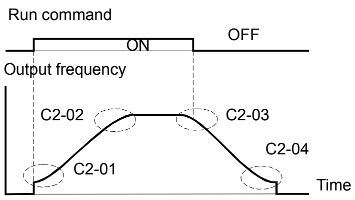
| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| C1-11 | Accel/decel time switch-ing fre-quency | Sets the frequency for auto-matic acceleration/decelera-tion switching.<br>If the output frequency is below the set frequency: Accel/decel time 4<br>If the output freuquency is above the set frequency: Accel/decel time 1<br>The multi-function input “accel/decel time 1” or “accel/decel time 2” has pri-ority. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A | 20AH | 6-19 |

* The setting range for acceleration/deceleration times will depends on the setting for C1-10. When C1-10 is set to 0, the setting range for acceleration/deceleration times becomes 0.00 to 600.00 seconds.

## ■S-Curve Acceleration/Deceleration: C2

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| C2-01 | S-curve character-istic time at acceler-ation start | When the S-curve characteristic time is set, the accel/decel times will increase by only half of the S-curve characteristic times at start and end.<br><br><br>$T_{accel} = \frac{C2\text{-}01}{2} + C1\text{-}01 + \frac{C2\text{-}02}{2}$<br>$T_{decel} = \frac{C2\text{-}03}{2} + C1\text{-}02 + \frac{C2\text{-}04}{2}$ | 0.00 to 2.50 | 0.20 s | No | A | A | A | 20BH | 6-20 |
| C2-02 | S-curve character-istic time at acceler-ation end | | 0.00 to 2.50 | 0.20 s | No | A | A | A | 20CH | 6-20 |
| C2-03 | S-curve character-istic time at deceler-ation start | | 0.00 to 2.50 | 0.20 s | No | A | A | A | 20DH | 6-20 |
| C2-04 | S-curve character-istic time at deceler-ation end | | 0.00 to 2.50 | 0.00 s | No | A | A | A | 20EH | 6-20 |

## ■Motor Slip Compensation: C3

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| C3-01 | Slip compensation gain | Used to improve speed accuracy when operating with a load.<br>Usually setting is not necessary.<br>Adjust this constant at the following times.<br>• When motor speed is lower than the frequency reference increase the set value.<br>• When motor speed is higher than the frequency reference decrease the set value. | 0.0 to 2.5 | 0.0* | Yes | A | No | A | 20FH | 4-14<br>6-35 |
| C3-02 | Slip compensation delay time | Slip compensation delay time is set in ms units.<br>Usually setting is not necessary.<br>Adjust this constant at the following times.<br>• Reduce the setting when slip compensation responsive is slow.<br>• When speed is not stabilized, increase the setting. | 0 to 10000 | 2000 ms * | No | A | No | A | 210H | 4-14<br>6-35 |
| C3-03 | Slip compensation limit | Sets the slip compensation limit as a percentage of motor rated slip. | 0 to 250 | 200% | No | A | No | A | 211H | 6-35 |
| C3-04 | Slip compensation selection during regeneration | 0: Disabled.<br>1: Enabled.<br>When the slip compensation during regeneration function has been activated and regeneration capacity increases momentarily, it might be necessary to use a braking option (braking resistor, braking resistor unit or braking unit.) | 0 or 1 | 0 | No | A | No | A | 212H | 6-35 |
| C3-05 | Output voltage limit operation selection | 0: Disabled.<br>1: Enabled. (The motor flux will be lowered automatically when the output voltage become saturated.) | 0 or 1 | 0 | No | No | No | A | 213H | 6-35 |

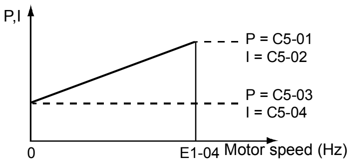
* The factory setting will change when the control method is changed. (V/f control factory settings are given.)

## ■Torque Compensation: C4

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| C4-01 | Torque compensation gain | Sets the torque compensation gain.<br>Usually setting is not necessary.<br>Adjust under the following circumstances:<br>• When the cable is long increase the set value.<br>• When the motor capacity is smaller than the Inverter capacity (Max. applicable motor capacity), increase the set values.<br>• When the motor is oscillating, decrease the set values.<br>Adjust the torque compensation gain so that at minimum speed the output current does not exceed the Inverter rated output current.<br>Do not alter the torque compensation gain from its default (1.00) when using open loop vector control. | 0.00 to 2.50 | 1.00 | Yes | A | A | A | 215H | 4-14<br>6-37 |
| C4-02 | Torque compensation delay time constant | The torque compensation delay time is set in ms units.<br>Usually setting is not necessary.<br>Adjust under the following circumstances:<br>• When the motor is oscillating, increase the set values.<br>• When the responsiveness of the motor is low, decrease the set values. | 0 to 10000 | 200 ms * | No | A | A | A | 216H | 4-14<br>6-37 |
| C4-03 | Starting torque compensation (FWD) | Sets the torque compensation value at start in FWD direction | 0.0 to 200.0% | 0.0% | No | No | No | A | 217H | 6-37 |
| C4-04 | Starting torque compensation (REV) | Sets the torque compensation value at start in REV direction | 0.0 to 200.0% | 0.0% | No | No | No | A | 218H | 6-37 |
| C4-05 | Starting torque compensation time constant | Sets starting torque start-up time.<br>When 0 ~ 4 ms is set, it is operated without filter. | 0 to 200 | 10 ms | No | No | No | A | 219H | 6-37 |

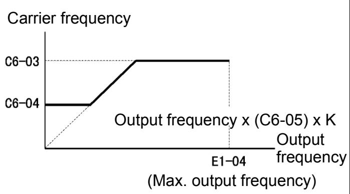
* The factory setting will change when the control method is changed. (V/f control factory settings are given.)

## ■Speed Control (ASR): C5

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| C5-01 | ASR pro-portional (P) gain 1 | Sets the proportional gain of the speed loop (ASR) | 0.00 to 300.00 | 0.20 | Yes | No | A | No | 21BH | 6-39 |
| C5-02 | ASR inte-gral (I) time 1 | Sets the integral time of the speed loop (ASR). | 0.000 to 10.000 | 0.200 s | Yes | No | A | No | 21CH | 6-39 |
| C5-03 | ASR pro-portional (P) gain 2 | Usually changing this setting is not necessary.   | 0.00 to 300.00 | 0.02 | Yes | No | A | No | 21DH | 6-39 |
| C5-04 | ASR inte-gral (I) time 2 | | 0.000 to 10.000 | 0.050 s | Yes | No | A | No | 21EH | 6-39 |
| C5-05 | ASR limit | Sets the upper limit for the compen-sation frequency for the speed con-trol loop (ASR) as a percentage of the maximum output frequency. | 0.0 to 20.0 | 5.0% | No | No | A | No | 21FH | 6-39 |

5

## ■Carrier Frequency: C6

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods: V/f | Control Methods: V/f with PG | Control Methods: Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| C6-01 | Heavy/ Normal Duty selection | 0: Heavy Duty (low carrier, constant torque, 150% current overload for 1 min.)<br>1: Normal Duty (high carrier, variable torque, 120% current overload for 1 min.) | 0 or 1 *1 | 1 | No | Q | Q | Q | 223H | 4-5 6-2 |
| C6-02 | Carrier frequency selection | Selects the carrier frequency.<br>Select F to enable detailed settings using constants C6-03 to C6-05. | 0 to F | 6 *2 | No | Q | Q | Q | 224H | 4-5 4-14 6-2 |
| C6-03 | Carrier frequency upper limit | Sets the carrier frequency upper limit and lower limit in kHz units.<br>The carrier frequency gain is set as follows:<br>With the vector control method, the upper limit of the carrier frequency is fixed in C6-03. | 2.0 to 15.0 *3 *4 | 15.0 kHz *2 | No | A | A | A | 225H | 6-2 |
| C6-04 | Carrier frequency lower limit |  | 0.4 to 15.0 *3 *4 | 15.0 kHz *2 | No | A | A | No | 226H | 6-2 |
| C6-05 | Carrier frequency proportional gain | K is a coefficient that depends on the setting of C6-03.<br>C6-03 ≥ 10.0 kHz: K = 3<br>10.0 kHz > C6-03 ≥ 5.0 kHz: K = 2<br>5.0 kHz > C6-03: K = 1 | 00 to 99 *4 | 00 | No | A | A | No | 227H | 6-2 |

* 1. On 200V class inverters with 110 kW and 400V class inverters with 220 kW and 300 kW the setting is fixed to 1. It cannot be changed to 0.
* 2. The factory setting depends on the capacity of the Inverter.
* 3. The setting range depends on the capacity of the Inverter.
* 4. This constant can be monitored or set only when 1 is set for C6-01 and F is set for C6-02.

## ◆ Reference Constants: d

### ■Preset Reference: d1

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| d1-01 | Frequency reference 1 | Sets the frequency reference. | 0 to 400.00 | 0.00 Hz | Yes | Q | Q | Q | 280H | 4-6 6-9 |
| d1-02 | Frequency reference 2 | Sets the frequency reference when multi-step speed command 1 is ON for a multi-function input. | | 0.00 Hz | Yes | Q | Q | Q | 281H | 4-6 6-9 |
| d1-03 | Frequency reference 3 | Sets the frequency reference when multi-step speed command 2 is ON for a multi-function input. | | 0.00 Hz | Yes | Q | Q | Q | 282H | 4-6 6-9 |
| d1-04 | Frequency reference 4 | Sets the frequency reference when multi-step speed commands 1 and 2 are ON for multi-function inputs. | | 0.00 Hz | Yes | Q | Q | Q | 283H | 4-6 6-9 |
| d1-05 | Frequency reference 5 | Sets the frequency when multi-step speed command 3 is ON for a multi-function input. | | 0.00 Hz | Yes | A | A | A | 284H | 6-9 |
| d1-06 | Frequency reference 6 | Sets the frequency reference when multi-step speed commands 1 and 3 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 285H | 6-9 |
| d1-07 | Frequency reference 7 | Sets the frequency reference when multi-step speed commands 2 and 3 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 286H | 6-9 |
| d1-08 | Frequency reference 8 | Sets the frequency reference when multi-step speed commands 1, 2, and 3 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 287H | 6-9 |
| d1-09 | Frequency reference 9 | Sets the frequency reference when multi-step speed command 4 is ON for a multi-function input. | | 0.00 Hz | Yes | A | A | A | 288H | 6-9 |
| d1-10 | Frequency reference 10 | Sets the frequency reference when multi-step speed commands 1 and 4 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 28BH | 6-9 |
| d1-11 | Frequency reference 11 | Sets the frequency reference when multi-step speed commands 2 and 4 are ON for a multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 28CH | 6-9 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| d1-12 | Frequency reference 12 | Sets the frequency reference when multi-step speed commands 1, 2, and 4 are ON for multi-function inputs. | 0 to 400.00 | 0.00 Hz | Yes | A | A | A | 28DH | 6-9 |
| d1-13 | Frequency reference 13 | Sets the frequency reference when multi-step speed commands 3 and 4 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 28EH | 6-9 |
| d1-14 | Frequency reference 14 | Sets the frequency reference when multi-step speed commands 1, 3, and 4 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 28FH | 6-9 |
| d1-15 | Frequency reference 15 | Sets the frequency reference when multi-step speed commands 2, 3, and 4 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 290H | 6-9 |
| d1-16 | Frequency reference 16 | Sets the frequency reference when multi-step speed commands 1, 2, 3, and 4 are ON for multi-function inputs. | | 0.00 Hz | Yes | A | A | A | 291H | 6-9 |
| d1-17 | Jog frequency reference | Sets the frequency reference when the jog frequency reference selection, FJOG command, or RJOG command is ON. | | 6.00 Hz | Yes | Q | Q | Q | 292H | 4-6<br>6-9<br>6-78 |

Note: The unit is set in o1-03 (frequency units of reference setting and monitor, default: 0.01 Hz).

## ■Reference Limits: d2

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| d2-01 | Frequency reference upper limit | Sets the frequency reference upper limit as a percentage of the max. output frequency. | 0.0 to 110.0 | 100.0% | No | A | A | A | 289H | 6-30<br>6-73 |
| d2-02 | Frequency reference lower limit | Sets the frequency reference lower limit as a percentage of the maximum output frequency. | 0.0 to 110.0 | 0.0% | No | A | A | A | 28AH | 6-30<br>6-73 |
| d2-03 | Master speed reference lower limit | Sets the master speed reference lower limit as a percentage of the max. output frequency. | 0.0 to 110.0 | 0.0% | No | A | A | A | 293H | 6-30<br>6-73 |

## ■Jump Frequencies: d3

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| d3-01 | Jump frequency 1 | Set the center values of the jump frequencies in Hz. This function is disabled when the jump frequency is set to 0 Hz. Always ensure that the following applies: d3-01 ≥ d3-02 ≥ d3-03 Operation in the jump frequency range is prohibited but during acceleration and deceleration, the speed changes smoothly without jumping | 0.0 to 400.0 | 0.0 Hz | No | A | A | A | 294H | 6-27 |
| d3-02 | Jump frequency 2 | | | 0.0 Hz | No | A | A | A | 295H | 6-27 |
| d3-03 | Jump frequency 3 | | | 0.0 Hz | No | A | A | A | 296H | 6-27 |
| d3-04 | Jump frequency width | Sets the jump frequency bandwidth in Hz. The jump frequency range will be the jump frequency ± d3-04. | 0.0 to 20.0 | 1.0 Hz | No | A | A | A | 297H | 6-27 |

## ■Reference Frequency Hold: d4

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| d4-01 | Frequency reference hold function selection | Sets whether or not frequency reference value on hold will be recorded.<br>0: Disabled (when operation is stopped or the power is turned on again the frequency reference is set to 0.)<br>1: Enabled (when operation is stopped or the power is turned on again the inverter starts at the previous hold frequency.)<br>This function is available when the multi-function inputs "Accel/Decel Ramp Hold" or "Up/Down" commands are set. | 0 or 1 | 0 | No | A | A | A | 298H | 6-72 |
| d4-02 | + – Speed limits | Sets the frequency to be add to or subtracted from the analog frequency reference as a percentage of the max. output frequency.<br>Enabled when the increase (+) speed command or decrease (–) speed command is set for a multi-function input. | 0 to 100 | 10% | No | A | A | A | 299H | 6-76 |

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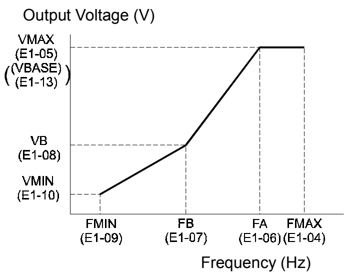
## ■Field Weakening: d6

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| d6-01 | Field weakening level | Sets the inverter output voltage when the field weakening command is input at a multi-function input.<br>Sets the voltage level as a percentage taking the voltage set by the V/f pattern as 100%. | 0 to 100 | 80% | No | A | A | No | 2A0H | 6-113 |
| d6-02 | Field weakening frequency limit | Sets the lower limit of the frequency range where field control is valid.<br>The field weakening command is valid only at frequencies above this setting and only when the speed is in agreement with the current speed reference. | 0.0 to 400.0 | 0.0 Hz | No | A | A | No | 2A1H | 6-113 |

## ◆ Motor Constants: E

### ■V/f Pattern: E1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| E1-01 | Input voltage setting | Sets the Inverter input voltage. This setting is used as a reference value for protection functions. | 155 to 255 *1 | 200 V *1 | No | Q | Q | Q | 300H | 4-6 6-116 |
| E1-03 | V/f pattern selection | 0 to E: Select from the 15 preset patterns.<br>F: Custom user-set pattern (Applicable for setting of E1-04 to E1-10.) | 0 to F | F | No | Q | Q | No | 302H | 6-116 |
| E1-04 | Max. output frequency (FMAX) | <br>To set V/f characteristics in a straight line, set the same values for E1-07 and E1-09. In this case, the setting for E1-08 will be disregarded.<br>Always ensure that the four frequencies are set in the following manner:<br>E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN) | 40.0 to 400.0 *2 | 50.0 Hz | No | Q | Q | Q | 303H | 6-116 |
| E1-05 | Max. output voltage (VMAX) | | 0.0 to 255.0 *1 | 200.0 V *1 | No | Q | Q | Q | 304H | 6-116 |
| E1-06 | Base frequency (FA) | | 0.0 to 400.0 | 50.0 Hz | No | Q | Q | Q | 305H | 6-116 |
| E1-07 | Mid. output frequency (FB) | | 0.0 to 400.0 | 2.5 Hz *3 | No | A | A | A | 306H | 6-116 |
| E1-08 | Mid. output frequency voltage (VB) | | 0.0 to 255 *1 | 15.0 V *1 *3 | No | A | A | A | 307H | 4-15 6-116 |
| E1-09 | Min. output frequency (FMIN) | | 0.0 to 400.0 | 1.2 Hz *3 | No | Q | Q | Q | 308H | 6-116 |
| E1-10 | Min. output frequency voltage (VMIN) | | 0.0 to 255.0 *1 | 9.0 V *1 *3 | No | A | A | A | 309H | 4-14 4-15 6-116 |
| E1-11 | Mid. output frequency 2 | Set only to fine-adjust V/f for the output range. Normally, this setting is not required. | 0.0 to 400.0 | 0.0 Hz *4 | No | A | A | A | 30AH | 6-116 |
| E1-12 | Mid. output frequency voltage 2 | | 0.0 to 255.0 *1 | 0.0 V *4 | No | A | A | A | 30BH | 6-116 |

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| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| E1-13 | Base voltage (VBASE) | Sets the output voltage of the base frequency (E1-06). | 0.0 to 255.0 *1 | 0.0 V *5 | No | A | A | Q | 30CH | 6-116 |

* 1. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 2. When C6-01 is set to 0, the upper limit of the setting range is 150.0 Hz.
* 3. The factory setting will change when the control method is changed. (V/f control factory settings are given.)
* 4. E1-11 and E1-12 are disregarded when set to 0.0.
* 5. E1-13 is set to the same value as E1-05 by autotuning.

## ■Motor Setup: E2

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| E2-01 | Motor rated current | Sets the motor rated current. This set value will become the reference value for motor protection and torque limits. This constant is an input data for autotuning. | 0.32 to 6.40 *1 | 1.90 A *2 | No | Q | Q | Q | 30EH | 6-51 6-114 |
| E2-02 | Motor rated slip | Sets the motor rated slip in Hz units. This set value will become the reference value for the slip compensation. This constant is automatically set during autotuning. | 0.00 to 20.00 | 2.90 Hz *2 | No | A | A | A | 30FH | 6-111 6-114 |
| E2-03 | Motor no-load current | Sets the motor no-load current. This constant is automatically set during autotuning. | 0.00 to 1.89 *3 | 1.20 A *2 | No | A | A | A | 310H | 6-114 |
| E2-04 | Number of motor poles | Sets the number of motor poles. This value is an input data for autotuning. | 2 to 48 | 4 poles | No | No | Q | No | 311H | 6-114 |
| E2-05 | Motor line-to-line resistance | Sets the motor phase-to-phase resistance in Ω units. This constant is automatically set during autotuning. | 0.000 to 65.000 | 9.842 Ω *2 | No | A | A | A | 312H | 6-114 |
| E2-06 | Motor leak inductance | Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage. This constant is automatically set during autotuning. | 0.0 to 40.0 | 18.2% *2 | No | No | No | A | 313H | 6-114 |
| E2-07 | Motor iron saturation coefficient 1 | Sets the motor iron saturation coefficient at 50% of magnetic flux. This constant is automatically set during rotating autotuning. | 0.00 to 0.50 | 0.50 | No | No | No | A | 314H | 6-114 |
| E2-08 | Motor iron saturation coefficient 2 | Sets the motor iron saturation coefficient at 75% of magnetic flux. This constant is automatically set during rotating autotuning. | 0.00 to 0.75 | 0.75 | No | No | No | A | 315H | 6-114 |
| E2-10 | Motor iron loss for torque compensation | Sets motor iron losses. | 0 to 65535 | 14 W *2 | No | A | A | No | 317H | 6-114 |
| E2-11 | Motor rated output power | Sets the rated output of the motor in units of 0.01 kW. This constant is an input data for autotuning. | 0.00 to 650.00 | 0.40 *2 | No | Q | Q | Q | 318H | 6-111 |

* 1. The setting range is 10% to 200% of the Inverter's rated output current. The value for a 200 V class inverter of 0.4 kW is given.
* 2. The factory setting depends upon the Inverter capacity. The value for a 200 V class inverter of 0.4 kW is given.
* 3. The setting range depends on the inverter capacity. The value for a 200 V class inverter of 0.4 kW is given.

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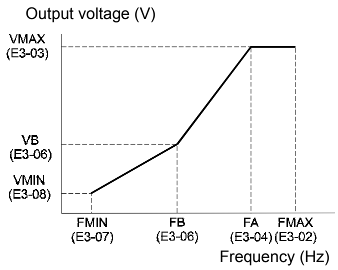
## ■ Motor 2 V/f Pattern: E3

<table>
<tr><th rowspan="2">Con-stant Number</th><th rowspan="2">Name</th><th rowspan="2">Description</th><th rowspan="2">Setting Range</th><th rowspan="2">Factory Setting</th><th rowspan="2">Change during Opera-tion</th><th colspan="3">Control Methods</th><th rowspan="2">MEMO-BUS Register</th><th rowspan="2">Page</th></tr>
<tr><th>V/f</th><th>V/f with PG</th><th>Open Loop</th></tr>
<tr><td>E3-01</td><td>Motor 2 control method selection</td><td>0: V/f control<br>1: V/f control with PG<br>2: Open-loop vector control</td><td>0 to 2</td><td>0</td><td>No</td><td>A</td><td>A</td><td>A</td><td>319H</td><td>6-123</td></tr>
<tr><td>E3-02</td><td>Motor 2 max. out-put fre-quency (FMAX)</td><td rowspan="7"><br>To set V/f characteristics in a straight line, set the same values for E3-05 and E3-07.<br>In this case, the setting for E3-06 will be disregarded.<br>Always ensure that the four fre-quencies are set in the following manner:<br>E3-02 (FMAX) ≥ E3-04 (FA) > E3-05 (FB) > E3-07 (FMIN)</td><td>40.0 to 400.0 *1</td><td>50.0 Hz</td><td>No</td><td>A</td><td>A</td><td>A</td><td>31AH</td><td>6-123</td></tr>
<tr><td>E3-03</td><td>Motor 2 max. out-put volt-age (VMAX)</td><td>0.0 to 255.0 *2</td><td>200.0 V *2</td><td>No</td><td>A</td><td>A</td><td>A</td><td>31BH</td><td>6-123</td></tr>
<tr><td>E3-04</td><td>Motor 2 max. volt-age fre-quency (FA)</td><td>0.0 to 400.0</td><td>50.0 Hz</td><td>No</td><td>A</td><td>A</td><td>A</td><td>31CH</td><td>6-123</td></tr>
<tr><td>E3-05</td><td>Motor 2 mid. output frequency 1 (FB)</td><td>0.0 to 400.0</td><td>2.5 Hz *3</td><td>No</td><td>A</td><td>A</td><td>A</td><td>31DH</td><td>6-123</td></tr>
<tr><td>E3-06</td><td>Motor 2 mid. output frequency voltage 1 (VB)</td><td>0.0 to 255.0 *2</td><td>15.0 V *2</td><td>No</td><td>A</td><td>A</td><td>A</td><td>31EH</td><td>6-123</td></tr>
<tr><td>E3-07</td><td>Motor 2 min. output frequency (FMIN)</td><td>0.0 to 400.0</td><td>1.2 Hz *3</td><td>No</td><td>A</td><td>A</td><td>A</td><td>31FH</td><td>6-123</td></tr>
<tr><td>E3-08</td><td>Motor 2 min. output frequency voltage (VMIN)</td><td>0.0 to 255.0 *2</td><td>9.0 V *2*3</td><td>No</td><td>A</td><td>A</td><td>A</td><td>320H</td><td>6-123</td></tr>
</table>

* 1. When C6-01 is set to 0, the upper limit of the setting range is 150.0 Hz.
* 2. These are values for a 200 V class Inverter. Values for a 400 V class Inverter are double.
* 3. The factory setting will change when the control method is changed. (V/f control factory settings are given.)

## ■Motor 2 Setup: E4

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| E4-01 | Motor 2 rated current | Sets the motor rated current. This set value will become a reference value for motor protection and torque limits. This constant is an input data for autotuning. | 0.32 to 6.40 *1 | 1.90 A *2 | No | A | A | A | 321H | 6-51 |
| E4-02 | Motor 2 rated slip | Sets the motor rated slip in Hz units. This set value will become a reference value for slip compensation. This constant is automatically set during autotuning. | 0.00 to 20.00 | 2.90 Hz *2 | No | A | A | A | 322H | 6-122 |
| E4-03 | Motor 2 no-load current | Sets the motor no-load current. This constant is automatically set during autotuning. | 0.00 to 1.89 *3 | 1.20 A *2 | No | A | A | A | 323H | 6-122 |
| E4-04 | Motor 2 number of poles (number of poles) | Sets the number of motor poles. This value is an input data for autotuning. | 2 to 48 | 4 poles | No | No | A | No | 324H | 6-122 |
| E4-05 | Motor 2 line-to-line resistance | Sets the motor phase-to-phase resistance in Ω units. This constant is automatically set during autotuning. | 0.000 to 65.000 | 9.842 Ω *2 | No | A | A | A | 325H | 6-122 |
| E4-06 | Motor 2 leak inductance | Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage. This constant is automatically set during autotuning. | 0.0 to 40.0 | 18.2% *2 | No | No | No | A | 326H | 6-122 |
| E4-07 | Motor 2 rated capacity | Sets the rated output of the motor in units of 0.01 kW. This constant is an input data for autotuning. | 0.40 to 650.00 | 0.40 *2 | No | A | A | A | 327H | 6-122 |

* 1. The setting range is 10% to 200% of the Inverter's rated output current. The values for a 200 V class Inverter of 0.4 kW is given.
* 2. The factory setting depends upon the Inverter capacity. The value for a 200 V class Inverter of 0.4 kW is given.
* 3. The setting range will depend upon the Inverter capacity. The value for a 200 V class Inverter of 0.4 kW is given.

## ◆ Option Constants: F

### ■PG Option Setup: F1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods: V/f | Control Methods: V/f with PG | Control Methods: Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| F1-01 | PG constant | Sets the number of PG (pulse generator or encoder) pulses. | 0 to 60000 | 1024 | No | No | Q | No | 380H | 6-136 |
| F1-02 | Operation selection at PG open circuit (PGO) | Sets the PG disconnection stopping method.<br>0: Ramp to stop (Deceleration to stop using the deceleration time 1, C1-02.)<br>1: Coast to stop<br>2: Fast stop (Emergency stop using the deceleration time in C1-09.)<br>3: Continue operation (To protect the motor or machinery, avoid to use this setting.) | 0 to 3 | 1 | No | No | A | No | 381H | 6-136 |
| F1-03 | Operation selection at overspeed (OS) | Sets the stopping method when an overspeed (OS) fault occurs.<br>0: Ramp to stop (Deceleration to stop using the deceleration time 1, C1-02.)<br>1: Coast to stop<br>2: Fast stop (Emergency stop using the deceleration time in C1-09.)<br>3: Continue operation (To protect the motor or machinery, avoid to use this setting.) | 0 to 3 | 1 | No | No | A | No | 382H | 6-136 |
| F1-04 | Operation selection at deviation | Sets the stopping method when a speed deviation (DEV) fault occurs.<br>0: Ramp to stop (Deceleration to stop using the deceleration time 1, C1-02.)<br>1: Coast to stop<br>2: Fast stop (Emergency stop using the deceleration time in C1-09.)<br>3: Continue operation (DEV is displayed and operation continued.) | 0 to 3 | 3 | No | No | A | No | 383H | 6-136 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| F1-05 | PG rotation | 0: Phase A leads with forward run command. (Phase B leads with reverse run command.)<br>1: Phase B leads with forward run command. (Phase A leads with reverse run command.) | 0 or 1 | 0 | No | No | A | No | 384H | 6-136 |
| F1-06 | PG division rate (PG pulse moni-tor) | Sets the division ratio for the PG speed control card pulse output.<br>Division ratio = (1+ n) /m (n=0 or 1 m=1 to 32)<br>The first digit of the value of F1-06 stands for n, the sec-ond and the third stand for m.<br>This constant is only effec-tive when a PG-B2 is used.<br>The possible division ratio settings are: 1/32 ≤ F1-06 ≤ 1. | 1 to 132 | 1 | No | No | A | No | 385H | 6-137 |
| F1-07 | Integral value during accel/decel enable/dis-able | Sets integral control during acceleration/deceleration to either enabled or disabled.<br>0: Disabled (The integral function isn't used while accelerating or decelerating; it is used at constant speeds.)<br>1: Enabled (The integral function is used at all times.) | 0 or 1 | 0 | No | No | A | No | 386H | 6-137 |
| F1-08 | Overspeed detection level | Sets the overspeed detection method.<br>Motor speeds that continue to exceed the value set in F1-08 (set as a percentage of the maximum output frequency) for the time set in F1-09 are detected as overspeed faults. | 0 to 120 | 115% | No | No | A | No | 387H | 6-137 |
| F1-09 | Overspeed detection delay time | | 0.0 to 2.0 | 1.0 s | No | No | A | No | 388H | 6-137 |
| F1-10 | Excessive speed devia-tion detec-tion level | Sets the speed deviation detection method.<br>Any speed deviation above the F1-10 set level (set as a percentage of the maximum output frequency) that con-tinues for the time set in F1-11 is detected as a speed deviation.<br>Speed deviation is the differ-ence between actual motor speed and the speed reference command. | 0 to 50 | 10% | No | No | A | No | 389H | 6-137 |
| F1-11 | Excessive speed devia-tion detec-tion delay time | | 0.0 to 10.0 | 0.5 s | No | No | A | No | 38AH | 6-137 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| F1-12 | Number of PG gear teeth 1 | Sets the number of teeth on the gears if there are gears between the PG and the motor. $\frac{\text{Input pulses from PG x 60}}{\text{F1-01}} \times \frac{\text{F1-13}}{\text{F1-12}}$ A gear ratio of 1 will be used if one of these constants is set to 0. | 0 to 1000 | 0 | No | No | A | No | 38BH | 6-137 |
| F1-13 | Number of PG gear teeth 2 | | | 0 | No | No | A | No | 38CH | 6-137 |
| F1-14 | PG open-cir-cuit detec-tion delay time | Used to set the PG discon-nection detection time. PGO will be detected if the detec-tion time exceeds the set time. | 0.0 to 10.0 | 2.0 s | No | No | A | No | 38DH | 6-137 |

## ■Communications Option Cards: F6

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| F6-01 | Operation selection after communications error | Set the stopping method for communications errors.<br>0: Deceleration to stop using the deceleration time in C1-02<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09<br>3: Continue operation | 0 to 3 | 1 | No | A | A | A | 3A2H | - |
| F6-02 | Input level of external error from Communications Option Card | 0: Always detect<br>1: Detect during operation | 0 or 1 | 0 | No | A | A | A | 3A3H | - |
| F6-03 | Stopping method for external error from Communications Option Card | 0: Deceleration to stop using the deceleration time in C1-02<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09<br>3: Continue operation | 0 to 3 | 1 | No | A | A | A | 3A4H | - |
| F6-04 | Trace sampling from Communications Option Card | - | 0 to 60000 | 0 | No | A | A | A | 3A5H | - |
| F6-05 | Current monitor unit selection | Sets the unit of current monitor<br>0: Ampere<br>1: 100%/8192 | 0 or 1 | 1 | No | A | A | A | 3A6H | - |

## ◆ Terminal Function Constants: H

### ■Multi-function Contact Inputs: H1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| H1-01 | Terminal S3 function selection | Multi-function contact input 1 | 0 to 77 | 24 | No | A | A | A | 400H | - |
| H1-02 | Terminal S4 function selection | Multi-function contact input 2 | 0 to 77 | 14 | No | A | A | A | 401H | - |
| H1-03 | Terminal S5 function selection | Multi-function contact input 3 | 0 to 77 | 3 (0)* | No | A | A | A | 402H | - |
| H1-04 | Terminal S6 function selection | Multi-function contact input 4 | 0 to 77 | 4 (3)* | No | A | A | A | 403H | - |
| H1-05 | Terminal S7 function selection | Multi-function contact input 5 | 0 to 77 | 6 (4)* | No | A | A | A | 404H | - |

* The values in parentheses indicate initial values when initialized in 3-wire sequence.

#### Multi-function Contact Input Functions

| Setting Value | Function | Control Methods | | | Page |
|---|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector | |
| 0 | 3-wire sequence (Forward/Reverse Run command) | Yes | Yes | Yes | 6-12 |
| 1 | Local/Remote selection (ON: Operator, OFF: Constant b1-01/b1-02 setting) | Yes | Yes | Yes | 6-69 |
| 2 | Operation Source Option Card/Inverter selection (ON: Option Card) | Yes | Yes | Yes | 6-78 |
| 3 | Multi-step speed reference 1<br>When H3-09 is set to 2, this function is combined with the master/auxiliary speed switch. | Yes | Yes | Yes | 6-9 |
| 4 | Multi-step speed reference 2 | Yes | Yes | Yes | 6-9 |
| 5 | Multi-step speed reference 3 | Yes | Yes | Yes | 6-9 |
| 6 | Jog frequency command (higher priority than multi-step speed reference) | Yes | Yes | Yes | 6-9<br>6-69 |
| 7 | Accel/decel time 1 | Yes | Yes | Yes | 6-19 |
| 8 | External baseblock NO (NO contact: Baseblock at ON) | Yes | Yes | Yes | 6-70<br>6-61 |
| 9 | External baseblock NC (NC contact: Baseblock at OFF) | Yes | Yes | Yes | 6-70<br>6-61 |
| A | Acceleration/deceleration ramp hold (ON: Acceleration/deceleration stopped, frequency is hold) | Yes | Yes | Yes | 6-72 |
| B | OH2 alarm signal input (ON: OH2 will be displayed) | Yes | Yes | Yes | 6-71 |
| C | Multi-function analog input A2 disable/enable (ON: Enable) | Yes | Yes | Yes | 6-71 |

| Set-ting Value | Function | Control Methods | | | Page |
|---|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector | |
| D | V/f control with/without PG (ON: Speed feedback control disabled,) (normal V/f control) | No | Yes | No | 6-42 |
| E | Speed control integral disable (ON: Integral control disabled) | No | Yes | No | 6-42 |
| F | Not used (Set when a terminal is not used) | - | - | - | - |
| 10 | Up command (Always set with the Down command) | Yes | Yes | Yes | 6-73 |
| 11 | Down command (Always set with the Up command) | Yes | Yes | Yes | 6-73 |
| 12 | FJOG command (ON: Forward run at jog frequency d1-17) | Yes | Yes | Yes | 6-78 |
| 13 | RJOG command (ON: Reverse run at jog frequency d1-17) | Yes | Yes | Yes | 6-78 |
| 14 | Fault reset (Reset when turned ON) | Yes | Yes | Yes | 7-2 |
| 15 | Emergency stop. (NO: Deceleration to stop in deceleration time set in C1-09 when ON.) | Yes | Yes | Yes | 6-17 |
| 16 | Motor switch command (Motor 2 selection) | Yes | Yes | Yes | 6-122 |
| 17 | Emergency stop (NC: Deceleration to stop in deceleration time set in C1-09 when OFF) | Yes | Yes | Yes | 6-17 |
| 18 | Timer function input (Functions are set in b4-01 and b4-02 and the timer function outputs are set in H2-☐☐.) | Yes | Yes | Yes | 6-101 |
| 19 | PID control disable (ON: PID control disabled) | Yes | Yes | Yes | 6-104 |
| 1A | Accel/Decel time 2 | Yes | Yes | Yes | 6-19 |
| 1B | Constants write enable (ON: All constants can be written-in. OFF: All constants are write protected.) | Yes | Yes | Yes | 6-134 |
| 1C | Trim control increase (ON: d4-02 frequency is added to analog frequency reference.) | Yes | Yes | Yes | 6-76 |
| 1D | Trim control decrease (ON: d4-02 frequency is subtracted from analog frequency reference.) | Yes | Yes | Yes | 6-76 |
| 1E | Analog frequency reference sample/hold | Yes | Yes | Yes | 6-77 |
| 20 to 2F | External fault<br>Input mode: NO contact/NC contact, Detection mode: Normal/during operation | Yes | Yes | Yes | 6-79 |
| 30 | PID control integral reset (reset when reset command is input or when stopped during PID control) | Yes | Yes | Yes | 6-104 |
| 31 | PID control integral hold (ON: Hold) | Yes | Yes | Yes | 6-104 |
| 32 | Multi-step speed command 4 | Yes | Yes | Yes | 6-9 |
| 34 | PID soft starter | Yes | Yes | Yes | 6-104 |
| 35 | PID input characteristics switch | Yes | Yes | Yes | 6-104 |
| 60 | DC injection braking command (ON: Performs DC injection braking) | Yes | Yes | Yes | 6-16 |
| 61 | External search command 1 (ON: Speed search from maximum output frequency) | Yes | No | Yes | 6-58 |
| 62 | External search command 2 (ON: Speed search from set frequency) | Yes | No | Yes | 6-58 |
| 63 | Field weakening command (ON: Field weakening control set for d6-01 and d6-02) | Yes | Yes | No | 6-113 |
| 64 | External speed search command 3 | Yes | Yes | Yes | 6-57 |
| 65 | KEB (deceleration at momentary power loss) command (NC contact) | Yes | Yes | Yes | 6-124 |
| 66 | KEB (deceleration at momentary power loss) command (NO contact) | Yes | Yes | Yes | 6-124 |
| 67 | Communications test mode | Yes | Yes | Yes | 6-100 |
| 68 | High-slip braking (HSB) | Yes | Yes | No | 6-126 |
| 69 | Jog Frequency 2 | Yes | Yes | Yes | 6-10 |

5

| Set-ting Value | Function | Control Methods | | | Page |
|---|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector | |
| 6A | Drive enable (NC, ON: Drive enabled, OFF: Drive disabled | Yes | Yes | Yes | 6-71 |

## ■ Multi-function Contact Outputs: H2

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| H2-01 | Terminal M1-M2 function selection | Multi-function contact output 1 | 0 to 37 | 0 | No | A | A | A | 40BH | - |
| H2-02 | Terminal M3-M4 function selection | Multi-function contact output 2 | 0 to 37 | 1 | No | A | A | A | 40CH | - |
| H2-03 | Terminal M5-M6 function selection | Multi-function contact output 3 | 0 to 37 | 2 | No | A | A | A | 40DH | - |

### Multi-function Contact Output Functions

| Set-ting Value | Function | Control Methods | | | Page |
|---|---|---|---|---|---|
| | | V/f | V/f with PG | Open loop Vector | |
| 0 | During run (ON: run command is ON or voltage is being output) | Yes | Yes | Yes | 6-80 |
| 1 | Zero-speed | Yes | Yes | Yes | 6-81 |
| 2 | $f_{ref}/f_{out}$ agree 1 (detection width L4-02 is used.) | Yes | Yes | Yes | 6-33 |
| 3 | $f_{ref}/f_{set}$ agree 1 (ON: Output frequency = ±L4-01, with detection width L4-02 used and during frequency agree) | Yes | Yes | Yes | 6-33 |
| 4 | Frequency detection 1 (ON: +L4-01 ≥ output frequency ≥ -L4-01, with detection width L4-02 used) | Yes | Yes | Yes | 6-33 |
| 5 | Frequency detection 2 (ON: Output frequency ≥ +L4-01 or output frequency ≤ -L4-01, with detection width L4-02 used) | Yes | Yes | Yes | 6-33 |
| 6 | Inverter operation ready<br>READY: After initialization or no faults | Yes | Yes | Yes | 6-81 |
| 7 | During DC bus undervoltage (UV) detection | Yes | Yes | Yes | 6-81 |
| 8 | During baseblock (NO contact, ON: during baseblock) | Yes | Yes | Yes | 6-81 |
| 9 | Frequency reference source selection (ON: Frequency reference from Operator) | Yes | Yes | Yes | 6-81 |
| A | Run command source selection status (ON: Run command from Operator) | Yes | Yes | Yes | 6-81 |
| B | Overtorque/undertorque detection 1 NO (NO contact, ON: Overtorque/undertorque detection) | Yes | Yes | Yes | 6-48 |
| C | Loss of frequency reference (Effective when 1 is set for L4-05) | Yes | Yes | Yes | 6-62 |
| D | Braking resistor fault (ON: Resistor overheat or braking transistor fault) | Yes | Yes | Yes | 6-64 |
| E | Fault (ON: Digital Operator communications error or fault other than CPF00 and CPF01 has occurred.) | Yes | Yes | Yes | 6-81 |
| F | Not used. (Set when the terminal is not used.) | Yes | Yes | Yes | - |
| 10 | Minor fault (ON: Alarm displayed) | Yes | Yes | Yes | 6-81 |

| Setting Value | Function | Control Methods V/f | Control Methods V/f with PG | Control Methods Open loop Vector | Page |
|---|---|---|---|---|---|
| 11 | Fault reset command active | Yes | Yes | Yes | 6-82 |
| 12 | Timer function output | Yes | Yes | Yes | 6-101 |
| 13 | $f_{ref}/f_{set}$ agree 2 (detection width L4-04 is used) | Yes | Yes | Yes | 6-33 |
| 14 | $f_{ref}/f_{set}$ agree 2 (ON: Output frequency = L4-03, with detection width L4-04 is used, and during frequency agree) | Yes | Yes | Yes | 6-33 |
| 15 | Frequency detection 3 (ON: Output frequency ≤ -L4-03, detection width L4-04 is used) | Yes | Yes | Yes | 6-33 |
| 16 | Frequency detection 4 (ON: Output frequency ≥ -L4-03, detection width L4-04 is used) | Yes | Yes | Yes | 6-33 |
| 17 | Overtorque/undertorque detection 1 NC (NC Contact, OFF: Torque detection) | Yes | Yes | Yes | 6-48 |
| 18 | Overtorque/undertorque detection 2 NO (NO Contact, ON: Torque detection) | Yes | Yes | Yes | 6-48 |
| 19 | Overtorque/undertorque detection 2 NC (NC Contact, OFF: Torque detection) | Yes | Yes | Yes | 6-48 |
| 1A | During reverse run (ON: During reverse run) | Yes | Yes | Yes | 6-82 |
| 1B | During baseblock 2 (OFF: During baseblock) | Yes | Yes | Yes | 6-82 |
| 1C | Motor selection (ON: Motor 2 selected) | Yes | Yes | Yes | 6-82 |
| 1E | Restart enabled (ON: Restart enabled) | Yes | Yes | Yes | 6-63 |
| 1F | Motor overload (OL1, including OH3) pre-alarm (ON: 90% or more of the detection level) | Yes | Yes | Yes | 6-51 |
| 20 | Inverter overheat (OH) pre-alarm (ON: Temperature exceeds L8-02 setting) | Yes | Yes | Yes | 6-64 |
| 30 | During torque limit (current limit) (ON: During torque limit) | No | No | Yes | 6-44 |
| 37 | During run 2 (ON: Frequency output, OFF: Base block, DC injection braking, initial excitation, operation stop) | Yes | Yes | Yes | 6-80 |
| 38 | Drive enabled | Yes | Yes | Yes | 6-82 |

## ■Analog Inputs: H3

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| H3-01 | Multi-function analog input terminal A1 signal level selection | 0: 0 to +10V (11 bit)<br>1: –10V to +10V (11 bit plus sign) | 0 or 1 | 0 | No | A | A | A | 410H | 6-25 |
| H3-02 | Gain (terminal A1) | Sets the frequency as a percentage of the maximum output frequency, when 10 V is input. | 0.0 to 1000.0 | 100.0% | Yes | A | A | A | 411H | 6-25 |
| H3-03 | Bias (terminal A1) | Sets the frequency as a percentage of the maximum frequency, when 0 V is input. | -100.0 to +100.0 | 0.0% | Yes | A | A | A | 412H | 6-25 |
| H3-08 | Multi-function analog input terminal A2 signal level selection | 0: 0 to +10V (11 bit).<br>1: –10V to +10V (11 bit plus sign).<br>2: 4 to 20 mA (9-bit input).<br>Switch current and voltage input using the switch S1 on the control terminal board. | 0 to 2 | 2 | No | A | A | A | 417H | 6-25 |
| H3-09 | Multi-function analog input terminal A2 function selection | Selects the multi-function analog input function for terminal A2. Refer to the table on the next page. | 0 to 1F | 0 | No | A | A | A | 418H | 6-25 |
| H3-10 | Gain (terminal A2) | Sets the input level when terminal A2 input is 10 V (20 mA) according to the 100% value of the function set in constant H3-09. | 0.0 to 1000.0 | 100.0% | Yes | A | A | A | 419H | 6-25 |
| H3-11 | Bias (terminal A2) | Sets the input level when terminal A2 is 0 V (4 mA) according to the 100% value of the function set in constant H3-09. | -100.0 to +100.0 | 0.0% | Yes | A | A | A | 41AH | 6-25 |
| H3-12 | Analog input filter time constant | Sets primary delay filter time constant for the two analog input terminals (A1 and A2). Effective for noise control etc. | 0.00 to 2.00 | 0.00 s | No | A | A | A | 41BH | 6-25 |
| H3-13 | Terminal A1/A2 switching | 0: Use terminal A1 analog input as main frequency reference.<br>1: Use terminal A2 analog input as main frequency reference.<br>Effective when H3-09 is set to 2. | 0 or 1 | 0 | No | A | A | A | 41CH | - |

### H3-09 Settings

| Setting Value | Function | Contents (100%) | Control Methods | | | Page |
|---|---|---|---|---|---|---|
| | | | V/f | V/f with PG | Open Loop Vector | |
| 0 | Frequency bias | Maximum output frequency | Yes | Yes | Yes | 6-26 |
| 1 | Frequency gain | Frequency reference (voltage) command value | Yes | Yes | Yes | 6-26 |
| 2 | Auxiliary frequency reference (is used as frequency reference 2) | Maximum output frequency | Yes | Yes | Yes | 6-7 |
| 4 | Voltage bias | Motor rated voltage (E1-05) | Yes | Yes | No | - |
| 5 | Accel/decel time gain | Set acceleration and deceleration times (C1-01 to C1-08) | Yes | Yes | Yes | 6-20 |
| 6 | DC injection braking current | Inverter rated output current | Yes | Yes | Yes | 6-17 |
| 7 | Overtorque/undertorque detection level | Motor rated torque for vector control<br>Inverter rated output current for V/f control | Yes | Yes | Yes | 6-50 |
| 8 | Stall prevention level during run | Inverter rated output current | Yes | Yes | No | 6-47 |
| 9 | Frequency reference lower limit level | Maximum output frequency | Yes | Yes | Yes | 6-31 |
| A | Jump frequency | Maximum output frequency | Yes | Yes | Yes | 6-28 |
| B | PID feedback | Maximum output frequency | Yes | Yes | Yes | 6-104 |
| C | PID target value | Maximum output frequency | Yes | Yes | Yes | 6-104 |
| E | Motor temperature input | – | Yes | Yes | Yes | 6-54 |
| 10 | Positive torque limit | Motor's rated torque | No | No | Yes | 6-44 |
| 11 | Negative torque limit | Motor's rated torque | No | No | Yes | 6-44 |
| 12 | Regenerative torque limit | Motor's rated torque | No | No | Yes | 6-44 |
| 15 | Positive/negative torque limit | Motor's rated torque | No | No | Yes | 6-44 |
| 1F | Analog input not used. | – | Yes | Yes | Yes | – |

## ■Multi-function Analog Outputs: H4

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| H4-01 | Monitor selection (terminal FM) | Sets the number of the monitor item to be output (U1-□□) at terminal FM. 4, 10 to 14, 28, 34, 39, 40 cannot be set. | 1 to 38 | 2 | No | A | A | A | 41DH | 6-83 |
| H4-02 | Gain (terminal FM) | Sets the multi-function analog output 1 (terminal FM) gain. Sets the percentage of the monitor item that is equal to 10V/20mA output at terminal FM. Note that the maximum output voltage/current is 10V/20mA. | 0 to 1000.0 % | 100% | Yes | Q | Q | Q | 41EH | 4-6<br>6-83 |
| H4-03 | Bias (terminal FM) | Sets the multi-function analog output 1 (terminal FM) bias. Sets the percentage of the monitor item that is equal to 0V/4mA output at terminal FM. The maximum output from the terminal is 10 V/20mA. | -110 to +110% | 0.0% | Yes | A | A | A | 41FH | 6-83 |
| H4-04 | Monitor selection (terminal AM) | Sets the number of the monitor item to be output (U1-□□) at terminal AM. 4, 10 to 14, 28, 34, 39, 40 cannot be set. | 1 to 38 | 3 | No | A | A | A | 420H | 6-83 |
| H4-05 | Gain (terminal AM) | Set the multi-function analog output 2 (terminal AM) gain. Sets the percentage of the monitor item that is equal to 10V/20mA output at terminal AM. Note that the maximum output voltage/current is 10V/20mA. | 0 to 1000.0 % | 50.0% | Yes | Q | Q | Q | 421H | 4-6<br>6-83 |
| H4-06 | Bias (terminal AM) | Sets the multi-function analog output 2 (terminal AM) bias. Sets the percentage of the monitor item that is equal to 0V/4mA output at terminal AM. The maximum output from the terminal is 10 V/20mA. | -110.0 to +110.0 % | 0.0% | Yes | A | A | A | 422H | 6-83 |
| H4-07 | Analog output 1 signal level selection | Sets the signal output level for multi-function output 1 (terminal FM)<br>0: 0 to +10 V output<br>1: –10V to +10V output<br>2: 4 – 20 mA<br>Switch current and voltage output using CN15 on the control panel | 0 to 2 | 0 | No | A | A | A | 423H | 6-83 |

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| H4-08 | Analog output 2 signal level selection | Sets the signal output level for multi-function output 2 (terminal AM)<br>0: 0 to +10 V output<br>1: –10V to +10V output<br>2: 4 – 20 mA<br>Switch current and voltage output using CN15 on the control panel | 0 to 2 | 0 | No | A | A | A | 424H | 6-83 |

## ■MEMOBUS Communications: H5

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| H5-01 | Station address | Sets the Inverter's node address. | 0 to 20 * | 1F | No | A | A | A | 425H | 6-88 |
| H5-02 | Communications speed selection | Sets the baud rate for MEMOBUS communications.<br>0: 1200 bps<br>1: 2400 bps<br>2: 4800 bps<br>3: 9600 bps<br>4: 19200 bps | 0 to 4 | 3 | No | A | A | A | 426H | 6-88 |
| H5-03 | Communications parity selection | Sets the parity for MEMOBUS communications.<br>0: No parity<br>1: Even parity<br>2: Odd parity | 0 to 2 | 0 | No | A | A | A | 427H | 6-88 |
| H5-04 | Stopping method after communications error | Sets the stopping method for communications errors.<br>0: Deceleration to stop using the deceleration time in C1-02<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09<br>3: Continue operation | 0 to 3 | 3 | No | A | A | A | 428H | 6-88 |
| H5-05 | Communications error detection selection | Sets whether or not a communications timeout is to be detected as a communications error.<br>0: Do not detect.<br>1: Detect | 0 or 1 | 1 | No | A | A | A | 429H | 6-88 |
| H5-06 | Send wait time | Sets the time from the Inverter receiving data to when the Inverter starts to send. | 5 to 65 | 5 ms | No | A | A | A | 42AH | 6-88 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| H5-07 | RTS control ON/OFF | Enables or disables RTS control.<br>0: Disabled (RTS is always ON)<br>1: Enabled (RTS turns ON only when sending) | 0 or 1 | 1 | No | A | A | A | 42BH | 6-88 |

* Set H5-01 to 0 to disable Inverter responses to MEMOBUS communications.

## ■Pulse Train I/O: H6

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| H6-01 | Pulse train input func-tion selec-tion | 0: Frequency reference<br>1: PID feedback value<br>2: PID target value | 0 to 2 | 0 | No | A | A | A | 42CH | 6-6<br>6-29<br>6-103 |
| H6-02 | Pulse train input scaling | Sets the number of pulses in Hertz, that is equivalent to 100% of the input item selected in H6-01. | 1000 to 32000 | 1440 Hz | Yes | A | A | A | 42DH | 6-6<br>6-29 |
| H6-03 | Pulse train input gain | Sets the input level according to 100% of the input item selected in H6-01, when a pulse train with the frequency set in H6-02 is input. | 0.0 to 1000.0 | 100.0% | Yes | A | A | A | 42EH | 6-29 |
| H6-04 | Pulse train input bias | Sets the input level according to 100% of the input item selected in H6-01, when the pulse train frequency is 0. | -100.0 to 100.0 | 0.0% | Yes | A | A | A | 42FH | 6-29 |
| H6-05 | Pulse train input filter time | Sets the pulse train input delay filter time constant in seconds. | 0.00 to 2.00 | 0.10 s | Yes | A | A | A | 430H | 6-29 |
| H6-06 | Pulse train monitor selection | Select the pulse train monitor output items (value of the □□ part of U1-□□).<br>There are two types of moni-tor items: Speed-related items and PID-related items. | 1, 2, 5, 20, 24, 36 | 2 | Yes | A | A | A | 431H | 6-85 |
| H6-07 | Pulse train monitor scaling | Sets the number of pulses output in hertz when the monitor item is 100%.<br>Sets H6-06 to 2, and H6-07 to 0, to make the pulse train monitor output synchro-nously to the output fre-quency. | 0 to 32000 | 1440 Hz | Yes | A | A | A | 432H | 6-85 |

## ◆ Protection Function Constants: L

### ■Motor Overload: L1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| L1-01 | Motor protection selection | Sets whether the motor overload function is enabled or disabled at electric thermal overload relay.<br>0: Disabled<br>1: General-purpose motor protection (fan cooled motor)<br>2: Inverter motor protection (externally cooled motor)<br>3: Vector motor protection When the Inverter power supply is turned off, the thermal value is reset, so even if this constant is set to 1, protection may not be effective.<br>When several motors are connected to one Inverter, set to 0 and ensure that each motor is installed with a protection device. | 0 to 3 | 1 | No | Q | Q | Q | 480H | 4-6<br>6-51 |
| L1-02 | Motor protection time constant | Sets the electric thermal detection time in seconds units.<br>Usually changing this setting is not necessary.<br>The factory setting is 150% overload for one minute.<br>When the motor's overload capability is known, also set the overload resistance protection time for when the motor is hot started. | 0.1 to 5.0 | 1.0 min | No | A | A | A | 481H | 6-51 |
| L1-03 | Alarm operation selection during motor overheating | Selects the operation when the input motor temperature (thermistor) input exceeds the alarm detection level (1.17 V) (H3-09 must be set to E).<br>0: Decelerate to stop<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09.<br>3: Continue operation (oH3 on the Operator flashes). | 0 to 3 | 3 | No | A | A | A | 482H | 6-53 |

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| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L1-04 | Motor overheating operation selection | Selects the operation when the motor temperature (thermistor) input exceeds the overheating detection level (2.34 V) (H3-09 must be set to E).<br>0: Decelerate to stop<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09. | 0 to 2 | 1 | No | A | A | A | 483H | 6-53 |
| L1-05 | Motor temperature input filter time constant | Sets H3-09 to E and sets the delay time constant for the motor temperature (thermistor) input in seconds. | 0.00 to 10.00 | 0.20 s | No | A | A | A | 484H | 6-53 |

## ■Power Loss Ridethrough: L2

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L2-01 | Momentary power loss detection | 0: Disabled (DC bus undervoltage (UV1) detection)<br>1: Enabled (Restarted when the power returns within the time set in L2-02. When L2-02 is exceeded, DC bus undervoltage is detected.)<br>2: Enabled while CPU is operating. (Restarts when power returns during control operations. Does not detect DC bus undervoltage.) | 0 to 2 | 0 | No | A | A | A | 485H | 6-56<br>6-124 |
| L2-02 | Momentary power loss ridethru time | Ridethrough time, when Momentary Power Loss Selection (L2-01) is set to 1, in units of seconds. | 0 to 2.0 | 0.1 s<br>*1 | No | A | A | A | 486H | 6-56 |
| L2-03 | Min. baseblock time | Sets the Inverter's minimum baseblock time, when the Inverter is restarted after power loss ridethrough.<br>Set the time to approximately 0.7 times the motor time constant.<br>When an overcurrent or overvoltage occurs when starting a speed search or DC injection braking, increase the set values. | 0.1 to 5.0 | 0.1 s<br>*1 | No | A | A | A | 487H | 6-56<br>6-57 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L2-04 | Voltage recovery time | Sets the time required to return the Inverter output voltage from 0V to normal voltage at the completion of a speed search. | 0.0 to 5.0 | 0.3 s *1 | No | A | A | A | 488H | 6-56 6-57 |
| L2-05 | Undervolt-age detec-tion level | Sets the main circuit under-voltage (UV) detection level (main circuit DC voltage). Usually changing this setting is not necessary. | 150 to 210 *2 | 190 V *2 | No | A | A | A | 489H | 6-56 6-124 |
| L2-06 | KEB decel-eration time | Sets the time required to decelerate from the speed where the deceleration at momentary power loss com-mand (KEB) is input to zero speed. | 0.0 to 200.0 | 0.0 s | No | A | A | A | 48AH | 6-124 |
| L2-07 | Momentary recovery time | Sets the time to accelerate to the set speed after recovery from a momentary power loss. | 0.0 to 25.5 | 0 s *3 | No | A | A | A | 48BH | 6-124 |
| L2-08 | Frequency reduction gain at KEB start | Sets the reduction gain of the output frequency at the beginning of deceleration at momentary power loss (KEB). Reduction = slip frequency before KEB operation × L2-08 × 2 | 0 to 300 | 100 | No | A | A | A | 48CH | 6-124 |

* 1. The factory setting depends upon the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.
* 2. These are values for a 200 V class Inverter. Value for a 400 V class Inverter is double.
* 3. If the setting is 0, the axis will accelerate to the specified speed over the specified acceleration time (C1-01 to C1-08).

## ■Stall Prevention: L3

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L3-01 | Stall preven-tion selec-tion during accel | 0: Disabled (Acceleration as set. With a heavy load, the motor may stall.)<br>1: Enabled (Acceleration stopped when L3-02 level is exceeded. Acceleration starts again when the current has fallen below the stall prevention level).<br>2: Intelligent acceleration mode (Using the L3-02 level as a basis, acceleration is automatically adjusted. Set acceleration time is disregarded.) | 0 to 2 | 1 | No | A | A | A | 48FH | 6-21 |
| L3-02 | Stall preven-tion level during accel | Effective when L3-01 is set to 1 or 2.<br>Set as a percentage of Inverter rated current.<br>Usually changing this setting is not necessary. Reduce the setting when the motor stalls. | 0 to 200 | 120% * | No | A | A | A | 490H | 6-21 |
| L3-03 | Stall preven-tion limit during accel | Sets the lower limit for stall prevention during accelera-tion, as a percentage of the Inverter rated current.<br>Usually changing this setting is not necessary. | 0 to 100 | 50% | No | A | A | A | 491H | 6-21 |
| L3-04 | Stall preven-tion selec-tion during decel | 0: Disabled (Deceleration as set. If deceleration time is too short, a DC-Bus overvoltage may result.)<br>1: Enabled (Deceleration is stopped when the DC-Bus voltage exceeds the stall prevention level. Deceleration restarts when the voltage falls below the stall prevention level again.)<br>2: Intelligent deceleration mode (Deceleration rate is automatically adjusted so that in Inverter can decelerate in the shortest possible time. The set deceleration time is disregarded.)<br>3: Enabled (with Braking Resistor Unit)<br>When a braking option (Braking Resistor, Braking Resistor Unit, Braking Unit) is used, always set to 0 or 3. | 0 to 3 | 1 | No | Q | Q | Q | 492H | 4-6<br>6-23 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L3-05 | Stall preven-tion selec-tion during running | 0: Disabled (Runs as set. With a heavy load, the motor may stall.)<br>1: Deceleration using deceleration time 1 (C1-02.)<br>2: Deceleration using dece-lerationtime 2 (C1-04.) | 0 to 2 | 1 | No | A | A | No | 493H | 6-46 |
| L3-06 | Stall preven-tion level during run-ning | Effective when L3-05 is 1 or 2.<br>Set as a percentage of the Inverter rated current.<br>Usually changing this setting is not necessary.<br>Reduce the setting when the motor stalls. | 30 to 200 | 120% * | No | A | A | No | 494H | 6-46 |

* The initial value when C6-01 is set to 1 is given. If C6-01 is set to 0, the initial value will be 150%.

5

## ■Reference Detection: L4

| Con- stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera- tion | Control Methods | | | MEMO- BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L4-01 | Speed agree- ment detec- tion level | Effective when "$f_{out}/f_{set}$ agree 1", "Frequency detec- tion 1" or "Frequency detec- tion 2" is set for a multi- function output. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A | 499H | 6-32 |
| L4-02 | Speed agree- ment detec- tion width | Effective when "$f_{ref}/f_{out}$ agree 1", "$f_{out}/f_{set}$ agree 1" or "Frequency detection 1" or "Frequency detection 2" is set for a multi-function out- put. | 0.0 to 20.0 | 2.0 Hz | No | A | A | A | 49AH | 6-32 |
| L4-03 | Speed agree- ment detec- tion level (+/ -) | Effective when "$f_{out}/f_{set}$ agree 2", "Frequency detec- tion 3" or "Frequency detec- tion 4" is set for a multi- function output. | -400.0 to +400.0 | 0.0 Hz | No | A | A | A | 49BH | 6-32 |
| L4-04 | Speed agree- ment detec- tion width (+/-) | Effective when "$f_{ref}/f_{out}$ agree 2" "$f_{out}/f_{set}$ agree 2", "Frequency detection 3" or "Frequency detection 4" is set for a multi-function out- put. | 0.0 to 20.0 | 2.0 Hz | No | A | A | A | 49CH | 6-32 |
| L4-05 | Operation when fre- quency ref- erence is missing | 0: Stop (Operation follows the frequency reference.)<br>1: Operation continues at the frequency, set in parame- ter L4-06.<br>Frequency reference loss means that the frequency reference value drops over 90% in 400 ms. | 0 or 1 | 0 | No | A | A | A | 49DH | 6-62 |
| L4-06 | Frequency reference value at fre- quency ref- erence loss | Sets the frequency reference value when the frequency reference is missing | 0.0 to 100.0% | 80% | No | A | A | A | 4C2H | 6-62 |

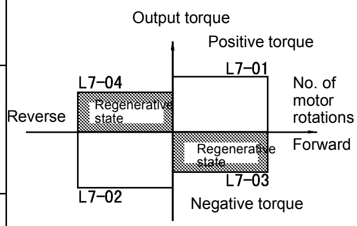
## ■Fault Restart: L5

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L5-01 | Number of auto restart attempts | Sets the number of auto restart attempts.<br>Automatically restarts after a fault and conducts a speed search from the run frequency. | 0 to 10 | 0 | No | A | A | A | 49EH | 6-63 |
| L5-02 | Auto restart operation selection | Sets whether a fault contact output is activated during fault restart.<br>0: No output (Fault contact is not activated.)<br>1: Output (Fault contact is activated.) | 0 or 1 | 0 | No | A | A | A | 49FH | 6-63 |

## ■Torque Detection: L6

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L6-01 | Torque detection selection 1 | 0: Overtorque/undertorque detection disabled.<br>1: Overtorque detection only with speed agreement; operation continues (warning is output).<br>2: Overtorque detected continuously during operation; operation continues (warning is output).<br>3: Overtorque detection only with speed agreement; output stopped upon detection.<br>4: Overtorque detected continuously during operation; output stopped upon detection.<br>5: Undertorque detection only with speed agreement; operation continues (warning is output).<br>6: Undertorque detected continuously during operation; operation continues (warning is output).<br>7: Undertorque detection only with speed agreement; output stopped upon detection.<br>8: Undertorque detected continuously during operation; output stopped upon detection. | 0 to 8 | 0 | No | A | A | A | 4A1H | 6-48 |
| L6-02 | Torque detection level 1 | Open loop vector control: Motor rated torque is set as 100%.<br>V/f control: Inverter rated current is set as 100%. | 0 to 300 | 150% | No | A | A | A | 4A2H | 6-48 |
| L6-03 | Torque detection time 1 | Sets the overtorque/undertorque detection time. | 0.0 to 10.0 | 0.1 s | No | A | A | A | 4A3H | 6-48 |
| L6-04 | Torque detection selection 2 | See L6-01 to L6-03 for a description. | 0 to 8 | 0 | No | A | A | A | 4A4H | 6-48 |
| L6-05 | Torque detection level 2 | | 0 to 300 | 150% | No | A | A | A | 4A5H | 6-48 |
| L6-06 | Torque detection time 2 | | 0.0 to 10.0 | 0.1 s | No | A | A | A | 4A6H | 6-48 |

## ■Torque Limits: L7

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L7-01 | Forward drive torque limit | Sets the torque limit value as a per-centage of the motor rated torque. Four individual regions can be set.<br><br> | 0 to 300 | 200%* | No | No | No | A | 4A7H | 6-44 |
| L7-02 | Reverse drive torque limit | | 0 to 300 | 200%* | No | No | No | A | 4A8H | 6-44 |
| L7-03 | Forward regenera-tive torque limit | | 0 to 300 | 200%* | No | No | No | A | 4A9H | 6-44 |
| L7-04 | Reverse regenera-tive torque limit | | 0 to 300 | 200%* | No | No | No | A | 4AAH | 6-44 |

* A setting value of 100% is equal to the motor rated torque.

## ■Hardware Protection: L8

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L8-01 | Protect selection for internal DB resistor (Type ERF) | 0: Disabled (no overheating protection)<br>1: Enabled (overheating protection) | 0 or 1 | 0 | No | A | A | A | 4ADH | 6-64 |
| L8-02 | Overheat pre-alarm level | Sets the detection tempera-ture for the Inverter overheat detection pre-alarm in °C. The pre-alarm detects when the cooling fin temperature reaches the set value. | 50 to 130 | 95 °C* | No | A | A | A | 4AEH | 6-65 |
| L8-03 | Operation selection after over-heat pre-alarm | Sets the operation for when the Inverter overheat pre-alarm occurs.<br>0: Decelerate to stop using the deceleration time C1-02.<br>1: Coast to stop<br>2: Fast stop in fast-stop time C1-09.<br>3: Continue operation (Monitor display only.)<br>A fault will be given in set-ting 0 to 2 and a minor fault will be given in setting 3. | 0 to 3 | 3 | No | A | A | A | 4AFH | 6-65 |

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| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| L8-05 | Input open-phase pro-tection selection | 0: Disabled<br>1: Enabled (Detects power supply open-phase, power supply voltage imbalance or DC bus electrostatic capacitor deterioration.) | 0 or 1 | 1 | No | A | A | A | 4B1H | 6-65 |
| L8-07 | Output open-phase protection selection | 0: Disabled<br>1: Enabled (Output open-phase detected at less than 5% of Inverter rated current.)<br>When the applied motor capacity is small compared to the Inverter capacity, the detection may not work prop-erly and should be disabled. | 0 or 1 | 0 | No | A | A | A | 4B3H | 6-65 |
| L8-09 | Ground pro-tection selection | 0:Disabled<br>1:Enabled<br>It is not recommended to use another setting than factory setting. | 0 or 1 | 1 | No | A | A | A | 4B5H | 6-65 |
| L8-10 | Cooling fan control selection | Set the ON/OFF control for the cooling fan.<br>0: ON only when Inverter is ON<br>1: ON whenever power is ON | 0 or 1 | 0 | No | A | A | A | 4B6H | 6-65 |
| L8-11 | Cooling fan control delay time | Set the time in seconds to delay turning OFF the cool-ing fan after the inverter STOP command is given. | 0 to 300 | 60 s | No | A | A | A | 4B7H | 6-65 |
| L8-12 | Ambient temperature | Set the ambient temperature. | 45 to 60 | 45 °C | No | A | A | A | 4B8H | 6-65 |
| L8-15 | OL2 charac-teristics selection at low speeds | 0: OL2 characteristics at low speeds disabled.<br>1: OL2 characteristics at low speeds enabled.<br>It is not be commonded to use another setting than fac-tory setting. | 0 or 1 | 1 | No | A | A | A | 4BBH | 6-65 |
| L8-18 | Soft CLA selection | 0: Disable (gain = 0)<br>1: Enable<br>It is not recommended to use another setting than factory setting. | 0 or 1 | 1 | No | A | A | A | 4BFH | 6-65 |

* The factory setting depends upon the Inverter capacity. The value for a 200 V Class Inverter of 0.4 kW is given.

## ◆ N: Special Adjustments

### ■Hunting Prevention Function: N1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| N1-01 | Hunting-prevention function selection | 0: Hunting-prevention function disabled<br>1: Hunting-prevention function enabled | 0 or 1 | 1 | No | A | A | No | 580H | 6-42 |
| N1-02 | Hunting-prevention gain | Sets the hunting-prevention gain multiplication factor. | 0.00 to 2.50 | 1.00 | No | A | A | No | 581H | 4-14<br>6-42 |

### ■Automatic Frequency Regulator: N2

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| N2-01 | Speed feedback detection control (AFR) gain | Sets the internal speed feedback detection control gain. Normally, there is no need to change this setting.<br>If necessary, adjust this constant as follows:<br>• If hunting occurs, increase the set value.<br>• If response is low, decrease the set value.<br>Adjust the setting by 0.05 at a time, while checking the response. | 0.00 to 10.00 | 1.00 | No | No | No | A | 584H | 4-14<br>6-43 |
| N2-02 | Speed feedback detection control (AFR) time constant | Set the time constant to decide the rate of change in the speed feedback detection control. | 0 to 2000 | 50 ms | No | No | No | A | 585H | 6-43 |
| N2-03 | Speed feedback detection control (AFR) time constant 2 | Set the time constant to decide the amount of change in the speed. | 0 to 2000 | 750 ms | No | No | No | A | 586H | 6-43 |

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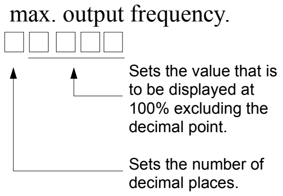
## ■High-slip Braking: N3

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| N3-01 | High-slip braking deceleration frequency width | Sets the frequency width for deceleration during high-slip braking in percent, taking the maximum frequency (E1-04) as 100%. | 1 to 20 | 5% | No | A | A | No | 588H | 6-126 |
| N3-02 | High-slip braking current limit | Sets the current limit for deceleration during high-slip braking in percent, taking the motor rated current as 100%. The resulting limit must be 150% of the Inverter rated current or less. | 100 to 200 | 150% | No | A | A | No | 589H | 6-126 |
| N3-03 | High-slip braking stop dwell time | Sets the dwell time for the output frequency for FMIN (1.5 Hz) during V/f control. Effective only during deceleration with high-slip braking. | 0.0 to 10.0 | 1.0 s | No | A | A | No | 58AH | 6-126 |
| N3-04 | High-slip braking OL time | Set the OL time when the output frequency does not change for any reason during deceleration with high-slip braking. | 30 to 1200 | 40 s | No | A | A | No | 58BH | 6-126 |

# ◆ Digital Operator Constants: o

## ■Monitor Select: o1

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| o1-01 | Monitor selection | Set the number of the 3rd. monitor item to be displayed in the Drive Mode. (U1-□□) (Not on LCD operator.) | 4 to 33 | 6 | Yes | A | A | A | 500H | 6-127 |
| o1-02 | Monitor selection after power up | Sets the monitor item to be displayed when the power is turned on.<br>1: Frequency reference<br>2: Output frequency<br>3: Output current<br>4: The monitor item set for o1-01 | 1 to 4 | 1 | Yes | A | A | A | 501H | 6-127 |

| Con-<br>stant<br>Number | Name | Description | Setting<br>Range | Factory<br>Setting | Change<br>during<br>Opera-<br>tion | Control Methods | | | MEMO-<br>BUS<br>Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f<br>with<br>PG | Open<br>Loop | | |
| o1-03 | Frequency units of reference setting and monitor | Sets the units that will be set and displayed for the frequency reference and frequency monitor.<br>0: 0.01 Hz units<br>1: 0.01% units (Maximum output frequency is 100%)<br>2 to 39:<br>rpm units (Set the motor poles.)<br>40 to 39999:<br>User desired display<br>Set the desired values for setting and display for the max. output frequency.<br><br><br>Example: When the max. output frequency value is 200.0, set 12000 | 0 to<br>39999 | 0 | No | A | A | A | 502H | 6-127 |
| o1-05 | LCD-Focus | Sets the brightness on the optional LCD operator (JVOP-160).<br>1: light<br>2:<br>3: normal<br>4:<br>5: dark | 0 to 5 | 3 | Yes | A | A | A | 509H | – |

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## ■Multi-function Selections: o2

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | MEMOBUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| o2-01 | LOCAL/ REMOTE key enable/ disable | Sets the Digital Operator Local/Remote key<br>0: Disabled<br>1: Enabled (Switches between the Digital Operator and the constant settings b1-01, b1-02.) | 0 or 1 | 1 | No | A | A | A | 505H | 6-127 |
| o2-02 | STOP key during control circuit terminal operation | Sets the Stop key in the run mode.<br>0: Disabled (When the run command is issued from an external terminal, the Stop key is disabled.)<br>1: Enabled (Effective even during run.) | 0 or 1 | 1 | No | A | A | A | 506H | 6-127 |
| o2-03 | User constant initial value | Clears or stores user initial values.<br>0: Stores/not set<br>1: Begins storing (Records the set constants as user initial values.)<br>2: All clear (Clears all recorded user initial values)<br>When the set constants are recorded as user initial values, 1110 will be set in A1-03. | 0 to 2 | 0 | No | A | A | A | 507H | 6-127 |
| o2-04 | kVA selection | Do not set unless using a control board from an Inverter with a different capacity. (Refer to *page 5-69* for the setting values). | 0 to FF | 0 | No | A | A | A | 508H | - |
| o2-05 | Frequency reference setting method selection | When the frequency reference is set on the Digital Operator frequency reference monitor, sets whether the Enter key is necessary or not.<br>0: Enter key needed<br>1: Enter key not needed<br>When set to 1, the Inverter accepts the frequency reference without Enter key operation. | 0 or 1 | 0 | No | A | A | A | 509H | 6-127 |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| o2-06 | Operation selection when digital operator is disconnected | Sets the operation when the Digital Operator is disconnected.<br>0: Disabled (Operation continues even if the Digital Operator is disconnected.)<br>1: Enabled (OPR is detected at Digital Operator disconnection. Inverter output is switched off, and fault contact is operated.) | 0 or 1 | 0 | No | A | A | A | 50AH | 6-127 |
| o2-07 | Cumulative operation time setting | Sets the cumulative operation time in hour units.<br>Operation time is calculated from the set values. | 0 to 65535 | 0 hr | No | A | A | A | 50BH | 6-127 |
| o2-08 | Cumulative operation time selection | 0: Cumulative time when the Inverter power is on. (All time while the Inverter power is on is accumulated.)<br>1: Cumulative Inverter run time. (Only Inverter output time is accumulated.) | 0 or 1 | 0 | No | A | A | A | 50CH | 6-127 |
| o2-09 | Initialize Mode | 1: US<br>2: Europe | 1 or 2 | 2 | No | A | A | A | 50DH | 6-127 |
| o2-10 | Fan operation time setting | Set the initial value of the fan operation time.<br>The operation time accumulates from the set value. | 0 to 65535 | 0 hr | No | A | A | A | 50EH | 6-127 |
| o2-12 | Fault trace initialize | 0: Disable<br>1: Initialize (= zero clear) after setting ”1“ o2-12 will be returned to ”0“ | 0 or 1 | 0 | No | A | A | A | 511H | 6-127 |

## ■ Copy Function: o3

User constants for the copy function are shown in the following table.

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| o3-01 | Copy function selection | 0: Normal operation<br>1: READ (Inverter to Operator)<br>2: COPY (Operator to Inverter)<br>3: Verify (compare) | 0 to 3 | 0 | No | A | A | A | 515H | 6-130 |
| o3-02 | Read permission selection | 0: READ prohibited<br>1: READ permitted | 0 or 1 | 0 | No | A | A | A | 516H | 6-130 |

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## ◆ T: Motor Autotuning

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | | MEMO-BUS Register | Page |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop | | |
| T1-00 | Motor 1/2 selection | Sets the location where the autotuned motor constants are to be stored.<br>1: E1 to E2 (motor 1)<br>2: E3 to E4 (motor 2) | 1 or 2 | 1 | No | No | No | A | 700H | 4-10 |
| T1-01 | Autotuning mode selec-tion | Sets the autotuning mode.<br>0: Rotating autotuning<br>1: Non-rotating autotuning<br>2: Non-rotating autotuning for line-to-line resistance only | 0 to 2 *1 | 0 | No | A | A | A | 701H | 4-9<br>4-10 |
| T1-02 | Motor out-put power | Sets the output power of the motor in kilowatts. | 0.00 to 650.00 | 0.40 kW *2 | No | A | A | A | 702H | 4-10 |
| T1-03 | Motor rated voltage | Sets the rated voltage of the motor in volts. | 0 to 255.0*3 | 200.0 V *3 | No | No | No | A | 703H | 4-10 |
| T1-04 | Motor rated current | Sets the rated current of the motor in Amps. | 0.32 to 6.40 *4 | 1.90 A *2 | No | A | A | A | 704H | 4-10 |
| T1-05 | Motor base frequency | Sets the base frequency of the motor in Hertz. | 0 to 400.0*5 | 50.0 Hz | No | No | No | A | 705H | 4-10 |
| T1-06 | Number of motor poles | Sets the number of motor poles. | 2 to 48 poles | 4 poles | No | No | No | A | 706H | 4-10 |
| T1-07 | Motor base speed | Sets the base speed of the motor in r/min. | 0 to 24000 | 1450 r/min | No | No | No | A | 707H | 4-10 |

* 1. Set T1-02 and T1-04 when 2 is set for T1-01. For V/f control or V/f control with PG a set value 2 is possible only.
* 2. The factory setting depends on the Inverter capacity. (The value for a 200 V Class Inverter for 0.4 kW is given.)
* 3. These are values for a 200 V class Inverter. Values for a 400 V class Inverter are double.
* 4. The setting range is from 10% to 200% of the Inverter rated output current. (The value for a 200 V Class Inverter for 0.4 kW is given.)
* 5. The upper setting limit will be 150.0 Hz when C6-01 is set to 0.

## ◆ U: Monitor Constants

### ■ Status Monitor Constants: U1

| Constant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | | MEMO-BUS Register |
|---|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector | |
| U1-01 | Frequency reference | Monitors/sets the frequency reference value.* | 10 V: Max. frequency (0 to ± 10 V possible) | 0.01 Hz | A | A | A | 40H |
| U1-02 | Output frequency | Monitors the output frequency.* | 10 V: Max. frequency (0 to ± 10 V possible) | 0.01 Hz | A | A | A | 41H |
| U1-03 | Output current | Monitors the output current. | 10 V: Inverter rated output current (0 to +10 V, absolute value output) | 0.1 A | A | A | A | 42H |
| U1-04 | Control method | Checks the current control method. | (Cannot be output.) | - | A | A | A | 43H |
| U1-05 | Motor speed | Monitors the detected motor speed.* | 10 V: Max. frequency (0 to ± 10 V possible) | 0.01 Hz | No | A | A | 44H |
| U1-06 | Output voltage | Monitors the output voltage reference value. | 10 V: 200 VAC (400 VAC) (0 to +10 V output) | 0.1 V | A | A | A | 45H |
| U1-07 | DC bus voltage | Monitors the main DC bus voltage. | 10 V: 400 VDC (800 VDC) (0 to +10 V output) | 1 V | A | A | A | 46H |
| U1-08 | Output power | Monitors the output power (internally detected value). | 10 V: Inverter capacity (max. applicable motor capacity) (0 to ± 10 V possible) | 0.1 kW | A | A | A | 47H |
| U1-09 | Torque reference | Monitors the internal torque reference value for open vector control. | 10 V: Motor rated torque (0 to ± 10 V possible) | 0.1% | No | No | A | 48H |

* The unit is set in o1-03 (frequency units of reference setting and monitor).

| Con-stant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | | MEMO-BUS Register |
|---|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector | |
| U1-10 | Input terminal status | Shows input ON/OFF status.<br>U1-10=11111111<br>1: FWD command (S1) is ON<br>1: REV command (S2) is ON<br>1: Multi input 1 (S3) is ON<br>1: Multi input 2 (S4) is ON<br>1: Multi input 3 (S5) is ON<br>1: Multi input 4 (S6) is ON<br>1: Multi input 5 (S7) is ON | (Cannot be output.) | - | A | A | A | 49H |
| U1-11 | Output terminal status | Shows output ON/OFF status.<br>U1-11= o1,,,,111<br>1: Multi-function contact output 1 (M1-M2) is ON<br>1: Multi-function contact output 2 (M3-M4) is ON<br>1: Multi-function contact output 3 (M5-M6) is ON<br>Not used (Always 0).<br>1: Error output (MA/MB-MC) is ON | (Cannot be output.) | - | A | A | A | 4AH |
| U1-12 | Operation status | Inverter operating status.<br>U1-12=11111111<br>Run<br>1: Zero speed<br>1: Reverse<br>1: Reset signal input<br>1: Speed agree<br>1: Inverter ready<br>1: Minor fault<br>1: Major fault | (Cannot be output.) | - | A | A | A | 4BH |
| U1-13 | Cumulative operation time | Monitors the total operating time of the Inverter.<br>The initial value and the operating time/power ON time selection can be set in o2-07 and o2-08. | (Cannot be output.) | 1 hr | A | A | A | 4CH |
| U1-14 | Software No. (flash memory) | (Manufacturer's ID number) | (Cannot be output.) | - | A | A | A | 4DH |
| U1-15 | Terminal A1 input level | Monitors the input level of analog input A1. A value of 100% corresponds to 10V input. | 10 V: 100%<br>(0 to ± 10 V possible) | 0.1% | A | A | A | 4EH |

| Constant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | | MEMO-BUS Register |
|---|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector | |
| U1-16 | Terminal A2 input level | Monitors the input level of analog input A2. A value of 100% corresponds to 10V/ 20mA input. | 10 V/20mA: 100% (0 to ±10 V possible) | 0.1% | A | A | A | 4FH |
| U1-18 | Motor secondary current (Iq) | Monitors the calculated value of the motor secondary current. The motor rated current corresponds to 100%. | 10 V:Motor rated current) (0 to ±10 V output) | 0.1% | A | A | A | 51H |
| U1-19 | Motor exciting current (Id) | Monitors the calculated value of the motor excitation current. The motor rated current corresponds to 100%. | 10 V:Motor rated current) (0 to ±10 V output) | 0.1% | No | No | A | 52H |
| U1-20 | Output frequency after soft-starter (SFS output) | Monitors the frequency reference after the soft starter. This frequency value does not include compensations, such as slip compensation. The unit is set in o1-03. | 10 V: Max. frequency (0 to ± 10 V possible) | 0.01 Hz | A | A | A | 53H |
| U1-21 | ASR input | Monitors the input to the speed control loop. The maximum frequency corresponds to 100%. | 10 V: Max. frequency (0 to ± 10 V possible) | 0.01 % | No | A | No | 54H |
| U1-22 | ASR output | Monitors the output from the speed control loop. The maximum frequency corresponds to 100%. | 10 V:Max. frequency (0 to ± 10 V possible) | 0.01 % | No | A | No | 55H |
| U1-24 | PID feedback value | Monitors the feedback value when PID control is used. | 10 V: 100% feedback value (0 to ± 10 V possible) | 0.01 % | A | A | A | 57H |
| U1-26 | Output voltage reference (Vq) | Monitors the Inverter internal voltage reference for motor secondary current control. | 10 V: 200 VAC (400 VAC) (0 to ± 10 V possible) | 0.1 V | No | No | A | 59H |
| U1-27 | Output voltage reference (Vd) | Monitors the Inverter internal voltage reference for motor excitation current control. | 10 V: 200 VAC (400 VAC) (0 to ± 10 V possible) | 0.1 V | No | No | A | 5AH |
| U1-28 | Software No. (CPU) | (Manufacturer's CPU software No.) | (Cannot be output.) | - | A | A | A | 5BH |
| U1-31 | LED Test | For testing LEDs on operator. If this monitor is selected, all LED's light up (only on LED operator). | (Cannot be output.) | - | A | A | A | 3CH |
| U1-32 | ACR output of q axis | Monitors the current control output value for the motor secondary current. | 10 V: 100% (0 to ± 10 V possible) | 0.1 % | No | No | A | 5FH |
| U1-33 | ACR output of d axis | Monitors the current control output value for the motor excitation current. | 10 V: 100% (0 to ± 10 V possible) | 0.1 % | No | No | A | 60H |
| U1-34 | OPE fault constant | Shows the first constant number when an OPE fault is detected. | (Cannot be output.) | - | A | A | A | 61H |

| Con-stant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | | MEMO-BUS Register |
|---|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector | |
| U1-36 | PID input volume | PID input volume | 10 V: 100% PID input<br>(0 to ± 10 V possible) | 0.01 % | A | A | A | 63H |
| U1-37 | PID output volume | PID control output | 10 V: 100% PID output<br>(0 to ± 10 V possible) | 0.01 % | A | A | A | 64H |
| U1-38 | PID setpoint | PID setpoint | 10 V: 100% PID setpoint | 0.01 % | A | A | A | 65H |
| U1-39 | MEMOBUS communica-tions error code | Shows MEMOBUS errors.<br>U1-39=<br>1: CRC error<br>1: Data length error<br>Not used (always 0)<br>1: Parity error<br>1: Overrun error<br>1: Framing error<br>1: Timeout<br>Not used (always 0) | (Cannot be output.) | - | A | A | A | 66H |
| U1-40 | Cooling fan operating time | Monitors the total operating time of the cooling fan. The time can be set in 02-10. | (Cannot be output.) | 1 hr | A | A | A | 68H |

## ■ Fault Trace: U2

| Constant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | | MEMOBUS Register |
|---|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector | |
| U2-01 | Current fault | The content of the current fault. | (Cannot be output.) | - | A | A | A | 80H |
| U2-02 | Last fault | The error content of the last fault. | | - | A | A | A | 81H |
| U2-03 | Reference frequency at fault | The reference frequency when the last fault occurred. | | 0.01 Hz | A | A | A | 82H |
| U2-04 | Output frequency at fault | The output frequency when the last fault occurred. | | 0.01 Hz | A | A | A | 83H |
| U2-05 | Output current at fault | The output current when the last fault occurred. | | 0.1 A | A | A | A | 84H |
| U2-06 | Motor speed at fault | The motor speed when the last fault occurred. | | 0.01 Hz | No | A | A | 85H |
| U2-07 | Output voltage reference at fault | The output reference voltage when the last fault occurred. | | 0.1 V | A | A | A | 86H |
| U2-08 | DC bus voltage at fault | The main current DC voltage when the last fault occurred. | | 1 V | A | A | A | 87H |
| U2-09 | Output power at fault | The output power when the last fault occurred. | | 0.1 kW | A | A | A | 88H |
| U2-10 | Torque reference at fault | The reference torque when the last fault occurred. The motor rated torque corresponds to 100%. | | 0.1% | No | No | A | 89H |
| U2-11 | Input terminal status at fault | The input terminal status when the last fault occurred.<br>The format is the same as for U1-10. | | - | A | A | A | 8AH |
| U2-12 | Output terminal status at fault | The output terminal status when the last fault occurred. The format is the same as for U1-11. | | - | A | A | A | 8BH |
| U2-13 | Operation status at fault | The operating status when the last fault occurred. The format is the same as for U1-12. | | - | A | A | A | 8CH |
| U2-14 | Cumulative operation time at fault | The operating time when the last fault occurred. | | 1 hr | A | A | A | 8DH |

Note The following errors are not included in the error trace: CPF00, 01, 02, 03, UV1, and UV2.

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## ■Fault History: U3

| Con-stant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | | MEMO-BUS Register |
|---|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vector | |
| U3-01 | Last fault | The error content of 1st last fault. | (Cannot be output.) | - | A | A | A | 90H |
| U3-02 | Second last fault | The error content of 2nd last fault. | | - | A | A | A | 91H |
| U3-03 | Third last fault | The error content of 3rd last fault. | | - | A | A | A | 92H |
| U3-04 | Fourth last fault | The error content of 4th last fault. | | - | A | A | A | 93H |
| U3-05 | Cumulative operation time at fault | The total operating time when the 1st previous fault occurred. | | 1 hr | A | A | A | 94H |
| U3-06 | Accumu-lated time of second fault | The total operating time when the 2nd previous fault occurred. | | 1 hr | A | A | A | 95H |
| U3-07 | Accumu-lated time of third fault | The total operating time when the 3rd previous fault occurred. | | 1 hr | A | A | A | 96H |
| U3-08 | Accumu-lated time of fourth/old-est fault | The total operating time when the 4th previous fault occurred. | | 1 hr | A | A | A | 97H |
| U3-09 – U3-14 | Fifth last to tenth last fault | The error content of the 5th to 10th last fault | | – | A | A | A | 804<br>805H<br>806H<br>807H<br>808H<br>809H |
| U3-15 – U3-20 | Accumu-lated time of fifth to tenth fault | Total generating time when 5th ... 10th pevious fault occured | | 1hr | A | A | A | 806H<br>80FH<br>810H<br>811H<br>812H<br>813H |

Note The following errors are not recorded in the error log: CPF00, 01, 02, 03, UV1, and UV2.

## ◆ Factory Settings that Change with the Control Method (A1-02)

| Constant Number | Name | Setting Range | Unit | Factory Setting | | |
|---|---|---|---|---|---|---|
| | | | | V/f Control A1-02=0 | V/F with PG A1-02=1 | Open Loop Vector A1-02=2 |
| b3-01 | Speed search selection | 0 to 3 | 1 | 2 | 3 | 2 |
| b3-02 | Speed search operating current | 0 to 200 | 1% | 120 | - | 100 |
| C3-01 | Slip compensation gain | 0.0 to 2.5 | 0.1 | 0.0 | - | 1.0 |
| C3-02 | Slip compensation primary delay time constant | 0 to 10000 | 1 ms | 2000 | - | 200 |
| C4-02 | Torque compensation primary delay time constant | 0 to 10000 | 1 ms | 200 | 200 | 20 |
| E1-07<br>E3-05 | Mid. output frequency (FB) | 0.0 to 400.0 | 0.1 Hz | 2.5 *1 | 2.5 *1 | 3.0 |
| E1-08<br>E3-06 | Mid. output frequency voltage (VB)*2 | 0.0 to 255.0<br>(0.0 to 510.0) | 0.1 V | 15.0 *1 | 15.0 *1 | 13.2 |
| E1-09<br>E3-07 | Min. output frequency (FMIN) | 0.0 to 400.0 | 0.1 Hz | 1.2 *1 | 1.2 *1 | 0.5 |
| E1-10<br>E3-08 | Min. output frequency voltage (VMIN)*2 | 0.0 to 255.0<br>(0.0 to 510.0) | 0.1 V | 9.0 *1 | 9.0 *1 | 2.4 |

* 1. Settings vary as shown in the following tables depending on the Inverter capacity and E1-03.

* 2. The settings shown are for 200 V class Inverters. The values will double for 400 V class Inverters.

## ■200 V and 400 V Class Inverters of 0.4 to 1.5 kW

| Constant Number | Unit | Factory Setting | | | | | | | | | | | | | | | | Open Loop Vector Control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E1-03 | - | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F | |
| E1-04 | Hz | 50.0 | 60.0 | 60.0 | 72.0 | 50.0 | 50.0 | 60.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 90.0 | 120.0 | 180.0 | 60.0 | 50.0 |
| E1-05 * | V | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 |
| E1-06 | Hz | 50.0 | 60.0 | 50.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 50.0 |
| E1-07 * | Hz | 2.5 | 3.0 | 3.0 | 3.0 | 25.0 | 25.0 | 30.0 | 30.0 | 2.5 | 2.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| E1-08 * | V | 15.0 | 15.0 | 15.0 | 15.0 | 35.0 | 50.0 | 35.0 | 50.0 | 19.0 | 24.0 | 19.0 | 24.0 | 15.0 | 15.0 | 15.0 | 15.0 | 13.2 |
| E1-09 | Hz | 1.3 | 1.5 | 1.5 | 1.5 | 1.3 | 1.3 | 1.5 | 1.5 | 1.3 | 1.3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.5 |
| E1-10 * | V | 9.0 | 9.0 | 9.0 | 9.0 | 8.0 | 9.0 | 8.0 | 9.0 | 11.0 | 13.0 | 11.0 | 15.0 | 9.0 | 9.0 | 9.0 | 9.0 | 2.4 |

* The settings shown are for 200 V class Inverters. The values will double for 400 V class Inverters.

## ■200 V and 400 V Class Inverters of 2.2 to 45 kW

| Constant Number | Unit | Factory Setting | | | | | | | | | | | | | | | | Open Loop Vector Control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E1-03 | - | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F | |
| E1-04 | Hz | 50.0 | 60.0 | 60.0 | 72.0 | 50.0 | 50.0 | 60.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 90.0 | 120.0 | 180.0 | 60.0 | 50.0 |
| E1-05 * | V | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 |
| E1-06 | Hz | 50.0 | 60.0 | 50.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 50.0 |
| E1-07 * | Hz | 2.5 | 3.0 | 3.0 | 3.0 | 25.0 | 25.0 | 30.0 | 30.0 | 2.5 | 2.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| E1-08 * | V | 14.0 | 14.0 | 14.0 | 14.0 | 35.0 | 50.0 | 35.0 | 50.0 | 18.0 | 23.0 | 18.0 | 23.0 | 14.0 | 14.0 | 14.0 | 14.0 | 13.2 |
| E1-09 | Hz | 1.3 | 1.5 | 1.5 | 1.5 | 1.3 | 1.3 | 1.5 | 1.5 | 1.3 | 1.3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.5 |
| E1-10 * | V | 7.0 | 7.0 | 7.0 | 7.0 | 6.0 | 7.0 | 6.0 | 7.0 | 9.0 | 11.0 | 9.0 | 13.0 | 7.0 | 7.0 | 7.0 | 7.0 | 2.4 |

* The settings shown are for 200 V class Inverters. The values will double for 400 V class Inverters.

## ■200 V Class Inverters of 55 to 110 kW and 400 V Class Inverters of 55 to 300 kW

| Constant Number | Unit | Factory Setting | | | | | | | | | | | | | | | | Open Loop Vector Control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E1-03 | - | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F | |
| E1-04 | Hz | 50.0 | 60.0 | 60.0 | 72.0 | 50.0 | 50.0 | 60.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 90.0 | 120.0 | 180.0 | 60.0 | 50.0 |
| E1-05 * | V | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 | 200.0 |
| E1-06 | Hz | 50.0 | 60.0 | 50.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 50.0 | 50.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 50.0 |
| E1-07 * | Hz | 2.5 | 3.0 | 3.0 | 3.0 | 25.0 | 25.0 | 30.0 | 30.0 | 2.5 | 2.5 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| E1-08 * | V | 12.0 | 12.0 | 12.0 | 12.0 | 35.0 | 50.0 | 35.0 | 50.0 | 15.0 | 20.0 | 15.0 | 20.0 | 12.0 | 12.0 | 12.0 | 12.0 | 13.2 |
| E1-09 | Hz | 1.3 | 1.5 | 1.5 | 1.5 | 1.3 | 1.3 | 1.5 | 1.5 | 1.3 | 1.3 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 0.5 |
| E1-10 * | V | 6.0 | 6.0 | 6.0 | 6.0 | 5.0 | 6.0 | 5.0 | 6.0 | 7.0 | 9.0 | 7.0 | 11.0 | 6.0 | 6.0 | 6.0 | 6.0 | 2.4 |

* The settings shown are for 200 V class Inverters. The values will double for 400 V class Inverters.

## ◆ Factory Settings that Change with the Inverter Capacity (o2-04)

### ■200 V Class Inverters

| Constant Number | Name | Unit | Factory Setting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - | Inverter Capacity | kW | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 |
| o2-04 | kVA selection | - | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| b8-03 | Energy-saving filter time constant | s | 0.50 (Open loop vector control only) | | | | | | | | |
| b8-04 | Energy-saving coefficient | - | 288.20 | 223.70 | 169.40 | 156.80 | 122.90 | 94.75 | 72.69 | 70.44 | 63.13 |
| C6-02 | Carrier frequency selection* | - | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| E2-01 (E4-01) | Motor rated current | A | 1.90 | 3.30 | 6.20 | 8.50 | 14.00 | 19.60 | 26.60 | 39.7 | 53.0 |
| E2-02 (E4-02) | Motor rated slip | Hz | 2.90 | 2.50 | 2.60 | 2.90 | 2.73 | 1.50 | 1.30 | 1.70 | 1.60 |
| E2-03 (E4-03) | Motor no-load current | A | 1.20 | 1.80 | 2.80 | 3.00 | 4.50 | 5.10 | 8.00 | 11.2 | 15.2 |
| E2-05 (E4-05) | Motor line-to-line resistance | Ω | 9.842 | 5.156 | 1.997 | 1.601 | 0.771 | 0.399 | 0.288 | 0.230 | 0.138 |
| E2-06 (E4-06) | Motor leak inductance | % | 18.2 | 13.8 | 18.5 | 18.4 | 19.6 | 18.2 | 15.5 | 19.5 | 17.2 |
| E2-10 | Motor iron loss for torque compensation | W | 14 | 26 | 53 | 77 | 112 | 172 | 262 | 245 | 272 |
| L2-02 | Momentary power loss ridethru time | s | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 1.0 | 1.0 | 1.0 | 2.0 |
| L2-03 | Min. baseblock (BB) time | s | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
| L2-04 | Voltage recovery time | s | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| L8-02 | Overheat pre-alarm level | °C | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 |

Note: Attach a Momentary Power Interruption Compensation Unit if compensation for power interruptions of up to 2.0 seconds is required for 200 V class Inverters with outputs of 0.4 to 11 kW.

* If C6-02 is set to 0, 1, or F and the initial value of C6-03 and C6-04 is 2.0 kHz, the initial settings for C6-02 are as follows: 2: 5.0 kHz, 3: 8.0 kHz, 4: 10 kHz, 5: 12.5 kHz, and 6: 15 kHz. If the carrier frequency is set higher than the factory setting for Inverters with outputs of 30 kW or more, the Inverter rated current will need to be reduced.

| Constant Number | Name | Unit | Factory Setting | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| - | Inverter Capacity | kW | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 |
| o2-04 | kVA selection | - | 9 | A | B | C | D | E | F | 10 | 11 |
| b8-03 | Energy-saving filter time constant | s | 0.50 (Open loop vector control only) | | | | | 2.00 (Open loop vector control only) | | | |
| b8-04 | Energy-saving coefficient | - | 57.87 | 51.79 | 46.27 | 38.16 | 35.78 | 31.35 | 23.10 | 23.10 | 23.10 |
| C6-02 | Carrier frequency selection* | - | 6 | 6 | 4 | 3 | 3 | 3 | 3 | 3 | 1 |
| E2-01 (E4-01) | Motor rated current | A | 65.8 | 77.2 | 105.0 | 131.0 | 160.0 | 190.0 | 260.0 | 260.0 | 260.0 |
| E2-02 (E4-02) | Motor rated slip | Hz | 1.67 | 1.70 | 1.80 | 1.33 | 1.60 | 1.43 | 1.39 | 1.39 | 1.39 |
| E2-03 (E4-03) | Motor no-load current | A | 15.7 | 18.5 | 21.9 | 38.2 | 44.0 | 45.6 | 72.0 | 72.0 | 72.0 |
| E2-05 (E4-05) | Motor line-to-line resistance | Ω | 0.101 | 0.079 | 0.064 | 0.039 | 0.030 | 0.022 | 0.023 | 0.023 | 0.023 |
| E2-06 (E4-06) | Motor leak inductance | % | 20.1 | 19.5 | 20.8 | 18.8 | 20.2 | 20.5 | 20.0 | 20.0 | 20.0 |
| E2-10 | Motor iron loss for torque compensation | W | 505 | 538 | 699 | 823 | 852 | 960 | 1200 | 1200 | 1200 |
| L2-02 | Momentary power loss ridethru time | s | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| L2-03 | Min. baseblock (BB) time | s | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.5 | 1.7 |
| L2-04 | Voltage recovery time | s | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1.0 | 1.0 | 1.0 | 1.0 |
| L8-02 | Overheat pre-alarm level | °C | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 |

Note: Attach a Momentary Power Interruption Compensation Unit if compensation for power interruptions of up to 2.0 seconds is required for 200 V class Inverters with outputs of 0.4 to 11 kW.

* If C6-02 is set to 0, 1, or F and the initial value of C6-03 and C6-04 is 2.0 kHz, the initial settings for C6-02 are as follows: 2: 5.0 kHz, 3: 8.0 kHz, 4: 10 kHz, 5: 12.5 kHz, and 6: 15 kHz. If the carrier frequency is set higher than the factory setting for Inverters with outputs of 30 kW or more, the Inverter rated current will need to be reduced.

## ■400 V Class Inverters

| Constant Number | Name | Unit | Factory Setting | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | Inverter Capacity | kW | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 4.0 | 5.5 | 7.5 | 11 | 15 |
| o2-04 | kVA selection | - | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| b8-03 | Energy-saving filter time constant | s | 0.50 (Open loop vector control only) | | | | | | | | | |
| b8-04 | Energy-saving coefficient | - | 576.40 | 447.40 | 338.80 | 313.60 | 245.80 | 236.44 | 189.50 | 145.38 | 140.88 | 126.26 |
| C6-02 | Carrier frequency selection * | - | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| E2-01 (E4-01) | Motor rated current | A | 1.00 | 1.60 | 3.10 | 4.20 | 7.00 | 7.00 | 9.80 | 13.30 | 19.9 | 26.5 |
| E2-02 (E4-02) | Motor rated slip | Hz | 2.90 | 2.60 | 2.50 | 3.00 | 2.70 | 2.70 | 1.50 | 1.30 | 1.70 | 1.60 |
| E2-03 (E4-03) | Motor no-load current | A | 0.60 | 0.80 | 1.40 | 1.50 | 2.30 | 2.30 | 2.60 | 4.00 | 5.6 | 7.6 |
| E2-05 (E4-05) | Motor line-to-line resistance | Ω | 38.198 | 22.459 | 10.100 | 6.495 | 3.333 | 3.333 | 1.595 | 1.152 | 0.922 | 0.550 |
| E2-06 (E4-06) | Motor leak inductance | % | 18.2 | 14.3 | 18.3 | 18.7 | 19.3 | 19.3 | 18.2 | 15.5 | 19.6 | 17.2 |
| E2-10 | Motor iron loss for torque compensation | W | 14 | 26 | 53 | 77 | 130 | 130 | 193 | 263 | 385 | 440 |
| L2-02 | Momentary power loss ridethru time | s | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.5 | 0.8 | 0.8 | 1.0 | 2.0 |
| L2-03 | Min. baseblock (BB) time | s | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 |
| L2-04 | Voltage recovery time | s | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| L8-02 | Overheat pre-alarm level | °C | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 |

| Constant Number | Name | Unit | Factory Setting | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | Inverter Capacity | kW | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 |
| o2-04 | kVA selection | - | 2A | 2B | 2C | 2D | 2E | 2F | 30 | 31 | 32 | 33 |
| b8-03 | Energy-saving filter time constant | s | 0.50 (Open loop vector control only) | | | | | 2.00 (Open loop vector control only) | | | | |
| b8-04 | Energy-saving coefficient | - | 115.74 | 103.58 | 92.54 | 76.32 | 71.56 | 67.20 | 46.20 | 41.22 | 36.23 | 33.18 |
| C6-02 | Carrier frequency selection * | - | 6 | 6 | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 2 |
| E2-01 (E4-01) | Motor rated current | A | 32.9 | 38.6 | 52.3 | 65.6 | 79.7 | 95.0 | 130.0 | 156.0 | 190.0 | 223.0 |
| E2-02 (E4-02) | Motor rated slip | Hz | 1.67 | 1.70 | 1.80 | 1.33 | 1.60 | 1.46 | 1.39 | 1.40 | 1.40 | 1.38 |
| E2-03 (E4-03) | Motor no-load current | A | 7.8 | 9.2 | 10.9 | 19.1 | 22.0 | 24.0 | 36.0 | 40.0 | 49.0 | 58.0 |
| E2-05 (E4-05) | Motor line-to-line resistance | Ω | 0.403 | 0.316 | 0.269 | 0.155 | 0.122 | 0.088 | 0.092 | 0.056 | 0.046 | 0.035 |
| E2-06 (E4-06) | Motor leak inductance | % | 20.1 | 23.5 | 20.7 | 18.8 | 19.9 | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 |
| E2-10 | Motor iron loss for torque compensation | W | 508 | 586 | 750 | 925 | 1125 | 1260 | 1600 | 1760 | 2150 | 2350 |
| L2-02 | Momentary power loss ridethru time | s | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| L2-03 | Min. baseblock (BB) time | s | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.5 | 1.7 | 1.7 |
| L2-04 | Voltage recovery time | s | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| L8-02 | Overheat pre-alarm level | °C | 95 | 95 | 95 | 95 | 95 | 100 | 95 | 110 | 110 | 110 |

| Constant Number | Name | Unit | Factory Setting | | | |
|---|---|---|---|---|---|---|
| - | Inverter Capacity | kW | 160 | 185 | 220 | 300 |
| o2-04 | kVA selection | - | 34 | 35 | 36 | 37 |
| b8-03 | Energy-saving filter time constant | s | 2.00 (Open loop vector control only) | | | |
| b8-04 | Energy-saving coefficient | - | 30.13 | 30.57 | 27.13 | 21.76 |
| C6-02 | Carrier frequency selection * | - | 2 | 2 | 1 | 1 |
| E2-01 (E4-01) | Motor rated current | A | 270.0 | 310.0 | 370.0 | 500.0 |
| E2-02 (E4-02) | Motor rated slip | Hz | 1.35 | 1.30 | 1.30 | 1.25 |
| E2-03 (E4-03) | Motor no-load current | A | 70.0 | 81.0 | 96.0 | 130.0 |
| E2-05 (E4-05) | Motor line-to-line resistance | Ω | 0.029 | 0.025 | 0.020 | 0.014 |
| E2-06 (E4-06) | Motor leak inductance | % | 20.0 | 20.0 | 20.0 | 20.0 |
| E2-10 | Motor iron loss for torque compensation | W | 2850 | 3200 | 3700 | 4700 |
| L2-02 | Momentary power loss ridethru time | s | 2.0 | 2.0 | 2.0 | 2.0 |
| L2-03 | Min. baseblock (BB) time | s | 1.8 | 1.9 | 2.0 | 2.1 |
| L2-04 | Voltage recovery time | s | 1.0 | 1.0 | 1.0 | 1.0 |
| L8-02 | Overheat pre-alarm level | °C | 100 | 95 | 95 | 95 |

Note Attach a Momentary Power Interruption Compensation Unit if compensation for power interruptions of up to 2.0 seconds is required for 200 V class Inverters with outputs of 0.4 to 11 kW.

* If C6-02 is set to 0, 1, or F and the initial value of C6-03 and C6-04 is 2.0 kHz, the initial settings for C6-02 are as follows: 2: 5.0 kHz, 3: 8.0 kHz, 4: 10 kHz, 5: 12.5 kHz, and 6: 15 kHz. If the carrier frequency is set higher than the factory setting for Inverters with outputs of 30 kW or more, the Inverter rated current will need to be reduced.

# 6

# Constant Settings by Function


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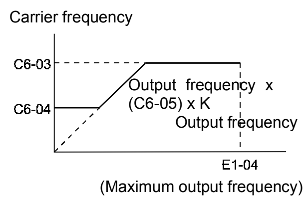
# Application and Overload Selections

## ◆ Select the Overload to Suit the Application

Set C6-01 (Heavy Duty: Low carrier, constant torque, Normal Duty: High carrier, variable torque) depending on the application for which the Inverter is used. The setting ranges for the Inverter carrier frequency, overload tolerance, and maximum output frequency depend on the setting of C6-01. For applications like fans and blowers (quadratic torque characteristic) set C6-01 to 1 (Normal Duty).  For applications with a constant torque characteristic set C6-01 to 0 (Heavy Duty).

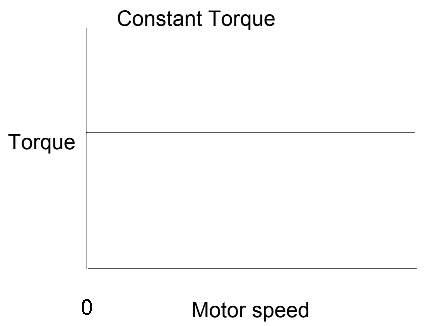
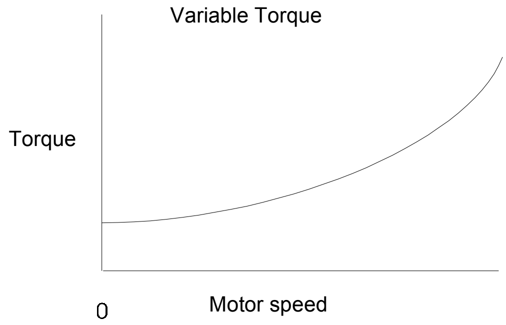
### ■Related Constants

| Con-stant No. | Name | Details | Setting Range | Factory Setting | Changes During Opera-tion? | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop vector |
|---|---|---|---|---|---|---|---|---|
| C6-01 | Heavy/Normal Duty selection | 0: Heavy Duty (low carrier, constant torque, 150% current overload for 1 min.)<br>1: Normal Duty (high carrier, variable torque, 120% current overload for 1 min.) | 0 or 1 | 1 | No | Q | Q | Q |
| C6-02 | Carrier frequency selection | Selects the carrier frequency.<br>Select F to enable detailed settings using constants C6-03 to C6-05. | 0 to F | 6*2 | No | Q | Q | Q |
| C6-03 | Carrier frequency upper limit | Sets the upper and lower carrier frequency limits in kHz.<br>Set the carrier wave gain as shown below.<br>In vector control method, the carrier frequency is fixed according to C6-03 (Carrier Frequency Upper Limit). | 2.0 to 15.0 *3 *4 | 15.0 kHz *1 | No | A | A | A |
| C6-04 | Carrier frequency lower limit |  | 0.4 to 15.0 *3 *4 | 15.0 kHz *2 | No | A | A | No |
| C6-05 | Carrier frequency proportional gain | K is the coefficient determined by the set value in C6-03.<br>C6-03 ≥ 10.0 kHz: K = 3<br>10.0 kHz > C6-03 ≥ 5.0 kHz : K = 2<br>5.0 kHz > C6-03: K = 1 | 00 to 99 *4 | 00 | No | A | A | No |

* 1. On 200V class inverters with 110 kW and 400V class inverters with 220 kW and 300 kW the setting is fixed to 1. It cannot be changed to 0.
* 2. The factory settings depend on the Inverter capacity.
* 3. The setting ranges depend on the Inverter capacity.
* 4. Can be set and referenced only when C6-01 is set to 1, and C6-02 is set to F.

## ■Difference Between Heavy Duty and Normal Duty

The characteristics of Heavy Duty (low carrier, constant torque) and Normal Duty (high carrier, variable torque) are shown below.

| Heavy Duty: Low Carrier, Constant Torque | Normal Duty: High Carrier, Variable Torque |
|---|---|
|  |  |
| Constant torque means a constant load torque for all motor speed. Typical applications are pushers, conveyors, cranes, and other high friction or heavy loads. These applications may require overload capability. | Variable torque means that the load torque will decrease as the speed decreases. Typical applications are fans and pumps. Normally not much overload capability is required. |
| Low carrier: High audible noise is present. | High carrier: Almost no audible noise. |

## ■Setting Precautions

### C6-01 (Heavy/Normal Duty Selection)

When setting C6-01, observe the following precautions.

- Depending on the set value in C6-01, the setting range of the related constants is limited as follows:

| C6-01 Set Value | 0 (Low Carrier, Constant Torque) *1 | 1 (High Carrier, Variable Torque) |
|---|---|---|
| Inverter Overload Protection Level | 150% Inverter rated current/1 min. | 120% Inverter rated current/1 min. |
| C6-02 (Carrier Frequency Selection) | 0: Low carrier, low noise<br>1: Carrier 2 kHz | 0: Low carrier low noise<br>1: Carrier 2 kHz<br>2: Carrier 5 kHz<br>3: Carrier 8.0 kHz<br>4: Carrier 10.0 kHz<br>5: Carrier 12.5 kHz<br>6: Carrier 15 kHz<br>F: User-set*2 |
| E1-04 and E3-02 (Max. Output Frequency) | 150 Hz | 400 Hz |
| L3-02 (Stall Prevention Level During Acceleration) | 150% | 120% |
| L3-06 (Stall Prevention Level During Operation) | 150% | 120% |

* 1. C6-01 can not be set to 0 at 200V class inverters with 110 kW and 400V class inverters with 220 kW and 300 kW.
* 2. Factory settings depend on Inverter capacity.

- When C6-01 is set to 0 for E1-04 or E3-02 no value higher than 150 Hz will be accepted.

6

### Carrier Frequency

When selecting the carrier frequency, observe the following precautions:

- When using a device with C6-01 set to 1 (Normal Duty), adjust the carrier frequency according to the cases shown below.
  If the wiring distance between Inverter and motor is long: Set the carrier frequency low. (Use the following values as guidelines.

| Wiring Length | 50 m or less | 100 m or less | Over 100 m |
|---|---|---|---|
| C6-02 (carrier frequency) setting | 0 to 6 (15 kHz) | 0 to 4 (10 kHz) | 0 to 2 (5 kHz) |

  If speed and torque vary at low speeds: Set the carrier frequency low.
  If Inverter noise is affecting peripheral devices: Set the carrier frequency low.
  If leakage current from the Inverter is large: Set the carrier frequency low.
  If metallic noise from the motor is large: Set the carrier frequency high.

- When using V/f control or V/f control with PG, you can vary the carrier frequency to match the output frequency, as shown in the following diagram, by setting C6-03 (Carrier Frequency Upper Limit), C6-04 (Carrier Frequency Lower Limit), and C6-05 (Carrier Frequency Proportional Gain).

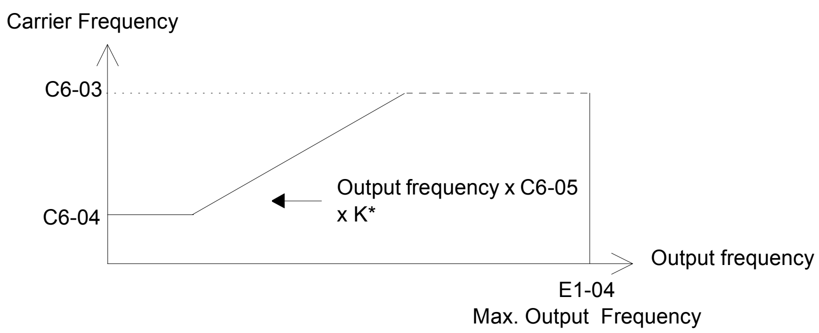



Fig 6.1

*K is the coefficient determined by the set value in C6-03.
C6-03 ≥ 10.0 kHz: K=3
10.0 kHz > C6-03 ≥ 5.0 kHz: K=2
5.0 kHz > C6-03: K=1

- With vector control, the carrier frequency is fixed by the Carrier Frequency Upper Limit in C6-03 if user-set, or by the carrier frequency set in C6-02.
- To fix the carrier frequency, set C6-03 and C6-04 to the same value, or set C6-05 to 0.
- If the settings are as shown below, OPE11 (Data setting error) will occur.

If Carrier Frequency Proportional Gain (C6-05) > 6 and C6-03 < C6-04.

If C6-01 = 0 and Carrier Frequency Selection C6-02 is set from 2 to E.

If C6-01 = 1 and Carrier Frequency Selection C6-02 is set from 7 to E.

## ■Carrier Frequency and Inverter Overload Current Level

The inverter overload capability depends among other things on the carrier frequency setting. If the carrier frequency setting is higher than the factory setting, the overload current capability must be reduced as shown in the tables below.

| Inverter Type | Initial carrier frequency setting | Maximum carrier frequency setting | Current derating % |
|---|---|---|---|
| 20P4 | 6 (15 kHz) | 6 (15 kHz) | – |
| 20P7 | 6 (15 kHz) | 6 (15 kHz) | – |
| 21P5 | 6 (15 kHz) | 6 (15 kHz) | – |
| 22P2 | 6 (15 kHz) | 6 (15 kHz) | – |
| 23P7 | 6 (15 kHz) | 6 (15 kHz) | – |
| 25P5 | 6 (15 kHz) | 6 (15 kHz) | – |
| 27P5 | 6 (15 kHz) | 6 (15 kHz) | – |
| 2011 | 6 (15 kHz) | 6 (15 kHz) | – |
| 2015 | 6 (15 kHz) | 6 (15 kHz) | – |
| 2018 | 6 (15 kHz) | 6 (15 kHz) | – |
| 2022 | 6 (15 kHz) | 6 (15 kHz) | – |
| 2030 | 4 (10 kHz) | 6 (15 kHz) | 80 % |
| 2037 | 3 (8 kHz) | 4 (10 kHz) | 80 % |
| 2045 | 3 (8 kHz) | 4 (10 kHz) | 80 % |
| 2055 | 3 (8 kHz) | 4 (10 kHz) | 80 % |
| 2075 | 3 (5 kHz) | 4 (10 kHz) | – |
| 2090 | 3 (5 kHz) | 4 (10 kHz) | – |
| 2110 | 1 (2 kHz) | 1 (2 kHz) | – |

| | | | |
|---|---|---|---|
| 40P4 | 6 (15 kHz) | 6 (15 kHz) | – |
| 40P7 | 6 (15 kHz) | 6 (15 kHz) | – |
| 41P5 | 6 (15 kHz) | 6 (15 kHz) | – |
| 42P2 | 6 (15 kHz) | 6 (15 kHz) | – |
| 43P7 | 6 (15 kHz) | 6 (15 kHz) | – |
| 44P0 | 6 (15 kHz) | 6 (15 kHz) | – |
| 45P7 | 6 (15 kHz) | 6 (15 kHz) | – |
| 47P5 | 6 (15 kHz) | 6 (15 kHz) | – |
| 4011 | 6 (15 kHz) | 6 (15 kHz) | – |
| 4015 | 6 (15 kHz) | 6 (15 kHz) | – |
| 4018 | 6 (15 kHz) | 6 (15 kHz) | – |
| 4022 | 6 (15 kHz) | 6 (15 kHz) | – |
| 4030 | 4 (10 kHz) | 6 (15 kHz) | 80 % |
| 4037 | 4 (10 kHz) | 6 (15 kHz) | 80 % |
| 4045 | 4 (10 kHz) | 6 (15 kHz) | 80 % |
| 4055 | 4 (10 kHz) | 6 (15 kHz) | 80 % |
| 4075 | 3 (8 kHz) | 4 (10 kHz) | 80 % |
| 4090 | 3 (8 kHz) | 4 (10 kHz) | 80 % |
| 4110 | 3 (8 kHz) | 4 (10 kHz) | 80 % |
| 4132 | 2 (5 kHz) | 4 (10 kHz) | 75 % |
| 4160 | 2 (5 kHz) | 4 (10 kHz) | 80 % |
| 4185 | 2 (5 kHz) | – | – |
| 4220 | 1 (2.5 kHz) | – | – |
| 4300 | 1 (2.5 kHz) | – | – |

# Frequency Reference

This section explains how to input the frequency reference.

## ◆ Selecting the Frequency Reference Source

Set constant b1-01 to select the frequency reference source.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b1-01 | Reference selection | Set the frequency reference source<br>0: Digital Operator<br>1: Control circuit terminal (analog input)<br>2: MEMOBUS communications<br>3: Option Card<br>4: Pulse train input | 0 to 4 | 1 | No | Q | Q | Q |
| H6-01 | Pulse train input function selection | 0: Frequency reference<br>1: PID feedback value<br>2: PID target value | 0 to 2 | 0 | No | A | A | A |
| H6-02 | Pulse train input scaling | Set the number of pulses that is equal to 100% of the input item selected in H6-01. | 1000 to 32000 | 1440 Hz | Yes | A | A | A |

### ■Input the Frequency Reference from the Digital Operator

When b1-01 is set to 0, you can input the frequency reference from the Digital Operator.

For details on setting the frequency reference, refer to *Chapter 3 Digital Operator and Modes*.

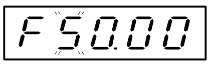



Fig 6.2 Frequency Setting Display

## ■Inputting the Frequency Reference Using Voltage (Analog Setting)

When b1-01 is set to 1, you can input the frequency reference from control circuit terminal A1 (voltage input), or control circuit terminal A2 (voltage or current input).

### Inputting Master Speed Frequency Reference Only

If inputting the master speed frequency reference only, input the voltage reference to control circuit terminal A1.

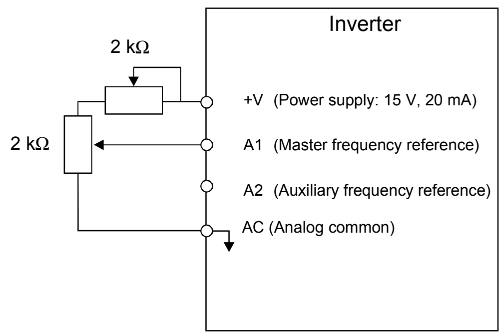



Fig 6.3 Master Speed Frequency Reference Input

### 2-Step Switching: Master/Auxiliary

If performing 2-step switching between master and auxiliary speed frequencies, input the master speed frequency reference to control circuit terminal A1, and input the auxiliary speed frequency reference to A2.

When terminal S3 (multi-step speed command 1) is OFF, terminal A1 input (master speed frequency reference) will be the Inverter frequency reference, and when terminal S3 is ON, terminal A2 input (auxiliary speed frequency reference) will be the Inverter frequency reference.

6

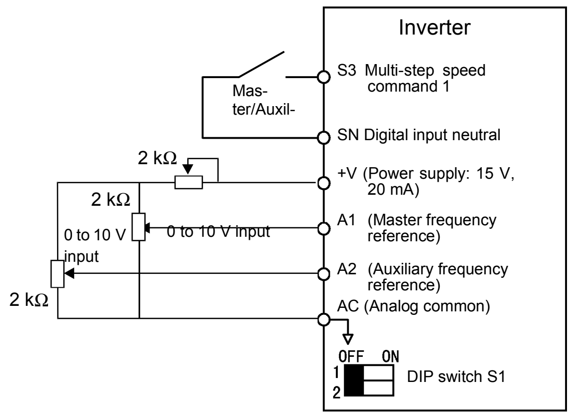



Fig 6.4 Master/Auxiliary Frequency Reference Input

### Setting Precautions

When inputting a voltage signal to terminal A2, turn OFF pin 2 on DIP switch S1 to switch to voltage input (factory setting is ON).

## ■Inputting Frequency Reference Using Current

When b1-01 is set to 1, the frequency reference can be input from control circuit terminal A2. Input the current (4 to 20 mA) in control circuit terminal A2.

When H3-09 (Multi-Function analog input terminal A2 function selection) is set to 0 (factory setting) the input on A2 is added to A1.

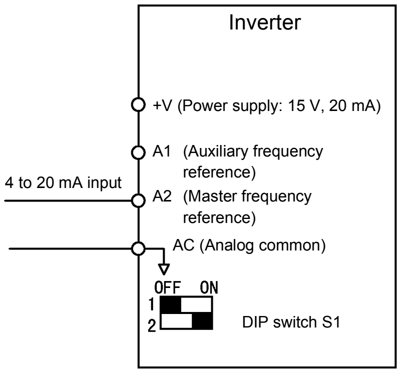



Fig 6.5  Frequency Reference Using Current

### Setting Precautions

- When inputting a current signal to terminal A2, turn ON pin 2 on DIP switch S1 (factory setting: ON).
- If using terminal A2 to input the master speed reference and terminal A1 to input the auxiliary frequency reference, set H3-13 (Terminal A1/A2 Switching) to 1.

## ■Setting Frequency Reference Using Pulse Train Signals

When b1-01 is set to 4, the pulse train input to control circuit terminal RP input is used as the frequency reference.

Set H6-01 (PulseTrain Input Function Selection) to 0 (frequency reference), and then set the reference pulse frequency that is equal to 100% of the reference value to H6-02 (Pulse Train Input Scaling).

| Pulse Input Specifications | |
|---|---|
| Low level voltage | 0.0 to 0.8 V |
| High level voltage | 3.5 to 13.2 V |
| Pulse duty factor | 30 to 70% |
| Pulse frequency | 0 to 32 kHz |

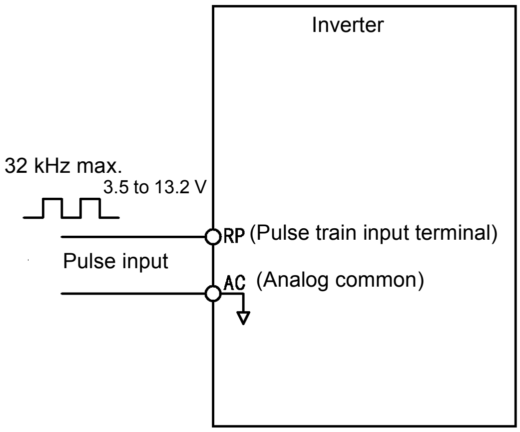



Fig 6.6  Frequency Reference Using Pulse Train Input

## ◆ Using Multi-Step Speed Operation

With Varispeed-F7 series Inverters, you can change the speed to a maximum of 17 steps, using 16 multi-step frequency references, and one jog frequency reference.

The following example of a multi-function input terminal function shows a 9-step operation using multi-step references 1 to 3 and jog frequency selection functions.

### ■Related Constants

To switch frequency references, set multi-step references 1 to 3 and the jog reference selection in the multi-function contact inputs.

#### Multi-function Contact Inputs (H1-01 to H1-05)

| Terminal | Constant Number | Set Value | Details |
|---|---|---|---|
| S4 | H1-02 | 3 | Multi-step speed command 1 (Also used for master speed/auxiliary speed switching when multi-function analog input H3-09 is set to 2 (auxiliary frequency reference).) |
| S5 | H1-03 | 4 | Multi-step speed command 2 |
| S6 | H1-04 | 5 | Multi-step speed command 3 |
| S7 | H1-05 | 6 | Jog frequency selection (given priority over multi-step speed command) |

#### Combining Multi-Step Speed References and Multi-Function Contact Inputs

You can change the selected frequency reference by combining the ON/OFF status of S4 to S7 (multi-function contact input terminals) . The following table shows the possible combinations.

| Speed | TerminalS4 | TerminalS5 | TerminalS6 | TerminalS7 | Selected Frequency |
|---|---|---|---|---|---|
| | Multi-step Speed Command 1 | Multi-step Speed Command 2 | Multi-step Speed Command 3 | Jog Frequency Selection | |
| 1 | OFF | OFF | OFF | OFF | Frequency reference 1 d1-01, master speed frequency |
| 2 | ON | OFF | OFF | OFF | Frequency reference 2 d1-02, auxiliary frequency |
| 3 | OFF | ON | OFF | OFF | Frequency reference 3 d1-03 |
| 4 | ON | ON | OFF | OFF | Frequency reference 4 d1-04 |
| 5 | OFF | OFF | ON | OFF | Frequency reference 5 d1-05 |
| 6 | ON | OFF | ON | OFF | Frequency reference 6 d1-06 |
| 7 | OFF | ON | ON | OFF | Frequency reference 7 d1-07 |
| 8 | ON | ON | ON | OFF | Frequency reference 8 d1-08 |
| 17 | - | - | - | ON* | Jog frequency d1-17 |

* Terminal S7's jog frequency selection is given priority over multi-step speed commands.

**Setting Precautions**

When setting analog inputs to step 1 and step 2, observe the following precautions.

- When setting terminal A1's analog input to step 1 set b1-01 to 1, when setting d1-01 (Frequency Reference 1) to step 1 set b1-01 to 0.
- When setting terminal A2's analog input to step 2 set H3-09 to 2 (auxiliary frequency reference). When setting d1-02 (Frequency Reference 2) to step 2 set H3-09 to 1F (do not use analog inputs).

## ■Connection Example and Time Chart

The following diagram shows a time chart and control circuit terminal connection example during a 9-step operation.

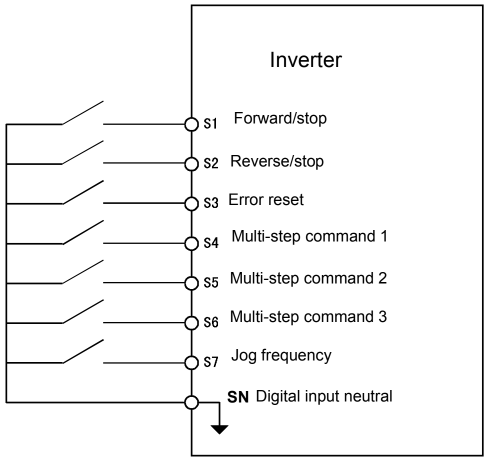



Fig 6.7 Control Circuit Terminal During 9-step Operation

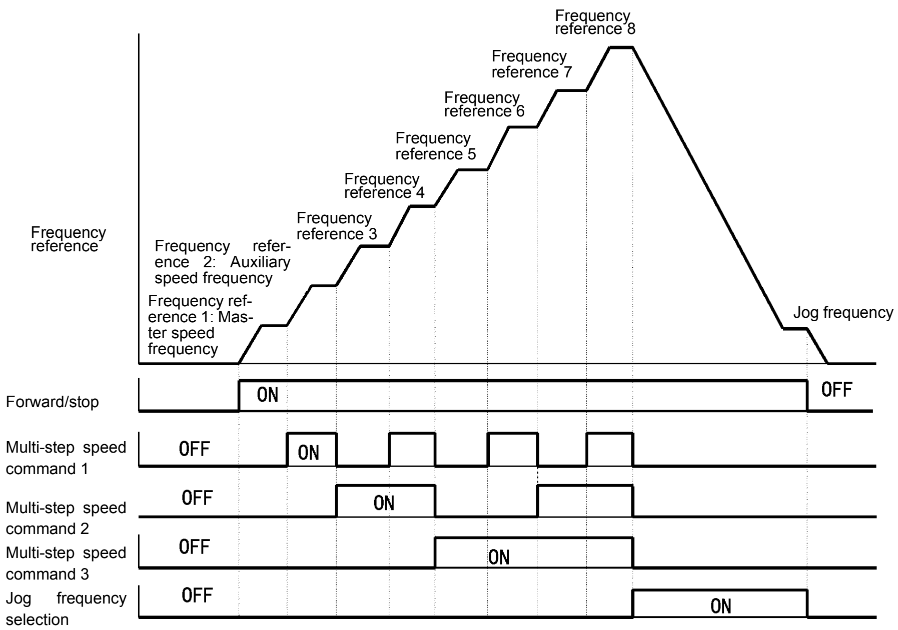



Fig 6.8 Multi-step speed command/Jog Frequency Selection Time Chart

Note:

- The multifunction input setting “Multistep Speed Reference 4” (32) has to be used for selecting the frequency references from d1-09 to d1-16.
- The multifunction input setting “Jog Frequency 2” (69) can be used for jog frequency selection when a 3-wire control is used for the control circuit. If it is selected while the inverter is initialized to 2-wire control an OPE03 error will be displayed.

# Run Command

This section explains input methods for the run command.

## ◆ Selecting the Run Command Source

Set constant b1-02 to select the source for the run command.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| b1-02 | Operation method selec-tion | Set the run command source.<br>0: Digital operator<br>1: Control circuit terminal (digital multifunction inputs)<br>2: MEMOBUS communications<br>3: Option Card | 0 to 3 | 1 | No | Q | Q | Q |

### ■Performing Operations Using a Digital Operator

When b1-02 is set to 0, you can perform Inverter operations using the Digital Operator keys (RUN, STOP, and FWD/REV). For details on the Digital Operator, refer to *Chapter 3 Digital Operator and Modes*.

### ■Performing Operations Using Control Circuit Terminals

When b1-02 is set to 1, you can perform Inverter operations using the control circuit terminals.

#### Performing Operations Using a 2-wire Control

The factory setting is set to a 2-wire control. When control circuit terminal S1 is set to ON, forward operation will be performed, and when S1 is turned OFF, the Inverter will stop. In the same way, when control circuit terminal S2 is set to ON, reverse operation will be performed, and when S2 is turned OFF, the Inverter will stop.

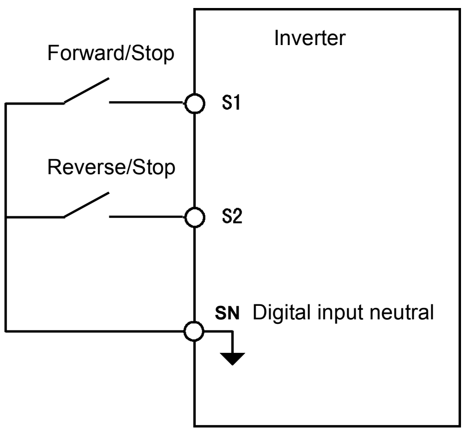



Fig 6.9 2-Wire Control Wiring Example with Positive Logic

### Performing Operations Using 3-Wire Control

When any constant from H1-01 to H1-05 (multi-function contact input terminals S3 to S7) is set to 0, terminals S1 and S2 are used for a 3-wire control, and the multi-function input terminal that has been set to 0 works as a forward/reverse selection command terminal.

When the Inverter is initialized for 3-wire control with A1-03, multi-function input 3 becomes the input terminal for the forward/reverse run command.

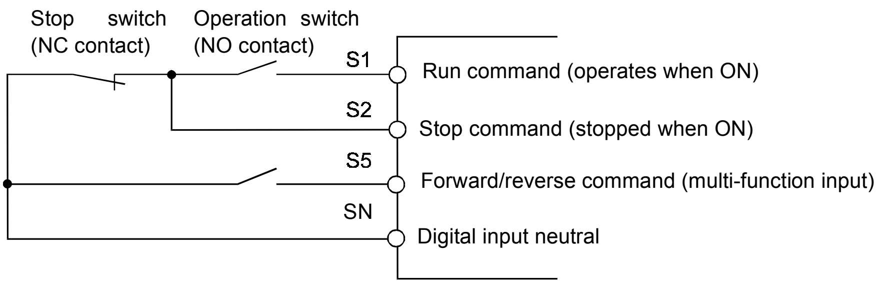



Fig 6.10 3-Wire Control Wiring Example

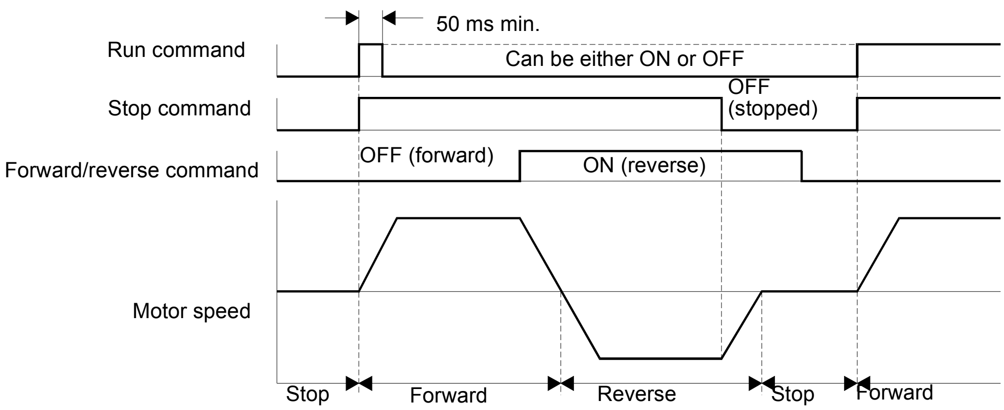



Fig 6.11 Three-wire Control Time Chart

**INFO**

Use a control circuit that turns ON terminal S1 for 50 ms or longer for the run command. This will make the run command self-holding in the Inverter.

# Stopping Methods

This section explains methods of stopping the Inverter.

## ◆ Selecting the Stopping Method when a Stop Command is Input

There are four methods of stopping the Inverter when a stop command is input:

- Deceleration to stop
- Coast to stop
- DC braking stop
- Coast to stop with timer

Set constant b1-03 to select the Inverter stopping method.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b1-03 | Stopping method selection | Select stopping method when stop command is given.<br>0: Deceleration to stop<br>1: Coast to stop<br>2: DC braking stop (Stops faster than coast to stop, without regenerative operation.)<br>3: Coast to stop with timer (Run commands are ignored during deceleration time.) | 0 to 3 | 0 | No | Q | Q | Q |
| b2-01 | Zero speed level (DC injection braking starting frequency) | Set the frequency at which the DC injection braking starts in units of Hz when b1-03 is set to 0 (deceleration to stop).<br>DC injection braking starts from E1-09 when b2-01 < E1-09. | 0.0 to 10.0 | 0.5 Hz | No | A | A | A |
| b2-02 | DC injection braking current | Set the DC injection braking current as a percentage, taking the Inverter rated current as 100%. | 0 to 100 | 50% | No | A | A | A |
| b2-04 | DC injection braking time at stop | Set the DC injection braking time at stop.<br>Use when stopping if rotations continue due to the machines inertia.<br>Set to 0.00 to disable DC injection braking time at stop. | 0.00 to 10.00 | 0.50 s | No | A | A | A |

6

## ■Deceleration to Stop

If the stop command is input (i.e., the run command is turned OFF) when b1-03 is set to 0, the motor decelerates to stop according to the deceleration time that has been set. (Factory setting: C1-02 (Deceleration Time 1))

If the output frequency when decelerating to stop falls below b2-01, the DC injection brake will be applied using the DC current set in b2-02 for the time set in b2-04.

For deceleration time settings, refer to *page 6-19* *Setting Acceleration and Deceleration Times*.

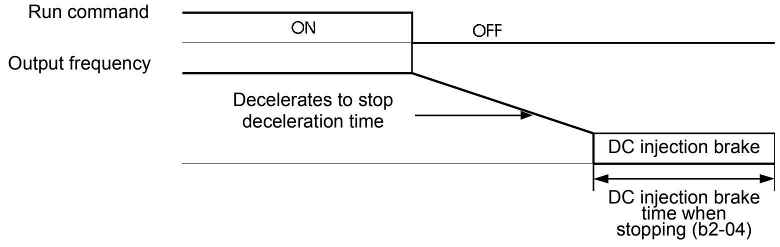



Fig 6.12  Deceleration to Stop

## ■Coast to Stop

If the stop command is input (i.e., the run command is turned OFF) when b1-03 is set to 1, the Inverter output voltage is switched off. The motor coasts to stop.

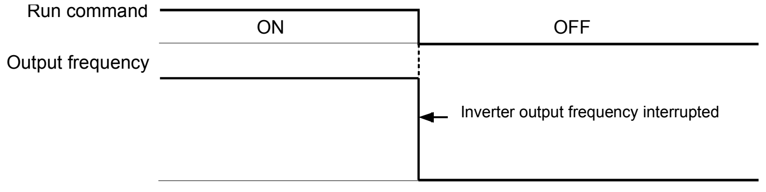



Fig 6.13  Coast to Stop

INFO

After the stop command is input, run commands are ignored until the Minimum Baseblock Time (L2-03) has elapsed.

## ■DC Braking Stop

After the stop command is input and the minimum baseblock time (L2-03) has elapsed, DC injection will be applied to the motor. The applied DC injection current is programmed in parameter b2-02. The DC injection brake time depends on the set value of b2-04 and on the output frequency at the moment the stop command is input.

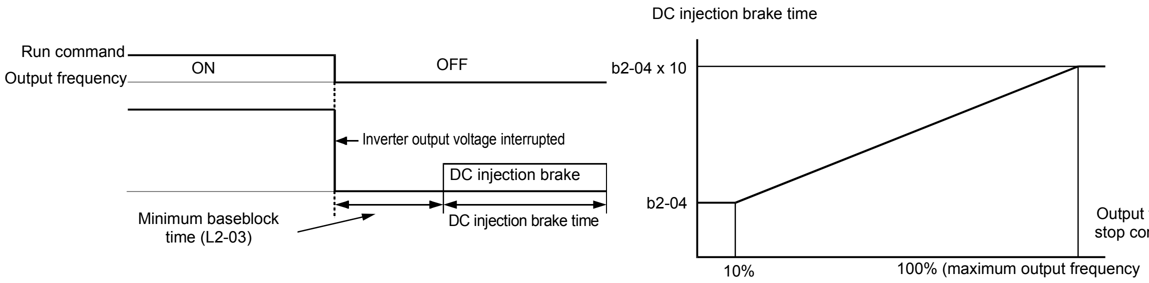



Fig 6.14 DC Injection Braking Stop

INFO

Lengthen the Minimum Baseblock Time (L2-03) when an overcurrent (OC) occurs during stopping.

## ■Coast to Stop with Timer

If the stop command is input (i.e., the run command is turned OFF) when b1-03 is set to 3, the Inverter output is switched off so that the motor coasts to stop. After the stop command is input, run commands are ignored until the time T has elapsed. The time T depends on the output frequency when the stop command is input and on the deceleration time.

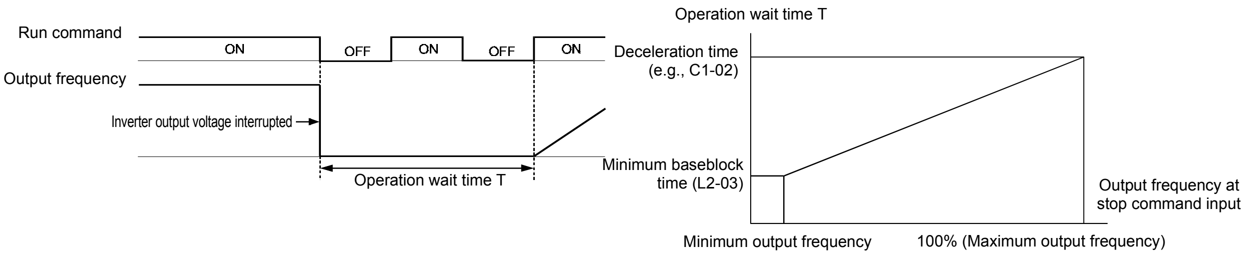



Fig 6.15 Coast to Stop with Timer

## ◆ Using the DC Injection Brake

Set constant b2-03 to apply DC injection to the motor, before it starts to accelerate. Applying DC injection at start will stop the motor before starting if it was coasting through inertia or wind mill effect.

Set b2-03 to 0 to disable the DC injection brake at start.

Set constant b2-04 to apply a DC injection brake to the motor at stopping. It prevents the motor from coasting when it would not be stopped completely using the normal deceleration. This can occur if the inertia is very high. The DC injection brake can be disabled by setting b2-04 to 0.

Set the DC injection brake current using b2-02.

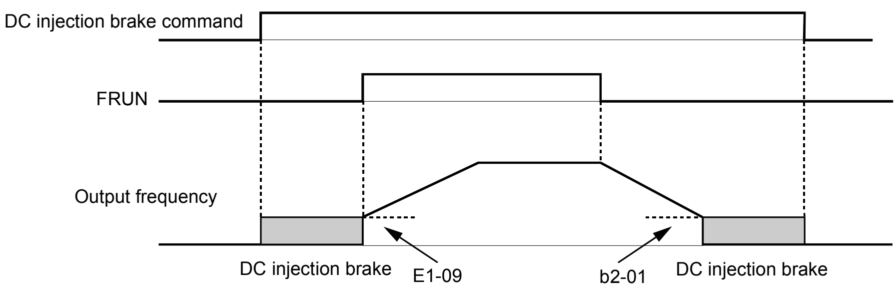
### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b2-01 | Zero speed level (DC injection braking starting frequency) | Used to set the frequency at which DC injection braking starts in units of Hz when b1-03 is set to 0 (deceleration to stop).<br>When b2-01 is less than E1-09, E1-09 becomes the DC injection braking starting frequency. | 0.0 to 10.0 | 0.5 Hz | No | A | A | A |
| b2-02 | DC injection braking current | Set the DC Injection Braking Current as a percentage of the Inverter rated current. | 0 to 100 | 50% | No | A | A | A |
| b2-03 | DC injection braking time at start | Used to set the time to perform DC injection braking at start.<br>Used to stop coasting motor and restart it. When the set value is 0, DC injection braking at start is not performed. | 0.00 to 10.00 | 0.00 s | No | A | A | A |
| b2-04 | DC injection braking time at stop | Used to set the time to perform DC injection braking at stop in units of 1 second. Used to prevent coasting after the stop command is input. When the set value is 0.00, DC injection braking at stop is not performed. | 0.00 to 10.0 | 0.50 s | No | A | A | A |

### ■Inputting the DC Injection Brake Command from Control Circuit Terminals

If you set a multi-function contact input terminal (H1-□□) to 60 (DC injection brake command), you can apply the DC injection brake to the motor by turning ON this terminal.

The time chart for the DC injection brake is shown below.




If you input the DC injection brake command from an external terminal, and if a run command or jog command is input, the DC injection brake will be disabled, and operation will resume.

Fig 6.16 DC Injection Brake Time Chart

## ■Changing the DC Injection Brake Current Using an Analog Input

If you set H3-09 (Multi-function Analog Input Terminal A2 Function Selection) to 6 (DC injection brake current), you can change the DC injection brake current level using the analog input.

At 10 V input (voltage) or 20 mA input (current), 100% of the Inverter rated current will be applied.

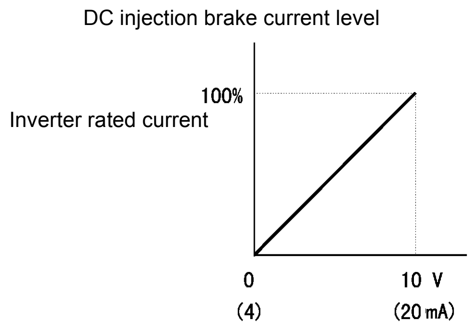



Fig 6.17 DC Injection Brake Current Using an Analog Input

# ◆ Using an Emergency Stop

Set a multi-function input terminal (H1-☐☐) to 15 or 17 (emergency stop) to decelerate to stop using the deceleration time set in C1-09. If inputting the emergency stop with an NO contact, set the multi-function input terminal (H1-☐☐) to 15, and if inputting the emergency stop with an NC contact, set the multi-function input terminal (H1-☐☐) to 17.

After the emergency stop command has been input, operation cannot be restarted until the Inverter has stopped. To cancel the emergency stop, turn OFF the run command and emergency stop command.



## ■Related parameters

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| C1-09 | Emergency stop time | Sets the deceleration time when the multi-function input "Emergency (fast) stop" is ON.<br>This time will be used when a fault is detected, for which emergency stop was programmed as stopping method. | 0.0 to 6000.0* | 10.0 s | No | A | A | A |

* The acceleration and deceleration settings range varies depending on the setting in C1-10. When C1-10 is set to 0, the acceleration/deceleration settings range is 0.00 to 600.00 (seconds).

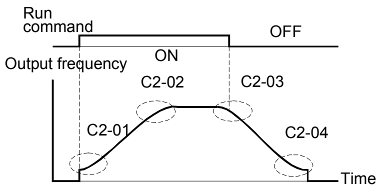
# Acceleration and Deceleration Characteristics

This section explains the acceleration and deceleration characteristics of the Inverter.

## ◆ Setting Acceleration and Deceleration Times

Acceleration time indicates the time to increase the output frequency from 0% to 100% of the maximum output frequency (E1-04). Deceleration time indicates the time to decrease the output frequency from 100% to 0% of (E1-04). The accel./decel. times 1 are used with the factory setting, the accel./decel. times 2 to 4 can be selected using a multifunction input.

### ■Related Parameters

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| C1-01 | Acceleration time 1 | Sets the acceleration time to accelerate from 0 to the maximum output frequency. | | | Yes | Q | Q | Q |
| C1-02 | Deceleration time 1 | Sets the deceleration time in seconds for the output frequency to fall from 100% to 0%. | | | Yes | Q | Q | Q |
| C1-03 | Acceleration time 2 | Sets the acceleration time when multi-function input "Acceleration/deceleration time selection 1" is ON. | | | Yes | A | A | A |
| C1-04 | Deceleration time 2 | Sets the deceleration time when multi-function input "Acceleration/deceleration time selection 1" is ON. | | | Yes | A | A | A |
| C1-05 | Acceleration time 3 | Sets the acceleration time when multi-function input "Acceleration/deceleration time selection 2" is ON. | 0.0 to 6000.0* | 10.0 s | No | A | A | A |
| C1-06 | Deceleration time 3 | Sets the deceleration time when multi-function input "Acceleration/deceleration time selection 2" is ON. | | | No | A | A | A |
| C1-07 | Acceleration time 4 | Sets the acceleration time when multi-function input "Acceleration/deceleration time selection 1" and "Acceleration/deceleration time selection 2" are ON. | | | No | A | A | A |
| C1-08 | Deceleration time 4 | Sets the deceleration time when multi-function input "Acceleration/deceleration time selection 1" and "Acceleration/deceleration time 2" are ON. | | | No | A | A | A |
| C1-10 | Acceleration/deceleration time setting unit | 0: 0.01 s<br>1: 0.1 s | 0 or 1 | 1 | No | A | A | A |
| C1-11 | Acceleration/deceleration time switching frequency | Sets the frequency at which acceleration/deceleration time switches automatically.<br>Less than set frequency: Acceleration/deceleration time 4<br>Set frequency or above: Acceleration/deceleration time 1<br>Multi-function inputs "Acceleration/deceleration time selection 1" and "Acceleration/deceleration time selection 2" are given priority. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A |
| C2-01 | S-curve characteristic time at acceleration start | Sets the S-curve characteristic time for each part in seconds.<br>When you set the S-curve characteristic time, the start time and end time S-curve characteristic time's acceleration/deceleration time is lengthened by 1/2 only.<br> | 0.00 to 2.50 | 0.20 s | No | A | A | A |
| C2-02 | S-curve characteristic time at acceleration end | | 0.00 to 2.50 | 0.20 s | No | A | A | A |
| C2-03 | S-curve characteristic time at deceleration start | | 0.00 to 2.50 | 0.20 s | No | A | A | A |
| C2-04 | S-curve characteristic time at deceleration end | | 0.00 to 2.50 | 0.00 s | No | A | A | A |

* The acceleration and deceleration settings range varies depending on the setting in C1-10. When C1-10 is set to 0, the acceleration/deceleration settings range is 0.00 to 600.00 (seconds).

## ■Setting Acceleration and Deceleration Time Units

Set the acceleration/deceleration time units using C1-10. The factory setting is 1.

| Set value | Details |
|---|---|
| 0 | The acceleration/deceleration time setting range is 0.00 to 600.00 in units of 0.01 s. |
| 1 | The acceleration/deceleration time setting range is 0.00 to 6000.0 in units of 0.1 s. |

## ■Switching Acceleration and Deceleration Time Using Multi-Function Input Terminal Commands

Four different acceleration times and deceleration times can be set. When the multi-function input terminals (H1-□□) are set to 7 (acceleration/deceleration time selection 1) and 1A (acceleration/deceleration time selection 2), you can switch the acceleration/deceleration time even during operation by combining the ON/OFF status of the terminals.

The following table shows the acceleration/deceleration time switching combinations.

| Acceleration/Deceleration Time Selection 1 Terminal | Acceleration/Deceleration Time Selection 2 Terminal | Acceleration Time | Deceleration Time |
|---|---|---|---|
| OFF | OFF | C1-01 | C1-02 |
| ON | OFF | C1-03 | C1-04 |
| OFF | ON | C1-05 | C1-06 |
| ON | ON | C1-07 | C1-08 |

## ■Switching Acceleration and Deceleration Time Automatically

Use this setting when you want to switch acceleration/deceleration time automatically using the output frequency.

When the output frequency reaches the set value in C1-11, the Inverter switches the acceleration/deceleration time automatically as shown in the following diagram.

Set C1-11 to a value other than 0.0 Hz. If C1-11 is set to 0.0 Hz, the function will be disabled.

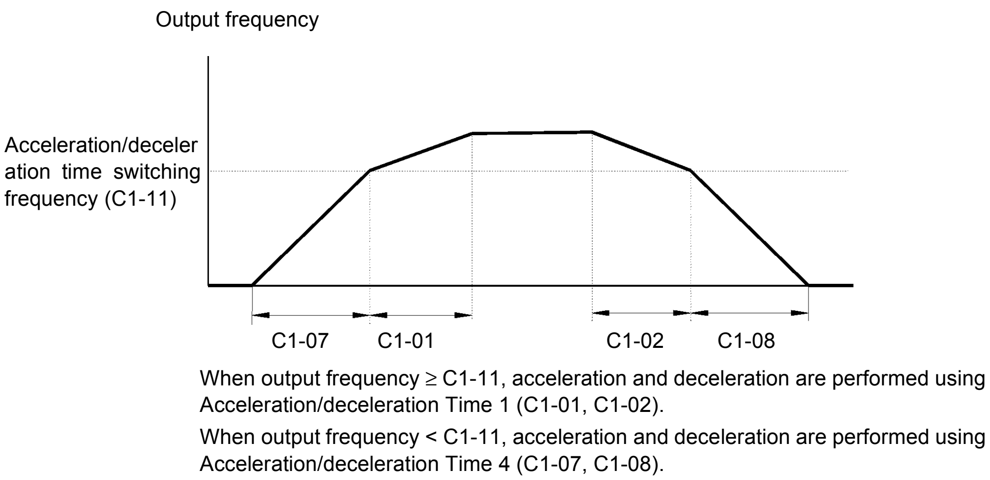



Fig 6.18 Acceleration/deceleration Time Switching Frequency

6

## ■Adjusting Acceleration and Deceleration Time Using an Analog Input

If you set H3-09 (Multi-function Analog Input Terminal A2 Function Selection) to 5 (acceleration/deceleration time gain), you can adjust the acceleration/deceleration time using terminal A2's input voltage.

The resulting acceleration time is as follows:

Acceleration time = C1-01 set value x acceleration/deceleration time gain

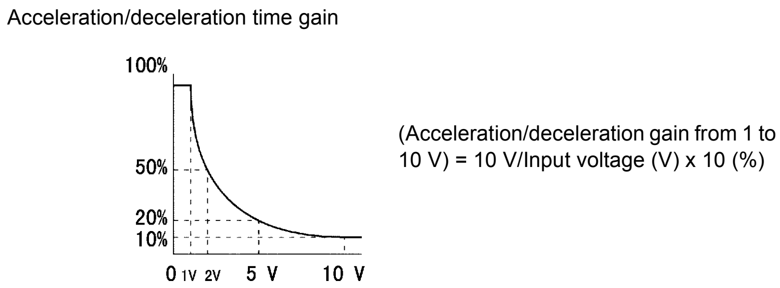



Fig 6.19 Acceleration/Deceleration Time Gain Using an Analog Input

## ■Entering S-curve Characteristics in the Acceleration and Deceleration Time

By performing acceleration and deceleration using an S-curve pattern, you can reduce shock when starting and stopping the machine.

Four different S-curve characteristic times can be set: At acceleration start, at deceleration start, at acceleration end and at deceleration end.

**INFO**

When S-curve is set, calculate acceleration/deceleration time as follows:

$$\text{Accel. time} = \frac{\text{C2-01} + \text{C2-02}}{2} + \text{C1-01}$$

$$\text{Decel. time} = \frac{\text{C2-03} + \text{C2-04}}{2} + \text{C1-02}$$

### Setting Example

The S-curve characteristic when switching operation (forward/reverse) is shown in the following diagram.

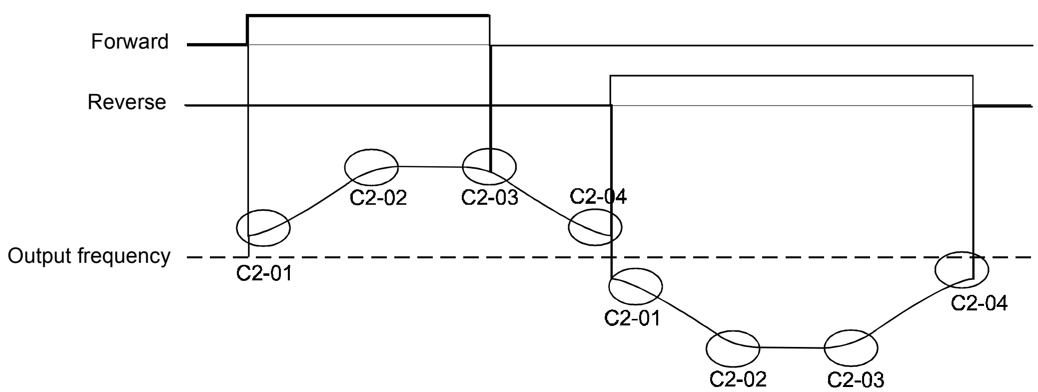
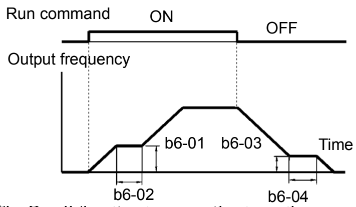



Fig 6.20 S-curve Characteristic during Operation Switching

## ◆ Accelerating and Decelerating Heavy Loads (Dwell Function)

The dwell function temporarily holds the output frequency when starting or stopping heavy loads. By using this function the motor can be prevented from stalling. When using the dwell function, deceleration to stop must be set as stopping method (b1-03 = 0).

### ■Related Parameters

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| b6-01 | Dwell frequency at start | <br>The Dwell function temporarily stores the frequency when starting and stopping heavy loads. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A |
| b6-02 | Dwell time at start | | 0.0 to 10.0 | 0.0 s | No | A | A | A |
| b6-03 | Dwell frequency at stop | | 0.0 to 400.0 | 0.0 Hz | No | A | A | A |
| b6-04 | Dwell time at stop | | 0.0 to 10.0 | 0.0 s | No | A | A | A |

## ◆ Preventing the Motor from Stalling During Acceleration (Stall Prevention During Acceleration Function)

The Stall Prevention During Acceleration function prevents the motor from stalling if a heavy load is applied to the motor, or sudden rapid acceleration is performed.

If you set L3-01 to 1 (enabled) and the Inverter output current reaches 85 % of the set value in L3-02, the acceleration rate will begin to slow down. When L3-02 is exceeded, the acceleration will stop.

If you set L3-01 to 2 (optimum adjustment), the motor accelerates so that the current is held at the level set in L3-03. With this setting, the acceleration time setting is ignored.

### ■Related Parameters

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| L3-01 | Stall prevention selection during acceleration | 0: Disabled (Accelerates according to the setting. Motor may stall if the load is too high.)<br>1: Enabled (Acceleration stops when the level set in L3-02 is exceeded. Acceleration continues when current value falls below the level set in L3-02.)<br>2: Optimum adjustment (Adjusts acceleration using the current level set in L3-02 as reference. The acceleration time setting is ignored.) | 0 to 2 | 1 | No | A | A | A |
| L3-02 | Stall prevention level during acceleration | Set as a percentage taking the Inverter rated current to be 100%.<br>Normally, it is not necessary to change this setting. Lower the set value if the motor stalls using the factory setting. | 0 to 200 | 120%* | No | A | A | A |
| L3-03 | Stall prevention limit during acceleration | Sets the lower current limit for stall prevention during acceleration as a percentage taking the inverter rated current as 100%.<br>Normally, it is not necessary to change this setting. | 0 to 100 | 50% | No | A | A | A |

* Shows the initial value when C6-01 is set to 1. If C6-01 is set to 0, the initial value is 150%.

6

## ■Time Chart

The following figure shows the frequency characteristics when L3-01 is set to 1.

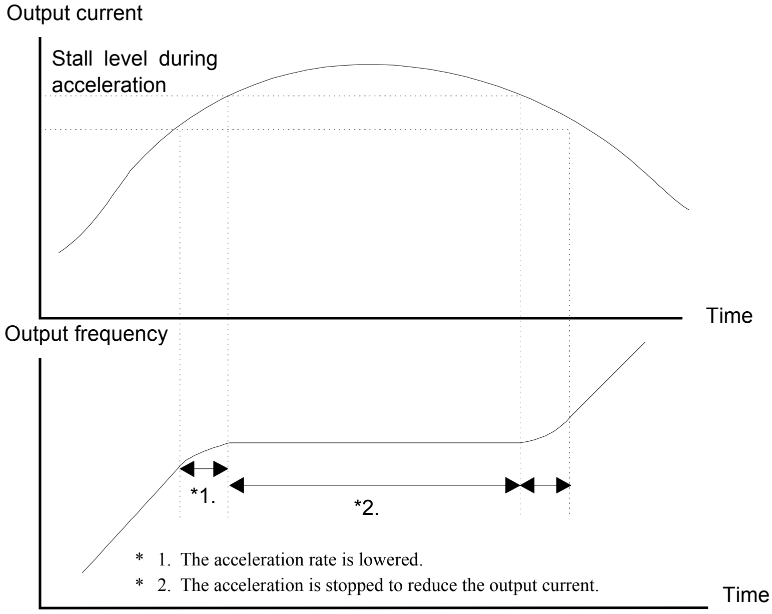



Fig 6.21 Time Chart for Stall Prevention During Acceleration

## ■Setting Precautions

- If the motor capacity is small compared to the Inverter capacity or if the inverter is operated using the factory settings and the motor stalls, lower the set value of L3-02.
- If using the motor in the constant output range, L3-02 will be automatically lowered to prevent stalling. L3-03 is the limit value to prevent the stall prevention level in the constant output range from being reduced more than necessary.
- Set the constants as a percentage taking the inverter rated current to be 100%.

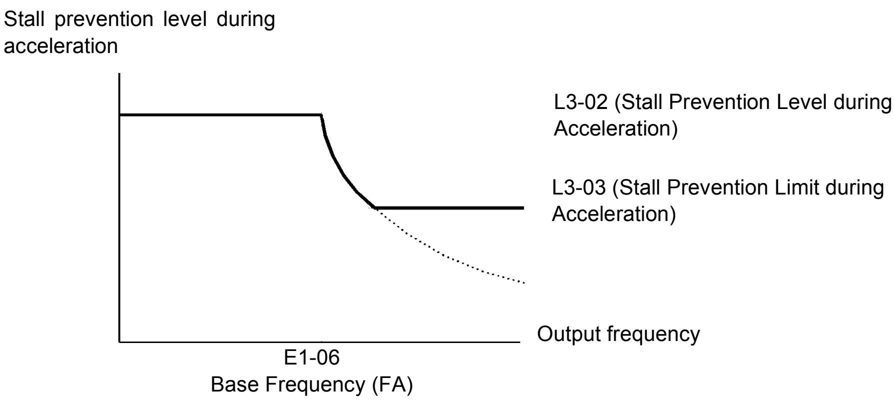



Fig 6.22 Stall Prevention Level and Limit During Acceleration

## ◆ Preventing Overvoltage During Deceleration (Stall Prevention During Deceleration Function)

This function automatically lengthens the deceleration time with respect to the DC-bus voltage to avoid overvoltage tripping.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| L3-04 | Stall prevention selection during deceleration function selection | 0: Disabled (Motor decelerates according to setting. When the deceleration time is too short, there is a risk of DC bus overvoltage (OV) occurring.)<br>1: Enabled<br>2: Optimum adjustment<br>3: Enabled (with dynamic braking)<br>If using the dynamic brake option (braking resistor, braking resistor units, and braking units), be sure to set constant L3-04 to 0 or 3. | 0 to 3 | 1 | No | A | A | A |

### ■Setting the Stall Prevention Selection During Deceleration (L3-04)

There are four different settings selectable for L3-04.

L3-04=0: This setting disables the stall prevention function during deceleration. The motor will be decelerated using the time set in C1-02 (C1-04/06/08). If the load inertia is very high and an OV fault occurs during deceleration a Braking option has to be used or the time has to be lengthened.

L3-04=1: This setting enables the stall prevention during deceleration. The inverter tries to decelerate within the set deceleration time. It also observes the DC bus voltage. If the DC bus voltage reaches the stall prevention level the deceleration is stopped and the output frequency is held. When the DC bus voltage falls below the stall prevention level the deceleration will be continued.

L3-04=2: This setting enables the stall prevention during deceleration. The deceleration time set as C1-☐☐ is taken as reference. The function automatically tries to optimize the deceleration time by observing the DC bus voltage and shortening the deceleration time. The function does not lengthen the deceleration time, i.e. if C1-☐☐ is set too short OV may occure.

L3-04=3: This setting enables the stall prevention during deceleration using a braking option. It works similar to setting 2, the only difference is that a braking option is used. The deceleration time set in C1-☐☐ is also disregarded.

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## ■Setting Example

An example of stall prevention during deceleration when L3-04 is set to 1 is shown below.

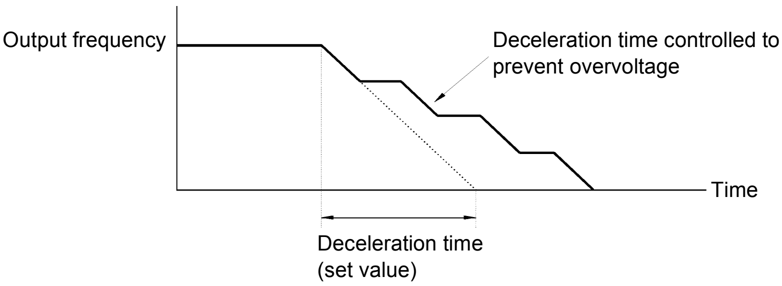


Fig 6.23 Stall Prevention During Deceleration Operation

## ■Setting Precautions

- The stall prevention level during deceleration differs depending on the inverter rated voltage and input voltage. Refer to the following table for details.

| Inverter Rated/Input Voltage | | Stall Prevention Level during Deceleration (V) |
|---|---|---|
| 200 V class | | 380 |
| 400 V class | E1-01 ≥ 400 V | 760 |
| | E1-01 < 400 V | 660 |

- When using the braking option (braking resistor, braking resistor units, and braking units), be sure to set constant L3-04 to 0 or 3.
- When a braking option is used and the deceleration time shall be optimized (shorter than setting of C1-02/04/06/08), L3-04 has to be set to 3.

# Adjusting Frequency References

This section explains methods of adjusting frequency references.

## ◆ Adjusting Analog Frequency References

Gain and bias are among the constants used to adjust analog inputs.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| H3-01 | Multi-function analog input terminal A1 signal level selection | 0: 0 to +10V (11 bit)<br>1: –10V to +10V (11 bit plus sign) | 0 or 1 | 0 | No | A | A | A |
| H3-02 | Frequency reference terminal A1 input gain | Sets the frequency as a percentage of the maximum output frequency, when 10V is input. | 0.0 to 1000.0 | 100.0% | Yes | A | A | A |
| H3-03 | Frequency reference terminal A1 input bias | Sets the frequency as a percentage of the maximum output frequency, when 0V is input. | -100.0 to +100.0 | 0.0% | Yes | A | A | A |
| H3-08 | Multi-function analog A2 signal level selection | 0: 0 to +10V (11 bit)<br>1: –10V to +10V (11 bit plus sign)<br>2: 4 to 20 mA (9-bit input)<br>Switch current and voltage input using the switch S1 on the control terminal board. | 0 to 2 | 2 | No | A | A | A |
| H3-09 | Multi-function analog A2 function selection | Selects the multi-function analog input function for terminal A2. | 0 to 1F | 0 | No | A | A | A |
| H3-10 | Multi-function analog A2 input gain | Sets the input levelwhen terminal A2 input is 10V (20mA) according to the 100% value of the function set in constant H3-09. | 0.0 to 1000.0 | 100.0% | Yes | A | A | A |
| H3-11 | Multi-function analog A2 input bias | Sets the input level when terminal A2 input is 0V (4mA) according to the 100% value of the function set in constant H3-09. | -100.0 to +100.0 | 0.0% | Yes | A | A | A |
| H3-12 | Analog input filter time constant | Sets primary delay filter time constant for the two analog input terminals (A1 and A2). Effective for noise control etc. | 0.00 to 2.00 | 0.00 s | No | A | A | A |
| H3-13 | Terminal A1/A2 switching | 0: Use terminal A1 analog input as main frequency reference.<br>1: Use terminal A2 analog input as main frequency reference.<br>Effective when H3-09 is set to 2. | | | | | | |

### ■Adjusting Analog Frequency Reference Using Constants

The frequency reference can be input from the control circuit terminals using analog voltage and current signals.

If using terminal A1 as an input terminal for the frequency reference value, perform adjustments using constants H3-01 to H3-03. If using multi-function analog input terminal A2 as a frequency reference terminal, perform adjustments using H3-08 to H3-11. Set the analog input signal level using the constants H3-01 or H3-08. Refer the following figures for setting the input gain and bias.

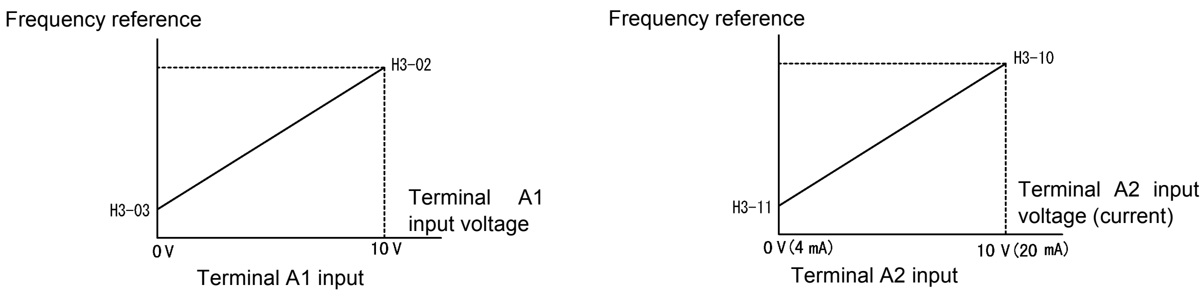


Fig 6.24 Terminals A1 and A2 Inputs

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## ■Adjusting Frequency Gain Using an Analog Input

When H3-09 is set to 1 (frequency gain), you can adjust the frequency gain using an analog input.

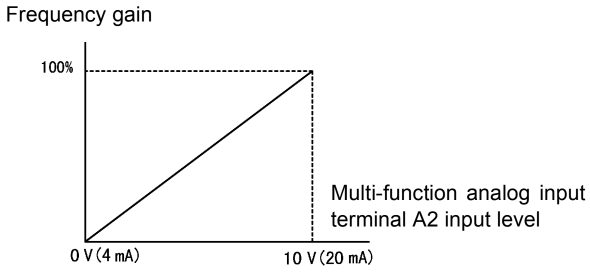
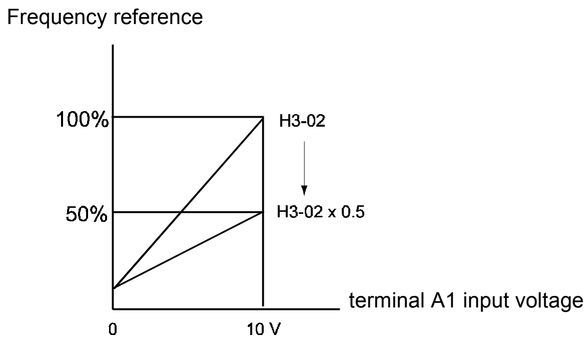



Fig 6.25 Frequency Gain Adjustment (Terminal A2 Input)

The frequency gain for terminal A1 is the sum of H3-02 and terminal A2 gain. For example, when H3-02 is set to 100% and terminal A2 is set to 5 V, the terminal A1 frequency reference will be 50%.




## ■Adjusting Frequency Bias Using an Analog Input

When constant H3-09 is set to 0 (Frequency Bias), the frequency equivalent to the terminal A2 input voltage is added to A1 as a bias.

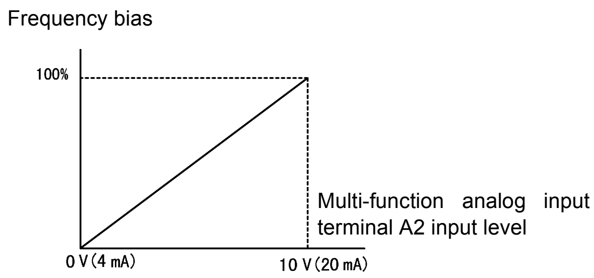
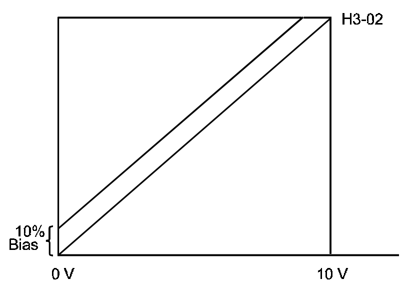



Fig 6.26 Frequency Bias Adjustment (Terminal A2 Input)

For example, if H3-02 is 100%, H3-03 is 0%, and terminal A2 is set to 1 V, the frequency reference from terminal A1 when 0 V is input to A1 will be 10%.




## ◆ Operation Avoiding Resonance (Jump Frequency Function)

- This function allows the prohibition or “jumping” of certain frequencies within the Inverter’s output frequency range so that the motor can operate without resonant oscillations caused by some machine systems.
- It can also be used for deadband control.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods: V/f | V/f with PG | Open Loop Vector |
|---|---|---|---|---|---|---|---|---|
| d3-01 | Jump frequency 1 | Set the frequency center value of the jump frequency settings, in hertz. Set to 0.0 to disable the jump frequency function. Make sure that the settings are as follows: d3-01 ≥ d3-02 ≥ d3-03. Operation within the jump frequency range is prohibited. Changes during acceleration and deceleration are made gradually without performing jumps. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A |
| d3-02 | Jump frequency 2 | | | 0.0 Hz | No | A | A | A |
| d3-03 | Jump frequency 3 | | | 0.0 Hz | No | A | A | A |
| d3-04 | Jump frequency width | Sets the jump frequency width in hertz. The jump frequency range is as follows: (Jump frequency ±d3-04). | 0.0 to 20.0 | 1.0 Hz | No | A | A | A |

The relationship between the output frequency and the jump frequency reference is as follows:

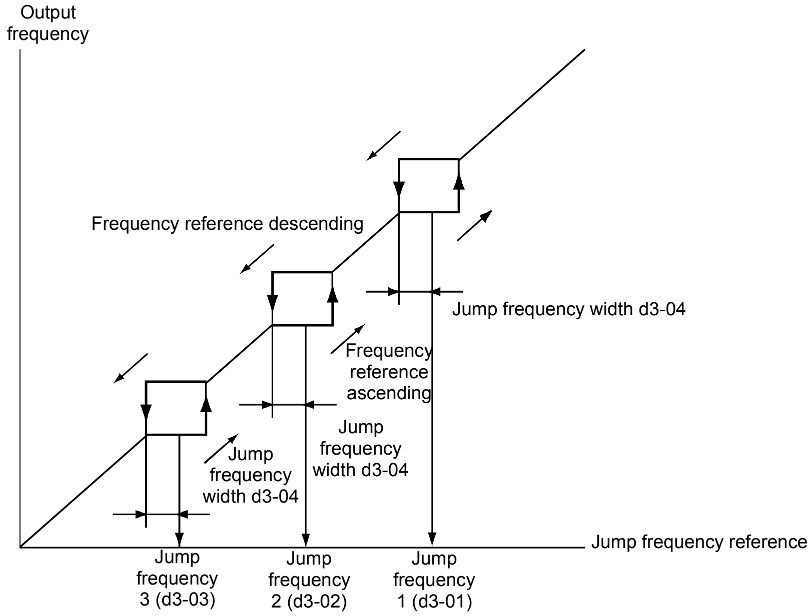



Fig 6.27 Jump Frequency

## ■Setting Jump Frequency Reference Using an Analog Input

When constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) is set to A (jump frequency), you can change the jump frequency using the terminal A2 input.

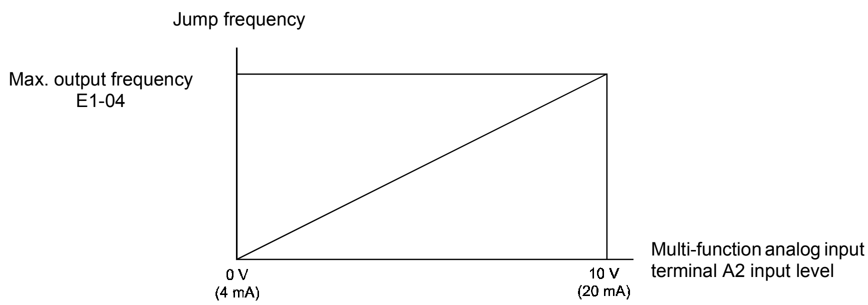



Fig 6.28 Jump Frequency Setting Using an Analog Input

## ■Setting Precautions

- Set the jump frequencies according to the following formula: d3-01 ≥ d3-02 ≥ d3-03 > Analog input.
- When constants d3-01 to d3-03 are set to 0 Hz, the jump frequency function is disabled.

## ◆ Adjusting Frequency Reference Using Pulse Train Input

The pulse train input will be accepted as frequency reference when b1-01 (Reference Source Selection) is set to 4 (Pulse Train Input). Set the pulse frequency that is equal to 100% reference in constant H6-02, and then adjust the gain and bias accordingly using H6-03 and H6-04.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| H6-01 | Pulse train input function selection | 0: Frequency reference<br>1: PID feedback value<br>2: PID target value | 0 to 2 | 0 | No | A | A | A |
| H6-02 | Pulse train input scaling | Set the number of pulses in Hz, taking the reference to be 100%. | 1000 to 32000 | 1440 Hz | Yes | A | A | A |
| H6-03 | Pulse train input gain | Set the input gain level as a percentage of the frequency set in H6-02. | 0.0 to 1000.0 | 100.0% | Yes | A | A | A |
| H6-04 | Pulse train input bias | Set the input bias when the pulse train is 0. | -100.0 to 100.0 | 0.0% | Yes | A | A | A |
| H6-05 | Pulse train input filter time | Set the pulse train input primary delay filter time constant in seconds. | 0.00 to 2.00 | 0.10 s | Yes | A | A | A |

The following block diagram explains the functioning of the pulse train input.

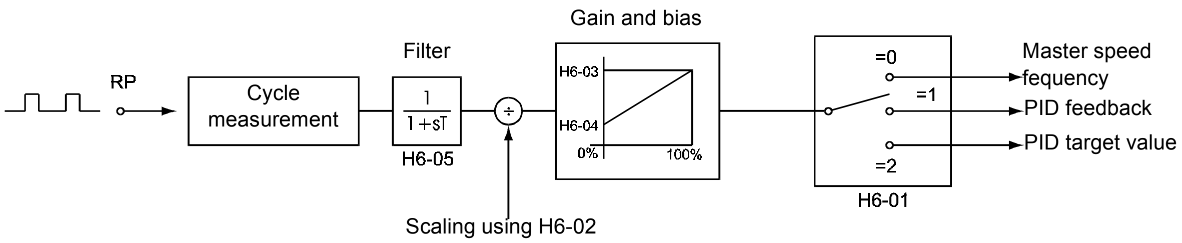



Fig 6.29 Frequency Reference Adjustments Using Pulse Train Inputs

The principle for setting the input gain and bias is the same as for the analog inputs (refer *page 6-25 pp*). The only difference is that the input signal is not a voltage or a current but a pulse train.

# Speed Limit (Frequency Reference Limit Function)

This section explains how to limit the motor speed.

## ◆ Limiting Maximum Output Frequency

If you do not want the motor to rotate above a given frequency, use constant d2-01.

Set the upper limit value of the frequency reference as a percentage, taking E1-04 (Maximum Output Frequency) to be 100%.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| d2-01 | Frequency reference upper limit | Set the output frequency upper limit, taking the max. output frequency to be 100%. | 0.0 to 110.0 | 100.0% | No | A | A | A |

## ◆ Limiting Minimum Frequency

If you do not want the motor to rotate at below a given frequency, use constants d2-02 or d2-03.

There are two methods of limiting the minimum frequency, as follows:

- Adjust the minimum level for all frequencies.
- Adjust the minimum level for the master speed frequency (i.e., the lower levels of the jog frequency, multi-step speed frequency, and auxiliary frequency will not be adjusted).

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| d2-02 | Frequency reference lower limit | Set the output frequency lower limit, taking the base reference to be 100%. | 0.0 to 110.0 | 0.0% | No | A | A | A |
| d2-03 | Master speed reference lower limit | Set the master speed reference lower limit, taking the max. output frequency to be 100%. | 0.0 to 110.0 | 0.0% | No | A | A | A |

## ■Adjusting Frequency Lower Limit Using an Analog Input

If you set constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) to 9 (output frequency lower level), you can adjust the frequency lower level using the terminal A2 input level.

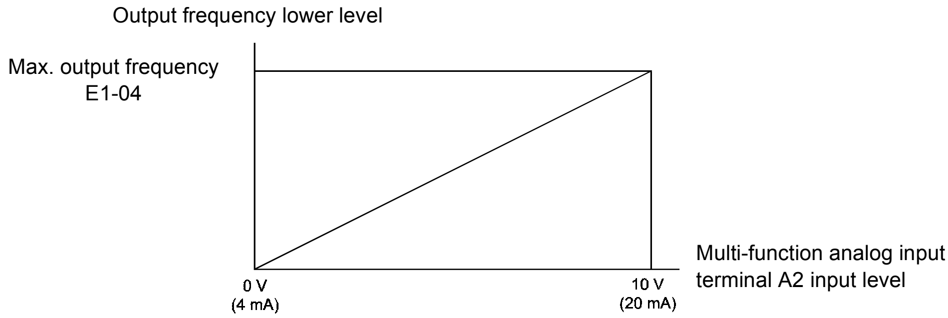



Fig 6.30 Analog Output Characteristics of Output Frequency Lower Level

If constant d2-02 and terminal A2 output frequency lower level have been set at the same time, the larger set value will become the frequency lower limit.

# Frequency Detection

## ◆ Speed Agreement Function

There are eight different types of frequency detection methods available. The digital multifunction outputs M1 to M6 can be programmed for this function and can be used to indicate a frequency detection or agreement to any external equipment.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Regelungsarten | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L4-01 | Speed agreement detection level | Effective when "$f_{out}/f_{set}$ agree 1", "Frequency detection 1" or "Frequency detection 2" is set for a multi-function output. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A |
| L4-02 | Speed agreement detection width | Effective when "$f_{ref}/f_{out}$ agree 1", "$f_{out}/f_{set}$ agree 1", "Frequency detection 1" or "Frequency detection 2" is set for a multi-function output. | 0.0 to 20.0 | 2.0 Hz | No | A | A | A |
| L4-03 | Speed agreement detection level (±) | Effective when "$f_{out}/f_{set}$ agree 2", "Frequency detection 3" or "Frequency detection 4" is set for a multi-function output. | -400.0 to +400.0 | 0.0 Hz | No | A | A | A |
| L4-04 | Speed agreement detection width (±) | Effective when "$f_{ref}/f_{out}$ agree 2", "$f_{out}/f_{set}$ agree 2", "Frequency detection 3" or "Frequency detection 4" is set for a multi-function output. | 0.0 to 20.0 | 2.0 Hz | No | A | A | A |

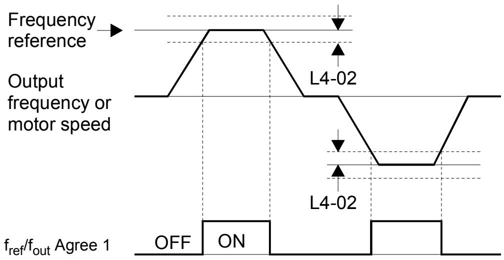
- With L4-01 an absolute speed agreement level is set, i.e. a speed agreement is detected in both directions (FWD and REV).
- With L4-03 a signed speed agreement level is set, i.e. a speed agreement is detected only in the set direction (positive level → FWD direction, negative level → REV direction).

## ■Time Charts

The following table shows the time charts for each of the speed agreement functions.

<table>
<tr><th>Related constant</th><th>L4-01: Speed Agree Level<br>L4-02: Speed Agree Width</th><th>L4-03: Speed Agree Level +/–<br>L4-04: Speed Agree Width</th></tr>
<tr><td>$f_{ref}/f_{out}$ Agree</td><td>

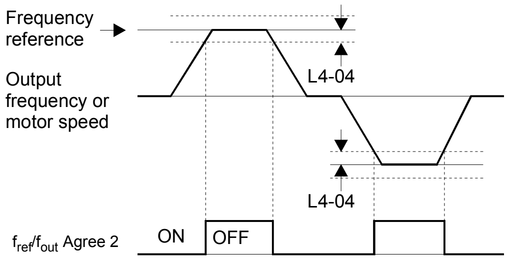
$f_{ref}/f_{out}$ Agree 1




(Multi-function output setting = 2)

</td><td>

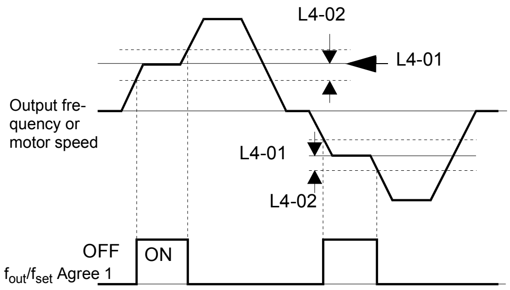
$f_{ref}/f_{out}$ Agree 2




(Multi-function output setting = 13)

</td></tr>
<tr><td>$f_{out}/f_{set}$ Agree</td><td>

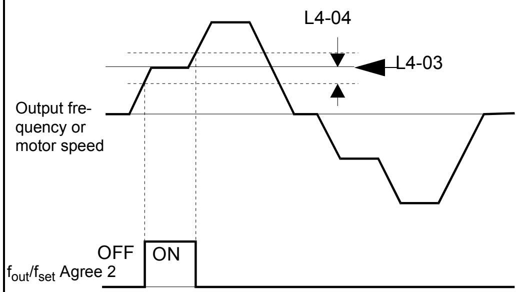
$f_{out}/f_{set}$ Agree 1
(ON at the following conditions during frequency agree)




(Multi-function output setting = 3)

</td><td>

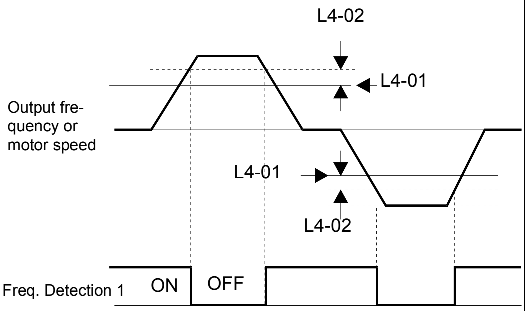
$f_{out}/f_{set}$ Agree 2
(ON at the following conditions during frequency agree)




(Multi-function output setting = 14)

</td></tr>
<tr><td rowspan="2">Frequency Detection</td><td>

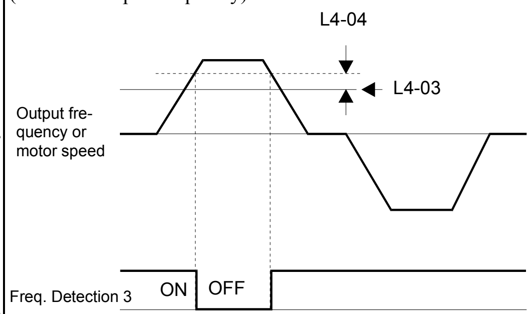
Frequency (FOUT) Detection 1
(L4-01 > | Output frequency |)




(Multi-function output setting = 4)

</td><td>

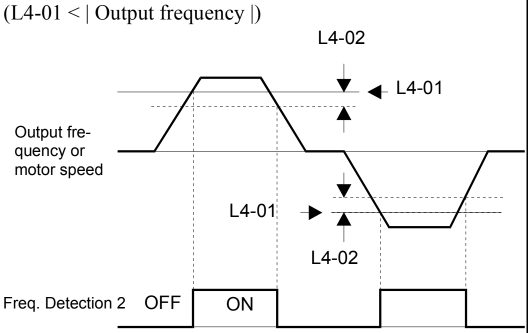
Frequency (FOUT) Detection 3
(L4-03 > Output frequency)




(Multi-function output setting = 15)

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

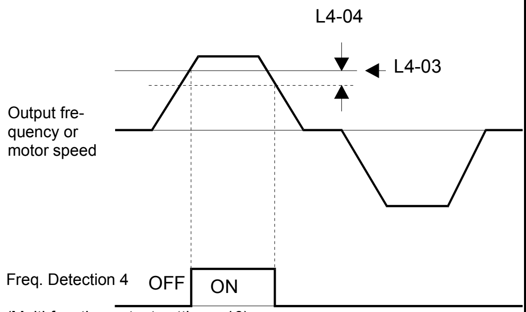
Frequency (FOUT) Detection 2
(L4-01 < | Output frequency |)




(Multi-function output setting = 5)

</td><td>

Frequency Detection 4
(L4-03 < Output frequency)




(Multi-function output setting = 16)

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

6

## ■Multifunction Output Settings: H2-01 to H2-03 (M1 – M6 function selection)

The table below shows the necessary H2-01 to H2-03 parameter setting for each of the speed agreement functions.

| Function | Setting |
|---|---|
| $f_{ref}/f_{out}$ Agree 1 | 2 |
| $f_{out}/f_{set}$ Agree 1 | 3 |
| Frequency detection 1 | 4 |
| Frequency detection 2 | 5 |
| $f_{ref}/f_{out}$ Agree 2 | 13 |
| $f_{out}/f_{set}$ Agree 2 | 14 |
| Frequency detection 3 | 15 |
| Frequency detection 4 | 16 |

# Improved Operating Efficiency

This section explains functions for improving motor operating efficiency.

## ◆ Reducing Motor Speed Fluctuation (Slip Compensation Function)

When the load is large, the motor slip also grows and the motor speed decreases. The slip compensation function keeps the motor speed constant, regardless of changes in load. When the motor is operating at the rated load, constant E2-02 (Motor Rated Slip) × the slip compensation gain value in constant C3-01 is added to the output frequency.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| C3-01 | Slip compensation gain | Use this constant to improve speed accuracy when operating under a load. Normally, there is no need to make this setting.<br>Adjust constant C3-01 under the following conditions:<br>• Increase the set value when the motor speed falls to below the target value.<br>• Decrease the set value when the motor speed rises to above the target value. | 0.0 to 2.5 | 0.0* | Yes | A | No | A |
| C3-02 | Slip compensation delay time | Sets the delay time constant for the slip compensation function.<br>Normally, there is no need to change this setting.<br>Adjust constant C3-02 under the following conditions:<br>• When the slip compensation response is low, lower the set value.<br>• When the speed is unstable, increase the set value. | 0 to 10000 | 2000 ms * | No | A | No | A |
| C3-03 | Slip compensation limit | Set the upper limit of the compensation amount for the slip compensation function as a percentage, taking the motor rated slip to be 100%. | 0 to 250 | 200% | No | A | No | A |
| C3-04 | Slip compensation during regeneration | 0: Slip compensation is disabled during regeneration.<br>1: Slip compensation is enabled during regeneration.<br>If the slip compensation function operates during regeneration, you might have to use a braking option (braking resistor, braking resistor unit, or braking unit). | 0 or 1 | 0 | No | A | No | A |
| C3-05 | Output voltage limit operation selection | 0: Disabled.<br>1: Enabled. (The motor flux will be lowered automatically when the output voltage become saturated.) | 0 or 1 | 0 | No | No | No | A |

* The factory setting will change when the control method is changed. (V/f control factory settings are given.)

## ■Adjusting Slip Compensation Gain (C3-01)

The setting value of C3-01 depends on the control method. The factory settings are:

- V/f control without PG: 0.0
- Open loop vector control: 1.0

Set C3-01 to 1.0 to compensate the slip depending on the actual torque output status using the rated slip (E2-02/E4-02) as reference.

Adjust the slip compensation gain using the following procedure.

1. Set E2-02 (Motor Rated Slip) and E2-03 (Motor No-load Current) correctly.
   The motor rated slip can be calculated using the values on the motor nameplate and the following formula.
   Motor rated slip (Hz) = Motor rated frequency (Hz) - Rated Motor speed (rpm) × No. of motor poles / 120
   The motor rated slip is set automatically in vector control using the autotuning function.
2. In V/f control, set C3-01 to 1.0. Setting this constant to 0.0 disables the slip compensation.
3. Apply a load, and measure the speed to adjust the slip compensation gain. Adjust the slip compensation gain by 0.1 at a time. If the speed is less than the target value, increase the slip compensation gain, and if the speed is higher than the target value, reduce the slip compensation gain.

## ■Adjusting Slip Compensation Primary Delay Time Constant (C3-02)

The slip compensation delay time constant is set in ms.

The setting value of C3-02 depends on the control method. The factory settings are:

- V/f control without PG: 2000 ms
- Open loop vector control: 200 ms

Normally, there is no need to change these settings. When the slip compensation response is low, lower the set value. When the speed is unstable, increase the set value.

## ■Adjusting Slip Compensation Limit (C3-03)

Using constant C3-03 the upper limit for the slip compensation can be set as a percentage, taking the motor rated slip as 100%.

If the speed is lower than the target value but does not change even after adjusting the slip compensation gain, the slip compensation limit may have reached. Increase the limit, and check the speed again. Always make sure that the value of the slip compensation limit and reference frequency does not exceed the tolerance of the machine.

The following diagram shows the slip compensation limit for the constant torque range and fixed output range.

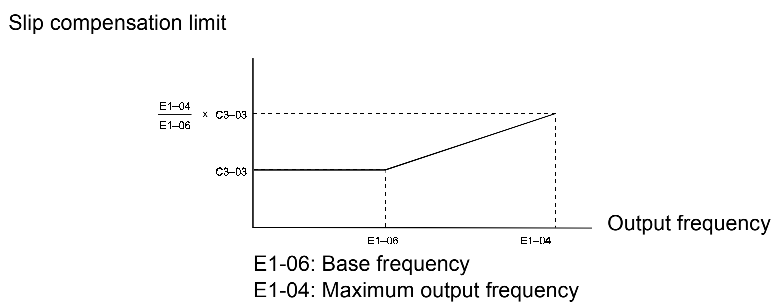



Fig 6.31 Slip Compensation Limit

### ■Selecting Slip Compensation Function During Regeneration (C3-04)

Set whether to enable or disable the slip compensation function during regeneration.

If the slip compensation function operates during regeneration, you might have to use a braking option (braking resistor, braking resistor unit, and braking unit).

### ■Operation Selection when Output Voltage Saturated (C3-05)

The Inverter cannot output a voltage that is higher than the input voltage. If the output voltage command to the motor (monitor constant U1-06) exceeds the input voltage in the high-speed region, the output voltage becomes saturated, and inverter cannot respond to speed or load changes. This function automatically reduces the output voltage to avoid voltage saturation.

## ◆ Torque Compensation for Sufficient Torque at Start and Low-speed Operation

The torque compensation function detects a rising motor load, and increases the output torque.

In V/f control the inverter calculates the motor primary loss voltage and adjusts the output voltage (V) to compensate insufficient torque at startup and during low-speed operation. The compensation voltage is calculated as follows: Motor primary voltage loss × constant C4-01.

The vector control separates the motor excitation current and the torque producing current and controls each of the two separately.

The torque producing current is calculated as follows: Calculated torque reference × C4-01

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| C4-01 | Torque compensation gain | Sets the torque compensation gain using the multiplication factor. Normally, there is no need to set this constant. Adjust the torque compensation gain under the following circumstances.<br>• If the cable is very long, increase the set value.<br>• If the motor capacity is smaller than the Inverter capacity (max. applicable motor capacity), increase the set value.<br>• If the motor is vibrating, reduce the set value.<br>Adjust this constant so that the output current during low-speed rotation does not exceed the Inverter rated output current range. | 0.00 to 2.50 | 1.00 | Yes | A | A | A |
| C4-02 | Torque compensation delay time constant | Set the delay for the torque compensation function in ms.<br>Normally, there is no need to make this setting. Adjust this constant in the following circumstances.<br>• If the motor is vibrating, increase the set value.<br>• If the motor response is low, decrease the set value. | 0 to 10000 | 200 ms * | No | A | A | A |
| C4-03 | Starting torque compensation value (forward direction) | Sets the torque compensation value at start in FWD direction. | 0.0 to 200.0% | 0.0 | No | No | No | A |
| C4-04 | Starting torque compensation value (reverse direction) | Sets the torque compensation value at start on REV direction. | –200.0 to 0.0% | 0.0 | No | No | No | A |
| C4-05 | Starting torque compensation time constant | Sets starting torque start-up time.<br>When 0 ~ 4 ms is set, it is operated without filter. | 0 to 200 | 1 ms | No | No | No | A |

* The factory setting will change when the control method is changed. (V/f control factory settings are given.)

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## ■Adjusting Torque Compensation Gain (C4-01)

Normally, there is no need to change this setting. Do not adjust the torque compensation gain when using open loop vector control.

Adjust the torque compensation gain in V/f control under the following circumstances.

- If the cable is very long, increase the set value.
- If the motor capacity is smaller than the Inverter capacity (max. applicable motor capacity), increase the set value.
- If the motor is vibrating, reduce the set value.

Adjust this constant so that the output current during low-speed rotation does not exceed the Inverter rated output current range.

## ■Adjusting the Torque Compensation Primary Delay Time Constant (C4-02)

Set the torque compensation function primary delay in ms.

The setting value of C4-02 depends on the control method. The factory settings are:

- V/f control without PG: 200 ms
- V/f control with PG: 200 ms
- open loop vector control: 20 ms

Normally, there is no need to change this setting. Adjust the constant under the following circumstances:

- If the motor is vibrating, increase the set value.
- If the motor response is low, decrease the set value.

## ■Starting Torque Compensation Function (C4-03 to C4-05)

Starting torque compensation can be input to speed up the torque command at starting with open-loop vector control.

This function is effective for machinery with large friction loads, cranes, and other applications where high starting torque is required. It works like shown in the following diagram.

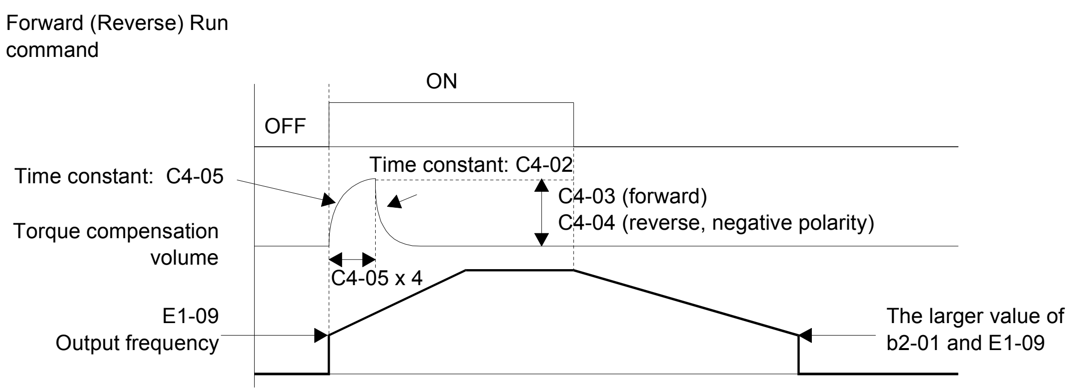



Fig. 6.32 Time Chart for Starting Torque Frequency

When this function is used, the following should be considered:

- When the machine runs in FWD and REV direction both values, C4-03 and C4-04 have to be set.
- The compensation works only for the motoring side. It can not be used with a regenerative load.
- If a large shock is generated at starting increase the starting torque compensation time constant (C4-05).

## ◆ Automatic Speed Regulator (ASR) (for V/f with PG only)

In V/f with PG control mode the Automatic Speed Regulator (ASR) is used to control the motor speed.  The speed control structure is shown in the figure below.

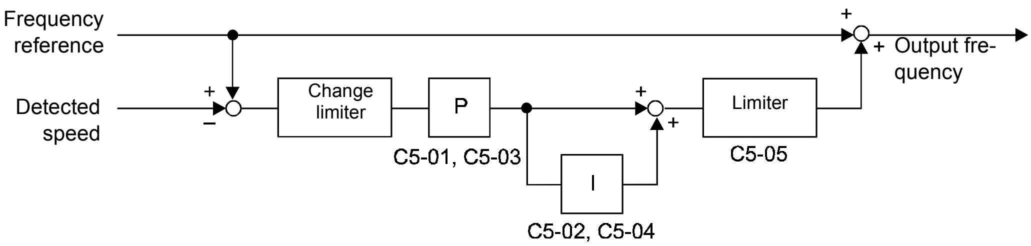
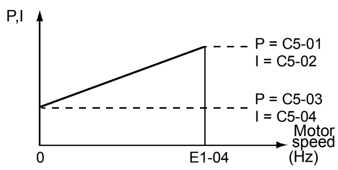



Fig. 6.33  Speed Control Structure

### ■Related Constants

| Constant Numberr | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | V/f with PG | Open Loop |
|---|---|---|---|---|---|---|---|---|
| C5-01 | ASR proportional (P) gain 1 | Sets the proportional gain of the speed loop (ASR). | 0.00 to 300.00 | 0.20 | Yes | No | A | No |
| C5-02 | ASR integral (I) time 1 | Sets the integral time of the speed loop (ASR). | 0.000 to 10.000 | 0.200 s | Yes | No | A | No |
| C5-03 | ASR proportional (P) gain 2 | Usually changing this setting is not necessary.   | 0.00 to 300.00 | 0.02 | Yes | No | A | No |
| C5-04 | ASR integral (I) time 2 | | 0.000 to 10.000 | 0.050 s | Yes | No | A | No |
| C5-05 | ASR limit | Sets the upper limit for the compensation frequency for the speed control loop (ASR) as a percentage of the maximum output frequency. | 0.0 to 20.0 | 5.0% | No | No | A | No |
| F1-07 | Integral value during accel/decel enable/disable | Sets integral control during acceleration/deceleration to either enabled or disabled.<br>0: Disabled (The integral function isn't used while accelerating or decelerating; it is used at constant speeds.)<br>1: Enabled (The integral function is used at all times.) | 0 or 1 | 0 | No | No | A | No |

6

## ■Adjusting Gain and Integral Times (C5-01 to C5-04)

The ASR proportional gain and ASR integral time can be set different for low and high output frequency (see *Fig. 6.34*.

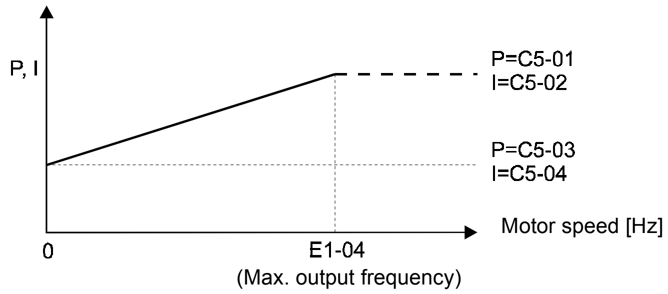



Fig. 6.34  ASR Gain and Integral Time Depending on the Output Frequency

Use the following procedure to adjust the ASR gain and integral time. The mechanical system and the load should be connected while this procedure.

## ■Gain and Integral Time at Minimum Output Frequency (C5-03 and C5-04)

11. Operate the motor at the minimum output frequency.
12. Increase C5-03 (ASR proportional gain 2) to a level where there is no oscillation in motor speed.
13. Decrease C5-04 (ASR integral time 2) to a level where there is no oscillation in motor speed.
14. Monitor the inverter's output current and verify that it is less than 50% of the inverter rated current. If the output current exceeds 50% of the inverter's rated current, decrease C5-03 and increase C5-04.

## ■Gain and Integral Time at Maximum Output Frequency (C5-01 and C5-02)

1. Operate the motor at the maximum output frequency.
2. Increase C5-01 (ASR proportional gain 1) to a level where there is no oscillation in motor speed.
3. Decrease C5-02 (ASR integral time 1) to a level where there is no oscillation in motor speed.

## ■Gain and Integral Time Adjustments for Integral Control during Acceleration/Deceleration (F1-07)

Normally the integral control is disabled during Acceleration/Deceleration (F1-07=0). Enable this function if you want the motor speed to follow the frequency reference very closely during accel./decel. The integral operation causes the speed to reach the target value as fast as possible. Wrong setting may cause oscillations or low speed response.

1. Set F1-07 to "1" to enable integral operation at all times.
2. Make the constant settings shown below in order to observe the speed waveform while making fine adjustments to the gain.

| Constant | Setting | Explanation |
|---|---|---|
| H4-01 Analog output selection (terminal FM) | 2 | Settings that allow multi-function analog output 1 to be used to monitor the output frequency. |
| H4-02 Analog output gain (terminal FM) | 100 % | |
| H4-03 Analog output bias (terminal FM) | 0.0 % | |
| H4-04 Analog output selection (terminal AM) | 5 | Settings that allow multi-function analog output 2 to be used to monitor the motor speed. |
| H4-05 Analog output gain (terminal AM) | 100 % | |
| H4-06 Analog output bias (terminal AM) | 0.0 % | |
| H4-07 Analog output 1 signal level selection | 1 | This setting allows a 0 to ± 10 V signal range to be monitored. |
| H4-08 Analog output 2 signal level selection | 1 | |

The multi-function analog outputs have the following functions with these constant settings.

- Multi-function analog output 1 (terminal FM): Outputs Inverter's output frequency 0 to ±10 V).
- Multi-function analog output 2 (terminal AM): Outputs the actual motor speed (0 to ± 10 V).

Terminal AC is the multi-function analog output common.

We recommend monitoring both, the output frequency and the motor speed to monitor the response delay or deviations from the reference value, as shown in the following diagram.

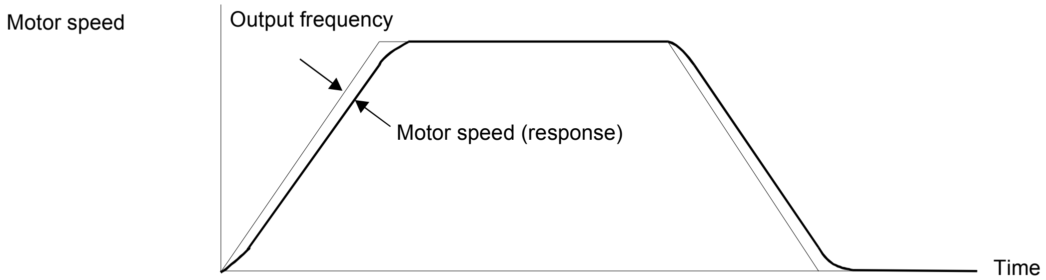



Fig. 6.35  Example Monitor Waveforms

3. Give acceleration/deceleration commands and adjust the gain while observing the waveform.

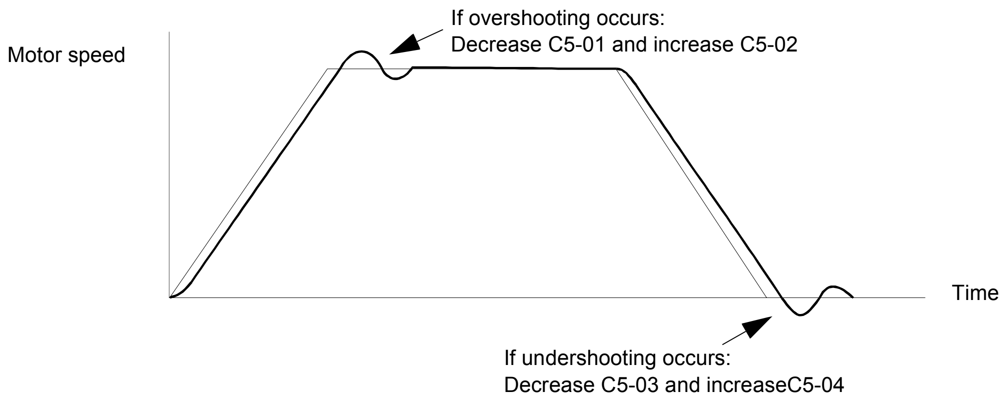



Fig. 6.36  Gain Adjustments

4. If the overshooting or undershooting can't be eliminated by adjusting the gain and integral time values, decrease the ASR limit (C5-05) to lower the frequency reference compensation limit.
   Note the following:
   - Since C5-05 can't be changed during operation, stop the Inverter's operation and then decrease the ASR limit by 0.5 (%).
   - Perform step 3 again after the setting has been changed.
   - The ASR limit is the frequency limit for compensation by speed control.  This frequency limit is set as a percentage of the maximum output frequency.
   - If the frequency limit is lowered too much, the motor speed might not reach the target speed.  Verify that the target speed is reached during normal operation.

## ■Multi-function Input Settings (H1-01 to H1-05) (Terminal S3 to S7)

### V/f Control with/without PG Selection: “D”

- When one of the digital inputs is set to “D” this input can be used to switch over to normal V/f control and thereby to disable the ASR.
- The ASR is disabled when the multifunction input is ON.

### Speed Control Integral Disable: “E”

- When one of the digital inputs is set to “E” this input can be used to switch the speed control between PI and P control.
- P control is active when the input is ON (Integral value is reset).

# ◆ Hunting-Prevention Function

The hunting-prevention function suppresses hunting when the motor is operating with a light load. This function can be used in the V/f control modes only.

If high response has the priority to vibration suppression this function should be disabled (N1-01 = 0).

## ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| N1-01 | Hunting-prevention function selection | 0: Hunting-prevention function disabled<br>1: Hunting-prevention function enabled | 0 or 1 | 1 | No | A | A | No |
| N1-02 | Hunting-prevention gain | Set the hunting-prevention gain multiplication factor. | 0.00 to 2.50 | 1.00 | No | A | A | No |

## ■Adjusting the Hunting-Prevention Gain (N1-02)

Normally it is not necessary to change this setting. Adjust the value under the following circumstances:

- If vibrations occur under light load condition increase the setting.
- If the motor stalls reduce the setting.

## ◆ Stabilizing Speed (Automatic Frequency Regulator)

The speed feedback detection control (AFR) function controls the stability of the speed when a load is suddenly applied by calculating the amount of fluctuation using the torque current (Iq) feedback value, and compensating the output frequency with the amount of fluctuation.

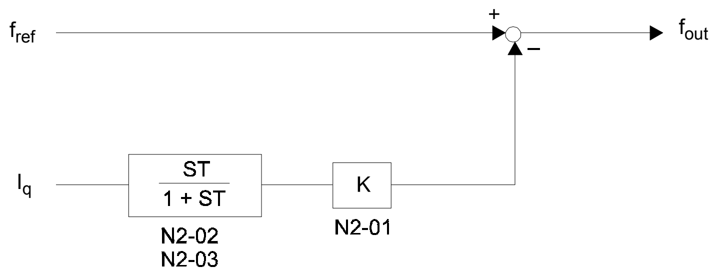



Fig. 6.37  AFR Control Loop

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| N2-01 | Speed feedback detection control (AFR) gain | Sets the internal speed feedback detection control gain. | 0.00 to 10.00 | 1.00 | No | No | No | A |
| N2-02 | Speed feedback detection control (AFR) time constant | Sets the time constant to detect the rate of change in the speed feedback detection control. | 0 to 2000 | 50 ms | No | No | No | A |
| N2-03 | Speed feedback detection control (AFR) time constant 2 | Sets the time constant to detect the amount of change in the speed. | 0 to 2000 | 750 ms | No | No | No | A |

### ■Setting the AFR Gain (N2-01)

Normally there is no need to change this setting.  If adjustments are necessary do the following:

- If hunting occurs increase N2-01.
- If the response is too low, decrease N2-01.

Adjust the setting by 0.05 at a time while checking the response.

### ■Setting the AFR Time Constants 1 and 2 (N2-02, N2-03)

Normally the setting value of N2-02 is used as AFR time constant.  The setting value of N2-03 is used when:

- L2-04 is set to 1 or 2 AND
- output frequency ≥ 5 Hz AND
- a transient load change occurs (causing transient regeneration or overshoot at acceleration).

Generally there is no need to change the settings.

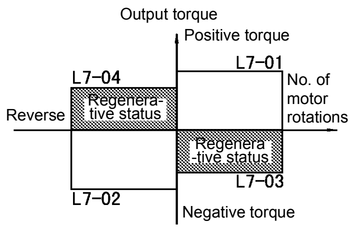
# Machine Protection

## ◆ Limiting Motor Torque (Torque Limit Function)

The motor torque limit function can only be used with open-loop vector control.

This function allows limitation of motor shaft torque independendly for each of the four quadrands.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| L7-01 | Forward drive torque limit | Set the torque limit value as a percent of the motor rated torque.<br>You can set up to four separate limits. | 0 to 300 | 200%* | No | No | No | A |
| L7-02 | Reverse drive torque limit | | 0 to 300 | 200%* | No | No | No | A |
| L7-03 | Forward regenerative torque limit |  | 0 to 300 | 200%* | No | No | No | A |
| L7-04 | Reverse regenerative torque limit | | 0 to 300 | 200%* | No | No | No | A |

* A setting value of 100% is equal to the motor rated torque.

### ■Setting the Torque Limit in Constants

Using L7-01 to L7-04, you can set individually four torque limits in the following directions: Forward drive, reverse drive, forward regeneration, and reverse regeneration.

### ■Set the Torque Limit Value Using an Analog Input

The analog input A2 can also be used to input several torque limits. The table below shows the possible analog input settings (H3-09) for the torque limit function.

| Set Value | Function | 100% of Contents | Control Methods | | |
|---|---|---|---|---|---|
| | | | V/f | V/f with PG | Open Loop Vec-tor |
| 10 | Positive torque limit | Motor rated torque | No | No | Yes |
| 11 | Negative torque limit | Motor rated torque | No | No | Yes |
| 12 | Regenerative torque limit | Motor rated torque | No | No | Yes |
| 15 | Positive/negative torque limit | Motor rated torque | No | No | Yes |

The analog input terminal A2 signal level is factory-set as follows: 4 to 20 mA (20 mA at input, torque limited to 100% motor rated torque). The following figure shows the relationship between the torque limits.

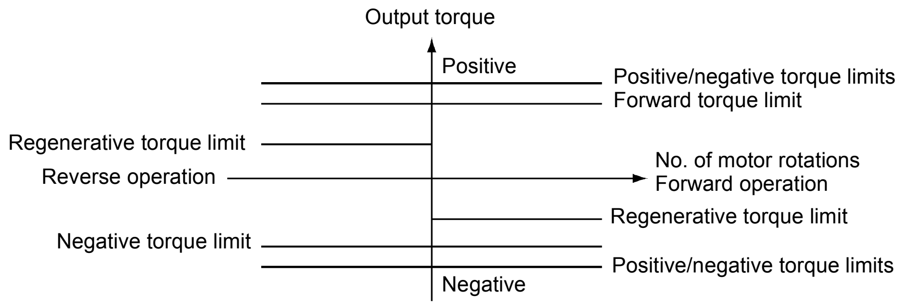



Fig 6.38 Torque Limits using the Analog Input

## ■Setting Torque Limits Using Constants and an Analog Input Together

The following block diagram shows the relationship between torque limit using constants (L7-01 to L7-04) and torque limit using the analog input A2.

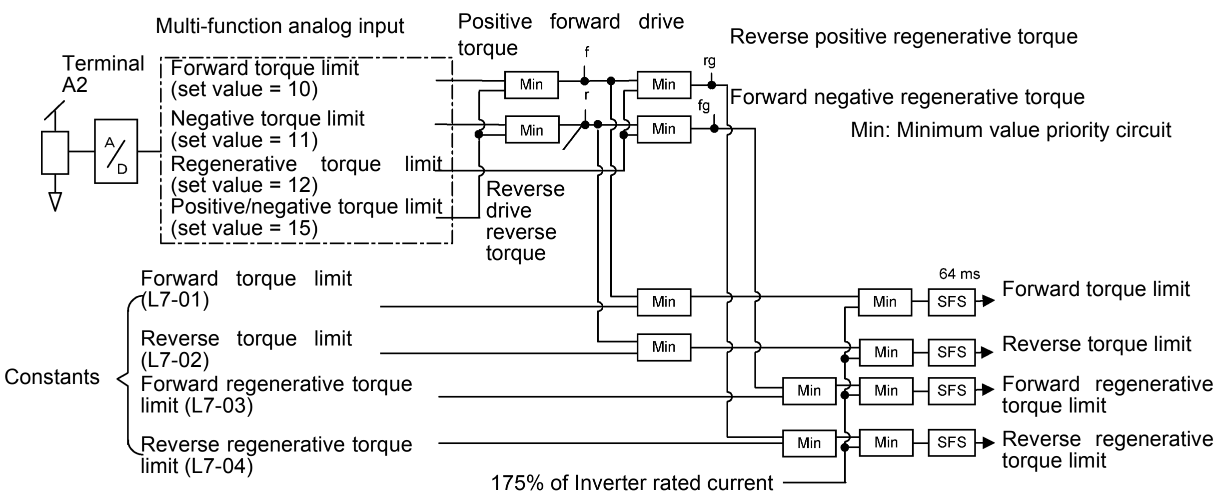



Fig 6.39 Torque Limit Using Constants and an Analog Input Together

## ■Multifunction Output Settings: H2-01 to H2-03 (M1 to M6 Function Selection)

### During Torque Limit: “30”

If a multifunction output is set for this function the output is switched ON when the motor output torque reaches one of the torque limits.

## ■Setting Precautions

- When the output torque reaches the torque limit, control and compensation of the motor speed is disabled to prevent the output torque from exceeding the torque limit. The torque limit has the priority.
- When using the torque limit for hoist applications, do not carelessly lower the torque limit value, as this may result in motor stalling.
- When using an analog input for torque limit setting, an analog input value of 10 V/20 mA is equal to a torque limit of 100% of the motor rated torque. To raise the torque limit value at an analog input of 10 V/20 mA for instance to 150% of the rated torque, set the input terminal gain to 150.0 (%). Adjust the gain for multi-function analog input terminal A2 using H3-10.
- The torque limit accuracy is ±5% at the output frequency of 10 Hz or above. When output frequency is lower than 10 Hz, the accuracy is lowered.

# ◆ Preventing Motor Stalling During Operation

Stall prevention during operation prevents the motor from stalling by automatically lowering the Inverter's output frequency when a transient overload occurs while the motor is operating at a constant speed.

Stall prevention during operation is enabled only in V/f control. If the Inverter output current continues to exceed the setting in constant L3-06 for 100 ms or longer, the motor speed is reduced. Set whether to enable or disable the stall prevention using constant L3-05. Set the according deceleration times using C1-02 (Deceleration time 1) or C1-04 (Deceleration Time 2).

If the Inverter output current reaches the set value in L3-06 – 2%, the motor will accelerate again to the set frequency.

## ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| L3-05 | Stall prevention selection during running function selection | 0: Disabled (Operates according to the setting. Motor may stall when the load is too large.)<br>1: Enabled--Deceleration time 1 (Deceleration time set in C1-02 is used.)<br>2: Enabled--Deceleration time 2 (Deceleration time set in C1-04 is used.) | 0 to 2 | 1 | No | A | A | No |
| L3-06 | Stall prevention level during running | Enabled when L3-05 is set to 1 or 2. Set as a percentage, taking Inverter rated current to be 100%. Normally, there is no need to change this setting. Lower the set value if the motor stalls at the factory setting. | 30 to 200 | 120% * | No | A | A | No |

* The initial value when C6-01 is set to 1 is given. If C6-01 is set to 0, the initial value will be 150%.

## ◆ Changing Stall Prevention Level during Operation Using an Analog Input

If you set H3-09 (Multi-function Analog Input Terminal A2 Function Selection) to 8 (stall prevention during operation level), you can change the stall level during operation using the analog input A2.

If the analog input A2 is used to set the stall prevention level, the function uses either the value from the multi-function analog input terminal A2 input level or the set value in constant L3-06. The lower value of both will be used as stall prevention level.

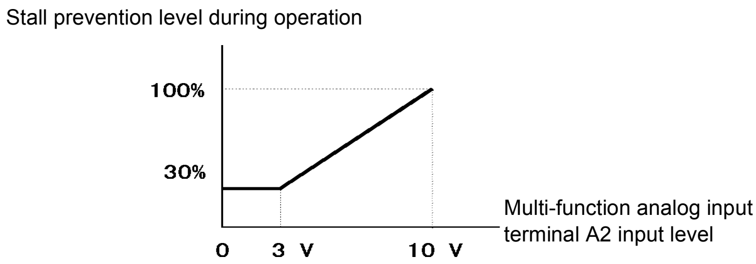



Fig 6.40 Stall Prevention Level during Operation Using an Analog Input

If the motor capacity is smaller than the Inverter capacity or the motor stalls when operating at the factory settings, lower the stall prevention level during operation.

## ◆ Detecting Motor Torque

If an excessive load is applied to the machinery (overtorque) or the load suddenly drops (undertorque), you can output an alarm signal to one of the multi-function output terminal M1-M2, M3-M4, or M5-M6.

To use the overtorque/undertorque detection function, set B, 17, 18, 19 (overtorque/undertorque detection NO/NC) in one of the constant H2-01 to H2-03 (multi-function output terminals M1-M2, M3-M4, and M5-M6 function selection).

The overtorque/undertorque detection level is the current level (taking the inverter rated output current as 100%) in V/f control, and the motor torque (taking the motor rated torque as 100%) in vector control.

## ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| L6-01 | Torque detection selection 1 | 0: Overtorque/undertorque detection disabled.<br>1: Overtorque detection only with speed agreement; operation continues after overtorque (warning is output).<br>2: Overtorque detected continuously during operation; operation continues (warning is output).<br>3: Overtorque detection only with speed agreement; output is stopped upon detection.<br>4: Overtorque detected continuously during operation; output is stopped upon detection.<br>5: Undertorque detection only with speed agreement; operation continues (warning is output).<br>6: Undertorque detected continuously during operation; operation continues (warning is output).<br>7: Undertorque detection only with speed agreement; output is stopped upon detection.<br>8: Undertorque detected continuously during operation; output is stopped upon detection. | 0 to 8 | 0 | No | A | A | A |
| L6-02 | Torque detection level 1 | Open-loop vector control: Motor rated torque is set as 100%.<br>V/f control: Inverter rated current is set as 100%. | 0 to 300 | 150% | No | A | A | A |
| L6-03 | Torque detection time 1 | Set the overtorque/undertorque detection time. | 0.0 to 10.0 | 0.1 s | No | A | A | A |
| L6-04 | Torque detection selection 2 | See L6-01 to L3-03 for a description.<br><br>Output of torque detection 1 is enabled by setting B or 17 for H2-□□ and output of torque detection 2 is enabled by setting 18 or 19 for H2-□□. | 0 to 4 | 0 | No | A | A | A |
| L6-05 | Torque detection level 2 | | 0 to 300 | 150% | No | A | A | A |
| L6-06 | Torque detection time 2 | | 0.0 to 10.0 | 0.1 s | No | A | A | A |

### Multi-function Output (H2-01 to H2-03)

| Set Value | Function | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vec-tor |
| B | Overtorque/undertorque detection 1 NO<br>(NO contact: Overtorque detection and undertorque detection enabled when contact is ON) | Yes | Yes | Yes |
| 17 | Overtorque/undertorque detection 1 NC<br>(NC contact: Overtorque detection and undertorque detection enabled when contact is OFF) | Yes | Yes | Yes |
| 18 | Overtorque/undertorque detection 2 NO<br>(NO contact: Overtorque detection and undertorque detection enabled when contact is ON) | Yes | Yes | Yes |
| 19 | Overtorque/undertorque detection 2 NC<br>(NC contact: Overtorque detection and undertorque detection enabled when contact is OFF) | Yes | Yes | Yes |

## ■L6-01 and L6-04 Set Values and Operator

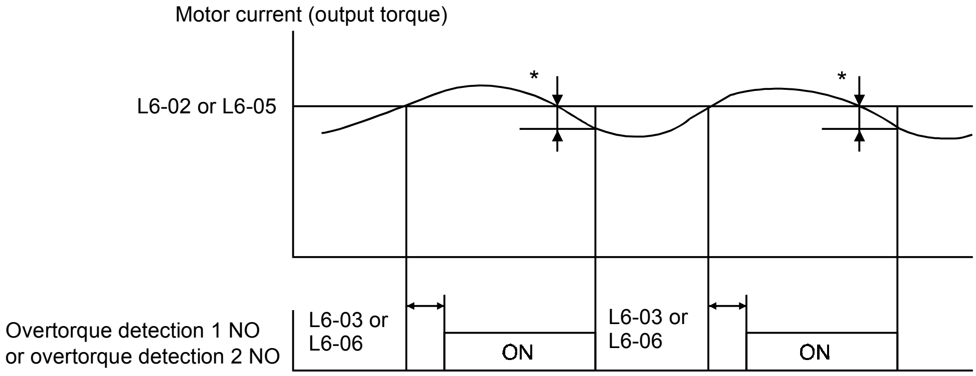
The relationship between alarms displayed on the Digital Operator when overtorque or undertorque is detected, and the set values in L6-01 and L6-04, is shown in the following table.

| Set Value | Function | Operator | |
|---|---|---|---|
| | | Overtorque/ Undertorque Detection 1 | Overtorque/ Undertorque Detection 2 |
| 0 | Overtorque/undertorque detection disabled. | – | – |
| 1 | Overtorque detection only with speed agree; operation continues (warning is output). | OL3 flashes | OL4 flashes |
| 2 | Overtorque detected continuously during operation; operation continues (warning is output). | OL3 flashes | OL4 flashes |
| 3 | Overtorque detection only with speed agree; output is stopped upon detection. | OL3 lights up | OL4 lights up |
| 4 | Overtorque detected continuously during operation; output is stopped upon detection. | OL3 lights up | OL4 lights up |
| 5 | Undertorque detection only with speed agree; operation continues (warning is output). | UL3 flashes | UL4 flashes |
| 6 | Undertorque detected continuously during operation; operation continues (warning is output). | UL3 flashes | UL4 flashes |
| 7 | Undertorque detection only with speed matching; output is stopped upon detection. | UL3 lights up | UL4 lights up |
| 8 | Undertorque detected continuously during operation; output is stopped upon detection. | UL3 lights up | UL4 lights up |

## ■Setting Example

The following diagram shows the time chart for overtorque and undertorque detection.

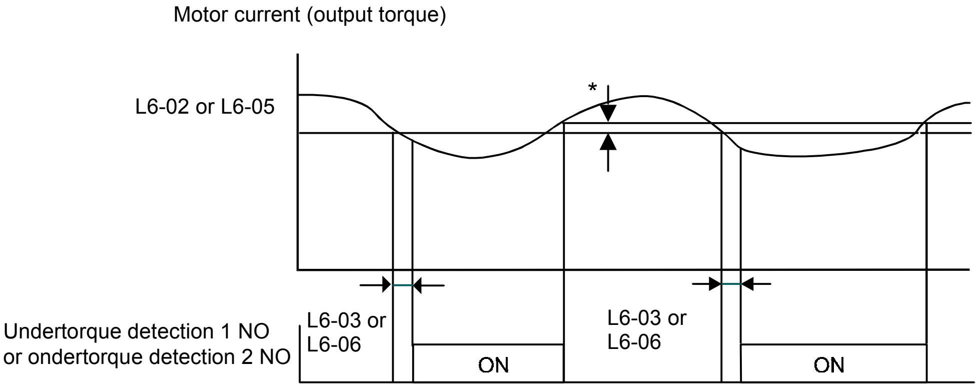
- Overtorque Detection




*Overtorque detection switch off bandwidth is approximately 10% of the Inverter rated output current (or motor rated torque).

6

- Undertorque Detection




*Undertorque detection switch off bandwidth is approximately 10% of the Inverter rated output current (or motor rated torque).

## ◆ Changing Overtorque and Undertorque Detection Levels Using an Analog Input

If constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection) is set to 7 (overtorque/undertorque detection level), the overtorque/undertorque detection level can be changed using the analog input A2 (refer to *Fig 6.41*.

Changing the overtorque/undertorque detection level using the analog input only affects the detection level 1. The overtorque/undertorque detection level 2 cannot be changed by an analog input.

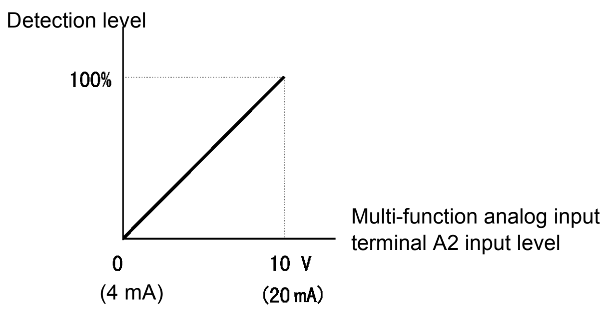



Fig 6.41  Overtorque/Undertorque Detection Level Using an Analog Input

### Multi-Function Analog Input (H3-09)

| Set Value | Function | Content at 100% | Control Methods | | |
|---|---|---|---|---|---|
| | | | V/f | V/f with PG | Open loop Vector |
| 7 | Overtorque/Undertorque Detection Level | Motor rated torque (vector control), Inverter rated current (V/f control) | Yes | Yes | Yes |

## ◆ Motor Overload Protection

The motor can be protected from overload using the Inverter's built-in electronic thermal overload relay function.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| E2-01 | Motor rated current | Sets the motor rated current of motor 1.<br>This set value becomes the base value for motor protection and torque limit. It is an input data for autotuning. | 0.32 to 6.40 *1 | 1.90 A *2 | No | Q | Q | Q |
| E4-01 | Motor 2 rated current | Sets the motor rated current of motor 2.<br>This set value becomes the base value for motor protection and torque limit. It is an input data for autotuning. | 0.32 to 6.40 *1 | 1.90 A *2 | No | A | A | A |
| L1-01 | Motor protection selection | Set to enable or disable the motor overload protection function using the electronic thermal relay.<br>0: Disabled<br>1: General motor protection (fan cooled motor)<br>2: Inverter special motor protection (externally cooled motor)<br>3: Vector motor protection<br>With applications where the power supply is often turned ON and OFF, there is a risk that the circuit cannot be protected even if this constant has been set to 1, because the thermal value will be reset. If multiple motors are connected to one Inverter, set this constant to 0, and install a thermal relay in each motor. | 0 to 3 | 1 | No | Q | Q | Q |
| L1-02 | Motor protection time constant | Set the electronic thermal detection time in minutes.<br>Normally, there is no need to make this setting. The factory setting is 150% overload for 1 min.<br>If the motor overload capability is known, set the overload resistance protection time during hot start to L1-02. | 0.1 to 5.0 | 1.0 min | No | A | A | A |

* 1. The settings range is 10% to 200% of the Inverter rated output current. (The values shown are for a 200 V Class Inverter with 0.4 kW.)
* 2. Factory settings depend on Inverter capacity. (The values shown are for a 200 V Class Inverter with 0.4 kW.)

#### Multi-Function Outputs (H2-01 to H2-03)

| Set Value | Function | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector |
| 1F | Motor overload (OL1, including OH3) pre-alarm (ON: 90% or more of the detection level) | Yes | Yes | Yes |

### ■Setting Motor Rated Current (E2-01 and E4-01)

Set the rated current value on the motor nameplate in constants E2-01 (for motor 1) and E4-01 (for motor 2). This set value is the base current for the internal thermal overload calculation.

6

## ■Setting Motor Overload Protection Characteristics (L1-01)

Set the overload protection function in L1-01 according to the applicable motor.

The induction motor's cooling abilities differ according to the motor type. Consequently, you must select the electronic thermal protection characteristics.

Set L1-01 to:
0: to disable the thermal motor protection function.
1: to enable the thermal motor protection for a fan cooled general purpose motor (self-cooled).
2: to enable the thermal motor protection for an inverter motor (externally cooled).
3: to enable the thermal motor protection for a special vector motor (exernally cooled).

## ■Setting Motor Protection Operation Time (L1-02)

Set the motor protection operation time in L1-02.

The motor protection operation time is the time for that the motor can handle a 150% overload when it was running with the rated load before (i.e. operating temperature was reached before applying the 150% overload). Set the motor protection operation time in L1-02. The factory setting is 60 sec.

The following diagram shows an example of the characteristics of the electronic thermal protection operation time (L1-02 = 1.0 min., operation at 50 Hz, general-purpose motor characteristics, when L1-01 is set to 1)

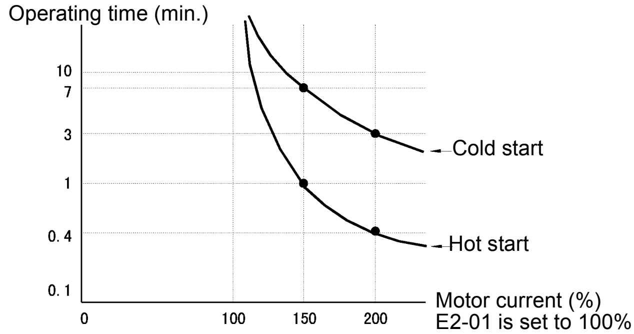



Fig 6.42 Motor Protection Operation Time

## ■Setting Precautions

- If multiple motors are connected to one inverter, set constant L1-01 to 0 (disabled). To protect each of the motors, use a control circuit that switches off the inverter output when one of the motors overheats.
- With applications where the power supply is often turned ON and OFF, there is a risk that the motor cannot be protected even if this constant has been set to 1 (enabled), because the thermal value will be reset after inverter power supply switch off.
- For safe overload tripping, set the value in constant L1-02 to a low setting.
- When using a general-purpose motor (standard motor), the cooling ability will be lowered by $f^{1/4}$ (frequency). Consequently, a low output frequency may cause motor overload protection (OL1) to occur, even when the output current is far below the rated current. If operating using the rated current at a low frequency, use a special motor externally cooled.

## ■Setting the Motor Overload Pre-Alarm

If the motor overload protection function is enabled (i.e., L1-01 is set to other than 0) and you set H2-01 to H2-03 (multi-function output terminals M1-M2, M3-M4, and M5-M6 function selection) to 1F (motor overload OL1 pre-alarm), the motor overload pre-alarm will be enabled. If the electronic thermal value reaches minimum 90% of the overload detection level, the output terminal that has been set will be turned ON.

## ◆ Motor Overheating Protection Using PTC Thermistor Inputs

This function provides a motor overheating protection using a thermistor (PTC characteristic – Positive Temperature Coefficient) that is built into the windings of each motor phase.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| L1-03 | Alarm operation selection during motor overheating | Selects the operation when the input motor temperature (thermistor) input exceeds the alarm detection level (1.17 V).<br>0: Decelerate to stop<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09.<br>3: Continue operation (oH3 on the Digital Operator flashes). | 0 to 3 | 3 | No | A | A | A |
| L1-04 | Motor overheating operation selection | Selects the operation when the motor temperature (thermistor) input exceeds the operation detection level (2.34 V).<br>0: Decelerate to stop<br>1: Coast to stop<br>2: Emergency stop using the deceleration time in C1-09. | 0 to 2 | 1 | No | A | A | A |
| L1-05 | Motor temperature input filter time constant | Sets the delay time constant for the motor temperature (thermistor) input in seconds. | 0.00 to 10.00 | 0.20 s | No | A | A | A |

### ■PTC Thermistor Characteristics

The following diagram shows the characteristics of the PTC thermistor temperature to the resistance value.



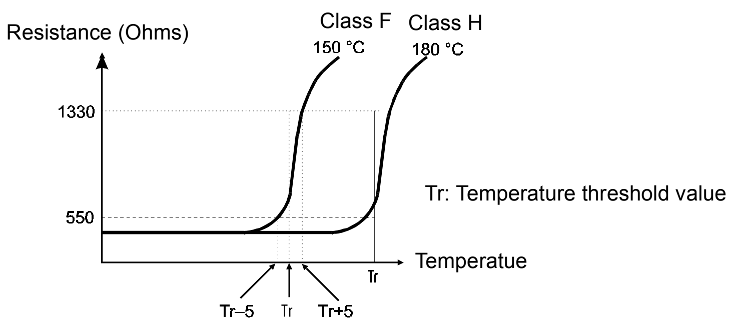



Fig 6.43 PTC Thermistor Temperature-Resistance Value Characteristics*

* The shown resistance value is for one motor phase. Normally the resistors are connected in series.

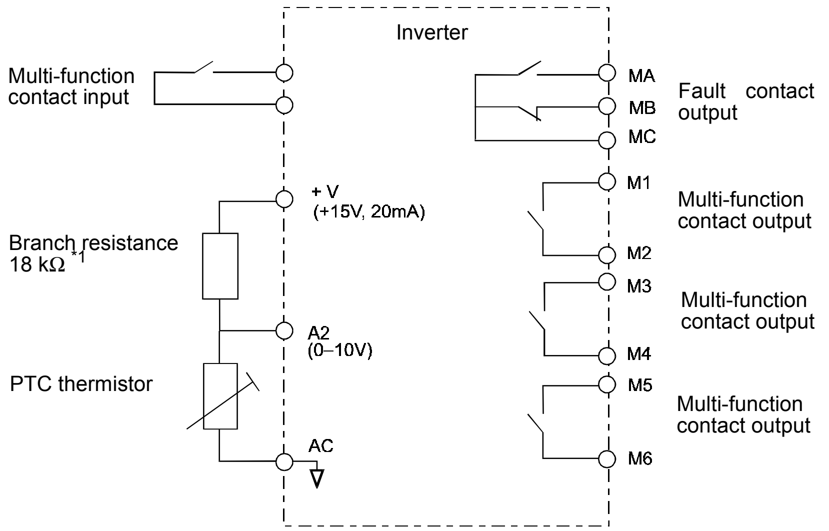
## ■Operation during Motor Overheating

The operation when the motor overheats can be selected using the constants L1-03 and L1-04. Set the motor temperature input filter time constant in L1-05. If the motor overheats, the OH3 and OH4 error codes will be displayed on the Digital Operator.

### Error Codes If the Motor Overheats

| Error Code | Details |
|---|---|
| OH3 | Inverter stops or continues to operate, according to the setting in L1-03. |
| OH4 | Inverter stops according to the setting in L1-04. The fault contact is activated |

By setting H3-09 (Multi-function Analog Input Terminal A2 Function Selection) to E (Motor temperature input) the motor temperature can be detected and OH3 respectively OH4 can be output if the motor overheats. The terminal connections that are to be used are shown in *Fig 6.44*.




*1 The resistance value of 18 kΩ is only valid when a 3-phase PTC with the characteristic shown on the previous page is used.

Fig 6.44 Terminal Connections for Motor Overheating Protection

### Setting Precautions

- Because this function uses a voltage signal to terminal A2, pin 2 of the DIP-switch S1 on the control terminal board has to be turned to OFF for A2 voltage input. The factory setting is ON (A2 current input).
- For the same reason the parameter H3-08 (analog input terminal A2 signal level) has to be set to 0 (0-10V input).

## ◆ Limiting Motor Rotation Direction and Output Phase Rotation

If the motor reverse rotation is prohibited, a reverse run command will not be accepted, even if it is input. Use this setting for applications in which reverse motor rotation can cause problems (e.g., fans, pumps, etc.)

In V/F mode it is also possible to change the output phase order by changing a parameter. This much easier and faster than changing the wiring if the motor rotational direction is wrong. If this function is used a prohibition of reverse direction is not possible.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b1-04 | Prohibition of reverse operation | 0: Reverse enabled<br>1: Reverse disabled | 0 or 2 | 0 | No | A | A | A |
| | | 2: Output Phase Rotation | | | | A | No | No |

# Automatically Restart

This section explains functions for continuing or automatically restarting Inverter operation after a momentary power loss.

## ◆ Restarting Automatically After Momentary Power Loss

After a momentary power loss, the Inverter can be restarted automatically to continue motor operation.

To restart the Inverter after power is recovered, set L2-01 to 1 or 2.

If L2-01 is set to 1, the inverter will restart, when power is recovered within the time set in L2-02. If the power loss time exceeds the time set in L2-02, an UV1 alarm (DC bus undervoltage) will be detected.

If L2-01 is set to 2, the inverter will restart, when the main power supply is recovered as long as the control power supply (i.e., power supply to the control circuit) is maintained. Consequently, alarm UV1 (DC bus undervoltage) will not be detected.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| L2-01 | Momentary power loss detection | 0: Disabled (DC bus undervoltage (UV) detection)<br>1: Enabled (Restarted when the power returns within the time for L2-02. When L2-02 is exceeded, DC bus undervoltage detection.)<br>2: Enabled while CPU is operating. (Restarts when power returns during control operations. Does not detect DC bus undervoltage.) | 0 to 2 | 0 | No | A | A | A |
| L2-02 | Momentary power loss ridethru time | Ridethrough time, when momentary power loss selection (L2-01) is set to 1. | 0 to 2.0 | 0.1 s *1 | No | A | A | A |
| L2-03 | Min. baseblock (BB) time | Sets the Inverter's minimum baseblock time; when the Inverter is restarted after power loss ridethrough.<br>Sets the time to approximately 0.7 times of the motor time constant.<br>When an overcurrent or overvoltage occurs when starting a speed search or DC injection braking, increase the set values. | 0.1 to 5.0 | 0.1 s | No | A | A | A |
| L2-04 | Voltage recovery time | Sets the time required to return the Inverter output voltage from 0 V to normal voltage at the completion of a speed search. | 0.0 to 5.0 | 0.3 s *1 | No | A | A | A |
| L2-05 | Undervoltage (UV) detection level | Sets the main circuit undervoltage (UV) detection level (main circuit DC voltage).<br>Usually changing this setting is not necessary. | 150 to 210 *2 | 190 V *2 | No | A | A | A |

* 1. Factory settings depend on Inverter capacity. (The values shown are for a 200 V Class Inverter for 0.4 kW.)
* 2. These values are for a 200 V Class Inverter. For a 400 V Class Inverter, double the values.

### ■Setting Precautions

- Error output signals are not output during momentary power loss recovery.
- To continue Inverter operation after power has been restored, make settings so that RUN commands from the control main circuit terminal are stored even while power is suspended.
- If the momentary power loss operation selection is set to 0 (Disabled), an alarm UV1 (main circuit undervoltage) will be detected when the momentary power loss exceeds 15 ms during operation.

## ◆ Speed Search

The speed search function finds the actual speed of a motor that is coasting without control, and then starts smoothly from that speed. It is also activated after momentary power loss detection when L2-01 is set to enabled.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| b3-01 | Speed search selection (current detection or speed calculation) | Enables/disables the speed search function for the RUN command and sets the speed search method.<br>0: Disabled, speed calculation<br>1: Enabled, speed calculation<br>2: Disabled, current detection<br>3: Enabled, current detection<br>Speed Calculation<br>When the search is started, the motor speed is calculated and acceleration/deceleration is performed from the calculated speed to the specified frequency (motor direction is also searched).<br>Current Detection<br>The speed search is started from the frequency when power was momentarily lost or the maximum frequency, and the speed is detected when the set search current level is reached. | 0 to 3 | 2*1 | No | A | A | A |
| b3-02 | Speed search operating current (current detection) | Sets the speed search operation current as a percentage, taking the Inverter rated current as 100%.<br>Usually not necessary to set. When restarting is not possible with the factory settings, reduce the value. | 0 to 200 | 120% | No | A | No | A |
| b3-03 | Speed search deceleration time (current detection) | Sets the output frequency deceleration time during speed search.<br>Sets the time for deceleration from the maximum output frequency to the minimum output frequency. | 0.1 to 10.0 | 2.0 s | No | A | No | A |
| b3-05 | Speed search wait time (current detection or speed calculation) | When a speed search is performed after recovering from a momentary power loss, the search operation is delayed for the time set here.<br>If e.g. a contactor is used at the output side of the inverter set this constant to the contactor delay time or more. | 0.0 to 20.0 | 0.2 s | No | A | A | A |
| L2-03 | Min. baseblock time | Sets the Inverter's minimum baseblock time, when the inverter is restarted after power loss ridethrough.<br>Set the time to approximately 0.7 times the motor time constant.<br>If an overcurrent or undercurrent occurs when starting a speed search or DC injection braking, increase the set values. | 0.1 to 5.0 | 0.1 s *1 | No | A | A | A |
| L2-04 | Voltage recovery time | Sets the time required to return the Inverter output voltage to normal voltage at the completion of a speed search.<br>Sets the time required to recover from 0 V to the maximum voltage. | 0.0 to 5.0 | 0.3 s*2 | No | A | A | A |

* 1. The factory setting will change when the control method is changed. (Open loop vector control factory settings are given.)
* 2. Factory settings depend on Inverter capacity. (The values shown are for a 200 V Class Inverter for 0.4 kW.)

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**Multi-function Contact Inputs**

| Set Value | Function | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector |
| 61 | External search command 1<br>OFF: Speed search disabled (Start from lowest output frequency)<br>ON: Speed calculation (Calculates the motor speed, and starts search from calculated speed)<br>Current detection (Starts speed search from maximum output frequency) | Yes | No | Yes |
| 62 | External search command 2<br>OFF: Speed search disabled (Start from lowest output frequency)<br>ON: Speed calculation (Calculates the motor speed, and starts search from calculated speed) (Same operation as external search command 1)<br>Current detection: Starts speed search from set frequency (reference frequency when search command was input). | Yes | No | Yes |
| 64 | External seach command 3<br>OFF: Inverter is base blocked<br>ON: Inverter starts operation using speed search (same operation as speed search 2) | Yes | Yes | Yes |

## ■Setting Precautions

- When both external search commands 1 and 2 are set for the multi-function contact terminals, an OPE03 (invalid multi-function input selection) operation error will occur. Set either external search command 1 or external search command 2.
- If speed search during startup is selected when using V/f control with PG, the unit will start from the frequency detected by PG.
- If performing speed search using external search commands, design the control circuit so that the run command and external search command are both ON. These two commands must be kept on, at least for the time set in parameter L2-03.
- If the Inverter output is equipped with a contactor, set the contactor operation delay time in the Speed Search Wait Time (b3-05). The factory setting is 0.2 s. When not using a contactor, you can reduce the search time to 0.0 s. After waiting for the speed search wait time, the Inverter starts the speed search.
- Constant b3-02 (current detection level for search completion) is effective only when current detection speed search is selected. When the current falls below the detection level, the speed search is supposed to be as completed, and the motor accelerates or decelerates to the set frequency.
- If an overcurrent (OC) is detected when using speed search after power recovery, lengthen the Minimum Baseblock Time (L2-03).

## ■Application Precautions for Speed Searches Using Estimated Speed

- When using V/f control with or without a PG, always perform stationary autotuning for line-to-line resistance before using speed searches based on calculated speeds.
- When using open loop vector control, always perform rotational autotuning before using speed searches based on calculated speeds.
- If the cable length between the motor and Inverter is changed after autotuning has been performed, perform stationary autotuning for line-to-line resistance again.

## ■Speed Search Selection

The speed search method can be selected using b3-01. If b3-01 is set to 0 the search method is speed calculation. It has to be activated by a multi-function input (H1-☐☐ set to 61 or 62).

If b3-01 is set to 1, the search method is speed calculation too, but speed search is performed at every RUN command and has not to be activated by a multifunction input.

The same is valid for setting b3-01 to 2 or 3, only the search method is current detection and not speed calculation.

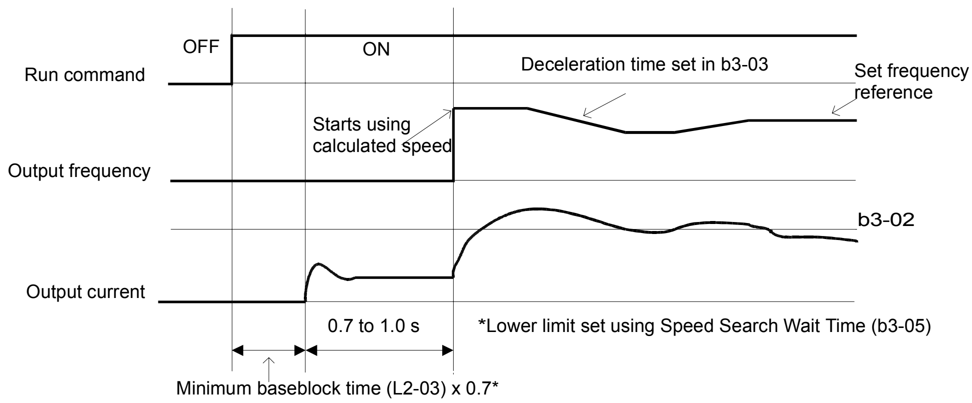
Table 6.1 Search Methods

| Search Name | Speed Calculation | Current Detection |
|---|---|---|
| Search Method | Calculates the motor speed when the search starts, and accelerates or decelerates from the calculated speed to the set frequency. The direction of motor rotation is also detected. | Starts speed search from the frequency when the temporary power loss was detected, or from the highest frequency, and performs speed detection by watching the current level during the search. |
| External Speed Search Command | External search command 1 and external search command 2 become the same operation calculation of the motor speed and starting the search from the calculated speed. | External speed search command 1:<br>Starts speed search from the maximum output frequency.<br>External speed search command 2:<br>Starts speed search from the frequency reference set before the search command. |
| Application Precautions | Cannot be used with multi-motor drives, with motors two or more sizes smaller than the Inverter capacity, and high-speed motors (130 Hz min.) | In control method without PG, the motor may accelerate suddenly with light loads. |

## ■Speed Calculation

### Search at Startup

The time chart for when speed search at startup and speed search to multi-function input terminals is shown below.




Note: If the stopping method is set to coast to stop, and the run command turns ON in a short time, the operation may be the same as the search in case 2.

Fig 6.45 Speed Search at Startup (Calculated Speed)

## Speed Search after Short Baseblock (during Power Loss Recovery, etc.)

- Loss Time shorter than the Minimum Baseblock Time (L2-03)

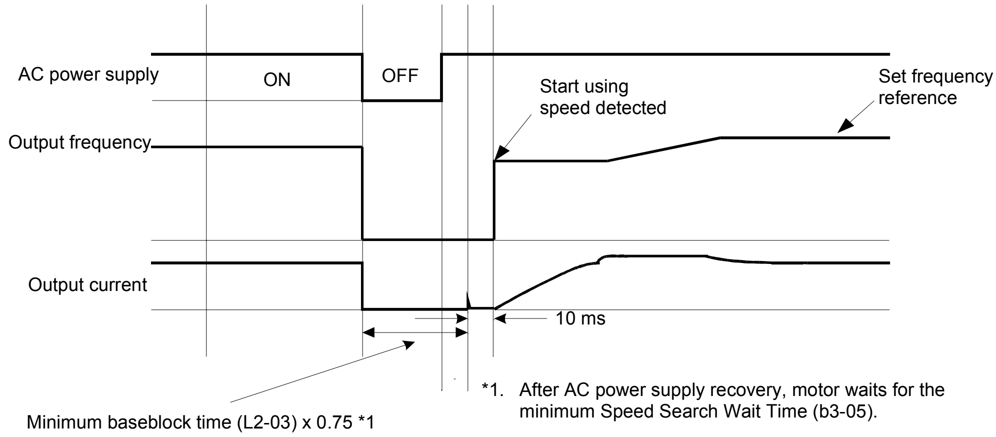



Fig 6.46 Speed Search after Baseblock (Calculated Speed: Loss Time Is Set in L2-03)

- Loss Time longer than the Minimum Baseblock Time (L2-03)

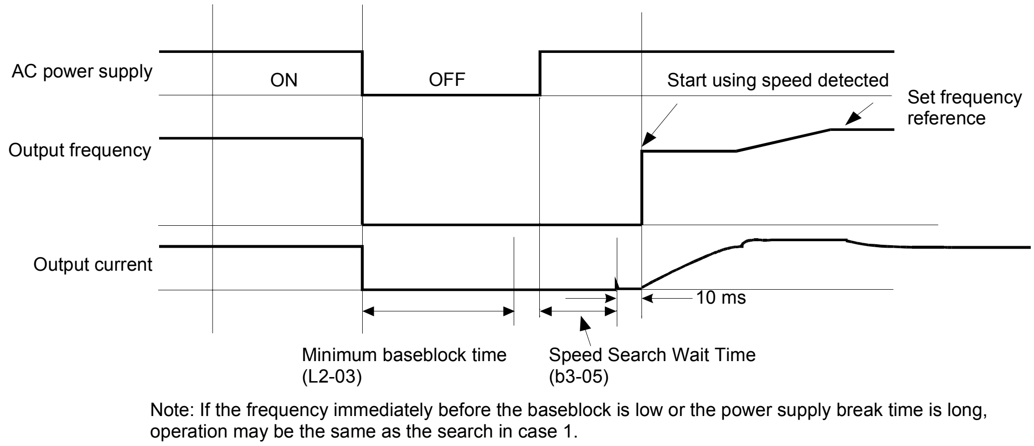



Fig 6.47 Speed Search after Baseblock (Calculated Speed: Loss Time > L2-03)

## ■Current Detection

### Speed Search at Startup

The time chart when speed search at startup or external speed search command is selected is shown below.

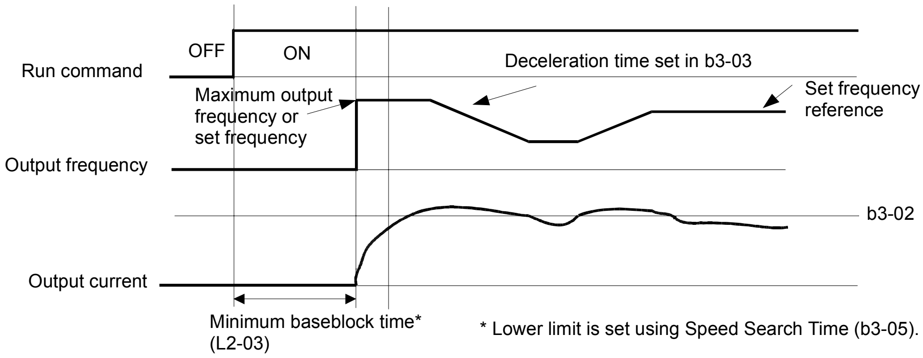



Fig 6.48 Speed Search at Startup (Current Detection)

### Speed Search after Short Baseblock (during Power Loss Recovery, etc.)

- Loss time shorter than minimum baseblock time

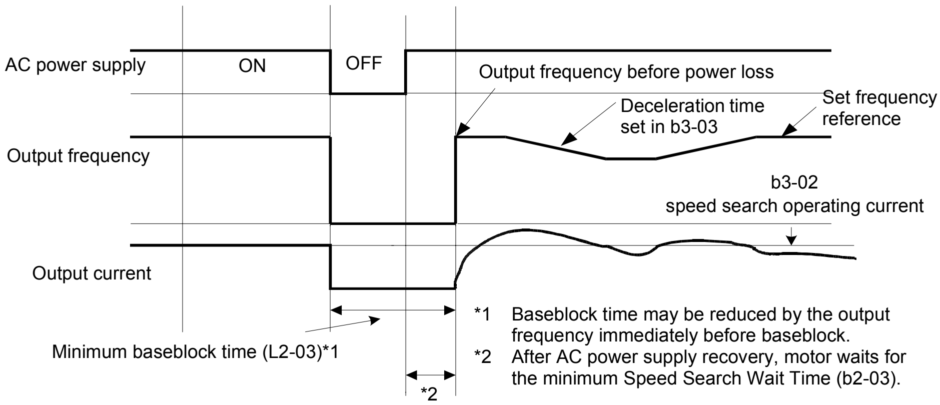



Fig 6.49 Speed Search After Baseblock (Current Detection: Loss Time < L2-03)

- Loss time longer than minimum baseblock time

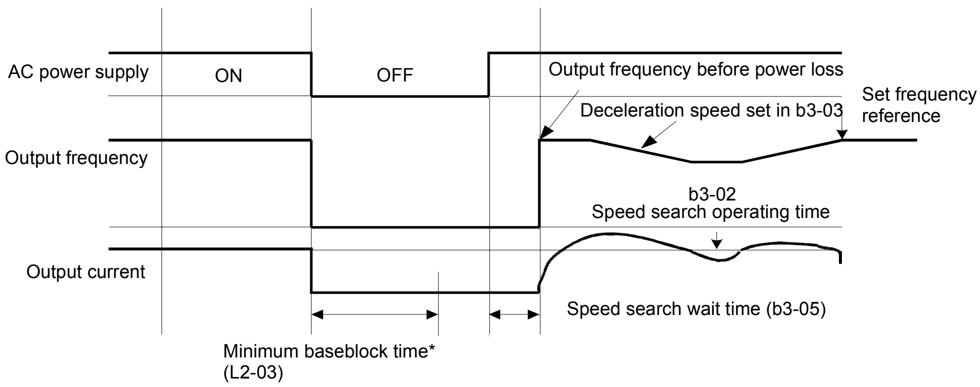



Fig 6.50 Speed Search After Baseblock (Current Detection: Loss Time > L2-03)

6

## ◆ Continuing Operation at Constant Speed When Frequency Reference Is Lost

The frequency reference loss detection function can be used to continue operation at reduced speed using the set value in parameter L4-06 as frequency reference value. When using an analog input as frequency reference source, a frequency reference loss is detected, when the reference value drops over 90 % in 400 ms or less.

When an error signal during frequency reference loss shall be output externally, set H2-01 to H2-03 (multi-function contact output terminal M1-M2, M3-M4, and M5-M6 function selection) to C (frequency reference lost).

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| L4-05 | Operation when frequency reference is missing | 0: Stop<br>1: Operation (L4-06*fref@loss) inverter runs with reduced speed.<br>Frequency reference loss means that the frequency reference drops over 90% in 400 ms. | 0 or 1 | 0 | No | A | A | A |
| L4-06 | Output frequency adjust-ment after freq. reference loss | If L4-05 is set to 1 and the reference is lost, inverter will run at:<br>fout = L4-06*fref<br>before lossing. | 0 – 100% | 80% | No | A | A | A |

## ◆ Restarting Operation After Transient Error (Auto Restart Function)

If an Inverter error occurs during operation, the Inverter will perform self-diagnosis. If no error is detected, the Inverter will automatically restart. This is called the auto restart function.

Set the number of auto restarts in constant L5-01.

The auto restart function can be applied to the following errors.

- OC (Overcurrent)
- GF (Ground fault)
- PUF (DC bus fuse blown)
- OV (Main circuit overvoltage)
- UV1 (Main Circuit Undervoltage, Main Circuit MC Operation Failure)*
- PF (Main circuit voltage fault)
- LF (Output phase failure)
- RH (Braking resistor overheated)
- RR (Braking transistor error)
- OL1 (Motor overload)
- OL2 (Inverter overload)
- OH1 (Motor overheat)
- OL3 (Overtorque)
- OL4 (Overtorque)

* When L2-01 is set to 1 or 2 (continue operation during momentary power loss)

If an error that is not listed above occurs, the protection function will operate and the auto restart function will not work.

### ■Auto Restart External Outputs

To output auto restart signals externally, set H2-01 to H2-03 (multi-function contact output terminals M1-M2, M3-M4, and M5-M6 function selection) to 1E (auto restart).

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| L5-01 | Number of auto restart attempts | Sets the number of auto restart attempts.<br>Automatically restarts after a fault and conducts a speed search from the run frequency. | 0 to 10 | 0 | No | A | A | A |
| L5-02 | Auto restart operation selection | Sets whether a fault contact output is activated during fault restart.<br>0: Not output (Fault contact is not activated.)<br>1: Output (Fault contact is activated.) | 0 or 1 | 0 | No | A | A | A |

### ■ Application Precautions

The number of auto restarts counter is reset under the following conditions:

- After auto restart, normal operation has continued for 10 minutes.
- After the protection operation has been performed and an error reset has been input.
- After the power supply is turned OFF, and then ON again.

Do not use the auto restart function for hoisting applications.

6

# Inverter Protection

## ◆ Overheating Protection for an Inverter-Mounted Braking Resistor

This function provides overheat protection for inverter-mounted braking resistors (Model: ERF-150WJ □□).

When overheating of a mounted braking resistor is detected, an fault RH (mounted braking resistor overheating) is displayed on the Digital Operator, and the motor coasts to stop.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| L8-01 | Protection selection for internal DB resistor (Type ERF) | 0: Disabled (no overheating protection)<br>1: Enabled (overheating protection) | 0 or 1 | 0 | No | A | A | A |

#### Multi-function Contact Outputs (H2-01 to H2-03)

| Set Value | Details | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector |
| D | Braking resistor fault (ON: Resistor overheats or brake transistor fault) | Yes | Yes | Yes |

Note: This function is not applicable for protecting external DB resistors. When external braking resistors are used together with the internal braking chopper, L8-01 should be set to 0 to disable the internal DB resistor protection.

**INFO**

The most likely causes of RH (Mounted braking resistor overheating) faults are that the deceleration time is too short or that the motor regeneration energy is too large. In these cases, lengthen the deceleration time or replace the Braking Resistor with one with a higher braking capacity.

## ◆ Inverter Overheat Protection

The Inverter is protected against overheating using a thermistor that detects the heatsink temperature.

When the overheat temperature level is reached the inverter output is switched off.

To prevent a suddenly and unexpected stop of the inverter due to an overtemperature, an overheating pre-alarm can be output. The temperature level for that pre-alarm can be set in constant L8-02. Using constant L8-03 the inverter operation when an overtemperature occurs can be selected.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| L8-02 | Overheat pre-alarm level | Sets the detection temperature for the Inverter overheat detection pre-alarm in °C.<br>The pre-alarm is detected when the cooling fin temperature reaches the set value. | 50 to 130 | 95°C | No | A | A | A |
| L8-03 | Inverter overheat (OH) pre-alarm operation selection | Sets the operation for when the Inverter overheat pre-alarm goes ON.<br>0: Decelerate to stop in deceleration time C1-02.<br>1: Coast to stop<br>2: Fast stop in fast-stop time C1-09.<br>3: Continue operation (Monitor display only.)<br>A fault will be given in setting 0 to 2 and a minor fault will be given in setting 3. | 0 to 3 | 3 | No | A | A | A |

### ■Multifunction Output Settings: H2-01 to H2-03 (M1 – M6 Function Selection)

#### Inverter Overheat Pre-Alarm: “20”

If a multifunction output is programmed for this function the output is switched ON when the heatsink temperature exceeds the overheat pre-alarm level set in L8-02.

6

## ◆ Input Open Phase Protection

This function detects an open input phase by observing the DC bus ripple level.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-05 | Input open-phase protection selection | 0: Disabled<br>1: Enabled (Detects input current open-phase, power supply voltage imbalance or DC bus electrostatic capacitor deterioration.) | 0 or 1 | 1 | No | A | A | A |

Generally it is not recommended to disable this function.

## ◆ Output Open Phase Protection

This function detects an open output phase by comparing the output current value of each phase with an internal set output open phase detection level (5% of inverter rated current). The detection will not work when the output frequency is below 2% of the base frequency (E1-13).

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-07 | Output open-phase protection selection | 0: Disabled<br>1: Enabled (Output open-phase detected at less than 5% of Inverter rated current.) | 0 or 1 | 0 | No | A | A | A |

Normally there is no need to change the setting.

Anyway the function should be disabled if the motor capacity is very low compared to the inverter capacity. Otherwise wrong output open phase errors could be detected.

## ◆ Ground Fault Protection

This function detects the earth leakage current by calculating the sum of the three output currents. Normally it should be 0. If the earth leakage current gets too high, the inverter output will be switched off and a GF fault is shown on the display. The fault contact is activated.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-09 | Ground protection selection | 0: Disabled<br>1: Enabled | 0 or 1 | 1 | No | A | A | A |

It is not recommended to disable this function.

## ◆ Cooling Fan Control

This function controls the fan that is mounted to the inverters heatsink.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-10 | Cooling fan control selection | Sets the ON/OFF control for the cooling fan.<br>0: ON only when inverter output is active.<br>1:ON whenever power is ON. | 0 or 1 | 0 | No | A | A | A |
| L8-11 | Cooling fan control delay time | Sets the time in seconds to delay turning OFF the cooling fan after the inverter STOP command is given. | 0 to 300 | 60 s | No | A | A | A |

### ■Selecting the Cooling Fan Control

Using constant L8-10 two modes can be selected:

0: The fan is ON only when the inverter output is ON, i.e. a voltage is output. This is the factory setting.

1: The fan is ON whenever the inverter power supply is switched ON.

If L8-10 is set to 0, the turn OFF delay time for the fan can be set in constant L8-11. After a stop command the inverter waits for this time before switching OFF the cooling fan. The factory setting is 60 sec.

## ◆ Setting the Ambient Temperature

The overload capability of the inverter depends on the ambient temperature. At ambient temperatures higher than 45°C (40°C for IP20/NEMA1 types) the output current capacity is reduced, i.e. the OL2 alarm level will be lowered.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-12 | Ambient temperature | Sets the ambient temperature. | 45 to 60 | 45 °C | No | A | A | A |

The ambient temperature must be set in constant L8-12.

## ◆ OL2 Characteristics at Low Speed

At output frequencies below 6 Hz the overload capability of the inverter is lower than at higher speeds, i.e. an OL2 fault (inverter overload) may occure even if the current is below the normal OL2 current level (see *Fig. 6.51*).

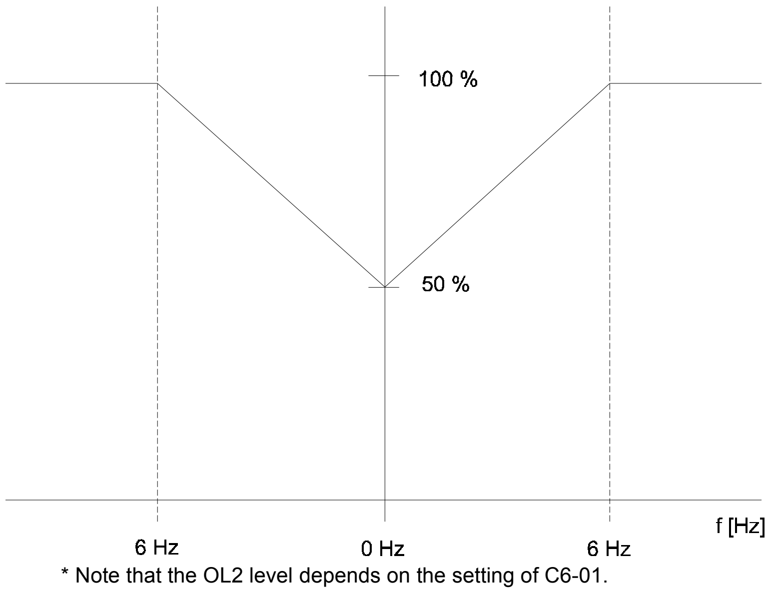



Fig. 6.51  OL2 Alarm Level at Low Frequencies

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-15 | OL2 characteristics selection at low speeds | 0: OL2 characteristics at low speeds disabled.<br>1: OL2 characteristics at low speeds enabled. | 0 or 1 | 1 | No | A | A | A |

Generally it is not recommended to disable this function.  Otherwise the inverter life time might be shortened.

## ◆ Soft CLA Selection

Soft CLA is a current detection level for the output IGBT protection.  Using constant L8-19 Soft CLA can be enabled or disabled.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L8-18 | Soft CLA selection | 0: Disable (gain = 0)<br>1: Enable | 0 or 1 | 1 | No | A | A | A |

It is absolutely not recommended to disable this function.

# Input Terminal Functions

## ◆ Temporarily Switching Operation between Digital Operator and Control Circuit Terminals

You can switch the Inverter run command inputs and frequency reference inputs between local (i.e., Digital Operator) and remote (input method set in b1-01 and b1-02).

If any input from H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection) has been set to 1 (local/remote selection), this input can be used to switch over between local and remote.

To set the frequency reference source and RUN command source to control circuit terminals, set b1-01 and b1-02 to 1.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b1-01 | Reference selection | Sets the frequency reference input method.<br>0: Digital Operator<br>1: Control circuit terminal (analog input)<br>2: MEMOBUS communications<br>3: Option Card<br>4: Pulse input | 0 to 4 | 1 | No | Q | Q | Q |
| b1-02 | RUN command source selection | Sets the run command input method<br>0: Digital Operator<br>1: Control circuit terminal (digital multifunction inputs)<br>2: MEMOBUS communications<br>3: Option Card | 0 to 3 | 1 | No | Q | Q | Q |



**INFO**

You can also perform local/remote switching using the LOCAL/REMOTE key on the Digital Operator. When the local/remote function has been set for one external terminal, the LOCAL/REMOTE key function on the Digital Operator will be disabled.

## ◆ Blocking Inverter Outputs (Baseblock Commands)

Set 8 or 9 (Baseblock command NO/NC) in one of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection) to perform baseblock commands using the terminal's ON/OFF operation, and thereby to block the inverter output.

Clear the baseblock command to restart the operating using the speed search method set in b3-01 (speed search selection).

### Multi-function Contact Inputs (H1-01 to H1-05)

| Set Value | Function | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vector |
| 8 | External baseblock NO (Normally Open contact: Baseblock when ON) | Yes | Yes | Yes |
| 9 | External baseblock NC (Normally Closed contact: Baseblock when OFF) | Yes | Yes | Yes |

### ■Time Chart

The time chart when using a baseblock command is shown below.

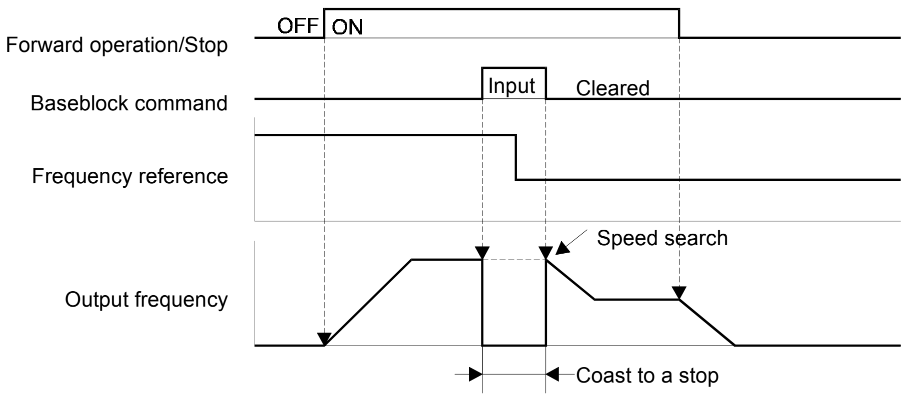



Fig 6.52 Baseblock Commands

**IMPORTANT**

If using baseblock commands with a variable load, do not frequently input baseblock commands during operation, as this may cause the motor to suddenly start coasting, and may result in motor stalling.
• When a contactor between inverter and motor is used, always perform a base block command before opening the contactor.

## ◆ OH2 (Overheat) Alarm Signal Input

If a digital input is programmed for this function (H1-☐☐ = B) an OH2 alarm message can be displayed on the display by turning this input to ON. The fault contact will not be operated.

## ◆ Multifunction Analog Input A2 Disable/Enable

If a digital input is programmed for this function (H1-☐☐ = C) the analog input A2 can be enabled or disabled by switching the digital input ON/OFF (ON – Analog Input A2 enabled).

## ◆ Drive Enable/Disable

If a digital input is programmed for this function (H1-☐☐ = 6A) the drive can be enabled or disabled by switching the digital input ON/OFF (ON – Drive enabled).

If the input is switched OFF while a RUN command is active the inverter will stop using the stopping method set in b1-03.

## ◆ Stopping Acceleration and Deceleration (Acceleration/Deceleration Ramp Hold)

- With this setting, the multi-function input pauses acceleration or deceleration and maintains (holds) the output frequency.
- Acceleration/deceleration is restarted when the acceleration/deceleration ramp hold input is turned OFF.
- The motor will be stopped if a stop command is input while the acceleration/deceleration ramp hold input is ON.
- When constant d4-01 (the frequency reference hold function selecton) is set to 1, the held frequency will be stored in memory. This stored frequency will be retained as frequency reference even after a power loss and the motor will be restarted at this frequency when a run command is input again.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| d4-01 | Frequency reference hold function selection | Sets whether or not frequencies will be recorded on hold command.<br>0: Disabled (when operation is stopped or the power is turned ON again the frequency reference is set to 0.)<br>1: Enabled (when operation is stopped or the power is turned ON again the inverter starts at the previous hold frequency.)<br>This function is available when the multi-function inputs “Accel/Decel Ramp Hold” or “Up/Down” commands are set. | 0 or 1 | 0 | No | A | A | A |

### ■Time Chart

The time chart when using Acceleration/Deceleration Ramp Hold commands is given below.

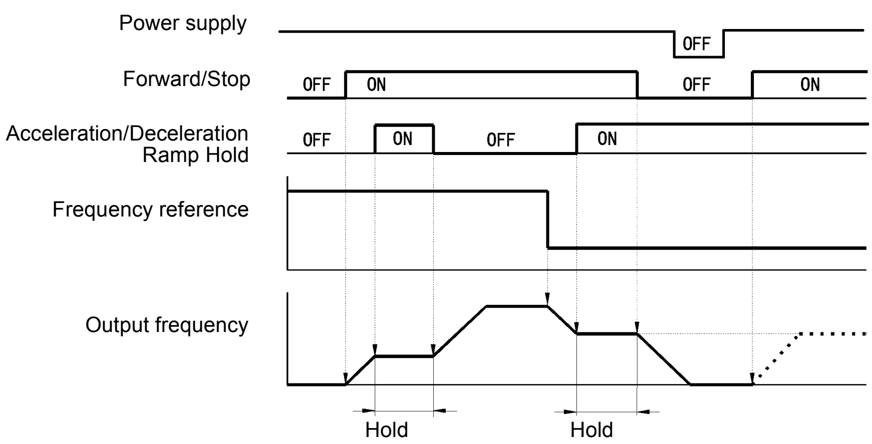



Fig 6.53 Acceleration/Deceleration Ramp Hold

## ◆ Raising and Lowering Frequency References Using Contact Signals (UP/DOWN)

The UP and DOWN commands raise and lower Inverter frequency references by turning ON and OFF a multi-function contact input terminal S3 to S7.

To use this function, set two of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection) to 10 (UP command) and 11 (DOWN command). Be sure to allocate two terminals so that the UP and DOWN commands are used as a pair. Otherwise an OPE03 alarm will be displayed.

The table below shows the possible combinations of the UP and DOWN command and the corresponding operation.

| Operation | Acceleration | Deceleration | Hold | Hold |
|---|---|---|---|---|
| Up command | ON | OFF | ON | OFF |
| Down command | OFF | ON | ON | OFF |

The change of the output frequency depends on the acceleration and deceleration times. Be sure to set b1-02 (Run command selection) to 1 (Control circuit terminal).

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| d2-01 | Frequency reference upper limit | Sets the frequency reference upper limit as a percent, taking the maximum output frequency to be 100%. | 0.0 to 110.0 | 100.0% | No | A | A | A |
| d2-02 | Frequency reference lower limit | Sets the frequency reference lower limit as a percentage of the maximum output frequency. | 0.0 to 110.0 | 0.0% | No | A | A | A |
| d2-03 | Master speed reference lower limit | Sets the master speed frequency reference lower limit as a percent, taking the maximum output frequency to be 100%. | 0.0 to 110.0 | 0.0% | No | A | A | A |

### ■Precautions

#### Setting Precautions

If multi-function input terminals S3 to S7 are set as follows, operation error OPE03 (Invalid multi-function input selection) will occur:

- Only either the UP command or DOWN command has been set.
- UP/DOWN commands and Acceleration/Deceleration Ramp Hold have been allocated at the same time.

### Application Precautions

- Frequency outputs using UP/DOWN commands are limited by the frequency reference upper and lower limits set in constants d2-01 to d2-03. Here, the frequency value from analog frequency reference input A1 becomes the frequency reference lower limit. If using a combination of the frequency reference from terminal A1 and the frequency reference lower limit set in either constant d2-02 or d2-03, the larger limit value will become the frequency reference lower limit.
- If inputting the run command when using UP/DOWN commands, the output frequency accelerates to the frequency reference lower limits set in d2-02.
- When using UP/DOWN commands, multi-step operations are disabled.
- When d4-01 (Frequency Reference Hold Function Selection) is set to 1, the frequency reference value using the UP/DOWN functions is stored even after the power supply is turned OFF. When the power supply is turned ON and the run command is input, the motor accelerates to the frequency reference that has been stored. To reset (i.e., to 0 Hz) the stored frequency reference, turn ON the UP or DOWN command while the run command is ON.

## ■Connection Example and Time Chart

The time chart and settings example when the UP command is allocated to the multi-function contact input terminal S3, and the DOWN command is allocated to terminal S4, are shown below.

| Constant | Name | Set Value |
|---|---|---|
| H1-01 | Multi-function input (terminal S3) | 10 |
| H1-02 | Multi-function input (terminal S4) | 11 |

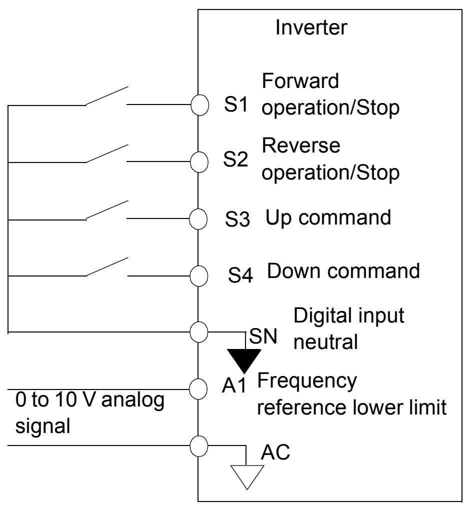
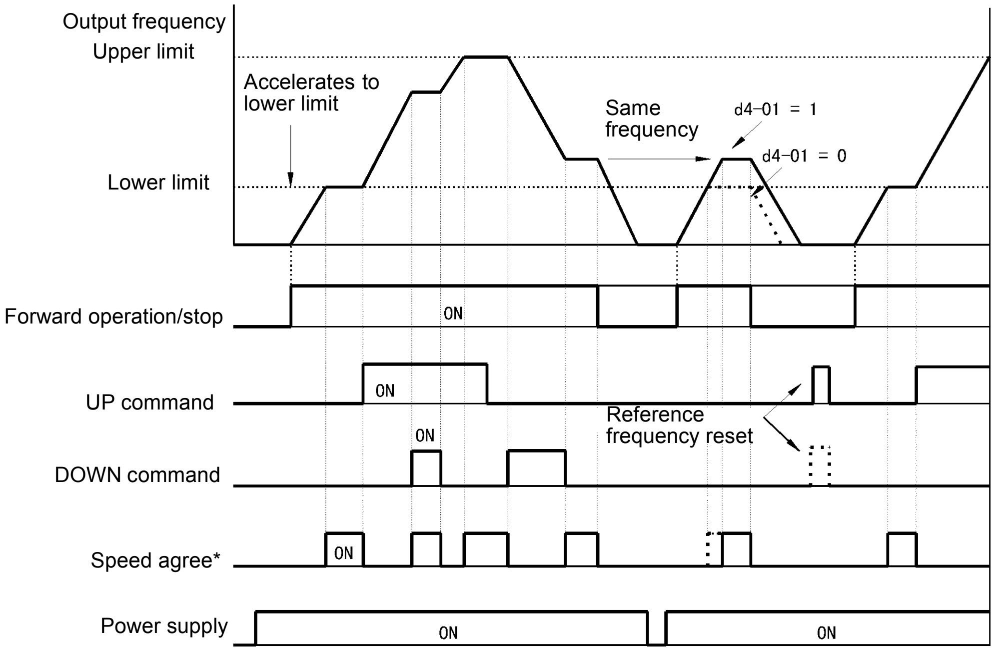



Fig 6.54  Connection Example when UP/DOWN Commands Are Allocated




* The speed agree signal turns ON when the motor is not accelerating/decelerating while the run command is ON.

Fig 6.55  UP/DOWN Commands Time Chart

## ◆ Accelerating and Decelerating Constant Frequencies in the Analog References (+/– Speed)

The +/– speed function increments or decrements the frequency reference from analog input by the value set in constant d4-02 (+/– Speed Limit) using two digital inputs.

To use this function, set two of the constants H1-01 to H1-05 (multi-function contact terminal inputs S3 to S7 function selection) to 1C (Trim Control Increase command) and 1D (Trim Control Decrease command). Be sure to allocate two terminals so that the Trim Control Increase command and Trim Control Decrease command are used as a pair. Otherwise an OPE03 alarm will be displayed.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | | Constant Number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector | |
| d4-02 | +/- speed limits | Set the frequency to be add to or subtracted from the analog frequency reference as a percent, taking the maximum output frequency to be 100%.<br>Enabled when the increase (+) speed command or decrease (-) speed command is set for a multi-function input. | 0 to 100 | 10% | No | A | A | A | 299H |

### ■Trim Control Increase/Decrease Command and Frequency Reference

The frequency references using Trim Control Increase/Decrease command ON/OFF operations are shown below.

| Frequency Reference | Set Frequency Reference + d4-02 | Set Frequency Reference - d4-02 | HOLD | |
|---|---|---|---|---|
| Trim Control Increase Command Terminal | ON | OFF | ON | OFF |
| Trim Control Decrease Command Terminal | OFF | ON | ON | OFF |

### ■Application Precautions

- Trim Control Increase/Decrease command is enabled when speed reference > 0 and the speed reference source is an analog input (A1 or A2).
- When the analog frequency reference value - d4-02 < 0, the frequency reference is set to 0.
- If only one of the Trim Control Increase command or Trim Control Decrease command has been set for a multi-function contact input terminal, operation error OPE03 (invalid multi-function input selected) will occur.

## ◆ Hold Analog Frequency Using User-set Timing

When one of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection) is set to 1E (sample/hold analog frequency command), the analog frequency reference will be held from 100 ms after the terminal is turned ON, and operation will continue at that frequency.

The analog value 100 ms after the command is turned ON is used as the frequency reference.

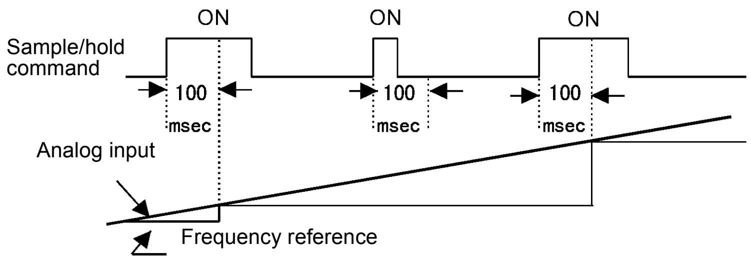



Fig 6.56  Sample/Hold Analog Frequency

### ■Precautions

When setting and executing sample and hold for analog frequency references, observe the following precautions.

#### Setting Precautions

When using sample/hold of analog frequency reference, you cannot use the following commands at the same time. Otherwise operation error OPE03 (invalid multi-function input selection) will occur.

- Acceleration/Deceleration Ramp Hold command
- UP/DOWN command
- Trim Control Increase/Decrease command

#### Application Precautions

- When performing sample/hold of analog frequency reference, be sure to close the digital input for 100 ms or more. If the sample/hold time is less than 100 ms, the frequency reference will not be held.
- The frequency reference value that is held will be deleted when the power supply is turned OFF.

## ◆ Switching Operation Source to Communication Option Card

The source of frequency reference and RUN command can be switched between a Communication option card and the sources selected in b1-01 and b1-02. Set one of the constants H1-01 to H1-05 (multi-function contact inputs S3 to S7 function selection) to 2 to enable operation source switchover.

If a RUN command is active, the switchover will not be accepted.

### ■Setting Precautions

To use the operation source switching function make the following settings:

- Set b1-01 (frequency reference source) to a value different from 3 (option card).
- Set b1-02 (RUN command source) to a value different from 3 (option card).
- Set one of the constants H1-01 to H1-02 to 2.

| Terminal Status | Frequency Reference and Run Command Selection |
|---|---|
| OFF | Inverter<br>(Frequency reference and RUN command source are set in b1-01 and b1-02.) |
| ON | Communications Option Card<br>(Frequency reference and run command are enabled from communications Option Card.) |

## ◆ Jog Frequency Operation without Forward and Reverse Commands (FJOG/RJOG)

The FJOG/RJOG function operates the inverter at the jog frequency. It can be activated by using the terminal ON/OFF operation. When using the FJOG/RJOG commands, there is no need to input the RUN command.

To use this function, set one of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection) to 12 (FJOG command) or 13 (RJOG command).

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| d1-17 | Jog frequency reference | Sets the frequency reference when the jog frequency reference selection, FJOG command, or RJOG command is ON. | 0 to 400.00 | 6.00 Hz | Yes | Q | Q | Q |

#### Multi-Function Contact Inputs (H1-01 to H1-05)

| Set Value | Function | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open Loop Vec-tor |
| 12 | FJOG command (ON: Forward run at jog frequency d1-17) | Yes | Yes | Yes |
| 13 | RJOG command (ON: Reverse run at jog frequency d1-17) | Yes | Yes | Yes |

## ■Application Precautions

- Jog frequencies using FJOG and RJOG commands have the priority over other frequency references.
- When both FJOG command and RJOG commands are ON for 500 ms or longer at the same time, the Inverter stops according to the setting in b1-03 (stopping method selection).

## ◆ Stopping the Inverter on External Device Errors (External Error Function)

The external error function activates the error contact output and stops the Inverter operation. Using this function the inverter operation can be stopped on peripheral devices break down or other errors. The digital operator will display EFx (External error [input terminal Sx]). The x in EFx shows the number of the terminal at which the external error signal is input. For example, if an external error signal is input to terminal S3, EF3 will be displayed.

To use the external error function, set one of the values 20 to 2F in one of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection).

Select the value to be set in H1-01 to H1-05 from a combination of any of the following three conditions.

- Signal input level from peripheral devices
- External error detection method
- Operation during external error detection

The following table shows the relationship between the combinations of conditions and the set value in H1-□□.

| Set Value | Input Level (See Note 1.) | | Error Detection Method (See Note 2.) | | Operation During Error Detection | | | |
|---|---|---|---|---|---|---|---|---|
| | NO Contact | NC Contact | Constant Detection | Detection During Operation | Decelerate to Stop (Error) | Coast to Stop (Error) | Emergency Stop (Error) | Continue Operation (Warning) |
| 20 | Yes | | Yes | | Yes | | | |
| 21 | | Yes | Yes | | Yes | | | |
| 22 | Yes | | | Yes | Yes | | | |
| 23 | | Yes | | Yes | Yes | | | |
| 24 | Yes | | Yes | | | Yes | | |
| 25 | | Yes | Yes | | | Yes | | |
| 26 | Yes | | | Yes | | Yes | | |
| 27 | | Yes | | Yes | | Yes | | |
| 28 | Yes | | Yes | | | | Yes | |
| 29 | | Yes | Yes | | | | Yes | |
| 2A | Yes | | | Yes | | | Yes | |
| 2B | | Yes | | Yes | | | Yes | |
| 2C | Yes | | Yes | | | | | Yes |
| 2D | | Yes | Yes | | | | | Yes |
| 2E | Yes | | | Yes | | | | Yes |
| 2F | | Yes | | Yes | | | | Yes |

Note: 1. Sets the input level at which errors are detected. (NO contact: External error when ON; NC contact: External error when OFF).
2. Set the detection method to detect errors using either constant detection or detection during operation.
Constant detection: Detects while power is supplied to the Inverter.
Detection during operation: Detects only during Inverter operation.

# Output Terminal Functions

The digital multifunction outputs can be set for several functions using the H2-01 to H2-03 constants (terminal M1 to M6 function selection). These functions are described in the following section.

## ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| H2-01 | Terminal M1-M2 function selection | Multi-function contact output 1 | 0 to 37 | 0 | No | A | A | A |
| H2-02 | Terminal M3-M4 function selection | Multi-function contact output 2 | 0 to 37 | 1 | No | A | A | A |
| H2-03 | Terminal M5-M6 function selection | Multi-function contact output 3 | 0 to 37 | 2 | No | A | A | A |

## ■During Run (Setting: 0) and During Run 2 (Setting: 37)

### During Run (Setting: 0)

| | |
|---|---|
| OFF | The Run command is OFF and there is not output voltage. |
| ON | The Run command is ON or a voltage is being output. |

### During Run 2 (Setting: 37)

| | |
|---|---|
| OFF | The inverter is not outputting a frequency. (Baseblock, DC injection braking or stopped) |
| ON | The inverter is outputting a frequency. |

These outputs can be used to indicate the inverter's operating status.

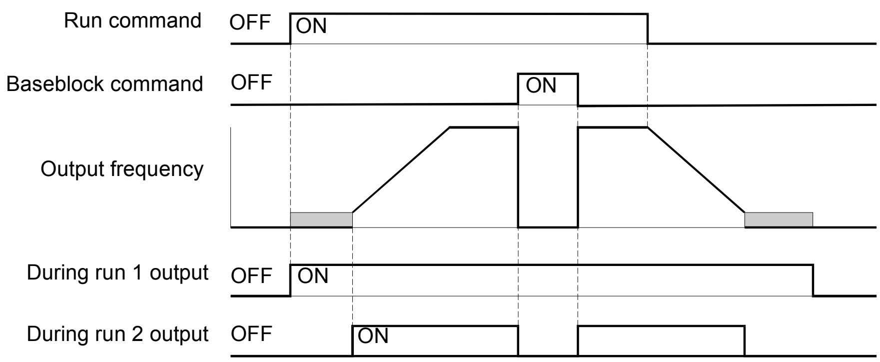



Fig. 6.57 Timing Chart for “During RUN” Output

## ■Zero Speed (Setting: 1)

| | |
|---|---|
| OFF | The output frequency is higher than the zero speed level (b2-01). |
| ON | The output frequency is lower than the zero speed level (b2-01). |

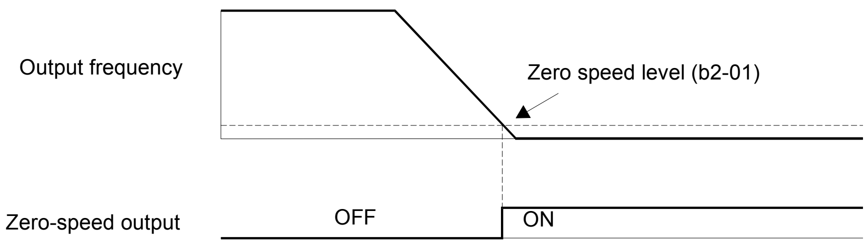



Fig 6.58  Timing Chart for Zero-speed

## ■Inverter Operation Ready (Setting: 6)

If a multifunction output is programmed for this function the output will be switched ON when the initialisation of the inverter at startup has finished without any faults.

## ■During DC Bus Undervoltage (Setting: 7)

If a multifunction output is programmed for this function the output is switched ON as long as a DC bus undervoltage is detected.

## ■During Baseblock (Setting: 8)

If a multifunction output is programmed for this function the output is switched ON as long as the inverter output is base blocked.

## ■Frequency Reference Source Selection (Setting: 9)

If a multifunction output is programmed for this function the output is ON when the digital operator is selected as frequency reference source.  If any other frequency reference is selected the output is switched OFF.

## ■Run Command Selection Status (Setting: A)

If a multifunction output is programmed for this function the output is switched ON when the digital operator is selected as RUN command source.  If any other RUN command source is selected output is switched OFF.

## ■Fault Output (Setting: E)

If a multifunction output is programmed for this function the output is switched ON when any fault different from CPF00 and CPF01 occurs.  The output is also not switched at minor faults.  (Refer to *Chapter 7* for a fault list.)

## ■Minor Fault Output (Setting: 10)

If a multifunction output is programmed for this function the output is switched ON when a minor fault occurs (refer to *Page 7-8* pp.).

## ■Fault Reset Command Active (Setting: 11)

If a multifunction output is set for this function the output is switched ON as long as a fault reset command is input at one of the digital inputs.

## ■During Reverse Run (Setting: 1A)

If a multifunction output is programmed for this function the output is switched ON whenever a RUN command in reverse direction is active. The contact will also be ON during DC injection, Braking and Base Block. It will not work when a forward RUN command is input.

## ■During Base Block 2 (Setting: 1B)

If a multifunction output is programmed for this function the output is switched OFF as long as a Baseblock command is input at a multifunction input.

## ■Motor 2 Selection (Setting: 1C)

If a multifunction output is programmed for this function the output is switched ON when motor 2 is selected.

## ■During Run 2 (Setting: 37)

When a multifunction output is set to this function the output is switched ON when a frequency is output. It will be switched OFF during Baseblock, DC injection braking or Stop.

## ■Drive Enabled (Setting: 38)

If a multifunction output is programmed for this function the output is switched ON when the drive is enabled. The drive can be enabled or disabled using a digital multifunction input.

# Monitor Constants

This section explains the analog monitor and pulse monitor constants.

## ◆ Using the Analog Monitor Constants

This section explains the analog monitor constants.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| H4-01 | Monitor selection (terminal FM) | Sets the number of the monitor item to be output (U1-□□) at terminal FM.<br>4, 10 to 14, 28, 34, 39, 40 cannot be set. | 1 to 38 | 2 | No | A | A | A |
| H4-02 | Gain (terminal FM) | Sets the multi-function analog output 1 (FM) voltage level gain.<br>Sets the percentage of the monitor item that is equal to 10V/20mA output at terminal FM. Note that the maximum output voltage/current is 10V/20mA. | 0 ~ 1000.0% | 100% | Yes | Q | Q | Q |
| H4-03 | Bias (terminal FM) | Sets the multi-function analog output 1 voltage level bias.<br>Sets the percentage of the monitor item that is equal to 0V/4mA output at terminal FM.<br>The maximum output from the terminal is 10V/20mA. | -110.0 ~ +110.0% | 0.0% | Yes | A | A | A |
| H4-04 | Monitor selection (terminal AM) | Sets the number of the monitor item to be output (U1-□□) at terminal AM.<br>4, 10 to 14, 28, 34, 39, 40 cannot be set. | 1 to 38 | 3 | No | A | A | A |
| H4-05 | Gain (terminal AM) | Sets the voltage level gain for multi-function analog output 2.<br>Sets the percentage of the monitor item that is equal to 10V/20mA output at terminal AM. Note that the maximum output voltage/current is 10V/20mA. | 0 ~ 1000.0% | 50% | Yes | Q | Q | Q |
| H4-06 | Bias (terminal AM) | Sets the multi-function analog output 2 voltage level bias.<br>Sets the percentage of the monitor item that is equal to 0V/4mA output at terminal AM.<br>The maximum output from the terminal is 10V/20mA. | -110.0 ~ +110.0% | 0.0% | Yes | A | A | A |
| H4-07 | Analog output 1 signal level selection (FM) | Sets the signal output level for multi-function output 1 (terminal FM)<br>0: 0 to 10 V output<br>1: –10 V to +10 V output<br>2: 4 to 20 mA | 0 to 2 | 0 | No | A | A | A |
| H4-08 | Analog output signal 2 level selection (AM) | Sets the signal output level for multi-function output 2 (terminal AM)<br>0: 0 to 10 V output<br>1: –10 to +10 V output<br>2: 4 to 20 mA | 0 to 2 | 0 | No | A | A | A |

6

### ■Selecting Analog Monitor Items

Some of the digital operator monitor items (U1-□□ [status monitor]) can be output at the multi-function analog output terminals FM-AC and AM-AC. Refer to *Chapter 5 User Constants*, and set the constant number of U1 group (□□ part of U1-□□) for the constants H4-01 respectively H4-04.

## ■Adjusting the Analog Monitor Items

Adjust the output/current voltage for multi-function analog output terminals FM-AC and AM-AC using the gain and bias in H4-02, H4-03, H4-05, and H4-06.

The gain sets the analog output voltage/current value which is equal to 100% of the monitor item.
The bias sets the analog output voltage/current value which is equal to 0% of the monitor item.
Note that the maximum output voltage/current is 10V/20mA. A voltage/current higher than these values can not be output.

### Adjusting the Meter

The influence of the settings of gain and bias on the analog output channel is shown on three examples in *Fig 6.59*.

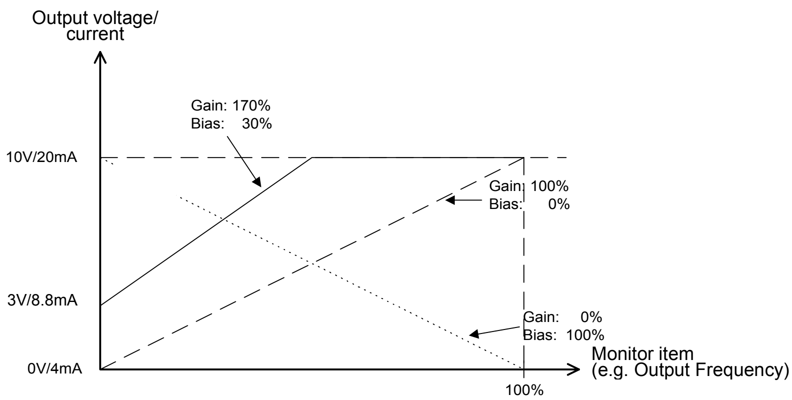



Fig 6.59 Monitor Output Adjustment

## ■Switching Analog Monitor Signal Levels

The values of some monitor items can be both, positive or negative. If these items shall be output at an analog output, the signal level should be set to –10V to +10V (H4-07/08 = 1). Negative values will be output as negative voltage (–10V to 0) and positive values will be output as positive voltage (0 to +10V).

For monitor items that can have positive or negative values please refer to *Chapter 5 User Constants*.

## ◆ Using Pulse Train Monitor Contents

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| H6-06 | Pulse train monitor selection | Select the pulse train monitor output items (value of the □□ part of U1-□□).<br>There are two types of monitor items that can be set: Speed-related items and PID-related items. | 1, 2, 5, 20, 24, 36 | 2 | Yes | A | A | A |
| H6-07 | Pulse train monitor scaling | Set the number of pulses output in hertz when the monitor item is 100%.<br>Set H6-06 to 2, and H6-07 to 0, to make the pulse train monitor output synchronously to the output frequency. | 0 to 32000 | 1440 Hz | Yes | A | A | A |

### ■Selecting Pulse Monitor Items

Some of the digital operator monitor items (U1-□□ [status monitor]) can be output at pulse monitor terminal MP-AC. Refer to *Chapter 5 User Constants*, and set the □□ part of U1-□□ (Status monitor) for H6-06. The possible monitor selections are limited as follows: U1-01, 02, 05, 20, 24, 36.

### ■Adjusting the Pulse Monitor Items

To adjust the pulse frequency output scaling, set the pulse output frequency which is equal to 100% of the monitor item in constant H6-07.

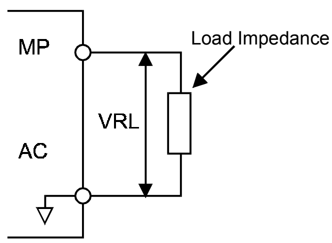
Set H6-06 to 2, and H6-07 to 0, to output the frequency synchronous with the Inverter's U-phase output frequency.

### ■Application Precautions

When using the pulse monitor output, connect a peripheral device according to the following load conditions. If the load conditions are different, there is a risk of characteristic insufficiency or damage to the inverter.

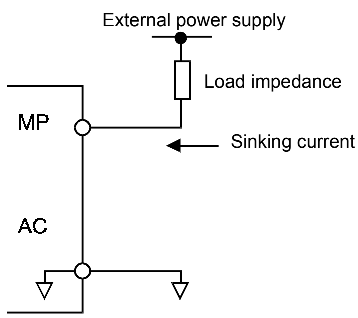
Using a passive load (power supply from output terminals)

| Output Voltage (Isolated) VRL (V) | Load Impedance (kΩ) |
|---|---|
| +5 V min. | 1.5 kΩ min. |
| +8 V min. | 3.5 kΩ min. |
| +10 V min. | 10 kΩ min. |




Using an external power supply

| External Power Supply (V) | 12 VDC±10%, 15 VDC±10% |
|---|---|
| Max. Current | 16 mA |




6

# Individual Functions

## ◆ Using MEMOBUS Communications

You can perform serial communications with Programmable Logic Controls (PLCs) or similar devices using the MEMOBUS protocol.

### ■MEMOBUS Communications Configuration

MEMOBUS communications are configured using 1 master (PLC) and a maximum of 31 slaves. Serial communications between master and slave are normally started by the master and the slaves respond.

The master performs serial communications with only one slave at a time. Consequently, you must set the address of each slave before, so that the master can perform serial communications using that address. A slave that receives a command from the master performs the specified function and sends a response to the master.

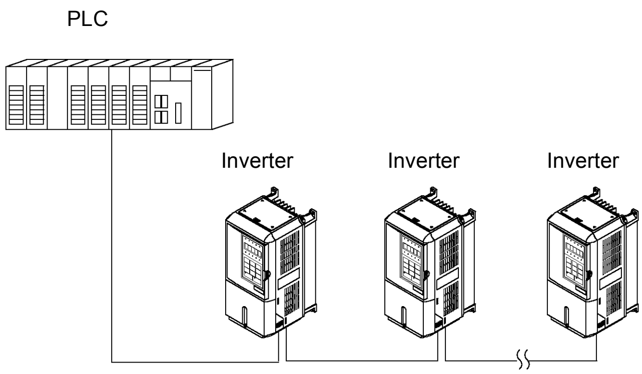



Fig 6.60   Example of Connections between PLC and Inverter

### ■Communications Specifications

The MEMOBUS communications specifications are shown in the following table.

| Item | Specifications |
|---|---|
| Interface | RS-422, RS-485 |
| Communications Cycle | Asynchronous (Start-stop synchronization) |
| Communications Parameters | Baud rate: Select from 1,200, 2,400, 4,800, 9,600 and 19,200 bps.<br>Data length: 8 bits fixed<br>Parity: Select from even, odd, or none.<br>Stop bits: 1 bit selected |
| Communications Protocol | MEMOBUS |
| Number of Connectable Units | 31 units max. |

## ■Communications Connection Terminal

The MEMOBUS communications use the following terminals: S+, S-, R+, and R-. Enable the terminating resistance by turning ON pin 1 of switch S1 for the last Inverter (seen from the PLC) only.

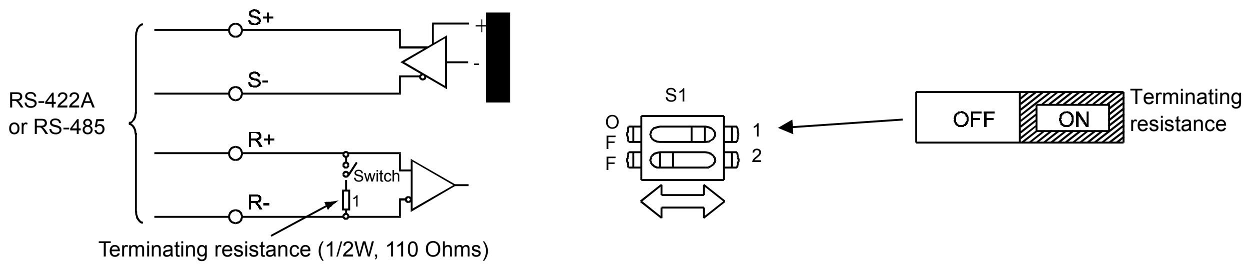
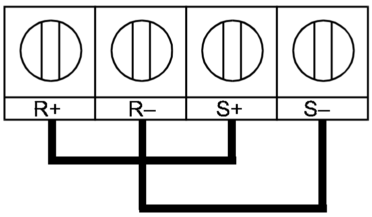



Fig 6.61  Communications Connection Terminal

IMPORTANT

1. Separate the communications cables from the main circuit cables and other wiring and power cables.
2. Use shielded cables for the communications cables, and use proper shield clamps
3. When using RS-485 communications, connect S+ to R+, and S- to R-, on the Inverter exterior. See picture below.




## ■Procedure for Communicating with the PLC

Use the following procedure to perform communications with the PLC.

1. Turn OFF the power supply and connect the communications cable between the PLC and the Inverter.
2. Turn ON the power supply.
3. Set the required communications constants (H5-01 to H5-07) using the Digital Operator.
4. Turn OFF the power supply, and check that the Digital Operator display has completely disappeared.
5. Turn ON the power supply once again.
6. Perform communications with the PLC.

## ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| b1-01 | Reference source selection | Sets the frequency reference input source<br>0: Digital Operator<br>1: Control circuit terminal (analog input)<br>2: MEMOBUS communications<br>3: Option Card<br>4: Pulse train input | 0 to 4 | 1 | No | Q | Q | Q |
| b1-02 | RUN command Source Selection | Sets the run command input source<br>0: Digital Operator<br>1: Control circuit terminal (digital multifunction inputs)<br>2: MEMOBUS communications<br>3: Option Card | 0 to 3 | 1 | No | Q | Q | Q |
| H5-01 | Station address | Sets the Inverter station address [hex]. | 0 to 20 * | 1F | No | A | A | A |
| H5-02 | Baud rate selection | Sets the baud rate for MEMOBUS communications.<br>0: 1200 bps<br>1: 2400 bps<br>2: 4800 bps<br>3: 9600 bps<br>4: 19200 bps | 0 to 4 | 3 | No | A | A | A |
| H5-03 | Communications parity selection | Sets the parity for MEMOBUS communications.<br>0: No parity<br>1: Even parity<br>2: Odd parity | 0 to 2 | 0 | No | A | A | A |
| H5-04 | Communications error detection selection | Sets the stopping method for communications errors.<br>0: Deceleration to stop using the deceleration time in C1-02<br>1: Coast to a stop<br>2: Emergency stop using the deceleration time in C1-09<br>3: Continue operation | 0 to 3 | 3 | No | A | A | A |
| H5-05 | Communications error detection selection | Sets whether or not a communications timeout is to be detected as a communications error.<br>0: Do not detect<br>1: Detect | 0 or 1 | 1 | No | A | A | A |
| H5-06 | Send wait time | Sets the time from the Inverter receiving data to when the Inverter starts to send. | 5 to 65 ms | 5 ms | No | A | A | A |
| H5-07 | RTS control ON/OFF | Enables or disables RTS control.<br>0: Disabled (RTS is always ON)<br>1: Enabled (RTS turns ON only when sending) | 0 or 1 | 1 | No | A | A | A |

* Set H5-01 to 0 to disable Inverter responses to MEMOBUS communications.

MEMOBUS communications can perform the following operations regardless of the settings in b1-01 and b1-02.

- Monitoring operation status of the inverter
- Setting and reading constants
- Resetting errors
- Inputting multi-function commands. (An OR operation is performed between the multi-function commands input from the PLC and commands input from multi-function contact input terminals S3 to S7.)

## ■Message Format

In MEMOBUS communications, the master sends commands to the slave, and the slave responds. The message format is configured for both sending and receiving as shown below, and the length of data packets depends on the command (function) content.

| |
|---|
| Slave address |
| Function code |
| Data |
| Error check |

The space between messages must meet the following conditions:

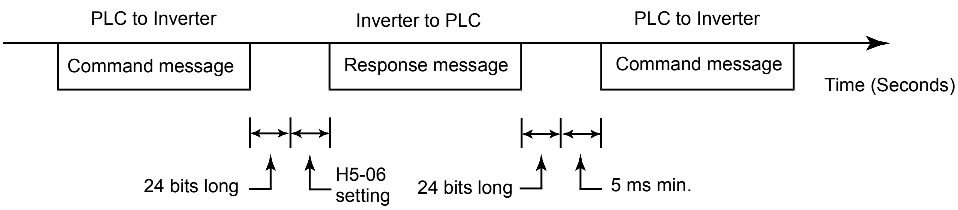



Fig 6.62  Message Spacing

### Slave Address

Set the Inverter address from 0 to 32. If you set 0, commands from the master will be received by all slaves. (Refer to “Broadcast Data” on the following pages.)

### Function Code

The function code specifies commands. The three function codes shown in the table below are available.

| Function Code (Hexadecimal) | Function | Command Message | | Response Message | |
|---|---|---|---|---|---|
| | | Min. (Bytes) | Max. (Bytes) | Min. (Bytes) | Max. (Bytes) |
| 03H | Read memory register contents | 8 | 8 | 7 | 37 |
| 08H | Loopback test | 8 | 8 | 8 | 8 |
| 10H | Write multiple memory registers | 11 | 41 | 8 | 8 |

### Data

Configure consecutive data by combining the memory register address (test code for a loopback address) and the data the register contains. The data length changes depending on the command details.

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### Error Check

Errors during communications are detected using CRC-16 (cyclic redundancy check, checksum method).

The result of the checksum calculation is stored in a data-word (16 bit), which starting value is FFFH. The value of this word is manipulated using Exclusive OR- and SHIFT operations together with the data package that should be sent (slave address, function code, data) and the fixed value A001H. At the end of the calculation the data-word contains the checksum value.

The checksum is calculated in the following way:

1. The starting value of the 16 Bit data-word, that is used for the calculation, has to be set to FFFFH.
2. An Exclusive OR operation has to be performed with the starting value and the slave address.
3. The result has to be shifted to the right until the overflow bit becomes 1.
4. When this bit becomes 1, an Esclusive OR operation with the result of step 3 and the fix value A001H has to be performed.
5. After 8 shift operations (every time when the overflow bit becomes 1, an Exclusive OR like in step 4 has to be done), perform an Exclusive OR operation with the result of the former operations and the next data package (8 bit function code). Again the result of this operation has to be shifted 8 times and if needed it has to be interconnected with the fix value A001H using an Exclusive OR operation.
6. The same steps have to be performed with the data, first with the higher byte and then with the lower byte until all data are proceeded.
7. The result of these operations is the checksum. It consists of a high and a low byte.

The following example clarifies the calculation method. It shows the calculation of a CRC-16 code with the slave address 02H (0000 0010) and the function code 03H (0000 0011). The resulting CRC-16 code is D1H for the lower and 40H for the higher byte. The example calculation in this example is not done completely (normally data would follow the function code).

| Calculations | Overflow | Description |
|---|---|---|
| 1111 1111 1111 1111 | | Initial value |
| 0000 0010 | | Address |
| 1111 1111 1111 1101 | | ExOr Result |
| 0111 1111 1111 1110 | 1 | Shift 1 |
| 1010 0000 0000 0001 | | |
| 1101 1111 1111 1111 | | ExOr Result |
| 0110 1111 1111 1111 | 1 | Shift 2 |
| 1010 0000 0000 0001 | | |
| 1100 1111 1111 1110 | | ExOr Result |
| 0110 0111 1111 1111 | 0 | Shift 3 |
| 0011 0011 1111 1111 | 1 | Shift 4 |
| 1010 0000 0000 0001 | | |
| 1001 0011 1111 1110 | | ExOr Result |
| 0100 1001 1111 1111 | 0 | Shift 5 |
| 0010 0100 1111 1111 | 1 | Shift 6 |
| 1010 0000 0000 0001 | | |
| 1000 0100 1111 1110 | | ExOr Result |
| 0100 0010 0111 1111 | 0 | Shift 7 |
| 0010 0001 0011 1111 | 1 | Shift 8 |
| 1010 0000 0000 0001 | | |
| 1000 0001 0011 1110 | | ExOr Result |
| 0000 0011 | | Function Code |
| 1000 0001 0011 1101 | | ExOr Result |
| 0100 0000 1001 1110 | 1 | Shift 1 |
| 1010 0000 0000 0001 | | |
| 1110 0000 1001 1111 | | ExOr Result |
| 0111 0000 0100 1111 | 1 | Shift 2 |
| 1010 0000 0000 0001 | | |
| 1101 0000 0100 1110 | | ExOr Result |
| 0110 1000 0010 0111 | 0 | Shift 3 |
| 0011 0100 0001 0011 | 1 | Shift 4 |
| 1010 0000 0000 0001 | | |
| 1001 0100 0001 0010 | | ExOr Result |
| 0100 1010 0000 1001 | 0 | Shift 5 |
| 0010 0101 0000 0100 | 1 | Shift 6 |
| 1010 0000 0000 0001 | | |
| 1000 0101 0000 0101 | | ExOr Result |
| 0100 0010 1000 0010 | 1 | Shift 7 |
| 1010 0000 0000 0001 | | |
| 1110 0010 1000 0011 | | ExOr Result |
| 0111 0001 0100 0001 | 1 | Shift 8 |
| 1010 0000 0000 0001 | | |
| 1101 0001 0100 0000 | | ExOr Result |
| D1H 40H | | CRC-16 Result |
| Higher Byte Lower Byte | | |

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## ■MEMOBUS Message Example

An example of MEMOBUS command/response messages is given below.

### Reading Inverter Memory Register Contents

The content of maximum 16 inverter memory registers can be readout at a time.

Among other things the command message must contain the start address of the first register that is to be read out and the quantity of registers that should be read out. The response message will contain the content of the first and the consecutive number of registers that has been set for the quantity.

The contents of the memory register are separated into higher 8 bits and lower 8 bits.

The following tables show message examples when reading status signals, error details, data link status, and frequency references from the slave 2 Inverter.

Command Message

| | | |
|---|---|---|
| Slave Address | | 02H |
| Function Code | | 03H |
| Start Address | Higher | 00H |
| | Lower | 20H |
| Quantity | Higher | 00H |
| | Lower | 04H |
| CRC-16 | Higher | 45H |
| | Lower | F0H |

Response Message (During Normal Operation)

| | | |
|---|---|---|
| Slave Address | | 02H |
| Function Code | | 03H |
| Data quantity | | 08H |
| 1st storage register | Higher | 00H |
| | Lower | 65H |
| Next storage register | Higher | 00H |
| | Lower | 00H |
| Next storage register | Higher | 00H |
| | Lower | 00H |
| Next storage register | Higher | 01H |
| | Lower | F4H |
| CRC-16 | Higher | AFH |
| | Lower | 82H |

Response Message (During Error)

| | | |
|---|---|---|
| Slave Address | | 02H |
| Function Code | | 83H |
| Error code | | 03H |
| CRC-16 | Higher | F1H |
| | Lower | 31H |

### Loopback Test

The loopback test returns command messages directly as response messages without changing the contents to check the communications between the master and slave. You can set user-defined test code and data values.

The following table shows a message example when performing a loopback test with the slave no. 1.

Command Message

| | | |
|---|---|---|
| Slave address | | 01H |
| Function code | | 08H |
| Test Code | Higher | 00H |
| | Lower | 00H |
| Data | Higher | A5H |
| | Lower | 37H |
| CRC-16 | Higher | DAH |
| | Lower | 8DH |

Response Message (During Normal Operation)

| | | |
|---|---|---|
| Slave address | | 01H |
| Function code | | 08H |
| Test Code | Higher | 00H |
| | Lower | 00H |
| Data | Higher | A5H |
| | Lower | 37H |
| CRC-16 | Higher | DAH |
| | Lower | 8DH |

Response Message (During Error)

| | | |
|---|---|---|
| Slave address | | 01H |
| Function code | | 89H |
| Error Code | | 01H |
| CRC-16 | Higher | 86H |
| | Lower | 50H |

### Writing to Multiple Inverter Memory Registers

The writing of inverter memory registers works similar to the reading process, i.e. the address of the first register that is to be written and the quantity of to be written registers must be set in the command message.

The to be written data must be consecutive, starting from the specified address in the command message. The data order must be higher 8 bits, then lower 8 bits. The data must be in memory register address order.

The following table shows an example of a message where a forward operation has been set with a frequency reference of 60.0 Hz for the inverter with the slave address 01H.

Command Message

| | | |
|---|---|---|
| Slave Address | | 01H |
| Function Code | | 10H |
| Start Address | Higher | 00H |
| | Lower | 01H |
| Quantity | Higher | 00H |
| | Lower | 02H |
| No. of data | | 04H |
| Lead data | Higher | 00H |
| | Lower | 01H |
| Next data | Higher | 02H |
| | Lower | 58H |
| CRC-16 | Higher | 63H |
| | Lower | 39H |

Response Message (During Normal Operation)

| | | |
|---|---|---|
| Slave Address | | 01H |
| Function Code | | 10H |
| Start Address | Higher | 00H |
| | Lower | 01H |
| Quantity | Higher | 00H |
| | Lower | 02H |
| CRC-16 | Higher | 10H |
| | Lower | 08H |

Response Message (During Error)

| | | |
|---|---|---|
| Slave Address | | 01H |
| Function Code | | 90H |
| Error code | | 02H |
| CRC-16 | Higher | CDH |
| | Lower | C1H |

* No. of data = 2 x (quantity)

**IMPORTANT**

For the number of data value in the command message the double value of the data quantity must be taken.

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## ■Data Tables

The data tables are shown below. The types of data are as follows: Reference data, monitor data, and broadcast data.

### Reference Data

The reference data table is shown below. These data can be read and written. They cannot be used for monitoring functions.

<table>
<tr><th>Register No.</th><th colspan="2">Contents</th></tr>
<tr><td>0000H</td><td colspan="2">Reserved</td></tr>
<tr><td rowspan="13">0001H</td><td colspan="2">Run operation and input commands</td></tr>
<tr><td>Bit 0</td><td>Run/stop command 1: Run 0: Stop</td></tr>
<tr><td>Bit 1</td><td>Forward/reverse operation 1: Reverse 0: Forward</td></tr>
<tr><td>Bit 2</td><td>External error 1: Error (EFO)</td></tr>
<tr><td>Bit 3</td><td>Error reset 1: Reset command</td></tr>
<tr><td>Bit 4</td><td>ComNet</td></tr>
<tr><td>Bit 5</td><td>ComCtrl</td></tr>
<tr><td>Bit 6</td><td>Multi-function input command 3</td></tr>
<tr><td>Bit 7</td><td>Multi-function input command 4</td></tr>
<tr><td>Bit 8</td><td>Multi-function input command 5</td></tr>
<tr><td>Bit 9</td><td>Multi-function input command 6</td></tr>
<tr><td>Bit A</td><td>Multi-function input command 7</td></tr>
<tr><td>Bits B to F</td><td>Not used</td></tr>
<tr><td>0002H</td><td colspan="2">Frequency reference (Set units using constant o1-03)</td></tr>
<tr><td>0003H to 0005H</td><td colspan="2">Not used</td></tr>
<tr><td>0006H</td><td colspan="2">PID target value</td></tr>
<tr><td>0007H</td><td colspan="2">Analog output 1 setting (-11 V/-726 to 11 V/726) → 10V = 660</td></tr>
<tr><td>0008H</td><td colspan="2">Analog output 2 setting (-11 V/-726 to 11 V/726) → 10V = 660</td></tr>
<tr><td rowspan="8">0009H</td><td colspan="2">Multi-function contact output setting</td></tr>
<tr><td>Bit 0</td><td>Contact output 1 (Terminal M1-M2) 1: ON 0: OFF</td></tr>
<tr><td>Bit 1</td><td>Contact output 2 (Terminal M3-M4) 1: ON 0: OFF</td></tr>
<tr><td>Bit 2</td><td>Contact output 3 (Terminal M5-M6) 1: ON 0: OFF</td></tr>
<tr><td>Bits 3 to 5</td><td>Not used</td></tr>
<tr><td>Bit 6</td><td>Set error contact (terminal MA-MC) output using bit 7. 1: ON 0: OFF</td></tr>
<tr><td>Bit 7</td><td>Error contact (terminal MA-MC) 1: ON 0: OFF</td></tr>
<tr><td>Bits 8 to F</td><td>Not used</td></tr>
<tr><td>000AH to 000EH</td><td colspan="2">Not used</td></tr>
</table>

| Register No. | Contents | |
|---|---|---|
| 000FH | Reference selection settings | |
| | Bit 0 | Not used |
| | Bit 1 | Input PID target value 1: Enabled 0: Disabled |
| | Bits 3 to B | Not used |
| | C | Broadcast data terminal S5 input 1: Enabled 0: Disabled |
| | D | Broadcast data terminal S6 input 1: Enabled 0: Disabled |
| | E | Broadcast data terminal S7 input 1: Enabled 0: Disabled |
| | F | Not used |

Note  Write 0 to all unused bits. Also, do not write data to reserved registers.

### Monitor Data

The following table shows the monitor data. Monitor data can only be read.

| Register No. | Contents | |
|---|---|---|
| 0020H | Inverter status | |
| | Bit 0 | Operation 1: Operating 0: Stopped |
| | Bit 1 | Reverse operation 1: Reverse operation 0: Forward operation |
| | Bit 2 | Inverter startup complete 1: Completed 2: Not completed |
| | Bit 3 | Error 1: Error |
| | Bit 4 | Data setting error 1: Error |
| | Bit 5 | Multi-function contact output 1 (terminal M1 - M2) 1: ON 0: OFF |
| | Bit 6 | Multi-function contact output 2 (terminal M3 - M4) 1: ON 0: OFF |
| | Bit 7 | Multi-function contact output 3 (terminal M5 - M6) 1: ON 0: OFF |
| | Bits 8 to F | Not used |
| 0021H | Error details | |
| | Bit 0 | Overcurrent (OC), Ground fault (GF) |
| | Bit 1 | Main circuit overvoltage (OV) |
| | Bit 2 | Inverter overload (OL2) |
| | Bit 3 | Inverter overheat (OH1, OH2) |
| | Bit 4 | Braking transistor/resistance overheat (rr, rH) |
| | Bit 5 | Fuse blown (PUF) |
| | Bit 6 | PID feedback lost (FbL) |
| | Bit 7 | External error (EF, EFO) |
| | Bit 8 | Control board error (CPF) |
| | Bit 9 | Motor overload (OL1) or overtorque 1 (OL3) detected |
| | Bit A | PG broken wire detected (PGO), Overspeed (OS), Speed deviation (DEV) |
| | Bit B | Main circuit undervoltage (UV) detected |
| | Bit C | Main circuit undervoltage (UV1), control power supply error (UV2), inrush prevention circuit error (UV3), power loss |
| | Bit D | Missing output phase (LF) |
| | Bit E | MEMOBUS communications error (CE) |
| | Bit F | Operator disconnected (OPR) |

| Register No. | Contents | |
|---|---|---|
| 0022H | Data link status | |
| | Bit 0 | Writing data |
| | Bit 1 | Not used |
| | Bit 2 | Not used |
| | Bit 3 | Upper and lower limit errors |
| | Bit 4 | Data integrity error |
| | Bits 5 to F | Not used |
| 0023H | Frequency reference | Monitors U1-01 |
| 0024H | Output frequency | Monitors U1-02 |
| 0025H | Output voltage (U1-06) | |
| 0026H | Output current | U1-03 |
| 0027H | Output power | U1-08 |
| 0028H | Torque reference | U1-09 |
| 0029H | Not used | |
| 002AH | Not used | |
| 002BH | Control terminals input status | |
| | Bit 0 | Input terminal S1 1: ON 0: OFF |
| | Bit 1 | Input terminal S2 1: ON 0: OFF |
| | Bit 2 | Multi-function input terminal S3 1: ON 0: OFF |
| | Bit 3 | Multi-function input terminal S4 1: ON 0: OFF |
| | Bit 4 | Multi-function input terminal S5 1: ON 0: OFF |
| | Bit 5 | Multi-function input terminal S6 1: ON 0: OFF |
| | Bit 6 | Multi-function input terminal S7 1: ON 0: OFF |
| | Bits 7 to F | Not used |

| Register No. | Contents | | |
|---|---|---|---|
| 002CH | Inverter status | | |
| | Bit 0 | Operation | 1: Operating |
| | Bit 1 | Zero speed | 1: Zero speed |
| | Bit 2 | Frequency agree | 1: Agreement |
| | Bit 3 | User-defined speed agree | 1: Agreement |
| | Bit 4 | Frequency detection 1 | 1: Output frequency ≤ L4-01 |
| | Bit 5 | Frequency detection 2 | 1: Output frequency ≥ L4-01 |
| | Bit 6 | Inverter startup completed | 1: Startup completed |
| | Bit 7 | Undervoltage detection | 1: Detected |
| | Bit 8 | Baseblock | 1: Inverter output baseblock |
| | Bit 9 | Frequency reference mode | 1: Not communication 0: Communication option |
| | Bit A | Run command mode | 1: Not communication 0: Communication option |
| | Bit B | Overtorque detection | 1: Detected |
| | Bit C | Frequency reference lost | 1: Lost |
| | Bit D | Restart enabled | 1: Restarting |
| | Bit E | Error (including MEMOBUS communications time-out) 1:Error occurred | |
| | Bit F | MEMOBUS communications time-out 1: Timed out | |
| 002DH | Multi-function contact output status | | |
| | Bit 0 | Multi-function contact output 1 (terminal M1-M2) 1: ON 0: OFF | |
| | Bit 1 | Multi-function contact output 2 (terminal M3-M4) 1: ON 0: OFF | |
| | Bit 2 | Multi-function contact output 3 (terminal M5-M6) 1: ON 0: OFF | |
| | Bits 3 to F | Not used | |
| 002EH - 0030H | Not used | | |
| 0031H | Main circuit DC voltage | | |
| 0032H - 0037H | Not used | | |
| 0038H | PID feedback (max. output frequency ≙ 100%; resolution 0.1%; without sign) | | |
| 0039H | PID input (max. output frequency ≙ 100%; resolution 0.1%; with sign) | | |
| 003AH | PID output (max. output frequency ≙ 100%; resolution 0.1%; with sign) | | |
| 003BH | CPU software number | | |
| 003CH | Flash software number | | |
| 003DH | Communications error details | | |
| | Bit 0 | CRC error | |
| | Bit 1 | Invalid data length | |
| | Bit 2 | Not used | |
| | Bit 3 | Parity error | |
| | Bit 4 | Overrun error | |
| | Bit 5 | Framing error | |
| | Bit 6 | Time-out | |
| | Bits 7 to F | Not used | |
| 003EH | kVA setting | | |

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| Register No. | Contents |
|---|---|
| 003FH | Control method |

Note  Communications error details are stored until an error reset is input (you can also reset while the Unit is operating).

### Broadcast Data

Using broadcast data a command can be given to all slaves at the same time.  The slave address in the command message must be set to 00H.  All slaves will receive the message.  They will not respond.

The following table shows the broadcast data. You can also write this data.

| Register Address | Contents | |
|---|---|---|
| 0001H | Operation signal | |
| | Bit 0 | Run command 1: Operating 0: Stopped |
| | Bit 1 | Reverse operation command 1: Reverse 0: Forward |
| | Bits 2 and 3 | Not used |
| | Bit 4 | External error 1: Error |
| | Bit 5 | Error reset 1: Reset command |
| | Bits 6 to B | Not used |
| | Bit C | Multi-function contact input terminal S5 input |
| | Bit D | Multi-function contact input terminal S6 input |
| | Bit E | Multi-function contact input terminal S7 input |
| | Bit F | Not used. |
| 0002H | Frequency reference | |

Note  Bit signals not defined in the broadcast operation signals use local node data signals continuously.

## ■ENTER Command

When writing constants to the Inverter from the PLC using MEMOBUS communications, the constants are temporarily stored in the constant data area in the Inverter. To enable these constants in the constant the ENTER command must be used.

There are two types of ENTER commands: ENTER commands that enable constant data in RAM, and ENTER commands that write data to EEPROM (non-volatile memory) in the Inverter at the same time as enabling the data in RAM.

The following table shows the ENTER command data. ENTER command data can only be written.

The ENTER command is enabled by writing 0 to register number 0900H or 0910H.

| Register No. | Contents |
|---|---|
| 0900H | Write constant data to EEPROM, RAM is refreshed |
| 0910H | Constant data are not written to EEPROM, but refreshed in RAM only. |

**INFO**

The maximum number of times you can write to EEPROM is 100,000. Do not frequently execute ENTER commands (0900H) that write into EEPROM.
The ENTER command registers are write-only. Consequently, if these registers should be read out, the register address will become invalid (Error code: 02H).

## ■Error Codes

The following table shows MEMOBUS communications error codes.

| Error Code | Contents |
|---|---|
| 01H | Function code error<br>A function code other than 03H, 08H, or 10H has been set by the PLC. |
| 02H | Invalid register number error<br>• The register address you are attempting to access is not recorded anywhere.<br>• With broadcast sending, a start address other than 0001H, or 0002H has been set. |
| 03H | Invalid quantity error<br>• The number of data packets (register content) being read or written is outside the range of 1 to 16.<br>• In write mode, the number of data bytes in the message is not No. of packets x 2. |
| 21H | Data setting error<br>• A simple upper limit or lower limit error has occurred in the control data or when writing constants.<br>• When writing constants, the constant setting is invalid. |
| 22H | Write mode error<br>• Attempting to write constants to the inverter during operation.<br>• Attempting to write via ENTER commands during operation.<br>• Attempting to write constants other than A1-00 to A1-05, E1-03, or 02-04 when warning alarm CPF03 (defective EEPROM) has occurred.<br>• Attempting to write read-only data. |
| 23H | Writing during DC bus undervoltage (UV) error<br>• Writing constants to the inverter during UV (DC bus undervoltage) alarm.<br>• Writing via ENTER commands during UV (DC bus undervoltage) alarm. |
| 24H | Writing error during constants processing<br>Attempting to write constants while processing constants in the Inverter. |

## ■Slave Not Responding

In the following cases, the slave will ignore the write function.

- When a communications error (overrun, framing, parity, or CRC-16) is detected in the command message.
- When the slave address in the command message and the slave address in the Inverter do not agree.
- When the gap between two blocks (8 bit) of a message exceeds 24 bits.
- When the command message data length is invalid.

### Application Precautions

INFO

If the slave address specified in the command message is 0, all slaves execute the write function, but do not return response messages to the master.

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## ■Self-Diagnosis

The Inverter has a built-in function for self-diagnosing the functioning of the serial communication interface circuits. This function is called the self-diagnosis function. It uses the connected communications parts of the send and receive terminals to receive data sent by the Inverter and thereby to check if communication is performed normally.

To perform the self-diagnosis function use the following procedure.

1. Turn ON the inverter power supply, and set 67 (communications test mode) in constant H1-05 (Terminal S7 Function Selection).
2. Turn OFF the inverter power supply.
3. Perform the wiring according to *Fig 6.63*.
4. Turn ON the terminating resistance. (Turn ON pin 1 on DIP switch 1.)
5. Turn ON the inverter power supply.

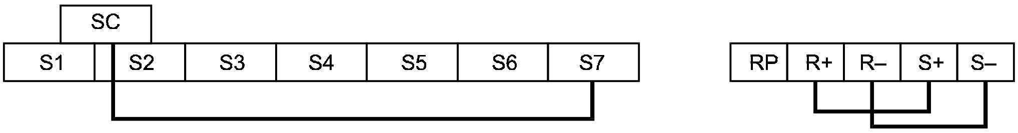


Fig 6.63 Communication Terminals Wiring for Self-Diagnosis

During normal operation, the Digital Operator displays “PASS” on the display.

If an error occurs, a “CE” (MEMOBUS communications error) alarm will be displayed on the Digital Operator, the error contact output will be turned ON, and the Inverter operation ready signal will be turned OFF.

## ◆ Using the Timer Function

The multi-function digital input terminals S3 to S7 can be used as timer function input terminals, and multi-function output terminals M1-M2, M3-M4, and M5-M6 can be used as timer function output terminals. By setting the delay time, you can prevent chattering of the sensors and switches.

- Set one of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7) to 18 (timer function input).
- Set H2-01 to H2-03 (multi-function output terminals M1-M2, M3-M4, and M5-M6 function selection) to 12 (timer function output).

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b4-01 | Timer function ON-delay time | Set the timer function output ON delay time (dead time) for the timer function input in 1-second units. Enabled when a timer function is set in H1-□□ and H2-□□. | 0.0 to 300.0 | 0.0 s | No | A | A | A |
| b4-02 | Timer function OFF-delay time | Set the timer function output OFF delay time (dead time) for the timer function input in 1-second units. Enabled when the timer function is set in H1-□□ and H2-□□. | 0.0 to 300.0 | 0.0 s | No | A | A | A |

### ■Setting Example

When the timer function input ON time is longer than the value set in b4-01, the timer output function is turned ON. When the timer function input OFF time is longer than the value set in b4-02, the timer output function is turned OFF. An example of timer function operation is given in the following diagram.

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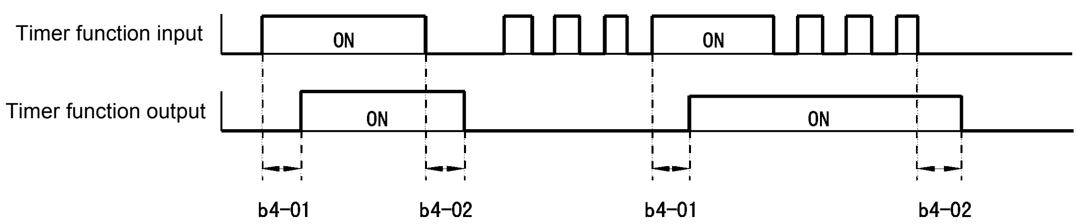


Fig 6.64 Timer Function Operation Example

## ◆ Using PID Control

PID control is a method of making the feedback value (detection value) match the set target value. By combining proportional control (P), integral control (I), and differential control (D), you can even control system with load fluctuation.

The characteristics of the PID control operations are given below.

P element — The output of a P-element is proportional to the input (deviation). With using a P-element alone it is not possible to eliminate the deviation completely.

I element — The output of an I-element is the time-integral of the input (deviation). With using a P-element and an I-element together the deviation can be eliminated completely.

D element — The output of a D-element is the derivative of the input (deviation). By adding a D-element the response can be improved rapidly.

### ■PID Control Operation

To understand the differences between the PID control operations P, I, and D, the output share of each operation is shown in the following diagram when the deviation (i.e., the difference between the target value and feedback value) is fixed.

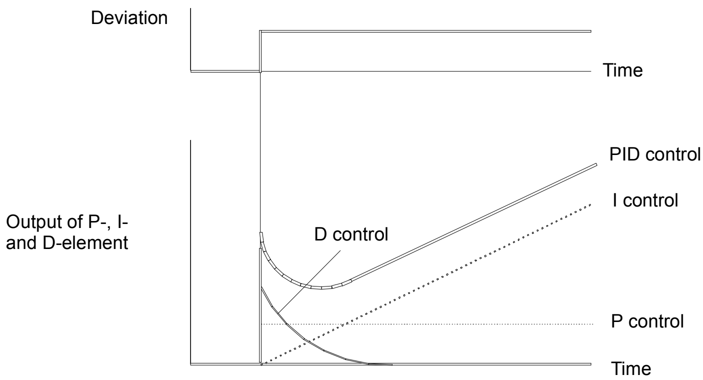


Fig 6.65 PID Control Operation

### ■PID Control Applications

The following table shows examples of PID control applications using the Inverter.

| Application | Control Details | Example of Sensor Used |
|---|---|---|
| Speed Control | • Machinery speed is fed back and adjusted to meet the target value.<br>• Speed informations from other machinery can be input as the target value and synchronous control using the actual speed feedback can be performed. | Tachometer generator |
| Pressure Control | Pressure information is fed back and constant pressure control is performed. | Pressure sensor |
| Flow Rate Control | Flow rate information is fed back and the flow rate is controled with high accuracy. | Flow rate sensor |
| Temperature Control | Temperature information is fed back and a temperature adjustment control using a fan can be performed. | • Thermocouple<br>• Thermistor |

## ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop Vector |
|---|---|---|---|---|---|---|---|---|
| b5-01 | PID control mode selection | 0: Disabled<br>1: Enabled (Deviation is D-controlled.)<br>2: Enabled (Feedback value is D-controlled.)<br>3: PID control enabled (frequency reference + PID output, D control of deviation)<br>4: PID control enabled (frequency reference + PID output, D control of feedback value). | 0 to 4 | 0 | No | A | A | A |
| b5-02 | Proportional gain (P) | Sets P-control proportional gain.<br>P-control is not performed when the setting is 0.00. | 0.00 to 25.00 | 1.00 | Yes | A | A | A |
| b5-03 | Integral (I) time | Sets I-control integral time.<br>I-control is not performed when the setting is 0.0. | 0.0 to 360.0 | 1.0 s | Yes | A | A | A |
| b5-04 | Integral (I) limit | Sets the I-control limit as a percentage of the maximum output frequency. | 0.0 to 100.0 | 100.0% | Yes | A | A | A |
| b5-05 | Differential (D) time | Sets D-control derivative time.<br>D-control is not performed when the setting is 0.00. | 0.00 to 10.00 | 0.00 s | Yes | A | A | A |
| b5-06 | PID limit | Sets the limit after PID-control as a percentage of the maximum output frequency. | 0.0 to 100.0 | 100.0% | Yes | A | A | A |
| b5-07 | PID offset adjustment | Sets the offset after PID-control as a percentage of the maximum outut frequency. | -100.0 to +100.0 | 0.0% | Yes | A | A | A |
| b5-08 | PID delay time constant | Sets the time constant for low pass filter for PID-control outputs.<br>Not usually necessary to set. | 0.00 to 10.00 | 0.00 s | Yes | A | A | A |
| b5-09 | PID output characteristics selection | Select forward/reverse for PID output.<br>0: PID output is forward.<br>1: PID output is reverse | 0 or 1 | 0 | No | A | A | A |
| b5-10 | PID output gain | Sets output gain. | 0.0 to 25.0 | 1.0 | No | A | A | A |
| b5-11 | PID reverse output selection | 0: Limit to 0 when PID output is negative.<br>1: Reverse when PID output is negative.<br>Limit to 0 is also active when reverse prohibit is selected using b1-04. | 0 or 1 | 0 | No | A | A | A |
| b5-12 | Selection of PID feedback loss detection | 0: No detection of PID feedback loss<br>1: Detection of PID feedback loss. Operation continues during detection, the fault contact is not operated.<br>2: Detection of PID feedback los. The motor coasts to stop at detection, and the fault contact operates. | 0 to 2 | 0 | No | A | A | A |
| b5-13 | PID feedback loss detection level | Set the PID feedback loss detection level as a percentage using the maximum output frequency as 100%. | 0 to 100 | 0% | No | A | A | A |
| b5-14 | PID feedback loss detection time | Sets the PID feedback loss detection level in s units. | 0.0 to 25.5 | 1.0 s | No | A | A | A |
| b5-15 | PID sleep function operation level | Set the PID sleep function start level as a frequency. | 0.0 to 400.0 | 0.0 Hz | No | A | A | A |
| b5-16 | PID sleep operation delay time | Set the delay time until the PID sleep function starts. | 0.0 to 25.5 | 0.0 s | No | A | A | A |
| b5-17 | Accel/decel time for PID reference | Set the accel/decel time for PID reference. | 0.0 to 25.5 | 0.0 s | No | A | A | A |
| b5-18 | PID Setpoint Selection | 0: Disabled<br>1: Enabled | 0 to 1 | 0 | No | A | A | A |
| b5-19 | PID setpoint | PID-target value | 0 to 100.0% | 0 | No | A | A | A |
| H6-01 | Pulse train input function selection | 0: Frequency reference<br>1: PID feedback value<br>2: PID target value | 0 to 2 | 0 | No | A | A | A |

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### Monitor Items (U1-□□)

| Con-stant Number | Name | Description | Output Signal Level During Multi-Function Analog Output | Min. Unit | Control Methods | | |
|---|---|---|---|---|---|---|---|
| | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| U1-24 | PID feedback value | Monitors the feedback value when PID control is used. | 10 V: 100% feedback | 0.01% | A | A | A |
| U1-36 | PID input volume | PID input volume | 10 V: 100% PID input | 0.01% | A | A | A |
| U1-37 | PID output volume | PID control output | 10 V: 100% PID output | 0.01% | A | A | A |
| U1-38 | PID setpoint | PID setpoint | 10 V: 100% PID target | 0.01% | A | A | A |

### Multi-Function Contact Inputs (H1-01 to H1-05)

| Set Value | Function | Control Methods | | |
|---|---|---|---|---|
| | | V/f | V/f with PG | Open loop Vec-tor |
| 19 | PID control disable (ON: PID control disabled) | Yes | Yes | Yes |
| 30 | PID control integral reset (reset when reset command is input or when stopped during PID control) | Yes | Yes | Yes |
| 31 | PID control integral hold (ON: Integral hold) | Yes | Yes | Yes |
| 34 | PID soft starter | Yes | Yes | Yes |
| 35 | PID input characteristics switch | Yes | Yes | Yes |

### Multi-Function Analog Input (H3-09)

| Set Value | Function | | Control Methods | | |
|---|---|---|---|---|---|
| | | | V/f | V/f with PG | Open loop Vec-tor |
| B | PID feedback | Max. output frequency | Yes | Yes | Yes |
| C | PID target value | Max. output frequency | Yes | Yes | Yes |

## ■PID Control Methods

There are four PID control methods. Select the method by setting constant b5-01.

| Set Value | Control Method |
|---|---|
| 1 | PID output becomes the Inverter output frequency, and D control is used in the deviation (difference between PID target value and feedback value.) |
| 2 | PID output becomes the Inverter output frequency, and D control is used in the PID feedback value. |
| 3 | PID output is added as compensation value of the Inverter output frequency, and D control is used in the deviation (difference between PID target value and feedback value). |
| 4 | PID output is added as compensation value of the Inverter output frequency, and D control is used in the PID feedback value. |

## ■PID Input Methods

### PID Target Value Input Methods

Select the PID control target value input method according to the setting in b1-01 (Reference Selection). Normally, the frequency reference selected in b1-01 is the PID target value, but you can also set the PID target value as shown in the following table.

| PID Target Input Method | Setting Conditions |
|---|---|
| Multi-Function Analog Terminal A2 Input | Set H3-09 to C (PID target value). Also, be sure to set H6-01 (pulse train input function selection) to 1 (PID feedback value). |
| MEMOBUS register 0006H | Set MEMOBUS bit 1 in register address 000FH to 1 (enable/disable PID target value from communications) to be able to use register number 0006H as the PID target value. |
| Pulse train input | Set H6-01 to 2 (PID target value). |
| Constant setting | If b5-18 is set to 1 the value in b5-19 becomes the PID target value. |

NOTE

If the PID function is used, the frequency reference value becomes the target value, which is set and shown in Hz on the operator. Nevertheless, internally the PID target value is used in percent. I.e. the following formula is used:

$$\text{PID target value [\%]} = \frac{\text{frequency reference [Hz]}}{\text{max. output frequency [Hz]}} \cdot 100\ \%$$

### PID Feedback Input Methods

Select one of the following PID control feedback input methods

| Input Method | Setting Conditions |
|---|---|
| Multi-function analog input | Set H3-09 (Multi-function Analog Input Terminal A2 Selection) to B (PID feedback). |
| Pulse train input | Set H6-01 to 1 (PID feedback). |

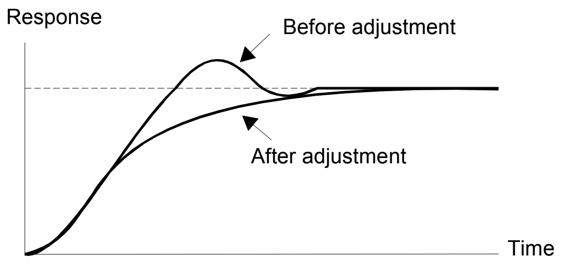
INFO

Adjust PID target value and PID feedback value using the following items.
- Analog input: Adjust using the analog input terminal gain and bias.
- Pulse train input: Adjust using pulse train scaling, pulse train input gain, and pulse train input bias.

## ■PID Adjustment Examples

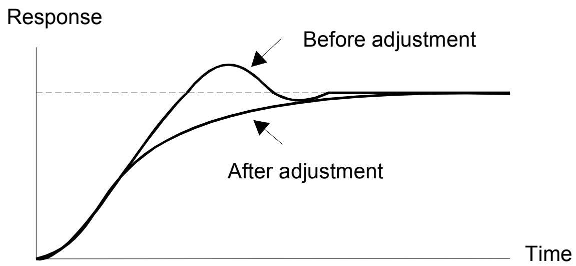
### Suppressing Overshoot

If overshoot occurs, reduce Proportional gain (P), and increase integral time (I).



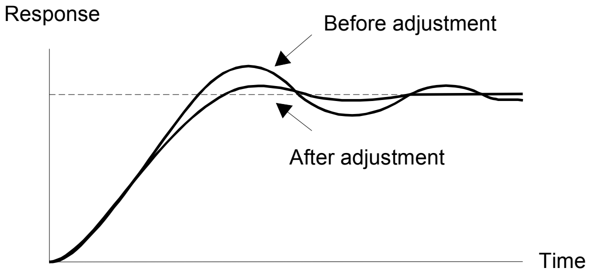

### Set a Rapidly Stabilizing Control Condition

To rapidly stabilize the control even if overshoot occurs, reduce integral time (I), and lengthen differential time (D).




### Suppressing Long-cycle Vibration

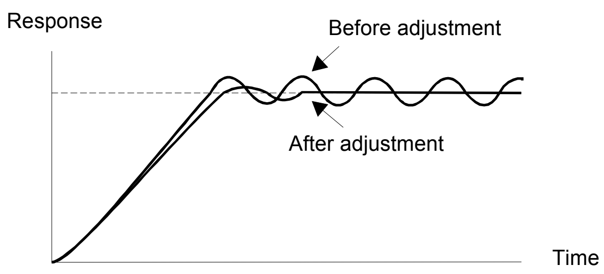
If vibration occurs with a longer cycle than the integral time (I) set value, lengthen the integral time (I) to suppress the vibration.



### Suppressing Short Cycle Vibration

If vibration occurs when the vibration cycle duration is short, and the cycle duration is almost identical to the differential time (D) set value, the differential operation is too strong. Shorten the differental time (D) to suppress the vibration.

If vibration continues even when the differential time (D) is set to 0.00 (D control disabled), reduce the proportional gain (P), or increase the PID primary delay time constant.




## ■Setting Precautions

- In PID control, the b5-04 constant is used to prevent the calculated integral control value from exceeding a specified amount. When the load varies rapidly, Inverter response is delayed, and the machine might get be damaged or the motor may stall. In this case, reduce the set value to speed up Inverter response.
- The b5-06 constant is used to prevent the output value of the the PID control calculation from exceeding a specified amount. The value is set taking the maximum output frequency as 100%.
- The b5-07 constant is used to adjust PID control offset. The value is set in increments of 0.1%, taking the maximum output frequency to be 100%.
- Set the filter time constant for the PID control output in b5-08. Enable this constant to prevent machinery resonance when machinery friction is great, or rigidity is poor. In this case, set the constant to be greater than the resonance frequency cycle duration. Increase this time constant to reduce Inverter responsiveness.
- Using b5-09, the PID output polarity can be inverted. If now the PID target value increases the output frequency will be lowered. This function is usable e.g. for vacuum pumps.
- Using b5-10, you can apply a gain to the PID control output. Enable this constant to adjust the amount of compensation if adding PID control output to the frequency reference as compensation (b5-01 = 3/4).
- When PID control output is negative, you can use constant b5-11 to determine what happens to the inverter output. When b1-04 (Prohibition of Reverse Operation) is set to 1 (enabled), however, the PID output limited to 0.
- Using the b5-17 constant the PID target value can be raised or lowered with an accel./decel. ramp function (PID soft starter).
  The normally used accel./decel. function (C1-☐☐ constants) is allocated after PID control so that, depending on the settings, resonance with the PID control and hunting in the machinery may occur. Using b5-17 this behaviour can be prevented.
  The PID soft starter function can also be disabled or enabled using a multifunction digital input (H1-☐☐ has to be set to 34).

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## ■PID Control Block

The following diagram shows the PID control block in the Inverter.

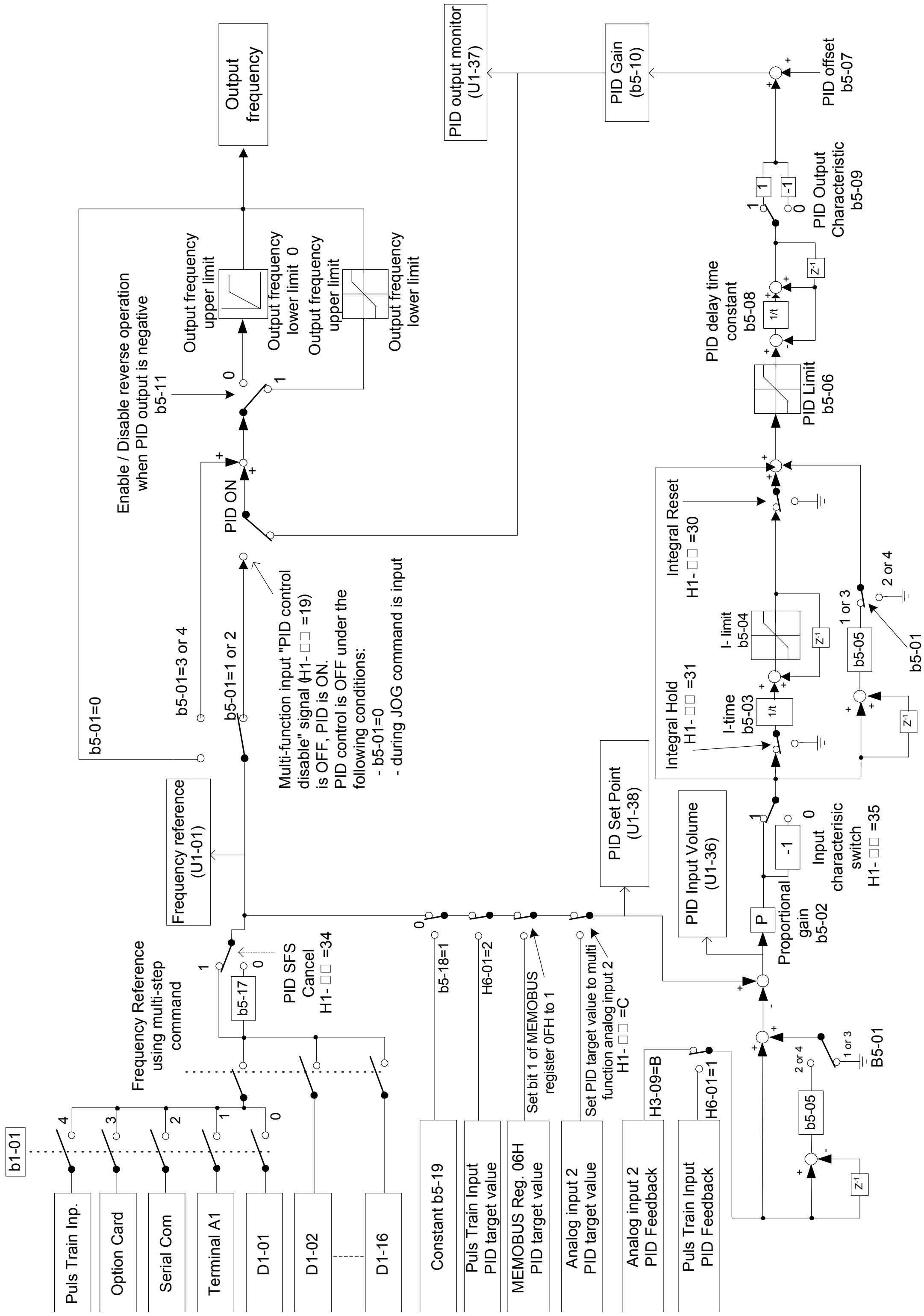


Fig 6.66  PID Control Block Diagram

## ■PID Feedback Loss Detection

When performing PID control, be sure to use the PID feedback loss detection function. Otherwise if the PID feedback gets lost, the Inverter output frequency may accelerate to the maximum output frequency.

When b5-12 is set to 1 and the PID feedback value falls below the PID feedback loss detection level (b5-13) for a time longer than the PID feedback loss detection time (b5-14), a Fbl alarm (Feedback loss) will be displayed at the operator and inverter operation is continued.

When the same happens and b5-12 is set to 2 a Fbl fault will be displayed on the digital operator and the inverter operation will be stopped. The motor coasts to stop and the fault contact is operated.

The time chart for PID feedback loss detection is shown below.

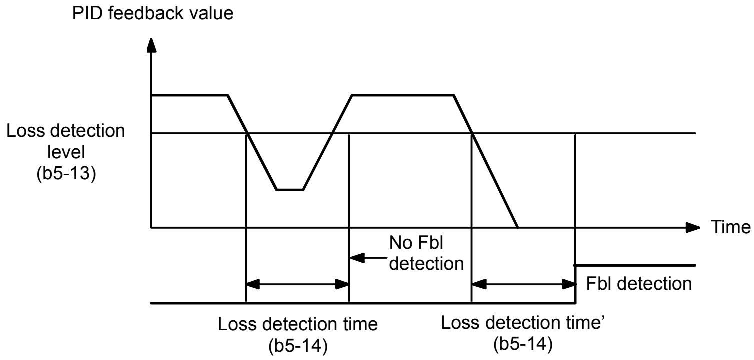


Fig 6.67 PID Feedback Loss Detection Time Chart

## ■PID Sleep

The PID sleep function stops the Inverter when the PID output value falls below the sleep operation level (b5-15) for the sleep operation time set in parameter b5-16 or longer. The inverter operation will resume, if the PID output value exceeds the sleep operation level for the time set in parameter b5-16 or longer.

When PID control is disabled, the PID sleep function is also disabled. When using the PID sleep function, select decelerate to stop or coast to stop as the stopping method.

The PID sleep time chart is shown below.

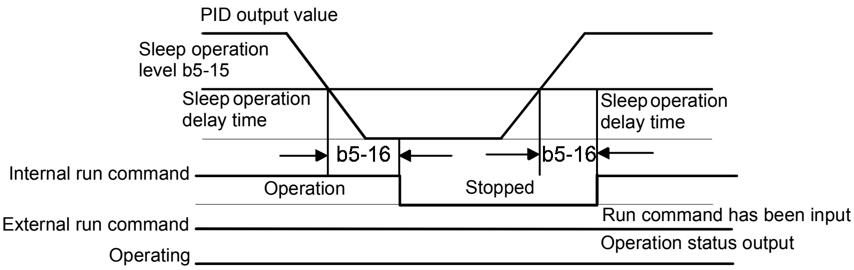


Fig 6.68 PID Sleep Time Chart

## ■Multifunction Digital Input Settings: H1-01 to H1-05 (Terminal S3 bis S7)

### PID Control Disable: “19”

- When a multifunction input is set for this function it can be used to disable the PID function by switching the input to ON.
- The PID target value becomes the frequency reference value.

### PID Control Integral Reset: “30”

- Using this function the integral share value of the PID control can be reset by setting a multifunction input to ON.

### PID Control Integral Hold: “31”

- Using this function the integral share value of the PID control can be hold by setting a multifunction input to ON. The value will be hold as long as the input is ON.

### PID Softstarter: “34”

- Using this function the PID target value can be raised or lowered slowly using an accel./decel. ramp function. The accel./decel. time can be set in constant b5-17. The function is active when the multi-function input with this function is ON.
- Note: The softstarter function works only if the frequency reference input becomes the PID target value (refer to *Fig 6.66*).

### PID Input Characteristic Switch: “35”

- Using this function the PID input characteristic can be inverted by setting a multifunction input to ON.

## ◆ Energy-saving

To perform energy saving, set b8-01 (Energy Saving Mode Selection) to 1. Energy-saving control can be performed using both V/f control and open loop vector control. The constants to be adjusted are different for each. In V/f control, adjust b8-04 to b8-05, and in open loop vector, adjust b8-02 and b8-03.

### ■Related Constants

| Constant Number | Name | Details | Setting Range | Factory Setting | Change During Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| b8-01 | Energy-saving mode selection | Select whether to enable or disable energy-saving control.<br>0: Disable<br>1: Enable | 0 or 1 | 0 | No | A | A | A |
| b8-02 | Energy-saving gain | Sets the energy-saving gain in open loop vector control. | 0.0 to 10.0 | 0.7 *1 | Yes | No | No | A |
| b8-03 | Energy-saving filter time constant | Sets the energy-saving filter time constant in open loop vector control. | 0.00 to 10.0 | 0.50 s *2 | Yes | No | No | A |
| b8-04 | Energy-saving coefficient | Sets the Energy-saving coefficient depending on the setting in E2-11 (motor rated current).<br>Adjusts the value in 5% steps until the output power becomes minimal. | 0.0 to 655.00*3 | *4 | No | A | A | No |
| b8-05 | Power detection filter time constant | Sets the time constant for output power detection. | 0 to 2000 | 20 ms | No | A | A | No |
| b8-06 | Search operation voltage limiter | Sets the limit value of the voltage control range during search operation.<br>Set to 0 to disable the search operation. 100% is the motor rated voltage. | 0 to 100 | 0% | No | A | A | No |

* 1. The factory setting is 1.0 when using V/f control with PG.
* 2. The factory setting is 2.00 s when Inverter capacity is 55 kW min.
* 3. The same capacity as the Inverter will be set by initializing the constants.
* 4. The factory settings depend on the Inverter capacity.

| No. Constant No. | Name | Details | Setting Range | Factory Setting | Change During Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open loop Vector |
| E2-02 | Motor rated slip | Sets the motor rated slip. This set value will become the reference value for the slip compensation. It is automatically set during autotuning. | 0.00 to 20.00 | 2.90 Hz * | No | A | A | A |
| E2-11 | Motor rated output power | Set the rated output power of the motor in units of 0.01 kW.<br>This constant is an input data for autotuning. | 0.00 to 650.00 | 0.40 * | No | Q | Q | Q |

* Factory settings depend on Inverter capacity. (The values shown are for a 200 V Class Inverter for 0.4 kW.)

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## ■Adjusting Energy-saving Control

The method of adjusting the energy-saving control function depends on the control method. Refer to the following when making adjustments.

### V/f Control Method

In V/f control the voltage for optimum motor efficiency is calculated and becomes the output voltage reference.

- b8-04 (Energy-saving Coefficient) is preset assuming that motor and inverter capacity are the same. If the inverter capacity differs from the motor capacity, set the motor capacity in E2-11 (Motor Rated Output Power). Also, adjust b8-04 in steps of 5 % until the output power reaches its minimum. The higher the energy-saving coefficient, the higher is the output voltage.
- To improve the responsiveness when the load fluctuates, reduce the power detection filter time constant b8-05. If b8-05 is set too small, however, the motor rotations may become unstable under light load conditions.
- Motor efficiency varies due to temperature fluctuations and differences in motor characteristics. Consequently the motor efficiency has to be controlled. To have optimized efficiency, the search operation varies the output voltage. Constant b8-06 (Search Operation Voltage Limiter) limits the range for the voltage search operation. For 200 V Class Inverters, a range of 100% is equal to 200 V and for 400 V Class Inverters a range of 100% is equal to 400 V. Set to 0 to disable the search operation voltage limiter.

### Open loop vector control

In open loop vector control, the slip frequency is controlled so that motor efficiency is maximized.

- Taking the motor rated slip for the base frequency as optimum slip, the inverter calculates the slip for the optimum motor efficiency depending on the output frequency. In vector control, be sure to perform autotuning, and set the motor rated slip.
- If hunting occurs when energy-saving control is used in vector control, reduce the set value in b8-02 (Energy-saving Gain), or increase the set value in b8-03 (Energy-saving Filter Time Constant).

## ◆ Field Weakening

The field weakening function is used to lower the output voltage when the motor load changes to a low level (no load). Thereby energy can be saved and motor audible noise is reduced.

Note that this function is designed for use with only one low load condition that does not change. If the low load condition changes, the field weakening function can not be optimized. In this case the energy saving function should be preferred.

The function can be activated using a multifunction input. Therefore set one of the constants H1-01 to H1-05 to 63.
Field weakening can only be used in V/f control.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | |
| d6-01 | Field weakening level | Sets the Inverter output voltage when the field weakening command is input at a multi-function input.<br>Sets the voltage level as a percentage taking the voltage set in the V/f pattern as 100%. | 0 to 100 | 80 % | No | A | A | No |
| d6-02 | Field weakening frequency limit | Sets the lower limit of the frequency range where field control is valid.<br>The field weakening command is valid only at frequencies above this setting and only when the speed is in agreement with the current speed reference. | 0.0 to 400.0 | 0.0 Hz | No | A | A | No |

### ■Setting the Field Weakening Level (d6-01)

To set the field weakening level run the motor under low load condition and activate the field weakening function using a multifunction input. Monitor the output current and raise or lower the field weakening level until the output current reaches it’s minimum value.

Observe the following:

- Constant d6-01 can not be changed during operation (i.e. a RUN command is input).
- If the field weakening level is set too low, the motor may stall.

### ■Multifunction Input Settings: H1-01 to H1-05 (Terminal S3 to S7)

#### Field Weakening Command: “63”

- If one of the constants H1-01 to H1-05 is set to “63”, the field weakening function can be activated switching the terminal input to ON.

## ◆ Setting Motor 1 Constants

In vector control method, the motor constants are set automatically during autotuning. If autotuning does not complete normally, set them manually.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| E2-01 | Motor rated current | Sets the motor rated current.<br>This set value will become the reference value for motor protection and torque limits.<br>It is an input data for autotuning. | 0.32 to 6.40 *1 | 1.90 A *2 | No | Q | Q | Q |
| E2-02 | Motor rated slip | Sets the motor rated slip.<br>This set value will become the reference value for slip compensation. | 0.00 to 20.00 | 2.90 Hz *2 | No | A | A | A |
| E2-03 | Motor no-load current | Sets the motor no-load current.<br>This constant is automatically set during autotuning. | 0.00 to 1.89 *3 | 1.20 A *2 | No | A | A | A |
| E2-04 | Number of motor poles (Number of poles) | Sets the number of motor poles.<br>This constant is an input data for autotuning. | 2 to 48 | 4 poles | No | No | Q | No |
| E2-05 | Motor line-to-line resistance | Sets the motor phase-to-phase resistance.<br>This constant is automatically set during autotuning. | 0.000 to 65.000 | 9.842 Ω *2 | No | A | A | A |
| E2-06 | Motor leak inductance | Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage.<br>This constant is automatically set during autotuning. | 0.0 to 40.0 | 18.2% | No | No | No | A |
| E2-07 | Motor iron saturation coefficient 1 | Sets the motor iron saturation coefficient at 50% of magnetic flux.<br>This constant is automatically set during rotating autotuning. | 0.00 to 0.50 | 0.50 | No | No | No | A |
| E2-08 | Motor iron saturation coefficient 2 | Sets the motor iron saturation coefficient at 75% of magnetic flux.<br>This constant is automatically set during rotating autotuning. | 0.00 to 0.75 | 0.75 | No | No | No | A |
| E2-10 | Motor iron loss for torque compensation | Sets motor iron loss in W units. | 0 to 65535 | 14 W *2 | No | A | A | No |
| E2-11 | Motor rated output power | Sets the rated output of the motor in units of 0.01 kW. This constant is an input data for autotuning. | 0.00 to 650.00 | 0.40 *2 | No | Q | Q | Q |

Note All factory-set constants are for a Yaskawa standard 4-pole motor.
* 1. The setting range is 10% to 200% of the Inverter rated output current (the values shown are for a 200 V Class Inverter for 0.4 kW).
* 2. The factory settings depend on Inverter capacity (the values shown are for a 200 V Class Inverter for 0.4 kW).
* 3. The setting range depends on Inverter capacity (the values shown are for a 200 V Class Inverter for 0.4 kW).

## ■Manual Setting of the Motor Constant

### Motor Rated Current Setting

Set E2-01 to the rated current value on the motor nameplate.

### Motor Rated Slip Setting

Set E2-02 to the motor rated slip calculated from the number of rated rotations on the motor nameplate.

$$\text{Motor rated slip} = \text{Motor rated frequency (Hz)} - \frac{\text{Rated speed (rpm) x No. of motor poles}}{120}$$

### Motor No-Load Current Setting

Set E2-03 to the motor no-load current at the rated voltage and rated frequency. Normally, the motor no-load current is not written on the motor nameplate. Consult the motor manufacturer.

Factory setting is the no-load current value for a standard Yaskawa 4-pole motor.

### Number of Motor Poles Setting

E2-04 is displayed only when V/f control method with PG is selected. Set the number of motor poles as written on the motor nameplate.

### Motor Line-to-Line Resistance Setting

E2-05 is set automatically when performing motor line-to-line resistance autotuning. When you cannot perform tuning, consult the motor manufacturer for the line-to-line resistance value. Calculate the resistance from the line-to-line resistance value in the motor test report using the following formula, and then make the setting accordingly.

- E-type insulation: [Line-to line resistance (Ω) at 75°C of test report] × 0.92 (Ω)
- B-type insulation: [Line-to line resistance (Ω) at 75°C of test repor]t × 0.92 (Ω)
- F-type insulation: [Line-to line resistance (Ω) at 115°C of test report] × 0.87 (Ω)



### Motor Leak Inductance Setting

Set the amount of voltage drop due to motor leakage inductance in E2-06 as percentage of the motor rated voltage. Make this setting when using high-speed motors because the standard value will be too high. (Normally, high speed motors have a low inductance compared to standard motors.) If the inductance is not written on the motor nameplate, consult the motor manufacturer.

### Motor Iron Saturation Coefficients 1 and 2 Settings

E2-07 and E2-08 are set automatically during rotating autotuning.

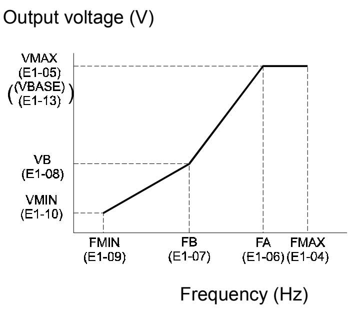
### Motor Iron Loss for Torque Compensation Setting

E2-10 is displayed only in V/f control method and can be set to increase the torque compensation accuracy. The motor iron loss has to be set in kW.

## ◆ Setting the V/f Pattern 1

Using the E1-□□ constants the Inverter input voltage and the V/f pattern can be set as needed. It is not recommended to change the settings when the motor is used in open loop vector control mode.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop Vector |
|---|---|---|---|---|---|---|---|---|
| E1-01 | Input voltage setting | Sets the Inverter input voltage. This setting is used as a reference value for protection functions. | 155 to 255 *1 | 200 V *1 | No | Q | Q | Q |
| E1-03 | V/f pattern selection | 0 to E: Select from the 15 preset V/f patterns.<br>F: Custom user-set patterns (Applicable for setting of E1-04 to E1-10.) | 0 to F | F | No | Q | Q | No |
| E1-04 | Max. output frequency (FMAX) | <br>To set V/f characteristics in a straight line, set the same values for E1-07 and E1-09. In this case, the setting for E1-08 will be disregarded.<br>Always ensure that the four frequencies are set in the following manner:<br>E1-04 (FMAX) ≥ E1-06 (FA) >E1-07 (FB) ≥ E1-09 (FMIN) | 40.0 to 400.0 *2 | 50.0 Hz | No | Q | Q | Q |
| E1-05 | Max. voltage (VMAX) | | 0.0 to 255.0 *1 | 200.0 V *1 | No | Q | Q | Q |
| E1-06 | Base frequency (FA) | | 0.0 to 400.0 | 50.0 Hz | No | Q | Q | Q |
| E1-07 | Mid. output frequency (FB) | | 0.0 to 255.0 *1 | 2.5 Hz *3 | No | A | A | A |
| E1-08 | Mid. output frequency voltage (VB) | | 0.0 to 400.0 | 15.0 V *1 *3 | No | A | A | A |
| E1-09 | Min. output frequency (FMIN) | | 0.0 to 400.0 | 1.2 Hz *3 | No | Q | Q | Q |
| E1-10 | Min. output frequency voltage (VMIN) | | 0.0 to 255.0 *1 | 9.0 V *1 *3 | No | A | A | A |
| E1-11 | Mid. output frequency 2 | Set only to fine-adjust V/f for the output range. Normally, this setting is not required. | 0.0 to 400.0 | 0.0 Hz *4 | No | A | A | A |
| E1-12 | Mid. output frequency voltage 2 | | 0.0 to 255.0 *1 | 0.0 V *3 | No | A | A | A |
| E1-13 | Base voltage (VBASE) | Sets the output vltage at the base frequency (E1-06) | 0.0 to 255.0 *1 | 0.0 V *5 | No | A | A | Q |

* 1. These are values for a 200 V Class Inverter. Values for a 400 V Class Inverter are double.
* 2. When C6-01 is set to 0, the upper limit of the setting range is 150.0 Hz.
* 3. The factory setting will change when the control method is changed. (V/f control factory settings are given.)
* 4. The contents of constants E1-11 and E1-12 are ignored when set to 0.00.
* 5. E1-13 is set to the same value as E1-05 by autotuning.

## ■Setting Inverter Input Voltage

Set the Inverter input voltage correctly in E1-01 so that it matches the power supply voltage. This set value will be the reference value for the protection functions and similar functions (overvoltage level, stall level).

## ■Setting V/f Pattern

The V/f pattern can be selected using constant E1-03. There are two methods of setting the V/f pattern: Select one of the 15 preset pattern types (set value: 0 to E), or set a user-defined V/f pattern (set value: F).

The factory setting for E1-03 is F.

To select one of the existing patterns, refer to the following table.

| Characteristic | Application | Set Value | Specifications |
|---|---|---|---|
| Constant Torque Characteristic | These patterns are used in general applications where the load torque is fixed, regardless of rotation speed, e.g. for linear transport systems. | 0 (F) | 50 Hz specifications |
| | | 1 | 60 Hz specifications |
| | | 2 | 60 Hz specifications, voltage saturation at 50 Hz |
| | | 3 | 72 Hz specifications, voltage saturation at 60 Hz |
| Variable torque characteristic | These patterns are used for loads with torque proportional to the square or cube of the rotation speed, such as fans and pumps. | 4 | 50 Hz specifications, cubical torque characteristic |
| | | 5 | 50 Hz specifications, quadratic torque characteristic |
| | | 6 | 60 Hz specifications, cubical torque characteristic |
| | | 7 | 60 Hz specifications, quadratic torque characteristic |
| High Startup Torque (See Note)* | Select a high startup torque V/f pattern only in the following cases.<br>• The wiring distance between Inverter and motor is large (approx. 150 m min.)<br>• A large torque is required at startup<br>• An AC reactor is inserted in the Inverter input or output. | 8 | 50 Hz specifications, medium startup torque |
| | | 9 | 50 Hz specifications, large startup torque |
| | | A | 60 Hz specifications, medium startup torque |
| | | B | 60 Hz specifications, large startup torque |
| Fixed Output Operation | This pattern is used for frequencies of 60 Hz or higher. A fixed voltage is applied. | C | 90 Hz specifications, voltage saturation at 60 Hz |
| | | D | 120 Hz specifications, voltage saturation at 60 Hz |
| | | E | 180 Hz specifications, voltage saturation at 60 Hz |

* The high start up torque is provided by the fully automatic torque boost function, so normally there is no need to use this pattern.

When you select these patterns, the values of constants E1-04 to E1-10 are changed automatically. There are three types of values for E1-04 to E1-10, depending on the Inverter capacity.

- 0.4 to 1.5 kW V/f pattern
- 2.2 to 45 kW V/f pattern
- 55 to 300 kW V/f pattern

The characteristics diagrams for each are shown in the following pages.

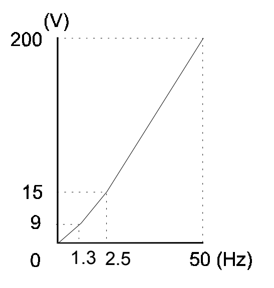
6

### 0.4 to 1.5 kW V/f Pattern

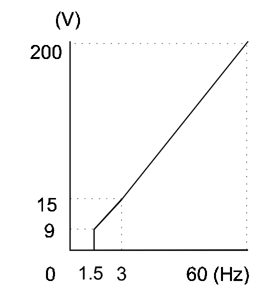
The diagrams show characteristics for a 200-V class motor. For a 400-V class motor, multiply all voltages by 2.

- Constant Torque Characteristics (Set Value: 0 to 3)

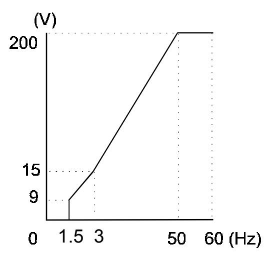
Set Value 0 | 50 Hz



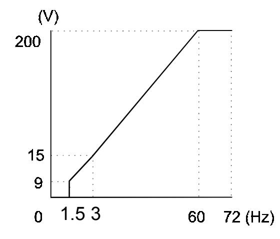

Set Value 1 | 60 Hz




Set Value 2 | 60 Hz

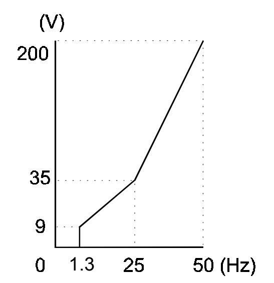



Set Value 3 | 72 Hz

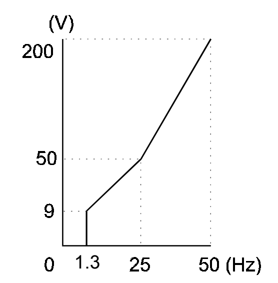



- Variable Torque Characteristics (Set Value: 4 to 7)

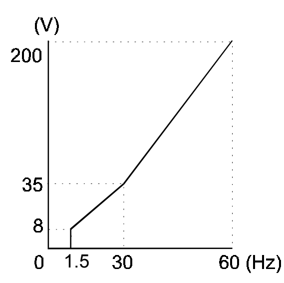
Set Value 4 | 50 Hz



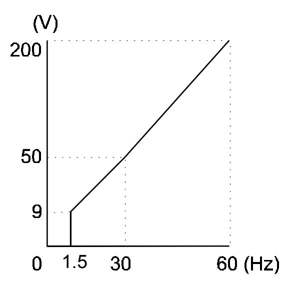

Set Value 5 | 50 Hz




Set Value 6 | 60 Hz

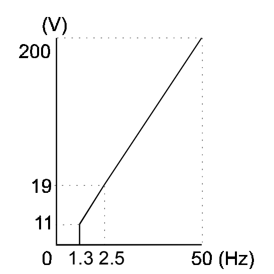



Set Value 7 | 60 Hz

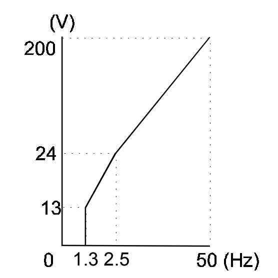



- High startup torque (Set value 8: to b)

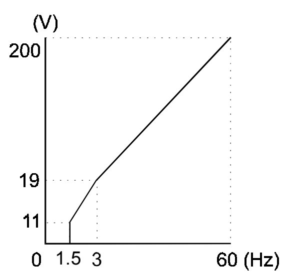
Set Value 8 | 50 Hz



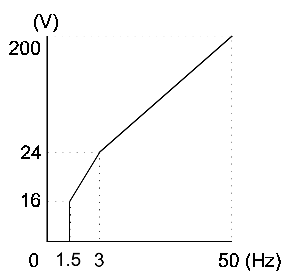

Set Value 9 | 50 Hz




Set Value A | 60 Hz

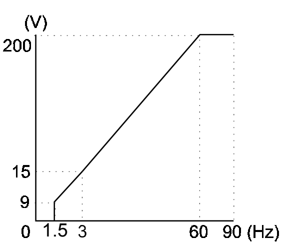



Set Value B | 60 Hz

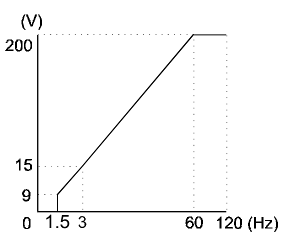



- Fixed Output Operation (Set Value: C to E)

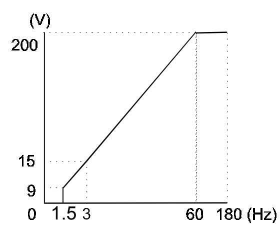
Set Value C | 90 Hz




Set Value D | 120 Hz




Set Value E | 180 Hz

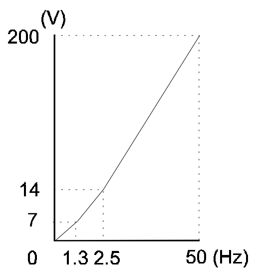


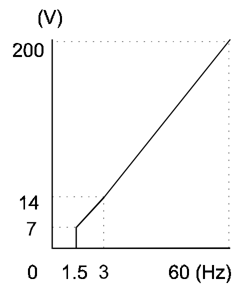
### 2.2 to 45 kW V/f Pattern

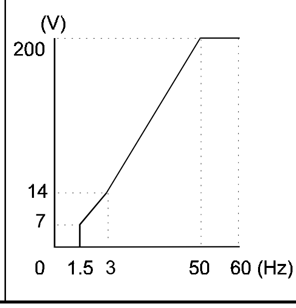
The diagrams show characteristics for a 200-V class motor. For a 400-V class motor, multiply all voltages by 2.

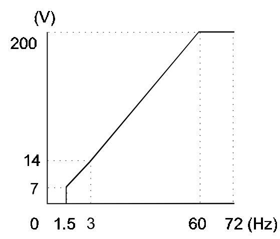
- Constant Torque Characteristics (Set Value: 0 to 3)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Set Value 0 | 50 Hz | Set Value 1 | 60 Hz | Set Value 2 | 60 Hz | Set Value 3 | 72 Hz |



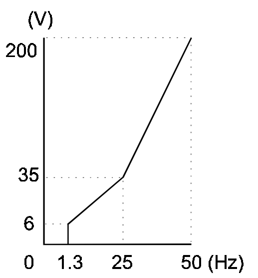



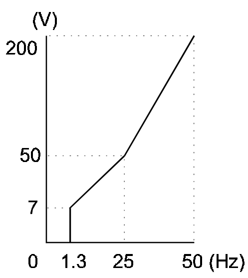



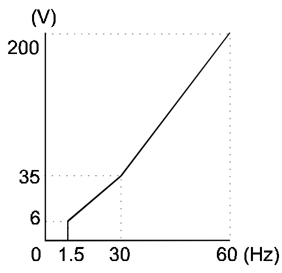



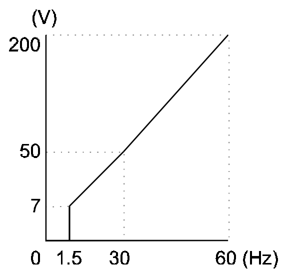

- Variable Torque Characteristics (Set Value: 4 to 7)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Set Value 4 | 50 Hz | Set Value 5 | 50 Hz | Set Value 6 | 60 Hz | Set Value 7 | 60 Hz |



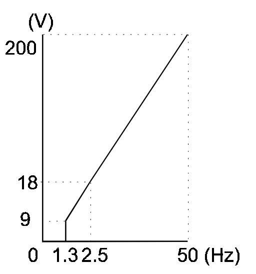



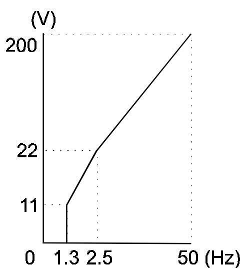



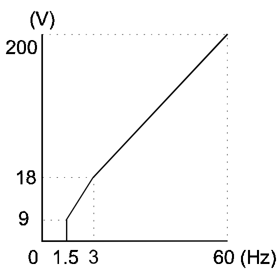



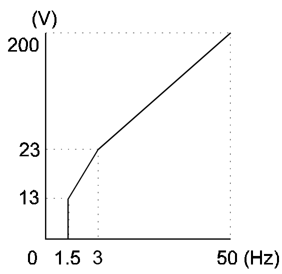

- High Startup Torque (Set Value: 8 to b)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Set Value 8 | 50 Hz | Set Value 9 | 50 Hz | Set Value A | 60 Hz | Set Value B | 60 Hz |



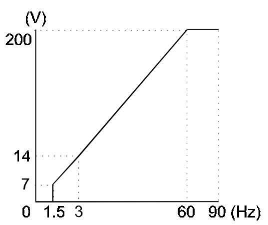



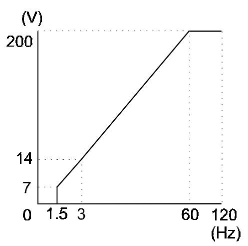



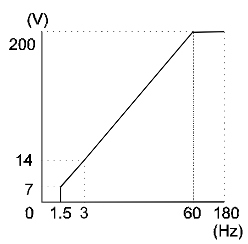




- Fixed Output Operation (Set Value: C to E)

| | | | | | |
|---|---|---|---|---|---|
| Set Value C | 90 Hz | Set Value D | 120 Hz | Set Value E | 180 Hz |



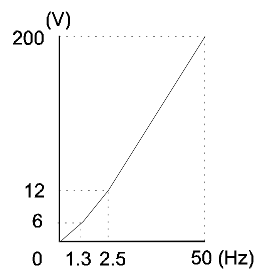



## 55 to 300 kW V/f Pattern

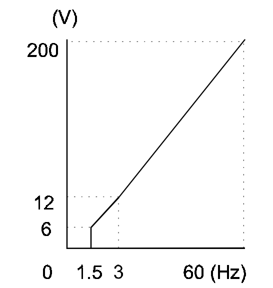
The diagrams show characteristics for a 200-V class motor. For a 400-V class motor, multiply all voltages by 2.

- Constant Torque Characteristics (Set Value: 0 to 3)

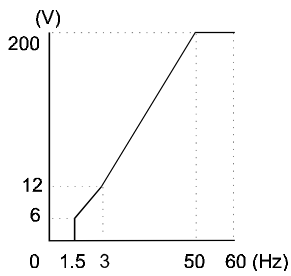
Set Value 0 — 50 Hz



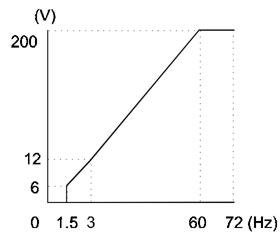

Set Value 1 — 60 Hz




Set Value 2 — 60 Hz

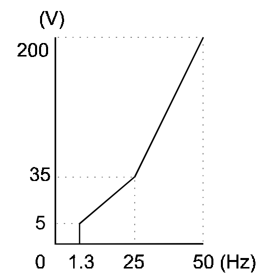



Set Value 3 — 72 Hz

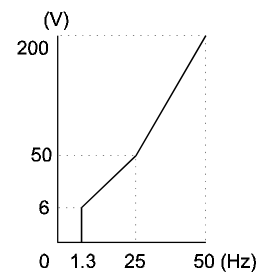



- Variable Torque Characteristics (Set Value: 4 to 7)

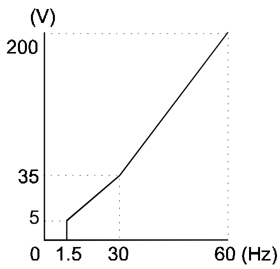
Set Value 4 — 50 Hz



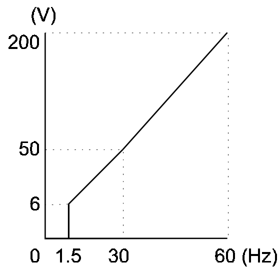

Set Value 5 — 50 Hz




Set Value 6 — 60 Hz

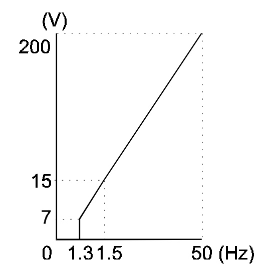



Set Value 7 — 60 Hz

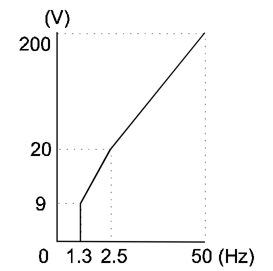



- High Startup Torque (Set Value: 8 to b)

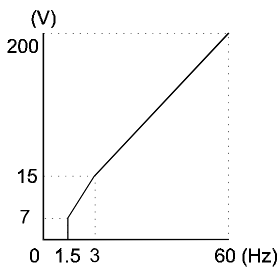
Set Value 8 — 50 Hz



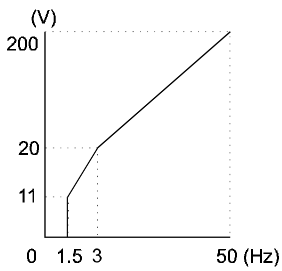

Set Value 9 — 50 Hz




Set Value A — 60 Hz

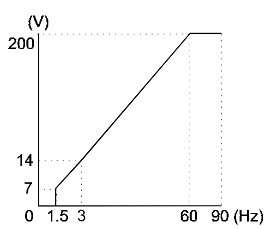



Set Value B — 60 Hz

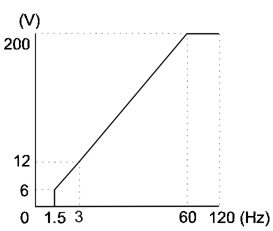



- Fixed Output Operation (Set Value: C to E)

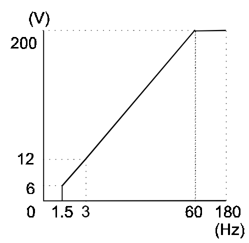
Set Value C — 90 Hz




Set Value D — 120 Hz




Set Value E — 180 Hz



INFO

When E1-03 is set to F (User-defined V/f pattern), you can set constants E1-04 to E1-10. If E1-03 is set to anything other than F, you can only read constants E1-04 to E1-10. If the V/f characteristics are linear, set E1-07 and E1-09 to the same value. In this case, E1-08 will be ignored.

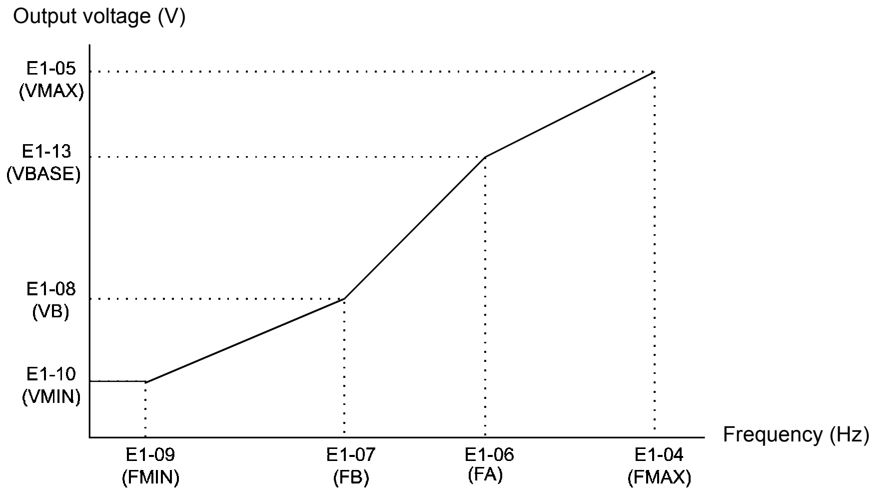



Fig 6.69  User-Set V/f Pattern

## ■Setting Precautions

When the setting is to user-defined V/f pattern, beware of the following points:

- When changing control method, constants E1-07 to E1-10 will change to the factory settings for that control method.
- Be sure to set the four frequencies as follows:
  E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)

## ◆ Setting Motor 2 Constants

The E4-☐☐ constants are for setting the motor constants for motor 2. In vector control mode the motor constants are set automatically during autotuning. If the autotuning does not complete normally, set them manually (refer to *Page 6-115*, Manual Settings of the Motor Constants).

**Note:** Autotuning for motor 2 can only be performed if one multifunction input H1-☐☐ is set to 16 (Motor 2 selection). Otherwise motor 2 cannot be selected during autotuning (T1-00 will not be shown).

### ■Related constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| E4-01 | Motor 2 rated current | Sets the motor rated current. This set value will become a reference value for motor protection and torque limits.<br>This constant is an input data for autotuning. | 0.32 to 6.40 *1 | 1.90 A *2 | No | A | A | A |
| E4-02 | Motor 2 rated slip | Sets the motor rated slip in Hz units.<br>This set value will become a reference value for slip compensation.<br>This constant is automatically set during autotuning. | 0.00 bis 20.00 | 2.90 Hz *2 | No | A | A | A |
| E4-03 | Motor 2 no-load current | Sets the motor no-load current.<br>This constant is automatically set during autotuning. | 0.00 bis 1.89 *3 | 1.20 A *2 | No | A | A | A |
| E4-04 | Motor 2 number of poles (number of poles) | Sets the number of motor poles.<br>This value is an input data for autotuning. | 2 to 48 | 4 poles | No | No | A | No |
| E4-05 | Motor 2 line-to-line resistance | Sets the motor phase-to-phase resistance in Ω units. This constant is automatically set during autotuning. | 0.000 to 65.000 | 9.842 Ω *2 | No | A | A | A |
| E4-06 | Motor 2 leak inductance | Sets the voltage drop due to motor leakage inductance as a percentage of the motor rated voltage.<br>This constant is automatically set during autotuning. | 0.0 to 40.0 | 18.2% *2 | No | No | No | A |
| E4-07 | Motor 2 rated capacity | Sets the rated output of the motor in units of 0.01 kW.<br>This constant is an input data for autotuning. | 0.40 to 650.00 | 0.40 *2 | No | A | A | A |

* 1. The setting range is 10% to 200% of the inverter's rated output current. The values for a 200 V class inverter of 0.4 kW is given.
* 2. The factory setting depends upon the inverter capacity. The value for a 200 V class inverter of 0.4 kW is given.
* 3. The setting range will depend upon the inverter capacity. The value for a 200 V class inverter of 0,4 kW is given.

### ■Multifunction Input Settings: H1-01 to H1-05 (Terminal S3 to S7)

#### Motor Switch Command (Motor 2 Selection): "16"

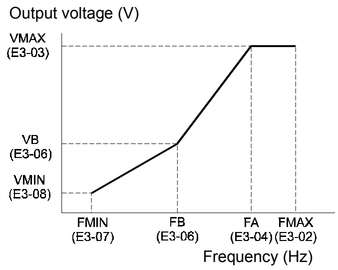
- Using this setting a multifunction input can be used to switch over between motor 1 and motor 2 settings.
- If motor 2 is selected the inverter uses the V/f pattern 2 (E3-☐☐ constants) and not V/f pattern 1.

## ◆ Setting the V/f Pattern 2

Using the E3-□□ constants the V/f pattern for motor 2 can be set as needed.

It is not recommended to change the settings when the motor is used in open loop vector mode.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Modes | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| E3-01 | Motor 2 control method selection | 0: V/f control<br>1: V/f control with PG<br>2: Open-loop vector control | 0 to 2 | 0 | No | A | A | A |
| E3-02 | Motor 2 max. output frequency (FMAX) |  | 40.0 to 400.0 *1 | 50.0 Hz | No | A | A | A |
| E3-03 | Motor 2 max. output voltage (VMAX) | | 0.0 to 255.0 *2 | 200.0 V *3 | No | A | A | A |
| E3-04 | Motor 2 max. voltage frequency (FA) | | 0.0 to 400.0 | 50.0 Hz | No | A | A | A |
| E3-05 | Motor 2 mid. output frequency 1 (FB) | | 0.0 to 400.0 | 2.5 Hz *3 | No | A | A | A |
| E3-06 | Motor 2 mid. output frequency voltage 1 (VB) | | 0.0 to 255.0 *2 | 15.0 V *2 | No | A | A | A |
| E3-07 | Motor 2 min. output frequency (FMIN) | | 0.0 bis 400.0 | 1.2 Hz *3 | No | A | A | A |
| E3-08 | Motor 2 min. output frequency voltage (VMIN) | To set V/f characteristics in a straight line, set the same values for E3-05 and E3-07.<br>In this case, the setting for E3-06 will be disregarded.<br>Always ensure that the four frequencies are set in the following manner:<br>E3-02 (FMAX) ≥ E3-04 (FA) ><br>E3-05 (FB) > E3-07 (FMIN) | 0.0 to 255.0 *2 | 9.0 V *2 | No | A | A | A |

* 1. When C6-01 is set to 0, the upper limit of the setting range is 150.0 Hz.
* 2. These are values for a 200 V class inverter. Values for a 400 V class inverter are double.
* 3. The factory setting will change when the control method is changed. (V/f control factory settings are given.)

### ■Selecting the Motor 2 Control Method (E3-01)

Using constant E3-01 the control method for motor 2 can be selected.

- The setting of this constant affects the autotuning function. If V/f or V/f with PG is selected the only possible autotuning method will be stationary autotuning for line-to-line resistance.

### ■Setting the V/f Pattern Characteristic

The principle of setting the V/f pattern 2 is the same as for V/f pattern 1. Please refer to *Pages 6-117pp*. for details.

**Note:** The V/f pattern 2 settings are only used for motor 2, i.e. motor 2 has to be selected using a multi-function input (setting 16).

## ◆ Kinetic Energy Buffering (KEB)

The kinetic energy buffering (KEB) function can be used to decelerate to stop after a sudden power loss using the kinetic energy of the rotating machine to maintain the DC bus voltage. Thereby an uncontrolled coasting of a machine can be prevented. The function can only be activated using a multifunction input that normally is operated by a voltage drop relay. A wiring example is shown in *Fig. 6.70*.

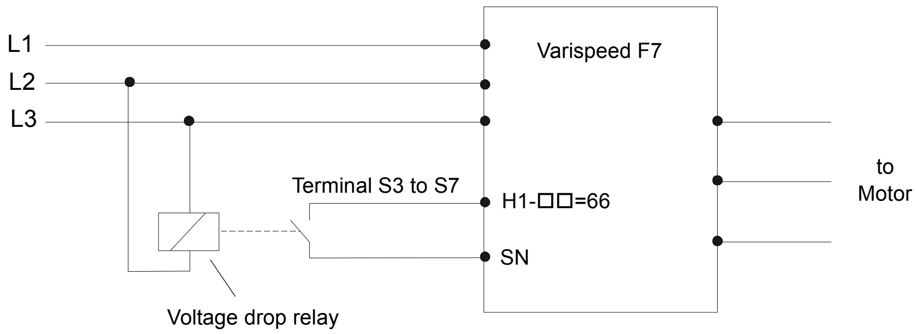



Fig. 6.70 Wiring Example for KEB function usage

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| L2-01 | Momentary power loss detection | 0: Disabled (DC bus undervoltage (UV1) detection<br>1: Enabled (Restarted when the power returns within the time set in L2-02. When L2-02 is exceeded, DC bus undervoltage is detected.<br>2: Enabled while CPU is operating. (Restarts when power returns during control operations. Does not detect DC bus undervoltage.) | 0 to 2 | 0 | No | A | A | A |
| L2-05 | Undervoltage detection level | Sets the main circuit undervoltage (UV) detection level (main circuit DC voltage).<br>Usually changing this setting is not necessary. | 150 to 210*1 | 190 V*1 | No | A | A | A |
| L2-06 | KEB deceleration time | Sets the time required to decelerate from the speed where the deceleration at momentary power loss command (KEB) is input to zero speed. | 0.0 to 200.0 | 0.0 s | No | A | A | A |
| L2-07 | Momentary recovery time | Sets the time to accelerate to the set speed after recovery from a momentary power loss. | 0.0 to 25.5 | 0 s*2 | No | A | A | A |
| L2-08 | Frequency reduction gain at KEB start. | Sets the reduction gain of the output frequency at the beginning of deceleration at momentary power loss (KEB).<br>Reduction = slip frequency before KEB operation × L2-08 × 2. | 0 to 300 | 100 | No | A | A | A |

* 1. The factory setting depends upon the inverter capacity. The value for a 200 V class inverter of 0.4 kW is given.
* 2. If the setting is 0, the axis will accelerate to the specified speed over the specified acceleration time (C1-01 to C1-08).

#### Setting the Momentary Power Loss Detection (L2-01)

- L2-01 = 0
  The inverter trips with undervoltage fault (UV1).
- L2-01 ≠ 0
  The inverter decelerates the motor to stop using the KEB deceleration time (L2-06).

#### Setting the Undervoltage Level (L2-05)

This constant sets the voltage level for the DC bus at which a DC bus undervoltage (UV, UV1) is detected.

Normally there is no need to change this setting.

### Adjusting the KEB Deceleration Time (L2-06)

Sets the time that is used to decelerate to stop when a KEB command is input.

To set up this constant do the following:

- Increase L2-06 until a UV1 fault is detected during deceleration. (If L2-01 is set to 2, no UV1 will be detected, but the motor will start to coast when the DC bus voltage drops too much.) The highest setting value of L2-06, at which no UV1 is detected will be the maximum KEB deceleration time.
- Decrease L2-06 until a DC bus overvoltage (OV) is detected. The lowest setting value of L2-06, at which no OV is detected, will be the minimal KEB deceleration time.
- Set a value for L2-06 that is somewhere in the middle between the maximum and the minimum KEB deceleration time.

### Setting the Momentary Recovery Time (L2-07)

This constant can be used to set the time to recover to the set frequency reference if the power supply returns while the KEB function is active. Note the following:

- The set time in L2-07 is the time that is taken to accelerate from the momentary frequency when the power supply returns to the frequency reference value. (It works not like the normal accel. function.).
- If L2-07 is set to 0 sec. (factory setting) the normal acceleration times set in the C1-☐☐ constants are used.

### Adjusting the Frequency Reduction Gain at KEB Start (L2-08)

Normally there is no need to change this setting.

- Increase the setting if an undervoltage fault occurs right after KEB start.
- Decrease the setting if an overvoltage fault occurs right after KEB start.

## ■Multifunction Input Settings: H1-01 to H1-05 (Terminal S3-S7)

## KEB Command NC: “65”

- Storing this setting for one of the constants H1-01 to H1-05, the KEB function can be activated using a NC contact.

### KEB command NO: “66”

- Using this setting for one of the constants H1-01 to H1-05, the KEB function can be activated using a NO contact.

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## ■High Slip Braking

If the load inertia is large the high slip braking function can be used to shorten the deceleration time compared to the normal deceleration time without using a braking option (braking resistor, braking resistor unit).

The function must be activated by a multifunction input.

Note:
- The HSB function is not comparable with the normal deceleration function. It does not use a ramp function.
- HSB should not be used at normal operation instead of a deceleration ramp.

## ■Related Constants

| Constan Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop |
| N3-01 | High-slip braking deceleration frequency width | Sets the frequency width for deceleration during high-slip braking in percent, taking the maximum frequency (E1-04) as 100%. | 1 to 20 | 5 % | No | A | A | A |
| N3-02 | High-slip braking current limit | Sets the current limit for deceleration during high-slip braking in percent, taking the motor rated current as 100%. The resulting limit must be 150% of the inverter rated current or less. | 100 to 200 | 150% | No | A | A | A |
| N3-03 | High-slip braking stop dwell time | Sets the dwell time for the output frequency for FMIN (1.5 Hz) during V/f control.<br>Effective only during deceleration with high-slip braking. | 0.0 to 10.0 | 1.0 s | No | A | A | A |
| N3-04 | High-slip braking OL time | Sets the OL7 time when the output frequency does not change for some reason during deceleration with high-slip braking. | 30 to 1200 | 40 s | No | A | A | A |

### Adjusting the HSB Deceleration Frequency Width (N3-01)

This constant sets the step value that is used for lowering the output frequency to achieve a large negative slip and thereby to brake the motor.

Normally no adjustments should be necessary. Increase the value if DC bus overvoltage faults occur.

### Adjusting the HSB Current Limit (N3-02)

The setting of constant N3-02 limits the output current while high slip braking is active. The current limit affects the achievable deceleration time.

The lower the current limit the longer is the deceleration time.

### Setting the HSB Dwell Time at Stop (N3-03)

At the end of a high slip braking the output frequency is held at the minimum output frequency for the time set in N3-03. Increase the time if the motor coasts after HSB.

### Setting the HSB Overload Time (N3-04)

N3-04 sets the HSB overload time. If the output frequency does not change for any reason although an HSB command is given, an OL7 fault will be displayed and the fault contact will operate.

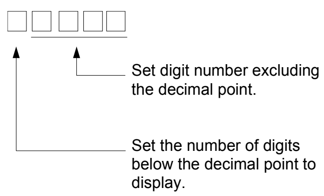
### Multifunction Input Settings: H1-01 to H1-05 (Terminal S3 to S7)
### High Slip Braking: “68”

If one of the multifunction inputs is set to “68” it can be used to activate the HSB function. The inverter will brake the motor immediately after the HSB command was given. HSB cannot be stopped, i.e. normal inverter operation cannot be resumed.

# Digital Operator Functions

## ◆ Setting Digital Operator Functions

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods V/f | Control Methods V/f with PG | Control Methods Open Loop Vector |
|---|---|---|---|---|---|---|---|---|
| o1-01 | Monitor selection | Set the number of the 3rd. monitor item to be displayed in the Drive Mode. (U1-□□)<br>(Not on LCD operator.) | 4 to 33 | 6 | Yes | A | A | A |
| o1-02 | Monitor selection after power up | Set the monitor item to be displayed when the power supply is turned ON.<br>1: Frequency reference<br>2: Output frequency<br>3: Output current<br>4: The monitor item set for o1-01 | 1 to 4 | 1 | Yes | A | A | A |
| o1-03 | Frequency units of reference setting and monitor | Sets the units that will be set and displayed for the frequency reference and frequency monitor.<br>0: 0.01 Hz units<br>1: 0.01% (Maximum output frequency is 100%)<br>2 to 39: rotation per minute (rpm) (Sets the motor poles)<br>40 to 39999: User desired display Set the desired values for setting and display for the max. output frequency.<br><br>Example: When the max. output frequency value is 200.0, set 12000. | 0 to 39999 | 0 | No | A | A | A |
| o2-01 | LOCAL/REMOTE key enable/disable | Set the run method selection key (LOCAL/REMOTE key) function.<br>0: Disabled<br>1: Enabled (Switches between the Digital Operator and the constant settings.) | 0 or 1 | 1 | No | A | A | A |
| o2-02 | STOP key during control circuit terminal operation | Set the STOP key in the run mode.<br>0: Disabled (When the run command is issued from an external terminal, the Stop key is disabled.)<br>1: Enabled (Effective even during run.) | 0 or 1 | 1 | No | A | A | A |
| o2-03 | User constant initial value | Clears or stores user initial values.<br>0: Stores/not set<br>1: Begins storing (Records the set constants as user initial values.)<br>2: All clear (Clears all recorded user initial values)<br>When the set constants are recorded as user initial values, 1110 will be set in A1-03. | 0 to 2 | 0 | No | A | A | A |
| o2-05 | Frequency reference setting method selection | When the frequency reference is set on the Digital Operator frequency reference monitor, sets whether the Enter key is necessary or not.<br>0: Enter key needed<br>1: Enter key not needed<br>When set to 1, the Inverter accepts the frequency reference without Enter key operation. | 0 or 1 | 0 | No | A | A | A |

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| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| o2-06 | Operation selection when digital operator is discon-nected | Sets the operation when the Digital Operator is disconnected.<br>0: Disabled (Operation continues even if the Digital Operator is disconnected.)<br>1: Enabled (OPR is detected at Digital Operator disconnection. Inverter output is switched off, and fault contact is operated.) | 0 or 1 | 0 | No | A | A | A |
| o2-07 | Cumulative operation time setting | Sets the cumulative operation time in hour units. Operation time is calculated from the set values. | 0 to 65535 | 0 | No | A | A | A |
| o2-08 | Cumulative operation time selection | 0: Cumulative time when the Inverter power is on. (All time while the Inverter power is on is accumulated.)<br>1: Cumulative Inverter run time. (Only Inverter output time is accumulated.) | 0 or 1 | 0 | No | A | A | A |
| o2-09 | Initialize Mode | 1: US<br>2: Europe | 1 or 2 | 2 | No | A | A | A |
| o2-10 | Fan operation time setting | Set the initial value of the fan operation time using hour units.<br>The operation time accumulates from the set value. | 0 to 65535 | 0 | No | A | A | A |
| o2-12 | Fault trace initialize | 0: Disable<br>1: Initialize (= zero clear) after setting ”1“ o2-12 will be returned to ”0“ | 0 or 1 | 0 | No | A | A | A |

## ■Monitor Selection (o1-01)

Using constant o1-01 the third monitor item that is displayed in drive mode can be selected. This function has no effect on the optional LCD-operator (JVOP-160).

## ■Monitor Display when the Power Supply is Turned ON (o1-02)

Using constant o1-02 the monitor item (U1-☐☐) that is to be displayed on the Digital Operator when the power supply is turned ON can be selected.

## ■Changing Frequency Reference and Display Units o1-03)

Set the Digital Operator frequency reference and display units using constant o1-03. The setting in o1-03 will affect the display units of the following monitor items:

- U1-01 (Frequency Reference)
- U1-02 (Output Frequency)
- U1-05 (Motor Speed)
- U1-20 (Output Frequency after Soft Start)
- d1-01 to d1-17 (Frequency references)

## ■Disabling the LOCAL/REMOTE Key (o2-01)

Set o2-01 to 0 to disable the LOCAL/REMOTE Key on the Digital Operator.

If the key is disabled, it cannot be used anymore to switch over the frequency reference source or the RUN command source between LOCAL and REMOTE.

## ■Disabling the STOP Key (o2-02)

This constant is used to set whether the STOP key on the operator is active during remote control (b1-02 ≠ 0) or not.

If o2-02 is set to 1, a STOP command from the operators STOP key will be accepted. If o2-02 is set to 0 it will be disregarded.

## ■Initializing Changed Constant Values (o2-03)

You can save the current Inverter constant setting values as user-set constant initial values. Therefore constant o2-03 has to be set to 1.

To initialize the Inverter constants using the user-set initial values in memory set constant A1-03 to 1110. To clear the user-set initial values in memory, set o2-03 to 2.

## ■Setting the Frequency Reference using the UP and DOWN Keys without Using the Enter Key (o2-05)

This function is active when frequency references are input from the Digital Operator. When o2-05 is set to 1, you can increment and decrement the frequency reference using the UP and DOWN keys without using the Enter key.

## ■Operation Selection when the Digital Operator is Disconnected (o2-06)

This function selects the operation when the digital operator gets disconnected when a RUN command is active.

If o2-06 is set to 0 the operation is continued.
If o2-06 is set to 1 the output is switched off and the motor coasts to stop. The fault contact is operated. When the operator is reconnected an OPR (Operator disconnected) is shown.



## ■Cumulative Operation Time (o2-07 and o2-08)

The inverter has a function that counts the operation time of the inverter cumulatively.

Using constant o2-07 the cumulative operation time can be changed, e.g. after a replacement of the control board. If constant o2-08 is set to 0 the inverter counts the time whenever the power supply is switched ON. If o2-08 is set to 1 the time when a RUN command is active is counted only. The factory setting is 0.

## ■Initialize Mode (o2-09)

This function is used to change the factory settings of several constants. If o2-09 is set to 1 the constants will be set to US standards. If o2-09 is set to 2 the constants will be set to European standards. After changing this setting the inverter has to be reinitialized using constant A1-03.

## ■Cooling Fan Operation Time (o2-10)

This function counts the operating time of the inverter mounted fan cumulatively.

Using constant o2-10 the counter can be reset, e.g. when the fan was replaced.

## ■Fault Trace Initialize (o2-12)

This function can be used to initialize the fault trace by setting constant o2-12 to 1.

## ◆ Copying Constants

The Digital Operator can perform the following three functions using a built-in EEPROM (non-volatile memory).

- Store Inverter constant set values in the Digital Operator (READ)
- Write constant set values stored in the Digital Operator to the Inverter (COPY)
- Compare constant set values stored in the Digital Operator with Inverter constants settings (VERIFY)

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| o3-01 | Copy function selection | 0: Normal operation<br>1: READ (Inverter to Operator)<br>2: COPY (Operator to Inverter)<br>3: Verify (compare) | 0 to 3 | 0 | No | A | A | A |
| o3-02 | Read permitted selection | 0: READ prohibited<br>1: READ permitted | 0 or 1 | 0 | No | A | A | A |

## ■Storing Inverter set values in the Digital Operator (READ)

To store Inverter set values in the Digital Operator use the following method.

Table 6.2 READ Function Procedure

| Step No. | Digital Operator Display | Explanation |
|---|---|---|
| 1 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the MENU key, and select advanced programming mode. |
| 2 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key to enter programming mode. |
| 3 | o3-01<br>DRIVE QUICK ADV VERIFY A.TUNE | Select constant o3-01 (Copy Function Selection) using the Increment key and Decrement key. |
| 4 | 00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key to enter the constants setting display. |
| 5 | 01<br>DRIVE QUICK ADV VERIFY A.TUNE | Change the set value to 1 using the Increment key. |
| 6 | rEd<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key. The READ function will start. |
| 7 | End → o3-01 | If the READ function ends normally, “End” is displayed on the Digital Operator. Constant o3-01 is automatically reset to 0, and then the display returns to o3-01. |

If an error is displayed, press any key to cancel the error display and return to the o3-01 display. Error displays and their meanings are shown below. (Refer to *Chapter 7 Errors when Using the Digital Operator Copy Function*.)

| Error Display | Meaning |
|---|---|
| PrE | You are attempting to set o3-01 to 1 while o3-02 is set to 0. |
| iFE | Read data length mismatch or read data error. |
| rdE | Tried to write constants to EEPROM on the Digital Operator, but unable to perform write operation. |

### Select READ Prohibited

This function prevents overwriting of the data that are stored in the EEPROM of the Digital Operator. When o3-02 is set to 0 and o3-01 is set to 1 to perform a write operation, PrE will be displayed on the Digital Operator and the write operation will be stopped.

## ■Writing Constant Set Values Stored in the Digital Operator to the Inverter (COPY)

To write constant set values stored in the Digital Operator to the Inverter, use the following method.

Table 6.3 COPY Function Procedure

| Step No. | Digital Operator Display | Explanation |
|---|---|---|
| 1 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the MENU key, and select advanced programming mode. |
| 2 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key to enter the programming mode. |
| 3 | o3-01<br>DRIVE QUICK ADV VERIFY A.TUNE | Select constant o3-01 (Copy Function Selection) using the Increment key and Decrement key. |
| 4 | 00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key to enter the constants setting display. |
| 5 | 02<br>DRIVE QUICK ADV VERIFY A.TUNE | Change the set value to 2 using the Increment key. |
| 6 | CPy<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key. The COPY function will start. |
| 7 | End → o3-01 | If the COPY function ends normally, “End” is displayed on the Digital Operator. Constant o3-01 is automatically reset to 0, and then the display returns to o3-01. |

If an error is displayed, set the constants again. Error displays and their meanings are shown below. (Refer to *Chapter 7 Errors when Using the Digital Operator Copy Function.*)

| Error Display | Meaning |
|---|---|
| CPE | Inverter product code or Inverter software number are different. |
| vAE | Inverter capacity with which you are trying to copy, and the Inverter capacity stored in the Digital Operator are different. |
| CrE | The Inverter control method in which you are trying to copy, and the Inverter control method stored in the Digital Operator are different. |
| CyE | Comparison between the constant written to the Inverter and the constant in the Digital Operator are different. |
| CSE | After copying has ended, comparison between the checksum value of the Inverter constant area and the checksum value of the Digital Operator constant area are different. |

## ■Comparing Inverter Constants and Digital Operator Constant Set Values (VERIFY)

To compare Inverter constants and Digital Operator constant set values, use the following method.

Table 6.4 VERIFY Function Procedure

| Step No. | Digital Operator Display | Explanation |
|---|---|---|
| 1 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the MENU key. and select advanced programming mode. |
| 2 | A1-00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key to enter the constants monitor display. |
| 3 | o3-01<br>DRIVE QUICK ADV VERIFY A.TUNE | Select constant o3-01 (Copy Function Selection) using the Increment key and Decrement key. |
| 4 | 00<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key to enter the function setting display. |
| 5 | 03<br>DRIVE QUICK ADV VERIFY A.TUNE | Change the set value to 3 using the Increment key. |
| 6 | vFy<br>DRIVE QUICK ADV VERIFY A.TUNE | Press the DATA/ENTER key. The VERIFY function will start. |
| 7 | End → o3-01 | If the VERIFY function ends normally, "End" is displayed on the Digital Operator. Constant o3-01 is automatically reset to 0, and then the display returns to o3-01. |

If an error is displayed, press any key to cancel the error display and return to the o3-01 display. Error displays and their meanings are shown below. (Refer to *Chapter 7 Errors when Using the Digital Operator Copy Function.*)

| Error Display | Meaning |
|---|---|
| vyE | Verify error (Settings in the Digital Operator and the Inverter do not match). |

## ■Application Precautions

**INFO**

When using the copy function, check that the following settings are the same between the Inverter and the Digital Operator.

- Inverter product and type
- Software number
- Inverter capacity and voltage
- Control method

## ◆ Prohibiting Writing Constants from the Digital Operator

If you set A1-01 to 0, all constants except A1-01 and A1-04 are write protected, U1-□□, U2-□□, and U3-□□ will be displayed. If A1-01 is set to 1, only the constants A1-01, A1-04 and A2-□□ can be read or written, U1-□□, U2-□□, and U3-□□ will be displayed. All other constants will not be displayed.

If you set one of the constants H1-01 to H1-05 (multi-function contact input terminal S3 to S7 function selection) to 1B (write constants permitted), you can write parameters from the digital operator when the terminal that has been set is ON. When the set terminal is OFF, writing constants other than the frequency reference is prohibited. You can, however, read the constants.

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| A1-01 | Constant access level | Used to set the constant access level (set/read.)<br>0: Monitoring only (Monitoring drive mode and setting A1-01 and A1-04.)<br>1: Used to select user constant (Only constants set in A2-01 to A2-32 can be read and set.)<br>2: ADVANCED (Constants can be read and set in both quick programming mode and advanced programming mode.) | 0 to 2 | 2 | Yes | A | A | A |

## ◆ Setting a Password

When a password is set in A1-05, and if the set values in A1-04 and A1-05 do not match, you cannot modify the settings of constants A1-01 to A1-03, or A2-01 to A2-32.

You can prohibit the setting of all constants except A1-00 by using the password function in combination with setting A1-01 to 0 (Monitor only).

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| A1-01 | Constant access level | Used to set the constant access level (set/read.)<br>0: Monitoring only (Monitoring drive mode and setting A1-01 and A1-04.)<br>1: Used to select user constant (Only constants set in A2-01 to A2-32 can be read and set.)<br>2: ADVANCED (Constants can be read and set in both quick programming mode and advanced programming mode.) | 0 to 2 | 2 | Yes | A | A | A |
| A1-04 | Password | Password input when a password has been set in A1-05.<br>This function write-protects constants of the initialize mode.<br>If the password is changed, A1-01 to A1-03 and A2-01 to A2-32 constants can only be changed after inputting the right password. | 0 to 9999 | 0 | No | A | A | A |
| A1-05 | Password setting | Used to set a four digit number as the password.<br>This constant is not usually displayed. When the password (A1-04) is displayed, hold down the RESET key and press the Menu key and A1-05 will be displayed. | 0 to 9999 | 0 | No | A | A | A |

## ◆ Displaying User-set Constants Only

The A2 constants (user-set constants) and A1-01 (constant access level) can be used to establish a parameter set that contains only the most important parameters.

Set the number of the constant to which you want to refer in A2-01 to A2-32, and then set A1-01 to 1. Using the advanced programming mode you can read and modify A1-01 to A1-03 and the constants set in A2-01 to A2-32 only.

### ■Related Constants

| Constant Number | Name | Description | Setting Range | Factory Setting | Change during Operation | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vector |
| A2-01 to A2-32 | User setting constants | Used to set the constant numbers that can be set/read. Maximum 32. Effective when the access level (A1-01) is set to User Program (1). Constants set in A2-01 to A2-32 can be set/read in programming mode. | b1-01 to o2-08 | - | No | A | A | A |

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# Options

This section explains the Inverter option functions.

## ◆ Performing Speed Control with PG

This section explains functions with V/f control with PG.

### ■Related Constants

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| F1-01 | PG constant | Set the number of PG (pulse generator or encoder) pulses. | 0 to 60000 | 600 | No | No | Q | No |
| F1-02 | Operation selection at PG open circuit (PGO) | Sets the PG disconnection stopping method.<br>0: Ramp to stop (Deceleration to stop using the deceleration time 1, C1-02.)<br>1: Coast to stop<br>2: Fast stop (Emergency stop using the deceleration time in C1-09.)<br>3: Continue operation (To protect the motor or machinery, do not make this setting.) | 0 to 3 | 1 | No | No | A | No |
| F1-03 | Operation selection at overspeed (OS) | Sets the stopping method when an overspeed (OS) fault occurs.<br>0: Ramp to stop (Deceleration stop using the deceleration time 1, C1-02.)<br>1: Coast to stop<br>2: Fast stop (Emergency stop using the deceleration time in C1-09.)<br>3: Continue operation (To protect the motor or machinery, avoid to use this setting.) | 0 to 3 | 1 | No | No | A | No |
| F1-04 | Operation selection at deviation (DEV) | Sets the stopping method when a speed deviation (DEV) fault occurs.<br>0: Decelerate to stop (Deceleration to stop using the deceleration time 1, C1-02.)<br>1: Coast to stop<br>2: Emergency stop (Emergency stop using the deceleration time in C1-09.)<br>3: Continue operation (DEV is displayed and operation continued.) | 0 to 3 | 3 | No | No | A | No |
| F1-05 | PG rotation | 0: Phase A leads with forward run command. (Phase B leads with reverse run command.)<br>1: Phase B leads with forward run command. (Phase A leads with reverse run command.) | 0 or 1 | 0 | No | No | A | No |
| F1-06 | PG division rate (PG pulse monitor) | Sets the division ratio for the PG speed control card pulse output.<br>Division ratio = (1 + n)/m<br>(n = 0 or 1, m = 1 to 32)<br>F1-06 = □ □□ (n, m)<br>This constant is effective only when a PG-B2 is used.<br>The possible division ratio settings are 1/32 ≤ F1-06 ≤ 1 | 1 to 132 | 1 | No | No | A | No |
| F1-07 | Integral value during accel/decel enable/disable | Sets integral control during acceleration/deceleration to either enabled or disabled.<br>0: Disabled (The integral function isn't used while accelerating or decelerating; it is used at constant speeds.)<br>1: Enabled (The integral function is used at all times.) | 0 or 1 | 0 | No | No | A | No |

| Con-stant Number | Name | Description | Setting Range | Factory Setting | Change during Opera-tion | Control Methods | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | V/f | V/f with PG | Open Loop Vec-tor |
| F1-08 | Overspeed (OS) detection level | Sets the overspeed detection method.<br>Motor speeds that continue to exceed the fre-quency value set in F1-08 (set as percentage of the maximum output frequency) for the time set in F1-09 are detected as overspeed faults. | 0 to 120 | 115% | No | No | A | No |
| F1-09 | Overspeed detection delay time (OS) | | 0.0 to 2.0 | 1.0 s | No | No | A | No |
| F1-10 | Excessive speed deviation (DEV) detection level | Sets the speed deviation detection method.<br>Any speed deviation above the F1-10 set level (set as a percentage of the maximum output fre-quency) that continues for the time set in F1-11 is detected as a speed deviation.<br>Speed deviation is the difference between actual motor speed and the speed reference command. | 0 to 50 | 10% | No | No | A | No |
| F1-11 | Excessive speed deviation detection delay time (DEV) | | 0.0 to 10.0 | 0.5 s | No | No | A | No |
| F1-12 | Number of PG gear teeth 1 | Sets the number of teeth on the gears if there are gears between the PG and the motor.<br>$\frac{\text{Input pulses from PG x 60}}{\text{F1-01}} \times \frac{\text{F1-13}}{\text{F1-12}}$<br>A gear ratio of 1 will be used if one of these con-stants is set to 0. | 0 to 1000 | 0 | No | No | A | No |
| F1-13 | Number of PG gear teeth 2 | | | 0 | No | No | A | No |
| F1-14 | PG open-circuit detection delay time | Used to set the PG disconnection detection time. PGO will be detected if the detection time contin-ues beyond the set time. | 0.0 to 10.0 | 2.0 s | No | No | A | No |

## ■Using PG Speed Control Card

There are four types of PG Speed Control Card that can be used in V/f control with PG.

- PG-A2: A-phase (single) pulse input, compatible with open collector.
- PG-B2: A/B-phase pulse input, compatible with complimentary outputs.
- PG-D2: A-phase (single) pulse input, compatible with line drivers (RS-422).
- PG-X2: A/B/Z-phase pulse input, compatible with line drivers (RS-422).

For the mounting instructions, specifications and connection diagrams refer to *page 2-32*.

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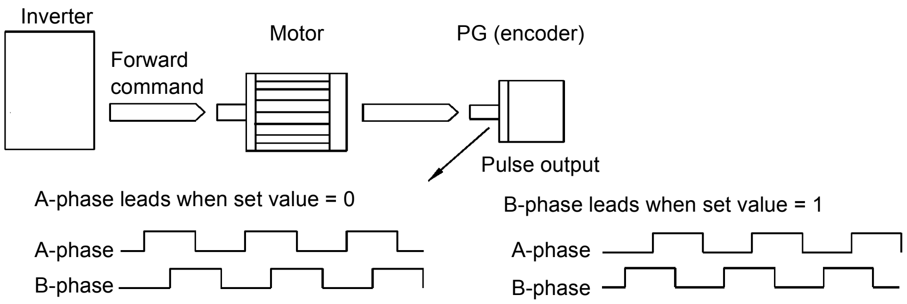
## ■Setting Number of PG Pulses (F1-01)

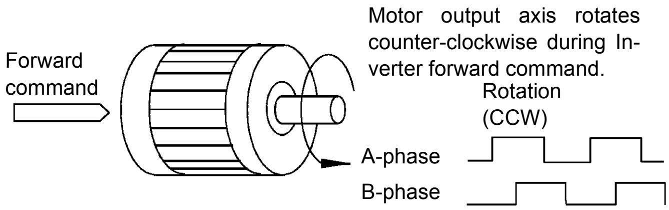
Set the number of PG (Pulse Generator/Encoder) pulses in pulses/rotation.

## ■Suit the PG Rotation Direction and Motor Rotation Direction (F1-05)

Constant F1-05 suits the PG rotation direction to the motor rotation direction. If the motor is rotating forwards, set whether it is A-phase leads or B-phase leads. Make this setting when using PG-B2 or PG-X2.



Example: Forward rotation of standard motor (PG)




With the used PG the A-phase leads (CCW) when motor rotation is forward.

Generally, the A-phase leads when the rotation direction is counter-clockwise (CCW) seen from the shaft side (FWD command is input).

## ■Setting Number of Gear Teeth Between PG and Motor (F1-12 and F1-13)

If there are gears between the motor and PG, the gear ratio can be set using F1-12 and F1-13.

When the number of gear teeth has been set, the number of motor rotations within the Inverter is calculated using the following formula.

No. of motor rotations (r/min.) = No. of input pulses from PG × 60 / F1-01 × F1-13 (No. of gear teeth on PG side) / F1-12 (No. of gear teeth on motor side)

## ■Integral Operation During Acceleration and Deceleration (F1-07)

You can select whether to enable or disable integral operation during acceleration and deceleration.

To make the motor speed matching the frequency reference as closely as possible even during acceleration and deceleration, set F1-07 to 1. Refer also to *Page 6-40*

**IMPORTANT**

If F1-01 is set to 1, overshoot or undershoot may occur easily immediately after acceleration and deceleration. To minimize the possibility of overshoot or undershoot occurring, set F1-01 to 0.

## ■Setting PG Pulse Monitor Output Dividing Ratio (F1-06)

This function is enabled only when using PG speed control card PG-B2. Set the dividing ratio for the PG pulse monitor output. The set value is expressed as n for the higher place digit, and m for the two lower place digits. The dividing ratio is calculated as follows:

Dividing ratio = (1 + n)/m (Setting range) n: 0 or 1, m: 1 to 32

F1-06 = $\underset{n}{\underline{\square}}\ \underset{m}{\underline{\square\square}}$

The dividing ratio can be set within the following range: 1/32 ≤ F1-06 ≤ 1. For example, if the dividing ratio is 1/2 (set value 2), half of the number of pulses from the PG are output at the pulse monitor.

## ■Detecting PG Open Circuit (F1-02 and F1-14)

Constant F1-02 select the stopping method when a PG disconnection is detected.

PG open (PGO) is only detected when the inverter is running at least with a frequency reference higher than 1% of the maximum output frequency or above the minimum frequency (E1-09) and the PG feedback signal is missing for the time set in F1-14 or longer.

## ■Detecting Motor Overspeed (F1-03, F1-08 and F1-09)

An error is detected when the number of motor rotations exceeds the set limit. An overspeed (OS) is detected when the motor speed continues to exceed the set frequency value in F1-08 for a time longer than set in F1-09. After detecting an overspeed (OS), the Inverter stops according to the setting in F1-03.

## ■Detecting Speed Difference between the Motor and Speed Reference (F1-04, F1-10 and F1-11)

An error is detected when the speed deviation (i.e., the difference between the speed reference and the actual motor speed) is too great. Speed deviation (DEV) is only detected after a speed agreement (speed reference and actual motor speed are within the setting range of L4-02) and if a speed deviation higher than the set value in F1-10 continues for longer than the time set in F1-11. After a speed deviation is detected, the Inverter stops according to the setting in F1-04.

# 7

# Troubleshooting

This chapter describes the fault displays and countermeasure for Inverter and motor problems.

Protective and Diagnostic Functions ............................7-2
Troubleshooting ........................................................7-15

# Protective and Diagnostic Functions

This section describes the alarm functions of the Inverter. The alarm functions include fault detection, alarm detection, operation error detection, and autotuning error detection.

## ◆ Fault Detection

When the Inverter detects a fault, the fault contact output operates, and the Inverter output is switched OFF causing the motor to coast to stop. (The stopping method can be selected for some faults.) A fault code is displayed on the Digital Operator.

When a fault has occurred, refer to the following table to identify the fault and to correct the causes.

Use one of the following methods to reset the fault before restarting the Inverter:

- Set a multi-function contact input (H1-01 to H1-05) to 14 (Fault Reset) and turn ON the error reset signal.
- Press the RESET key on the Digital Operator.
- Turn the main circuit power supply OFF and then ON again.

Table 7.1 Fault Displays and Processing

| Display | Meaning | Probable Causes | Corrective Actions |
|---|---|---|---|
| oC | Overcurrent<br>The Inverter output current exceeded the overcurrent detection level. | • A short-circuit or ground fault occurred at the Inverter output. (A short or ground fault can be caused by motor burn damage, worn insulation, or a damaged cable.)<br>• The load is too large or the acceleration time is too short.<br>• A special-purpose motor or motor with a capacity that is too large for the Inverter is used.<br>• A magnetic switch was switched at the Inverter output while running. | Reset the fault after correcting its cause. |
| GF | Ground Fault<br>The ground fault current at the Inverter output exceeded approximately 50% of the Inverter rated output current. | A ground fault occurred at the Inverter output. (A ground fault can be caused by motor burn damage, worn insulation, or a damaged cable.) | Reset the fault after correcting its cause. |
| PUF | Fuse Blown<br>The fuse in the main circuit is blown. | The output transistor has failed because of a short-circuit or ground fault at the Inverter output. | • Check the motor and cables for short circuits or insulation failures.<br>• Replace the Inverter after correcting the cause. |
| ou | Main Circuit Overvoltage<br>The main circuit DC voltage exceeded the overvoltage detection level.<br>200 V class: Approx. 410 V<br>400 V class: Approx. 820 V | The deceleration time is too short and the regenerative energy from the motor is too large. | Increase the deceleration time or connect a braking option. |
| | | The power supply voltage is too high. | Decrease the voltage so that it is within the inverters specifications. |

Table 7.1 Fault Displays and Processing (Continued)

| Display | Meaning | Probable Causes | Corrective Actions |
|---|---|---|---|
| Uv1 | Main Circuit Undervoltage<br>The main circuit DC voltage is below the Undervoltage Detection Level (L2-05).<br>200 V class: Approx. 190 V<br>400 V class: Approx. 380 V<br>Main Circuit MC Operation Failure<br>The MC stopped responding during Inverter operation. (Applicable Inverter Capacities<br>200 V class: 37 to 110 kW<br>400 V class: 75 to 300 kW) | • An open-phase error occurred at the input power supply.<br>• A momentary power loss occurred.<br>• The wiring terminals for the input power supply are loose.<br>• The voltage fluctuations in the input power supply are too large.<br>• A fault occurred in the inrush current prevention circuit. | Reset the fault after correcting its cause. |
| Uv2 | Control Power Fault<br>The control power supply voltage dropped. | --- | • Try turning the power supply off and on.<br>• Replace the Inverter if the fault continues to occur. |
| Uv3 | Inrush Current Prevention Circuit Fault<br>Overheating occurred in the inrush resistor.<br>The MC did not respond for 10 s after the MC ON signal has been output.<br>(Applicable Inverter Capacities<br>200 V class: 37 to 110 kW<br>400 V class: 75 to 300 kW) | • The MC in the main circuit failed.<br>• The MC excitation coil is burned out. | • Try turning the power supply off and on.<br>• Replace the Inverter if the fault continues to occur. |
| PF | Main Circuit Voltage Fault<br>The main circuit DC bus voltage oscillates unusually (not when regenerating).<br>This fault is detected when L8-05 is set to "Enabled." | • An open-phase occurred in the input power supply.<br>• A momentary power loss occurred.<br>• The wiring terminals for the input power supply are loose.<br>• The voltage fluctuations in the input power supply are too high.<br>• The voltage balance between the phases is bad. | Reset the fault after correcting its cause. |
| LF | Output Open-phase<br>An open-phase occurred at the Inverter output.<br>This fault is detected when L8-07 is set to "Enabled." | • There is a broken wire in the output cable.<br>• There is a broken wire in the motor-winding.<br>• The output terminals are loose. | Reset the fault after correcting its cause. |
| | | The motor being used has a capacity less than 5% of the Inverter's maximum motor capacity. | Check the motor and Inverter capacity. |
| oH<br>(oH1) | Cooling Fin Overheating<br>The temperature of the Inverter's cooling fin exceeded the setting in L8-02 or 105°C.<br>OH: The temperature exceeded the setting in L8-02 (Stopping method can be changed by L8-03.).<br>OH1: The temperature exceeded 105°C (Stopping method: Coast to stop). | The ambient temperature is too high. | Install a cooling unit. |
| | | There is a heat source nearby. | Remove the heat source. |
| | | The Inverter's cooling fan has stopped. | Replace the cooling fan. (Contact your sales representative.) |
| | Inverter's Cooling Fan Stopped | The Inverter's cooling fan has stopped. | |

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Table 7.1 Fault Displays and Processing (Continued)

| Display | Meaning | Probable Causes | Corrective Actions |
|---|---|---|---|
| oH3 | **Motor Overheating Alarm**<br>The Inverter will stop or will continue to operate according to the setting of L1-03. | The motor has overheated. | Check the size of the load and the length of the acceleration, deceleration, and cycle times. |
| | | | Check the V/f characteristics. |
| | | | Check the motor temperature input at terminal A2. |
| oH4 | **Motor Overheating Fault**<br>The Inverter will stop according to the setting of L1-04. | The motor has overheated. | Check the size of the load and the length of the acceleration, deceleration, and cycle times. |
| | | | Check the V/f characteristics. |
| | | | Check the motor temperature input at terminal A2. |
| rH | **Inverter Mounted Braking Resistor Overheating (ERF-type)**<br>The braking resistor is overheated and the protection function has operated if it has been enabled in L8-01. | The deceleration time is too short and the regenerative energy from the motor is too large. | • Reduce the load, increase the deceleration time, or reduce the motor speed.<br>• Change to a Braking Resistor Unit. |
| rr | **Internal Braking Transistor Fault**<br>The braking transistor is not operating properly. | - | • Try turning the power supply off and on.<br>• Replace the Inverter if the fault continues to occur. |
| oL1 | **Motor Overload**<br>The motor overload protection function has operated based on the internal electronic thermal value. | The load is too heavy. The acceleration time, deceleration time, and cycle time are too short. | Check the size of the load and the length of the acceleration, deceleration, and cycle times. |
| | | The V/f characteristics voltage is too high or too low. | Check the V/f characteristics. |
| | | The Motor Rated Current (E2-01) is incorrect. | Check the Motor Rated Current Setting (E2-01). |
| oL2 | **Inverter Overload**<br>The Inverter overload protection function has operated based on the internal electronic thermal value. | The load is too heavy. The acceleration time, deceleration time and cycle time are too short. | Check the size of the load and the length of the acceleration, deceleration, and cycle times. |
| | | The V/f characteristics voltage is too high or too low. | Check the V/f characteristics. |
| | | The Inverter capacity is too low. | Replace the Inverter with one that has a larger capacity. |
| oL3 | **Overtorque Detected 1**<br>There has been a torque higher than the setting in L6-02 for longer than the time in L6-03. | – | • Make sure that the settings in L6-02 and L6-03 are appropriate.<br>• Check the mechanical system and correct the cause of the overtorque. |
| oL4 | **Overtorque Detected 2**<br>There has been a torque higher than the setting in L6-05 for longer than the time in L6-06. | - | • Make sure that the current setting in L6-05 and time setting in L6-06 are appropriate.<br>• Check the mechanical system and correct the cause of the overtorque. |

Table 7.1 Fault Displays and Processing (Continued)

| Display | Meaning | Probable Causes | Corrective Actions |
|---|---|---|---|
| oL7 | High-slip Braking OL<br>The output frequency did not change for longer than the time set in N3-04. | The inertia of the connected machine is too large. | Make sure the load is an inertial load. |
| UL3 | Undertorque Detected 1<br>There has been a torque lower than the setting in L6-02 for longer than the time in L6-03. | – | • Make sure that the settings in L6-02 and L6-03 are appropriate.<br>• Check the mechanical system and correct the cause of the undertorque. |
| UL4 | Undertorque Detected 2<br>There has been a torque lower than the setting in L6-05 for longer than the time in L6-06. | – | • Make sure that the current setting in L6-05 and time setting in L6-06 are appropriate.<br>• Check the mechanical system and correct the cause of the undertorque. |
| oS | Overspeed<br>The speed has been higher than the setting in F1-08 for longer than the time in F1-09. | Overshooting/Undershooting are occurring. | Adjust the gain again. |
| | | The reference speed is too high. | Check the reference circuit and reference gain. |
| | | The settings in F1-08 and F1-09 aren't appropriate. | Check the settings in F1-08 and F1-09. |
| PGo | PG Disconnection Detected<br>No PG pulses were input when the Inverter was outputting a frequency (soft start output ≥ E1-09). | There is a break in the PG wiring. | Fix the broken/disconnected wiring. |
| | | The PG is wired incorrectly. | Fix the wiring. |
| | | Power isn't being supplied to the PG. | Supply power to the PG properly. |
| | | Wrong brake control sequence when a brake is used. | Check wheather the brake is opened at a RUN command. |
| dEv | Excessive Speed Deviation<br>The speed deviation has been higher than the setting in F1-10 for longer than the time in F1-11. | The load is too heavy. | Reduce the load. |
| | | The acceleration time and deceleration time are too short. | Lengthen the acceleration time and deceleration time. |
| | | The load is locked. | Check the mechanical system. |
| | | The settings in F1-10 and F1-11 aren't appropriate. | Check the settings in F1-10 and F1-11. |
| | | Wrong brake control sequence when a brake is used. | Check wheather the brake is opened at a RUN command. |
| CF | Control Fault<br>The torque limit was reached continuously for 3 seconds or longer during a deceleration stop during open-loop vector control. | – | Check the motor constants. |
| FbL | PID Feedback Lost<br>A PID feedback loss detection is enabled (b5-12 ≠ 0) and the PID feedback input was less than b5-13 (PID feedback loss detection level) for longer than the time set in b5-14 (PID feedback loss detection time). | – | • Check the PID feedback signal source for correct operation.<br>• Check the wiring. |

Table 7.1 Fault Displays and Processing (Continued)

| Display | Meaning | Probable Causes | Corrective Actions |
|---|---|---|---|
| EF0 | External fault input from Communications Option Card | – | Check the Communications Option Card and communications signals. |
| EF3 | External fault (Input terminal 3) | An "external fault" was input from a multi-function input terminal (S3 to S7). | Remove the cause of the external fault. |
| EF4 | External fault (Input terminal 4) | | |
| EF5 | External fault (Input terminal 5) | | |
| EF6 | External fault (Input terminal 6) | | |
| EF7 | External fault (Input terminal 7) | | |
| oPr | Digital Operator Connection Fault<br>The connection to the Digital Operator was broken during operation using the operator as RUN command source. | – | Check the connection to the Digital Operator. |
| CE | MEMOBUS Communications Error<br>A normal receive was not possible for 2 s or longer after control data were received once. | – | Check the communications devices and communications signals. |
| bUS | Option Communications Error<br>A communications error was detected during a run command or while setting a frequency reference from a Communications Option Card. | – | Check the communications devices and communications signals. |
| CPF00 | Digital Operator Communications Error 1<br>Communications with the Digital Operator were not established within 5 seconds after the power was turned on. | The Digital Operator's connector isn't connected properly. | Disconnect the Digital Operator and then connect it again. |
| | | The Inverter's control circuits are faulty. | Replace the Inverter. |
| | CPU External RAM Fault | – | Try turning the power supply off and on again. |
| | | The control circuits were destroyed. | Replace the Inverter. |
| CPF01 | Digital Operator Communications Error 2<br>After communications were established, there was a communications error with the Digital Operator for more than 2 seconds. | The Digital Operator isn't connected properly. | Disconnect the Digital Operator and then connect it again. |
| | | The Inverter's control circuits are faulty. | Replace the Inverter. |
| CPF02 | Baseblock circuit error | – | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |
| CPF03 | EEPROM error | – | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |
| CPF04 | CPU internal A/D converter error | – | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |

Table 7.1 Fault Displays and Processing (Continued)

| Display | Meaning | Probable Causes | Corrective Actions |
|---|---|---|---|
| CPF05 | CPU internal A/D converter error | - | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |
| CPF06 | Option Card connection error | The Option Card is not connected properly. | Turn off the power and insert the Card again. |
| | | The Inverter or Option Card is faulty. | Replace the Option Card or the Inverter. |
| CPF07 | ASIC internal RAM fault | - | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |
| CPF08 | Watchdog timer fault | - | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |
| CPF09 | CPU-ASIC mutual diagnosis fault | - | Try turning the power supply off and on again. |
| | | The control circuit is damaged. | Replace the Inverter. |
| CPF10 | ASIC version fault | The Inverter control circuit is faulty | Replace the Inverter. |
| CPF20 | Communications Option Card A/D converter error | The Option Card is not connected properly. | Turn off the power and insert the Card again. |
| | | The Option Card's A/D converter is faulty. | Replace the Communications Option Card. |
| CPF21 | Communications Option Card self diagnostic error | Communications Option Card fault. | Replace the Option Card. |
| CPF22 | Communications Option Card model code error | | |
| CPF23 | Communications Option Card DPRAM error | | |

## ◆ Alarm Detection

Alarms are detected as a type of Inverter protection function that do not operate the fault contact output. The system will automatically returned to its original status when the cause of the alarm has been removed.

The Digital Operator display flashes and the alarm can be output at the multi-function outputs (H2-01 to H2-03).

When an alarm occurs, take appropriate countermeasures according to the table below.

Table 7.2 Alarm Displays and Processing

| Display | Meaning | Probable causes | Corrective Actions |
|---|---|---|---|
| EF (blink-ing) | Forward/Reverse Run Commands Input Together<br>Both the forward and reverse run commands have been ON for more than 0.5 s. | – | Check the sequence of the forward and reverse run commands.<br>Since the rotational direction is unknown, the motor will be decelerated to a stop when this minor fault occurs. |
| Uv (blink-ing) | Main Circuit Undervoltage<br>The following conditions occurred when there was no Run signal.<br>• The main circuit DC voltage was below the Undervoltage Detection Level Setting (L2-05).<br>• The inrush current limiting resistor bypass contactor opened.<br>• The control power supply voltage when below the CUV level. | See causes for UV1, UV2, and UV3 faults in the previous table. | See corrective actions for UV1, UV2, and UV3 faults in the previous table. |
| ov (blink-ing) | Main Circuit Overvoltage<br>The main circuit DC voltage exceeded the overvoltage detection level.<br>200 V class: Approx. 400 V<br>400 V class: Approx. 800 V | The power supply voltage is too high. | Decrease the voltage so it's within specifications. |
| oH (blink-ing) | Cooling Fin Overheating<br>The temperature of the Inverter's cooling fin exceeded the setting in L8-02. | The ambient temperature is too high. | Install a cooling unit. |
| | | There is a heat source nearby. | Remove the heat source |
| | | The Inverter cooling fan has stopped. | Replace the cooling fan. (Contact your Yaskawa representative.) |
| oH2 (blink-ing) | Inverter Overheating Pre-alarm<br>An OH2 alarm signal (Inverter overheating alarm signal) was input from a multi-function input terminal (S3 to S7). | – | Clear the multi-function input terminal's overheating alarm input. |
| oH3 (blink-ing) | Motor overheating<br>H3-09 is set to “E” and the motor temperature thermistor input exceeded the alarm detection level. | The motor has overheated. | Check the size of the load and the length of the acceleration, deceleration, and cycle times. |
| | | | Check the V/f characteristics. |
| | | | Check the motor temperature input on terminal A2. |
| oL3 (blink-ing) | Overtorque 1<br>There has been a torque higher than the setting in L6-02 for longer than the time in L6-03. | – | • Make sure that the settings in L6-02 and L6-03 are appropriate.<br>• Check the mechanical system and correct the cause of the overtorque. |

Table 7.2 Alarm Displays and Processing (Continued)

| Display | Meaning | Probable causes | Corrective Actions |
|---|---|---|---|
| oL4 (blinking) | Overtorque 2<br>There has been a torque higher than the setting in L6-05 for longer than the time in L6-06. | – | • Make sure that the setting in L6-05 and time setting in L6-06 are appropriate.<br>• Check the mechanical system and correct the cause of the overtorque. |
| UL3 (blinking) | Undertorque 1<br>There has been a torque lower than the setting in L6-02 for longer than the time in L6-03. | – | • Make sure that the settings in L6-02 and L6-03 are appropriate.<br>• Check the mechanical system and correct the cause of the undertorque. |
| UL4 (blinking) | Undertorque 2<br>There has been a torque lower than the setting in L6-05 for longer than the time in L6-06. | – | • Make sure that the setting in L6-05 and time setting in L6-06 are appropriate.<br>• Check the mechanical system and correct the cause of the undertorque. |
| oS (blinking) | Overspeed<br>The speed has been higher than the setting in F1-08 for longer than the time in F1-09. | Overshooting/undershooting are occurring. | Adjust the gain again. |
| | | The reference speed is too high. | Check the reference circuit and reference gain. |
| | | The settings in F1-08 and F1-09 aren't appropriate. | Check the settings in F1-08 and F1-09. |
| PGo (blinking) | The PG is disconnected<br>The Inverter is outputting a frequency, but PG pulses aren't being input. | There is a break in the PG wiring. | Fix the broken/disconnected wiring. |
| | | The PG is wired incorrectly. | Fix the wiring. |
| | | Power isn't being supplied to the PG. | Supply power to the PG properly. |
| dEv (blinking) | Excessive Speed Deviation<br>The speed deviation has been higher than the setting in F1-10 for longer than the time in F1-11. | The load is too large. | Reduce the load. |
| | | The acceleration time and deceleration time are too short. | Lengthen the acceleration time and deceleration time. |
| | | The load is locked. | Check the mechanical system. |
| | | The settings in F1-10 and F1-11 aren't appropriate. | Check the settings in F1-10 and F1-11. |
| EF0 | External error detected for Communications Card other than SI-K2<br>Continuing operation was specified for EF0 (F6-03 = 3)and an external fault was input from the Option Card. | – | Remove the cause of the external fault. |

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Table 7.2  Alarm Displays and Processing (Continued)

| Display | Meaning | Probable causes | Corrective Actions |
|---|---|---|---|
| EF3 (blinking) | External fault (Input terminal S3) | An external fault was input from a multi-function input terminal (S3 to S7). | Remove the cause of the external fault. |
| EF4 (blinking) | External fault (Input terminal S4) | | |
| EF5 (blinking) | External fault (Input terminal S5) | | |
| EF6 (blinking) | External fault (Input terminal S6) | | |
| EF7 (blinking) | External fault (Input terminal S7) | | |
| FbL (blinking) | PID Feedback Lost<br>A PID feedback loss detection is enabled (b5-12 ≠ 0) and the PID feedback input was less than b5-13 (PID feedback loss detection level) for longer than the time set in b5-14 (PID feedback loss detection time). | – | – |
| CF (blinking) | MEMOBUS Communications Error<br>Normal receive was not possible for 2 s or longer after received control data. | – | Check the communications devices and signals. |
| bUS (blinking) | Option Card Communications Error<br>A communications error occurred in a mode where the run command or a frequency reference is set from an Communications Option Card. | – | Check the communications devices and signals. |
| CALL (blinking) | Communications on Standby<br>Control data was not normally received when power was turned ON. | – | Check the communications devices and signals. |

## ◆ Operation Errors

An operation error will occur if there is an invalid setting or a contradiction between two constant settings. It won't be possible to start the Inverter until the constants have been set correctly. (The alarm output and fault contact outputs will not operate.)

When an operation error has occurred, refer to the following table to identify and correct the cause of the errors.

Table 7.3 Operation Error Displays and Incorrect Settings

| Display | Meaning | Incorrect settings |
|---|---|---|
| oPE01 | Incorrect Inverter capacity setting | The Inverter capacity setting doesn't match the Unit. Check constant o2-04 for the correct setting. |
| oPE02 | Constant setting range error | The constant setting is outside of the valid setting range. |
| oPE03 | Multi-function input selection error | One of the following errors has been made in the multi-function input (H1-01 to H1-05) settings:<br>• The same setting has been selected for two or more multi-function inputs.<br>• An up or down command was selected separately. (They must be used together.)<br>• The up/down commands (10 and 11) and Accel/Decel Ramp Hold (A) were selected at the same time.<br>• Speed Search 1 (61) and Speed Search 2 (62) were selected at the same time for a digital input.<br>• External Baseblock NO (8) and External Baseblock NC (9) were selected at the same time.<br>• The up/down commands (10 and 11) were selected while PID Control (b5-01) was enabled.<br>• The emergency stop command NO and NC have been set at the same time. |
| oPE05 | Option Card selection error | The Option Card was selected as the frequency reference source by setting b1-01 to 3, but an Option Card isn't connected (C option). |
| oPE06 | Control method selection error | V/f control with PG feedback was selected by setting A1-02 to 1, but a PG Speed Control Card isn't connected. |
| oPE07 | Multi-function analog input/pulse train input selection error | The same setting has been selected for the analog input selection and the pulse train input.<br>• H3-09 = B and H6-01 = 1<br>• H3-09 = C and H6-01 = 2<br>b1-01 (Reference Selection) is set to 4 (pulse input) and H6-01 (Pulse Train Input Function Selection) is set to a value other than 0 (frequency reference). |
| oPE08 | Constant selection error | A setting has been made that is not usable with the current control method. Example: A function used only with open loop vector control was selected for V/f control. |
| oPE09 | PID control selection error | The following settings have been made at the same time.<br>• b5-01 (PID Control Mode Selection) has been set to a value other than 0.<br>• b5-15 (PID Sleep Function Operation Level) has been set to a value other than 0.<br>• b1-03 (Stopping Method Selection) has been set to 2 or 3. |
| oPE10 | V/f data setting error | Constants E1-04, E1-06, E1-07, and E1-09 do not satisfy the following conditions:<br>• E1-04 (FMAX) ≥ E1-06 (FA) > E1-07 (FB) ≥ E1-09 (FMIN)<br>• E3-02 (FMAX) ≥ E3-04 (FA) > E3-05 (FB) ≥ E3-07 (FMIN) |
| oPE11 | Constant setting error | One of the following constant setting errors exists.<br>• C6-05 (Carrier frequency Gain) > 6 and C6-03 (Carrier Frequency Upper Limit) < C6-04 (Carrier Frequency Lower Limit)<br>• Upper/lower limit error in C6-03 to 04.<br>• C6-01 is 0 and C6-02 is 2 to E.<br>• C6-01 is 1 and C6-02 is 7 to E. |

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Table 7.3  Operation Error Displays and Incorrect Settings (Continued)

| Display | Meaning | Incorrect settings |
|---|---|---|
| Err | EEPROM write error | A verification error occurred when writing EEPROM.<br>• Try turning the power supply off and on again.<br>• Try setting the constants again. |

## ◆ Errors During Autotuning

The errors that can occur during autotuning are given in the following table. If an error is detected, the motor will coast to a stop and an error code will be displayed on the Digital Operator. The error contact output and alarm output will not function.

Table 7.4 Errors During Autotuning

| Display | Meaning | Probable causes | Corrective Actions |
|---|---|---|---|
| Er-01 | Motor data error | There is an error in the data input for autotuning.<br>There is an error in the relationship between the motor output and the motor rated current.<br>The is an error between the no-load current setting and the input motor rated current (when autotuning for only line-to-line resistance is performed for vector control). | • Check the input data.<br>• Check the capacity of the Inverter and motor.<br>• Check the motor rated current and no-load current. |
| Er-02 | Alarm | A minor fault occurred during autotuning. | • Check the input data.<br>• Check wiring and the machine.<br>• Check the load. |
| Er-03 | STOP key input | The STOP key was pressed to cancel autotuning. | |
| Er-04 | Line-to-line resistance error | Autotuning was not completed in the specified time.<br>The results of autotuning has exceeded the setting range for a user constant. | • Check the input data.<br>• Check motor wiring.<br>• If the motor is connected to the machine, disconnect it.<br>• If the setting of T1-03 is higher than the Inverter input power supply voltage (E1-01), change the input data. |
| Er-05 | No-load current error | | |
| Er-08 | Rated slip error | | |
| Er-09 | Acceleration error (detected only for rotating autotuning) | The motor did not accelerate in the specified time. | • Increase C1-01 (Acceleration Time 1).<br>• Increase L7-01 and L7-02 (Drive Torque Limits) if they are low.<br>• If the motor is connected to the machine, disconnect it. |
| Er-11 | Motor speed error (detected only for rotating autotuning) | The torque reference exceded 100% during acceleration (for open loop vector control only). | • If the motor is connected to the machine, disconnect it.<br>• Increase C1-01 (Acceleration Time 1).<br>• Check the input data (particularly the number of PG pulses and the number of motor poles). |
| Er-12 | Current detection error | The current flow exceeded the motor rated current.<br>The detected current sign was the opposite of what it should be.<br>There is a phase fault for U, V, or W. | Check the motor wiring and installation methods. |
| Er-13 | Leakage inductance error | Autotuning was not completed in the specified time. | Check motor wiring. |
| End1 | V/f settings excessive* | The torque reference exceeded 100% and the no-load torque exceeded 70% during autotuning. | • Check and correct the settings.<br>• Disconnect the load from the motor. |

Table 7.4 Errors During Autotuning (Continued)

| Display | Meaning | Probable causes | Corrective Actions |
|---|---|---|---|
| End2 | Motor core saturation error (detected only for rotational autotuning) | Autotuning for the motor core saturation value could not be completed in the specified time.<br>The results of autotuning has exceeded the setting range for a user constant so a temporary setting was made for the motor core saturation coefficient. | • Check the input data.<br>• Check motor wiring.<br>• If the motor is connected to the machine, disconnect it. |
| End3 | Rated current setting alarm* | The rated current is set too high. | Check the input data (particularly the motor rated current). |

* Displayed after autotuning has been completed.

## ◆ Errors when Using the Digital Operator Copy Function

The errors that can occur when using the copy function from the Digital Operator are given in the following table. An error code will be displayed on the Digital Operator. If a Digital Operator key is pressed when an error code is being displayed, the display will be cleared and o3-01 will be displayed. The error contact output and alarm output will not be operated.

Table 7.5 Errors during Copy Function

| Function | Display | Meaning | Probable causes | Corrective Actions |
|---|---|---|---|---|
| Read | PrE | Digital Operator write-protected | o3-01 was set to 1 to read constants when the Digital Operator was write-protected (o3-02 = 0). | Set o3-02 to 1 to enable writing constants into the Digital Operators memory. |
| | iFE | Illegal read data | The read data length does not agree.<br>The read data are incorrect. | Repeat the read.<br>Check the Digital Operator cable.<br>Replace the Digital Operator. |
| | rdE | Illegal write status | An attempted write of a constant to the EEPROM of the Digital Operator failed. | A low Inverter voltage has been detected.<br>Repeat the read.<br>Replace the Digital Operator. |
| Copy | CPE | ID does not match | The Inverter product code or software number is different. | Use the copy function for the same product code and software number only. |
| | vAE | Inverter capacity does not match | The capacity of the Inverter being copied and the capacity stored in the Digital Operator are different. | Use the copy function for the same Inverter capacity only. |
| | CrE | Control method matched | The control method of the Inverter being copied and the control method in the Digital Operator are different. | Use the copy function for the same control method only. |
| | CYE | Verify error | The constant written to the Inverter was compared with the constant in the Digital Operator and they were different. | Retry the copy. |
| | CSE | Checksum error | The checksum in the Inverter constant area was compared with the checksum in the Digital Operator constant area and they were different. | Retry the copy. |
| Verify | vYE | Verify error | The settings in the operator and the inverter do not match. | – |

# Troubleshooting

Due to constant setting errors, faulty wiring, and so on, the Inverter and motor may not operate as expected when the system is started up. If that occurs, use this section as a reference and perform the appropriate counter measures.

If the contents of the fault are displayed, refer to *Protective and Diagnostic Functions*.

## ◆ If Constants Cannot Be Set

### ■The display does not change when the Increment and Decrement keys are pressed.

The following causes are possible.

#### The Inverter is operating (drive mode).

There are some constants that cannot be set during operation. Turn off the RUN command and then make the settings.

#### Constant write enable is input.

This occurs when "constant write enable" (set value: 1B) is set for a multi-function input terminal (H1-01 to H1-05). If the constant write enable input is OFF, the constants cannot be changed. Turn it ON and then set the constants.

#### Passwords do not match. (Only when a password is set.)

If the constant A1-04 (Password) and A1-05 (Password Setting) numbers are different, the constants for the initialize mode cannot be changed. Reset the password.

If you cannot remember the password, display A1-05 (Password Setting) by pressing the Reset key and the Menu key simultaneously while in the A1-04 display. Then reset the password. (Input the reset password in constant A1-04.)

### ■OPE01 through OPE11 is displayed.

The set value for the constant is wrong. Refer to *Operation Errors* in this chapter and correct the setting.

### ■CPF00 or CPF01 is displayed.

This is a Digital Operator communications error. The connection between the Digital Operator and the Inverter may be faulty. Remove the Digital Operator and then re-connect it.

## ◆ If the Motor Does Not Operate

### ■The motor does not operate when the RUN key on the Digital Operator is pressed.

The following causes are possible.

#### The operation method setting is wrong.

If constant b1-02 (Operation Method Selection) is set to 1 (control circuit terminal), the motor will not operate when the RUN key is pressed. Either press the LOCAL/REMOTE key* to switch to Digital Operator operation or set b1-02 to 0 (Digital Operator).

**INFO** The LOCAL/REMOTE key can be enabled or disabled by setting o2-01. It is enabled when the drive mode is entered and o2-01 is set to 1.

#### The frequency reference is too low.

If the frequency reference is set below the frequency set in E1-09 (Minimum Output Frequency), the Inverter will not operate.

Raise the frequency reference to at least the minimum output frequency.

#### There is a multi-function analog input setting error.

If multi-function analog input H3-09 is set to 1 (frequency gain), and if no voltage (current) is input, then the frequency reference will be zero. Check to be sure that the set value and analog input value are correct.

### ■The motor does not operate when an external operation signal is input.

The following causes are possible.

#### The Inverter is not in drive mode.

If the Inverter is not in drive mode, it will remain in ready status and will not start. Press the MENU key make the DRIVE indicator flash, and enter the drive mode by pressing the DATA/ENTER key. The DRIVE indicator will light up when drive mode is entered.

#### The operation method selection is wrong.

If constant b1-02 (reference selection) is set to 0 (Digital Operator), the motor will not operate when an external operation signal is input. Set b1-02 to 1 (control circuit terminal) and try again.

The motor will also not operate if the LOCAL/REMOTE key has been pressed to switch to Digital Operator operation. In that case press the LOCAL/REMOTE key* again to return to the original setting.

**INFO** The LOCAL/REMOTE key can be enabled or disabled by setting o2-01. It is enabled when the drive mode is entered and o2-01 is set to 1.

#### A 3-wire control in effect.

The input method for a 3-wire control is different than when operating by forward/stop and reverse/stop (2-wire control). If a 3 wire control is selected, the motor will not operate when a wiring that is suitable for 2-wire control is used. When using a 3-wire control, refer to the wiring example and timing chart on *Page 6-11* and input the proper signals.

When using a 2-wire control, set the multi-function input terminal (H1-01 through H1-05, terminals S3 to S7) to a value other than 0.

#### The frequency reference is too low.

If the frequency reference is set below the frequency set in E1-09 (Minimum Output Frequency), the Inverter will not operate. Raise the frequency reference to at least the minimum output frequency.

#### There is a multi-function analog input setting error.

If H3-09 (Analog Input A2 Function Selection) is set to 1 (frequency gain), and if no voltage (current) is input, then the frequency reference will be zero. Check to be sure that the set value and analog input value are correct.

### ■The motor stops during acceleration or when a load is connected.

The load may be too heavy. The Inverter has a stall prevention function and an automatic torque boost function, but the motor responsiveness limit may be exceeded if acceleration is too rapid or if the load is too heavy. Lengthen the acceleration time or reduce the load. Also consider increasing the motor capacity.

### ■The motor only rotates in one direction.

"Reverse run prohibited" is selected. If b1-04 (Prohibition of Reverse Operation) is set to 1 (reverse run prohibited), the Inverter will not accept reverse run commands. To use both forward and reverse operation, set b1-04 to 0.



## ◆ If the Direction of the Motor Rotation is Reversed

If the motor operates in the wrong direction, the motor output wiring is faulty. When the Inverter T1(U), T2(V), and T3(W) are properly connected to the motor T1(U), T2(V), and T3(W), the motor operates in a forward direction when a forward run command is executed. The forward direction depends on the manufacturer and the motor type, so be sure to check the specifications.

The direction of rotation can be reversed by switching two wires among U, V, and W, or use constant b1-04 to reverse output direction (in V/f mode only).

## ◆ If the Motor Does Not Develop Torque or If Acceleration is Slow

### ■The torque limit has been reached.

When a torque limit has been set in constants L7-01 to L7-04, no torque will be output beyond that limit. This can cause the torque to be insufficient, or the acceleration time to be too long. Check to be sure that the value set for the torque limit is suitable.

If torque limits have been set for the multi-function analog input (H3-09 = 10 to 12 or 15), check to be sure that the analog input value is suitable.

### ■The stall prevention level during acceleration is too low.

If the value set for L3-02 (Stall Prevention Level during Acceleration) is too low, the acceleration time will be very long. Check to be sure that the set value is suitable.

### ■The stall prevention level during running is too low.

If the value set for L3-06 (Stall Prevention Level during Running) is too low, the speed may drop already at low output torque. Check to be sure that the set value is suitable.

### ■Autotuning has not been performed for vector control

Vector control will not work properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

## ◆ If the Motor Operates at Higher Speed than the Frequency Reference

### ■The analog frequency reference bias or gain setting is wrong.

The frequency reference bias or gain set in constant H3-03 or H3-02 influence the frequency reference. Check to be sure that these set values are suitable.

### ■A signal is being input to the multifunction analog input terminal A2.

When "0" (frequency bias) is set for constant H3-09 (Multi-function Analog Input Terminal A2 Function Selection), a frequency corresponding to the terminal A2 input voltage (current) is added to the frequency reference. Check to be sure that the set value and analog input value are suitable.

## ◆ If the Slip Compensation Function Has Poor Speed Precision

If speed control accuracy is low using the slip compensation function, maybe the slip compensation limit has been reached. The slip compensation function does not work beyond the slip compensation limit set in constant C3-03. Check to be sure that the set value is suitable.

## ◆ If There is Low Speed Accuracy at High-speed Rotation in Open-loop Vector Control Mode

The Inverter's maximum output voltage is determined by its input voltage. (For example, if 200 VAC is input, then the maximum output voltage will be 200 VAC.) If, as a result of vector control, the output voltage reference value exceeds the Inverter output voltage maximum value, the speed control accuracy will decrease. Use a motor with a low rated voltage (i.e., a special motor for use with vector control).

## ◆ If Motor Deceleration is Slow

### ■The deceleration time is long even when braking resistor is connected.

The following causes are possible.

#### "Stall prevention during deceleration enabled" is set.

When braking resistor is connected, set constant L3-04 (Stall Prevention Selection during Deceleration) to 0 (disabled) or 3 (with braking resistor). When this constant is set to 1 (enabled), braking resistor does not fully functions.

#### The deceleration time setting is too long.

Check the deceleration time setting (constants C1-02, C1-04, C1-06, and C1-08).

#### Motor torque is insufficient.

If the constants are correct and there is no overvoltage fault, maybe then the motor's power limit is reached. Consider increasing the motor capacity.

#### The torque limit has been reached.

When torque limits have been set in constants L7-01 to L7-04, no torque output beyond that limits will be output. This can cause the deceleration time to be too long. Check to be sure that the values set for the torque limits are suitable.

If torque limits have been set for the multi-function analog input terminal A2 Function H3-09 (set value: 10 to 12 or 15), check to be sure that the analog input value is suitable.

## ◆ If a Vertical-Axis Load Drops When Brake is Applied (Brake ON/OFF Controlled by Digital Output)

The control sequence baybe incorrect. The Inverter goes into DC injection braking status for 0.5 seconds after deceleration is completed. (This is the factory-set default.)

To ensure that the brake (controlled by digital output M1-M2) holds, set frequency detection 2 (H2-01 = 5) for the multi-function contact output terminals (M1 and M2) so that the contacts will turn OFF when the output frequency is higher than L4-01 (3.0 to 5.0 Hz). (The contacts will turn ON below L4-01.)

There is hysteresis in frequency detection 2 (i.e., a frequency detection width, L4-02 = 2.0 Hz) . Change the setting to approximately 0.5 Hz if there are load drops during stop. Do not use the multi-function contact output run signal (H2-01 = 0) for the brake ON/OFF signal.

## ◆ If the Motor Overheats

### ■The load is too big.

If the motor load is too heavy and the motor is used continuously with a torque that exceeds the motor's rated torque, the motor will overheat. Reduce the load amount by lowering the load. Also consider increasing the motor capacity.

### ■The ambient temperature is too high.

The motor rating is determined within a particular ambient operating temperature range. The motor will burn out if it is run continuously at the rated torque in an environment in which the maximum ambient operating temperature is exceeded. Lower the motor's ambient temperature to be within the acceptable ambient operating temperature range.

### ■The withstand voltage between the motor phases is insufficient.

When the motor is connected to the Inverter output, a surge is generated between the Inverter output and the motor coil. Normally the maximum surge voltage is three times the Inverter's input power supply voltage (i.e., 1,200 V for 400 V class). Be sure to use a motor with a withstand voltage between the motor phases that is higher than the maximum surge voltage.

### ■Autotuning has not been performed for vector control

Vector control will not work properly if autotuning has not been performed. Perform autotuning, or set the motor constants through calculations.

## ◆ If peripheral devices like PLC’s or other are influenced by the starting or running inverter

If electrical noise is generated by Inverter perform the following countermeasures:

- Change the Inverter's Carrier Frequency Selection (C6-02) to lower the carrier frequency.
- Install an Input Noise Filter at the Inverter's power supply input.
- Install an Output Noise Filter at the Inverter's output.
- Ground the Inverter and motor.
- Separate main circuit wiring from control circuit wiring.

## ◆ If the Earth Leakage Breaker Operates when a RUN Command is Input

The Inverter performs internal switching, so there is a certain amount of leakage current. This may cause the ground fault interrupter to operate and cut off the power supply. Change to a ground fault interrupter with a high leakage detection level (i.e., a sensitivity current of 200 mA or higher, with an operating time of 0.1 s or more), or one that incorporates high frequencies (i.e., one designed for use with Inverters). It will also help to some extent to lower the Inverter's Carrier Frequency Selection (C6-02). In addition, remember that the leakage current increases as the cable is lengthened.

## ◆ If There is Mechanical Oscillation

### ■The machinery is making unusual sounds.

The following causes are possible.

#### There may be resonance between the mechanical system's characteristic frequency and the carrier frequency.

If the motor is running with no problems and the machinery is oscillating with a high-pitched whine, it may indicate that this is occurring. To prevent this type of resonance, adjust the carrier frequency with constants C6-02 to C6-05.

#### There may be resonance between a machine's characteristic frequency and the output frequency of the Inverter.

To prevent this from occurring, either use the jump frequency functions in constants d3-01 to d3-04 or install rubber padding on the motor base to reduce oscillation.

### ■Oscillation and hunting are occurring with open-loop vector control.

The gain and time constant adjustments for the slip and torque compensation may be insufficient. Lower the gain settings and raise the delay time settings. Also adjust the AFR settings (N2-☐☐).

Vector control will not work properly if autotuning has not been performed. Perform autotuning or set the motor constants through calculations.

### ■Oscillation and hunting are occurring with V/f control.

The gain and time constant adjustments for the slip and torque compensation may be insufficient. Lower the gain settings and raise the delay time settings. Also adjust the hunting prevention function (N1-☐☐).

### ■Oscillation and hunting are occurring with V/f with PG control.

The ASR adjustments may are insufficient. Adjust the speed control loop (ASR) gains and integral times.

If the oscillation cannot be eliminated in this way, set the hunting prevention selection (constant N1-01) to 0 (disabled) and then try adjusting the gain again.

### ■Oscillation and hunting are occurring with PID control.

If there is oscillation or hunting during PID control, check the oscillation cycle and individually adjust P, I, and D constants. (Refer to *Page 6-104pp.*)

## ◆ If the Motor Rotates Even When Inverter Output is Stopped

If the motor rotates even when the Inverter output is stopped, maybe the DC injection braking is insufficient. If the motor coasts at low speed after a deceleration to stop has been executed, it means that the DC injection braking is not decelerating enough. Adjust the DC injection braking as follows:

- Increase the constant b2-02 (DC Injection Braking Current) setting.
- Increase the constant b2-04 (DC Injection Braking (initial excitation) Time at Stop) setting.

## ◆ If OV (Overvoltage) is Detected When a Fan is Started, or Fan Stalls

Generation of OV (DC bus overvoltage) and stalling can occur if a fan is turning before it is started (e.g. through the windmill effect).

This can be prevented by slowing fan rotation using DC injection braking before starting the fan. Alternatively the speed search function can be used to catch the rotating motor.

## ◆ If Output Frequency Does Not Rise to Frequency Reference

### ■The frequency reference is within the jump frequency range.

When the jump frequency function is used, the output frequency does not change within the jump frequency range. Check to be sure that the Jump Frequency (constants d3-01 to d3-03) and Jump Frequency Width (constant d3-04) settings are suitable.

### ■The frequency reference upper limit has been reached.

The output frequency upper limit is determined by the following formula:
Maximum Output Frequency (E1-04) × Frequency Reference Upper Limit (d2-01) / 100
Check to be sure that the constant E1-04 and d2-01 settings are suitable.

# 8

# Maintenance and Inspection

This chapter describes basic maintenance and inspection for the Inverter

Maintenance and Inspection........................................8-2

# Maintenance and Inspection

## ◆ Outline of Maintenance

The maintenance period of the Inverter is as follows:

Maintenance Period: Within 18 months from shipping from the factory or within 12 months from being delivered to the final user, whichever comes first.

## ◆ Daily Inspection

Check the following items with the system in operation.

- The motor should not be vibrating or making unusual noises.
- There should be no abnormal heat generation.
- The ambient temperature should not be too high.
- The output current value shown on the monitor displays should not be higher than normal.
- The cooling fan on the bottom of the Inverter should be operating normally.

## ◆ Periodic Inspection

Check the following items during periodic maintenance.

Always turn OFF the power supply before beginning inspection. Confirm that the LED indicators on the front cover have all turned OFF, and then wait until at least five minutes has elapsed before beginning the inspection. Be sure not to touch terminals right after the power has been turned off. Doing so can result in electric shock.

Fig 8.1 Periodic Inspections

| Item | Inspection | Corrective Procedure |
|---|---|---|
| External terminals, mounting bolts, connectors, etc. | Are all screws and bolts tight? | Tighten loose screws and bolts firmly. |
| | Are connectors tight? | Reconnect the loose connectors. |
| Cooling fins | Are the fins dirty or dusty? | Clean off any dirt and dust with an air gun using dry air at a pressure of $39.2 \times 10^4$ to $58.8 \times 10^4$ Pa (4 to 6 kg•cm$^2$). |
| PCBs | Is there any conductive dirt or oil mist on the PCBs? | Clean off any dirt and dust with an air gun using dry air at a pressure of $39.2 \times 10^4$ to $58.8 \times 10^4$ Pa (4 to 6 kg•cm$^2$).<br>Replace the boards if they cannot be made clean. |
| Cooling fan | Is there any abnormal noise or vibration or has the total operating time exceeded 20,000 hours? | Replace the cooling fan. |
| Power elements | Is there any conductive dirt or oil mist on the elements? | Clean off any dirt and dust with an air gun using dry air at a pressure of $39.2 \times 10^4$ to $58.8 \times 10^4$ Pa (4 to 6 kg•cm$^2$). |
| Smoothing capacitor | Are there any irregularities, such as discoloration or odour? | Replace the capacitor or Inverter. |

## ◆ Periodic Maintenance of Parts

The Inverter consists of many parts, and these parts must be operating properly in order to ensure full functioning of the Inverter.

Among the electronic components, there are some that require maintenance depending on their usage conditions. In order to keep the Inverter operating normally over a long period of time, it is necessary to perform period inspections and replace parts according to their service life.

Periodic inspection standards vary depending the Inverter's installation environment and usage conditions. The Inverter's maintenance periods are noted below. Keep them as reference.

Fig 8.2 Part Replacement Guidelines

| Part | Standard Replacement Period | Replacement Method |
|---|---|---|
| Cooling fan | 2 to 3 years | Replace with new part. |
| Smoothing capacitor | 5 years | Replace with new part. (Determine need by inspection.) |
| Soft charge resistor bypass contactor | – | Determine need by inspection. |
| Fuses | 10 years | Replace with new part. |
| Aluminum capacitors on PCBs | 5 years | Replace with new board. (Determine need by inspection.) |

Note The standard replacement period is based on the following usage conditions:
Ambient temperature:Yearly average of 30°C
Load factor: 80% max.
Operating rate: 12 hours max. per day

## ◆ Cooling Fan Replacement Outline

### ■200 V and 400 V Class Inverters of 18.5 kW or Less

A cooling fan is attached to the bottom of the Inverter.

If the Inverter is installed using the mounting holes on the back of the Inverter, the cooling fan can be replaced without removing the Inverter from the installation panel.

#### Removing the Cooling Fan

1. Press in on the right and left sides of the fan cover in the direction of arrows 1 and when pull the fan out in the direction of arrow 2.
2. Pull out the cable connected to the fan from the fan cover and disconnect the cable.
3. Open the fan cover on the left and right sides and remove the fan cover from the fan.

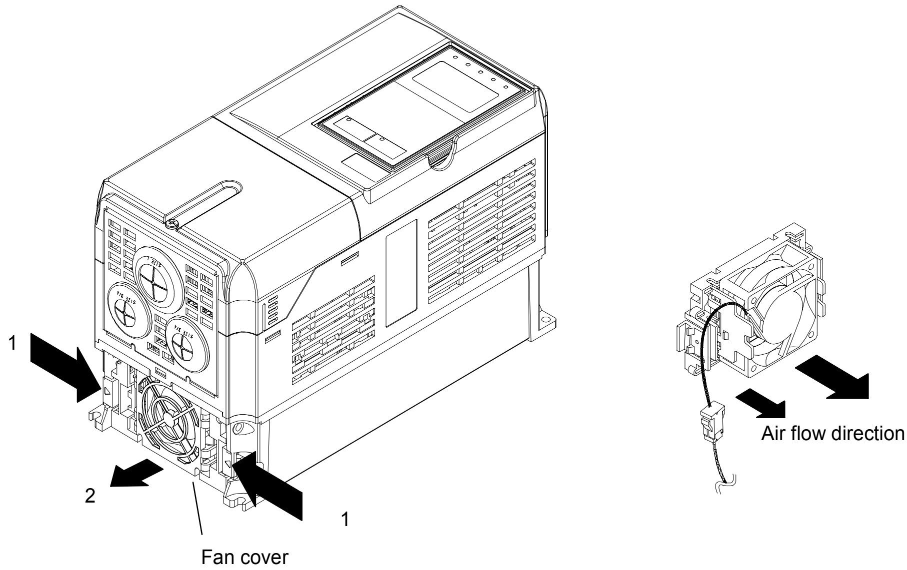



Fig 8.3 Cooling Fan Replacement (Inverters of 18.5 kW or Less)

#### Mounting the Cooling Fan

1. Attach the fan cover to the cooling fan. Be sure that the air flow direction is correct (see figure above).
2. Connect the cables securely and place the connector and cable into the fan cover.
3. Mount the fan cover on the Inverter. Be sure that the tabs on the sides of the fan cover click into place on the Inverter heatsink.

## ■200 V and 400 V Class Inverters of 22 kW or More

A cooling fan is attached to the top panel inside the Inverter.

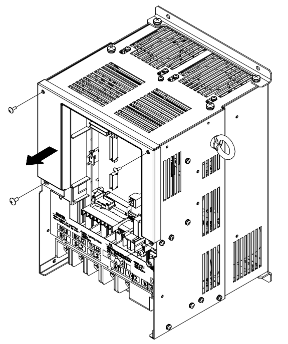
The cooling fan can be replaced without removing the Inverter from the installation panel.

### Removing the Cooling Fan

1. Remove the terminal cover, Inverter cover, Digital Operator, and front cover from the Inverter.
2. Remove the controller bracket to which the cards are mounted. Remove all cables connected to the controler.
3. Remove the cooling fan power cable connector (CN26 and CN27) from the gate driver positioned at the back of the controller.
4. Remove the fan cover screws and pull out the fan cover from the Inverter.
5. Remove the cooling fan from the fan cover.

### Mounting the Cooling Fan

After attaching a new cooling fan, use the above described procedure in reverse order to attach all of the components.
When attaching the cooling fan to the mounting bracket, be sure that the air flow direction faces the top of the Inverter.



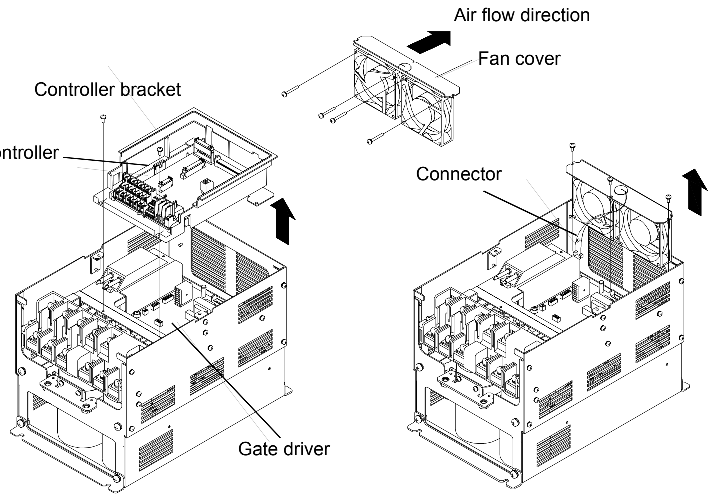



Fig 8.4 Cooling Fan Replacement (Inverters of 22 kW or More)

8

## ◆ Removing and Mounting the Control Circuit Terminal Card

### ■Removing the Control Circuit Terminal Card

1. Remove the Digital Operator and front cover.
2. Remove the connecting line connectors connected to FE and NC on the control circuit terminal card.
3. Loosen the mounting screws (1) on the left and right sides of the control terminals until they are free. (It is not necessary to remove these screws completely. They are self-rising.)
4. Pull the terminal card out downwars (in direction 2).

### ■Mounting the Control Circuit Terminal Card

Use the removal procedure in reverse order to mount the terminal card.

Confirm that the terminal circuit card and the controller card properly meet at connector CN5 before pressing into its plan.

The connector pins may be bent if the card is forced into place!

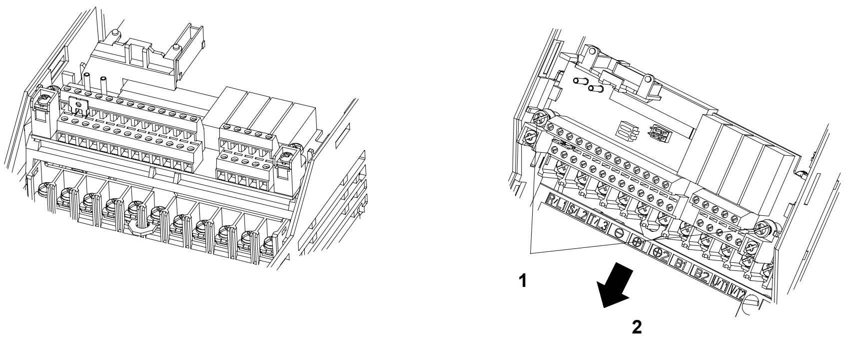



Fig 8.5 Removing the Control Circuit Terminal Card

**IMPORTANT**

Always confirm that the charge indicator does not light anymore before removing or mounting the control circuit terminal card.

# 9

# Specifications

This chapter describes the basic specifications of the Inverter and specifications for options and peripheral devices.

Standard Inverter Specifications..................................9-2

# Standard Inverter Specifications

The standard Inverter specifications are listed by capacity in the following tables.

## ◆ Specifications by Model

Specifications are given by model in the following tables.

### ■200V Class

Table 9.1 200 V Class Inverters

| Model Number CIMR-F7C □ | | | 20P4 | 20P7 | 21P5 | 22P2 | 23P7 | 25P5 | 27P5 | 2011 | 2015 | 2018 | 2022 | 2030 | 2037 | 2045 | 2055 | 2075 | 2090 | 2110 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Max. applicable motor output (kW)[*1] | | | 0.55 | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 |
| Output ratings | Rated output capacity (kVA) | | 1.2 | 1.6 | 2.7 | 3.7 | 5.7 | 8.8 | 12 | 17 | 22 | 27 | 32 | 44 | 55 | 69 | 82 | 110 | 130 | 160 |
| Output ratings | Rated output current (A) | | 3.2 | 4.1 | 7.0 | 9.6 | 15 | 23 | 31 | 45 | 58 | 71 | 85 | 115 | 145 | 180 | 215 | 283 | 346 | 415 |
| Output ratings | Max. output voltage (V) | | 3-phase; 200, 208, 220, 230, or 240 VAC (Proportional to input voltage.) | | | | | | | | | | | | | | | | | |
| Output ratings | Max. output frequency (Hz) | | Heavy Duty selected (low carrier, constant torque applications): 150 Hz max.[*2] Normal Duty selected (high carrier, variable torque applications): 400 Hz max. | | | | | | | | | | | | | | | | | |
| Power supply characteristics | Rated voltage (V) Rated frequency (Hz) | | 3-phase, 200/208/220/230/240 VAC, 50/60 Hz | | | | | | | | | | | | | | | | | |
| Power supply characteristics | Allowable voltage fluctuation | | + 10%, - 15% | | | | | | | | | | | | | | | | | |
| Power supply characteristics | Allowable frequency fluctuation | | ±5% | | | | | | | | | | | | | | | | | |
| Control characteristics | Measures for power supply harmonics | DC reactor | Optional | | | | | | | | | | Built in | | | | | | | |
| Control characteristics | Measures for power supply harmonics | 12-pulse rectification | Not possible | | | | | | | | | | Possible[*3] | | | | | | | |

* 1. The maximum applicable motor output is given for a standard 4-pole Yaskawa motor. When selecting the actual motor and Inverter, be sure that the Inverter's rated current is applicable for the motor's rated current.

* 2. Not available for 110kW inverters.

* 3. A transformer with dual star-delta secondary is required on the power supply for 12-pulse rectification.

## ■400 V Class

Table 9.2 400 V Class Inverters

| | Model Number CIMR-F7C ☐ | | 40P4 | 40P7 | 41P5 | 42P2 | 43P7 | 44P0 | 45P5 | 47P5 | 4011 | 4015 | 4018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. applicable motor output (kW) *1 | | 0.55 | 0.75 | 1.5 | 2.2 | 3.7 | 4.0 | 5.5 | 7.5 | 11 | 15 | 18.5 |
| Output ratings | Rated output capacity (kVA) | | 1.4 | 1.6 | 2.8 | 4.0 | 5.8 | 6.6 | 9.5 | 13 | 18 | 24 | 30 |
| Output ratings | Rated output current (A) | | 1.8 | 2.1 | 3.7 | 5.3 | 7.6 | 8.7 | 12.5 | 17 | 24 | 31 | 39 |
| Output ratings | Max. output voltage (V) | | 3-phase; 380, 400, 415, 440, 460, or 480 VAC (Proportional to input voltage.) | | | | | | | | | | |
| Output ratings | Max. output frequency (Hz) | | Heavy Duty selected (low carrier, constant torque applications): 150 Hz max.<br>Normal Duty selected (high carrier, variable torque applications): 400 Hz max. | | | | | | | | | | |
| Power supply characteristics | Rated voltage (V)<br>Rated frequency (Hz) | | 3-phase, 380, 400, 415, 440, 460 or 480 VAC, 50/60 Hz | | | | | | | | | | |
| Power supply characteristics | Allowable voltage fluctuation | | + 10%, - 15% | | | | | | | | | | |
| Power supply characteristics | Allowable frequency fluctuation | | ±5% | | | | | | | | | | |
| Control characteristics | Measures for power supply harmonics | DC reactor | Optional | | | | | | | | | | |
| Control characteristics | Measures for power supply harmonics | 12-phase rectification | Not possile | | | | | | | | | | |

| | Model Number CIMR-F7C ☐ | | 4022 | 4030 | 4037 | 4045 | 4055 | 4075 | 4090 | 4110 | 4132 | 4160 | 4185 | 4220 | 4300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. applicable motor output (kW)*1 | | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 | 160 | 185 | 220 | 300 |
| Output ratings | Rated output capacity (kVA) | | 34 | 46 | 57 | 69 | 85 | 110 | 140 | 160 | 200 | 230 | 280 | 390 | 510 |
| Output ratings | Rated output current (A) | | 45 | 60 | 75 | 91 | 112 | 150 | 180 | 216 | 260 | 304 | 370 | 506 | 675 |
| Output ratings | Max. output voltage (V) | | 3-phase, 380, 400, 415, 440, 460, or 480 VAC (Proportional to input voltage.) | | | | | | | | | | | | |
| Output ratings | Max. output frequency (Hz) | | Heavy Duty selected (low carrier, constant torque applications): 150 Hz max.*2<br>Normal Duty selected (high carrier, variale torque applications): 400 Hz max. | | | | | | | | | | | | |
| Power supply characteristics | Max. voltage (V)<br>Rated frequency (Hz) | | 3-phase, 380, 400, 415, 440, 460, or 480 VAC, 50/60 Hz | | | | | | | | | | | | |
| Power supply characteristics | Allowable voltage fluctuation | | + 10%, - 15% | | | | | | | | | | | | |
| Power supply characteristics | Allowable frequency fluctuation | | ±5% | | | | | | | | | | | | |
| Control characteristics | Measures for power supply harmonics | DC reactor | Built in | | | | | | | | | | | | |
| Control characteristics | Measures for power supply harmonics | 12-phase rectification | Possible*3 | | | | | | | | | | | | |

* 1. The maximum applicable motor output is given for a standard 4-pole Yaskawa standard motor. When selecting the actual motor and Inverter, be sure that the Inverter's rated current is higher than the motor's rated current.

* 2. Not available for 220kW and 300kW inverters.

* 3. A transformer with dual star-delta secondary is required on the power supply for 12-pulse-rectification.

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## ◆ Common Specifications

The following specifications apply to both 200 V and 400 V Class Inverters.

Table 9.3 Common Specifications

| Model Number CIMR-F7C ☐ | | Specification |
|---|---|---|
| Control characteristics | Control method | Sine wave PWM<br>Open loop vector control, V/f control, V/f with PG control (switched by constant setting) |
| | Torque characteristics | Heavy Duty selected (low carrier, constant torque applications): 150% /0.5 Hz (Open loop vector control)<br>Normal Duty selected (high carrier, variable torque applications): 120%/0.5 Hz (Open loop vector control) |
| | Speed control range | 1:100 (Open loop vector control) |
| | Speed control accuracy | ±0.2% (25°C ± 10°C) (Open loop vector control) |
| | Speed control response | 5 Hz (Open loop vector control) |
| | Torque limits | Provided (4 quadrant steps can be changed by constant settings.) (Open loop vector control) |
| | Torque accuracy | ±5% |
| | Frequency control range | 0.01 to 150 Hz (Heavy Duty selected.), 0.01 to 400 Hz (Normal Duty selected.) |
| | Frequency accuracy (temperature characteristics) | Digital references: ± 0.01% (-10°C to +40°C) |
| | | Analog references: ±0.1% (25°C ±10°C) |
| | Frequency setting resolution | Digital references: 0.01 Hz |
| | | Analog references: 0.025/50 Hz (11 bits plus sign) |
| | Output frequency resolution | 0.01 Hz |
| | Overload capacity and maximum current*2 | Heavy Duty selected (low carrier, fconstant torque applications): 150% of rated output current for 1 minute*1<br>Normal Duty selected (high carrier, variable torque applications): 120% of rated output current for 1 minute |
| | Frequency setting signal | 0 to +10V, –10 to +10 V, 4 to 20 mA, pulse train |
| | Acceleration/Deceleration time | 0.01 to 6000.0 s (4 selectable combinations of independent acceleration and deceleration settings) |
| | Braking torque | Approximately 20% (Approximately 125% with Braking Resistor option, braking transistor built into 200 V and 400 V Class Inverters for 18.5 kW or less.) |
| | Main control functions | Restarting for momentary power loss, speed searches, overtorque detection, torque limits, 16-speed control (maximum), acceleration/deceleration time changes, S-curve acceleration/deceleration, 3-wire control, autotuning (rotational or stationary), dwell functions, cooling fan ON/OFF control, slip compensation, torque compensation, jump frequencies, upper and lower limits for frequency references, DC braking for starting and stopping, high-slip braking, PID control (with sleep function), energy-saving control, MEMOBUS communications (RS-485/422, 19.2 kbps maximum), fault reset, and copy function. |
| Protective functions | Motor protection | Protection by electronic thermal overload relay. |
| | Instantaneous overcurrent protection | Stops at approx. 200% of rated output current. |
| | Fuse blown protection | Stops for fuse blown. |
| | Overload protection | Heavy Duty selected (low carrier, constant torque applications): 150% of rated output current for 1 minute*1<br>Normal Duty selected (high carrier, variable torque applications): 120% of rated output current for 1 minute |
| | Overvoltage protection | 200 Class Inverter: Stops when main-circuit DC voltage is above 410 V.<br>400 Class Inverter: Stops when main-circuit DC voltage is above 820 V. |
| | Undervoltage protection | 200 Class Inverter: Stops when main-circuit DC voltage is below 190 V.<br>400 Class Inverter: Stops when main-circuit DC voltage is below 380 V. |
| | Momentary power loss ridethrough | By selecting the momentary power loss method, operation can be continued if power is restored within 2 s. |
| | Cooling fin overheating | Protection by thermistor. |
| | Stall prevention | Stall prevention during acceleration, deceleration, or running. |
| | Grounding protection | Protection by electronic circuits. |
| | Charge indicator | Lit when the main circuit DC voltage is approx. 50 V or more. |
| Protective structure | | Enclosed wall-mounted type (NEMA 1): 18.5 kW or less (same for 200 V and 400 V class Inverters)<br>Open chassis type (IP00): 22 kW or more (same for 200 V and 400 V class Inverters) |
| Environment | Ambient operating temperature | -10°C to 40°C (Enclosed wall-mounted type)<br>–10°C to 45°C (Open chassis type) |
| | Ambient operating humidity | 95% max. (with no condensation) |
| | Storage temperature | - 20°C to + 60°C (short-term temperature during transportation) |
| | Application site | Indoor (no corrosive gas, dust, etc.) |
| | Altitude | 1000 m max. |
| | Vibration | 10 to 20 Hz, 9.8 $m/s^2$ max.; 20 to 50 Hz, 2 $m/s^2$ max |

Note Rotational autotuning is required to obtain the specifications labelled as "open loop vector control."

* 1. Not available for 200 V Class Inverters with 110 kW and the 400 V Class Inverters with 220 and 300 kW.

* 2. Increase the Inverter capacity if loads exceeding these current values are expected.

# 10

# Appendix

This chapter provides precautions for the Inverter, motor, and peripheral devices and also provides lists of constants.


Inverter Application Precautions ................................ 10-2

Motor Application Precautions ................................... 10-5

User Constants ......................................................... 10-7

# Inverter Application Precautions

## ◆ Selection

Observe the following precautions in selecting an Inverter.

### ■Installing Reactors

A large peak current will flow in the power input circuit when the Inverter is connected to a large-capacity power transformer (600 kVA or higher) or when switching a compensating capacitor. Excessive peak current can destroy the convertor section. To prevent this, install a DC or AC reactor (optional) to improve the power supply power factor.

DC reactors are built into 200 V class Inverters of 22 to 110 kW and 400 V class Inverters of 22 to 300 kW.

If a thyristor convertor, such as a DC drive, is connected in the same power supply system, connect a DC or AC reactor regardless of the power supply conditions shown in the following diagram.

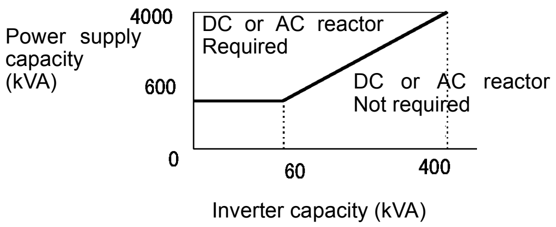


Fig 10.1

### ■Inverter Capacity

When connecting special motors or multiple motors in parallel to an Inverter, select the Inverter capacity so that the rated output current of the Inverter is minimum 1.1 times the sum of all the motor rated currents.

### ■Initial Torque

The startup and acceleration characteristics of the motor are restricted by the overload current ratings of the Inverter that is driving the motor. The torque characteristic generally is different from those when starting a motor at a normal commercial power supply. If a large initial torque is required, select an Inverter with a somewhat larger capacity or increase the capacity of both, the motor and the inverter.

### ■Options

Terminals B1, B2, ⊖, ⊕1, ⊕2, ⊕3 are for connecting only the options specifically provided by Yaskawa. Never connect any other devices to these terminals.

## ◆ Installation

Observe the following precautions when installing an Inverter.

### ■Installation in Enclosures

Either install the Inverter in a clean location where it is not subjected to oil mist, dust, and other contaminants, or install the Inverter in a completely enclosed panel. Provide cooling measures and sufficient panel space so that the temperature surrounding the Inverter does not go beyond the allowable temperature. Do not install the Inverter on wood or other combustible materials.

### ■Installation Direction

Mount the Inverter vertically to a wall or other vertical surface.

## ◆ Settings

Observe the following precautions when making settings for an Inverter.

### ■Upper Limits

The Digital Operator can be used to set high-speed operation up to a maximum of 400 Hz (depends on the carrier frequency). Incorrect settings can be dangerous. Use the maximum frequency setting functions to set upper limits. (The maximum output frequency is factory-set to 50 Hz.)

### ■DC Injection Braking

The motor can overheat if the DC injection braking current or braking time is set to a too  large value.

### ■Acceleration/Deceleration Times

The motor's acceleration and deceleration times are determined by the torque generated by the motor, the load torque, and the load's inertial moment ($GD^2/4$). If the stall prevention functions are activated during acceleration or deceleration, it might be necessary to increase the acceleration or deceleration time.

To reduce the acceleration or deceleration times, increase the capacity of the motor and Inverter.

## ◆ Handling

Observe the following precautions when wiring or performing maintenance for an Inverter.

### ■Wiring Check

The Inverter will be internally damaged if the power supply voltage is applied to output terminal U, V, or W. Check wiring for any mistakes before supplying power. Check all wiring and control sequences carefully.

### ■Magnetic Contactor Installation

Do not start and stop operation frequently with a magnetic contactor installed on the power supply line. Doing so can cause the Inverter to malfunction. Do not turn the Inverter ON and OFF with a magnetic contactor more than one time every 30 minutes.

### ■Maintenance and Inspections

After turning OFF the main circuit power supply, always confirm that the CHARGE indicator has gone out before performing maintenance or inspections. The voltage remaining in the capacitor may cause electric shock.

# Motor Application Precautions

## ◆ Using the Inverter for an Existing Standard Motor

Observe the following precautions when using an Inverter for an existing standard motor.

### ■Low Speed Ranges

Cooling effects diminish in the low-speed range, resulting in an increase of the motor temperature. Therefore, the motor torque should be reduced in the low-speed range whenever using a fan cooled motor. If 100% torque is required continuously at low speed, consider using a special inverter or vector motor.

### ■Installation Withstand Voltage

If the input voltage is high (440 V or higher) or the wiring distance is long, the motor insulation voltage must be considered. Contact your Yaskawa representative for details.

### ■High-speed Operation

When using the motor at a high speed (50 Hz or more), problems may arise in dynamic balance and bearing durability. Contact your Yaskawa representative for details.

### ■Noise

Noise varies with the carrier frequency. At high carrier frequencies, the noise is almost the same when the motor is operated with a commercial power supply.

## ◆ Using the Inverter for Special Motors

Observe the following precautions when using a special motor.

### ■Pole-changing Motor

The rated input current of pole-changing motors differs from that of standard motors. Select an appropriate Inverter according to the maximum input current of the motor.

### ■Submersible Motor

The rated input current of submersible motors is higher than that of standard motors. Therefore, always select an Inverter by checking its rated output current. When the distance between the motor and Inverter is long, use a cable thick enough to connect the motor and Inverter to prevent voltage drop and thereby motor torque reduction.

### ■Explosion-proof Motor

When an explosion-proof motor is to be used, it must be subjected to an explosion-proof test in conjunction with the Inverter. This is also applicable when an existing explosion-proof motor is to be operated with the Inverter. Since the Inverter itself is, however, not explosion-proof, always install it in a safe place.

### ■Gearmotor

The speed range for continuous operation differs according to the lubrication method and motor manufacturer. In particular, continuous operation of an oil-lubricated motor in the low speed range may result in damaging. If the motor is to be operated at a speed higher than 50 Hz, consult the manufacturer.

### ■Synchronous Motor

A synchronous motor is not suitable for Inverter control.

### ■Single-phase Motor

Do not use an Inverter for a single-phase motor. The motor should be replaced with a 3-phase motor.

## ◆ Power Transmission Mechanism (Speed Reducers, Belts and Chains)

If an oil-lubricated gearbox or speed reducer is used in the power transmission mechanism, oil lubrication will be affected when the motor operates only in the low speed range. The power transmission mechanism will make noise and experience problems with service life and durability if the motor is operated at low speeds continuously.

# User Constants

Factory settings are given in the following table. These are factory settings for a 200 V Class Inverter with 0.4 kW (open loop vector control).

Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| A1-00 | Language selection for digital operator display (JVOP-160) | 0 | |
| A1-01 | Constant access level | 2 | |
| A1-02 | Control method selection | 0 | |
| A1-03 | Initialize | 0 | |
| A1-04 | Password | 0 | |
| A1-05 | Password setting | 0 | |
| A2-01 to A2-32 | User setting constants | – | |
| b1-01 | Reference source selection | 1 | |
| b1-02 | RUN command source selection | 1 | |
| b1-03 | Stopping method selection | 0 | |
| b1-04 | Prohibition of reverse operation | 0 | |
| b1-06 | Control input scan | 1 | |
| b1-07 | Operation selection after switching to remote mode | 0 | |
| b1-08 | Run command selection in programming modes | 0 | |
| b2-01 | Zero speed level (DC injection braking starting frequency) | 0.5 Hz | |
| b2-02 | DC injection braking current | 50 % | |
| b2-03 | DC injection braking time at start | 0.00 s | |
| b2-04 | DC injection braking time at stop | 0.50 s | |
| b3-01 | Speed search selection | 2[*1] | |
| b3-02 | Speed search operating current | 120 %[*1] | |
| b3-03 | Speed search deceleration time | 2.0 s | |
| b3-05 | Speed search wait time | 0.2 s | |
| b4-01 | Timer function ON-delay time | 0.0 s | |
| b4-02 | Timer function OFF-delay time | 0.0 s | |
| b5-01 | PID control mode selection | 0 | |
| b5-02 | Proportional gain (P) | 1.00 | |
| b5-03 | Integral (I) time | 1.0 s | |
| b5-04 | Integral (I) limit | 100.0 % | |
| b5-05 | Differential (D) time | 0.00 s | |
| b5-06 | PID limit | 100.0 % | |
| b5-07 | PID offset adjustment | 0.0 % | |
| b5-08 | PID delay time constant | 0.00 s | |
| b5-09 | PID output characteristics selection | 0 | |
| b5-10 | PID output gain | 1.0 | |
| b5-11 | PID reverse output selection | 0 | |
| b5-12 | Selection of PID feedback loss detection | 0 | |
| b5-13 | PID feedback loss detection level | 0 % | |
| b5-14 | PID feedback loss detection time | 1.0 s | |
| b5-15 | PID sleep function operation level | 0.0 Hz | |
| b5-16 | PID sleep operation delay time | 0.0 s | |
| b5-17 | Acceleration/deceleration time for PID reference | 0.0 s | |
| b5-18 | PID Setpoint Selection | 0 | |

Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| b5-19 | PID Setpoint | 0.0 % | |
| b6-01 | Dwell frequency at start | 0.0 Hz | |
| b6-02 | Dwell time at start | 0.0 s | |
| b6-03 | Dwell frequency at stop | 0.0 Hz | |
| b6-04 | Dwell time at stop | 0.0 s | |
| b8-01 | Energy-saving mode selection | 0 | |
| b8-02 | Energy-saving gain | 0.7*2 | |
| b8-03 | Energy-saving filter time constant | 0.50 s*3 | |
| b8-04 | Energy-saving coefficient | *4 | |
| b8-05 | Power detection filter time constant | 20 ms | |
| b8-06 | Search operation voltage limiter | 0 % | |
| C1-01 | Acceleration time 1 | 10.0 s | |
| C1-02 | Deceleration time 1 | 10.0 s | |
| C1-03 | Acceleration time 2 | 10.0 s | |
| C1-04 | Deceleration time 2 | 10.0 s | |
| C1-05 | Acceleration time 3 | 10.0 s | |
| C1-06 | Deceleration time 3 | 10.0 s | |
| C1-07 | Acceleration time 4 | 10.0 s | |
| C1-08 | Deceleration time 4 | 10.0 s | |
| C1-09 | Emergency stop time | 10.0 s | |
| C1-10 | Accel/decel time setting unit | 1 | |
| C1-11 | Accel/decel time switching frequency | 0.0 Hz | |
| C2-01 | S-curve characteristic time at acceleration start | 0.20 s | |
| C2-02 | S-curve characteristic time at acceleration end | 0.20 s | |
| C2-03 | S-curve characteristic time at deceleration start | 0.20 s | |
| C2-04 | S-curve characteristic time at deceleration end | 0.00 s | |
| C3-01 | Slip compensation gain | 0.0*1 | |
| C3-02 | Slip compensation primary delay time | 2000 ms*1 | |
| C3-03 | Slip compensation limit | 200 % | |
| C3-04 | Slip compensation selection during regeneration | 0 | |
| C3-05 | Output voltage limit operation selection | 0 | |
| C4-01 | Torque compensation gain | 1.00 | |
| C4-02 | Torque compensation time constant | 200 ms*1 | |
| C4-03 | Starting torque compensation (FWD) | 0.0 | |
| C4-04 | Starting torque compensation (REV) | 0.0 | |
| C4-05 | Starting torque compensation time constant | 10 ms | |
| C5-01 | ASR proportional (P) gain 1 | 0.20 | |
| C5-02 | ASR integral (I) time 1 | 0.200 s | |
| C5-03 | ASR proportional (P) gain 2 | 0.02 | |
| C5-04 | ASR integral (I) time 2 | 0.050 s | |
| C5-05 | ASR limit | 5.0 % | |
| C6-01 | Heavy/Normal Duty selection | 1 | |
| C6-02 | Carrier frequency selection | 6*4 | |
| C6-03 | Carrier Frequency Upper Limit | 15 kHz*4 | |
| C6-04 | Carrier Frequency Lower Limit | 15 kHz*4 | |
| C6-05 | Carrier Freq. Proportional Gain | 00 | |

Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| d1-01 | Frequency reference 1 | 0.00 Hz | |
| d1-02 | Frequency reference 2 | 0.00 Hz | |
| d1-03 | Frequency reference 3 | 0.00 Hz | |
| d1-04 | Frequency reference 4 | 0.00 Hz | |
| d1-05 | Frequency reference 5 | 0.00 Hz | |
| d1-06 | Frequency reference 6 | 0.00 Hz | |
| d1-07 | Frequency reference 7 | 0.00 Hz | |
| d1-08 | Frequency reference 8 | 0.00 Hz | |
| d1-09 | Frequency reference 9 | 0.00 Hz | |
| d1-10 | Frequency reference 10 | 0.00 Hz | |
| d1-11 | Frequency reference 11 | 0.00 Hz | |
| d1-12 | Frequency reference 12 | 0.00 Hz | |
| d1-13 | Frequency reference 13 | 0.00 Hz | |
| d1-14 | Frequency reference 14 | 0.00 Hz | |
| d1-15 | Frequency reference 15 | 0.00 Hz | |
| d1-16 | Frequency reference 16 | 0.00 Hz | |
| d1-17 | Jog frequency reference | 6.00 Hz | |
| d2-01 | Frequency reference upper limit | 100.0 % | |
| d2-02 | Frequency reference lower limit | 0.0 % | |
| d2-03 | Master speed reference lower limit | 0.0 % | |
| d3-01 | Jump frequency 1 | 0.0 Hz | |
| d3-02 | Jump frequency 2 | 0.0 Hz | |
| d3-03 | Jump frequency 3 | 0.0 Hz | |
| d3-04 | Jump frequency width | 1.0 Hz | |
| d4-01 | Frequency reference hold function selection | 0 | |
| d4-02 | + - Speed limits | 10 % | |
| d6-01 | Field weakening level | 80 % | |
| d6-02 | Field weakening frequency limit | 0.0 Hz | |
| E1-01 | Input voltage setting | 200 V*5 | |
| E1-03 | V/f pattern selection | F | |
| E1-04 | Max. output frequency | 50.0 Hz | |
| E1-05 | Max. voltage | 200.0 V*5 | |
| E1-06 | Base frequency | 50.0 Hz | |
| E1-07 | Mid. output frequency | 2,4 Hz *1 | |
| E1-08 | Mid. output frequency voltage | 13,2 V*1 *5 | |
| E1-09 | Min. output frequency | 0.5 Hz*1 | |
| E1-10 | Min. output frequency voltage | 2,4 V*1 *5 | |
| E1-11 | Mid. output frequency 2 | 0.0 Hz*6 | |
| E1-12 | Mid. output frequency voltage 2 | 0.0 V*6 | |
| E1-13 | Base voltage | 0.0 V*7 | |
| E2-01 | Motor rated current | 1.90 A*4 | |
| E2-02 | Motor rated slip | 2.90 Hz*4 | |
| E2-03 | Motor no-load current | 1.20 A*4 | |
| E2-04 | Number of motor poles | 4 | |
| E2-05 | Motor line-to-line resistance | 9.842Ω*6 | |

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Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| E2-06 | Motor leak inductance | 18.2 %*4 | |
| E2-07 | Motor iron saturation coefficient 1 | 0.50 | |
| E2-08 | Motor iron saturation coefficient 2 | 0.75 | |
| E2-10 | Motor iron loss for torque compensation | 14 W*4 | |
| E2-11 | Motor rated output | 0.40 kW*4 | |
| E3-01 | Motor 2 control method selection | 0 | |
| E3-02 | Motor 2 max. output frequency | 50.0 Hz | |
| E3-03 | Motor 2 max. output voltage | 200.0 V*5 | |
| E3-04 | Motor 2 max. output voltage frequency | 50.0 Hz | |
| E3-05 | Motor 2 mid. output frequency 1 | 2.4 Hz *1 | |
| E3-06 | Motor 2 mid. output frequency voltage 1 | 13,2 V *1*5 | |
| E3-07 | Motor 2 min. output frequency | 0.5 Hz *1 | |
| E3-08 | Motor 2 min. output frequency voltage | 2.4 V *1*5 | |
| E4-01 | Motor 2 rated current | 1.90 A *4 | |
| E4-02 | Motor 2 rated slip | 2.90 Hz *4 | |
| E4-03 | Motor 2 no-load current | 1.20 A *4 | |
| E4-04 | Motor 2 number of poles (number of poles) | 4 | |
| E4-05 | Motor 2 line-to-line resistance | 9.842Ω*4 | |
| E4-06 | Motor 2 leak inductance | 18.2 %*4 | |
| E4-07 | Motor 2 rated capacity | 0.40 kW*4 | |
| F1-01 | PG constant | 1024 | |
| F1-02 | Operation selection at PG open circuit (PGO) | 1 | |
| F1-03 | Operation selection at overspeed (OS) | 1 | |
| F1-04 | Operation selection at deviation | 3 | |
| F1-05 | PG rotation | 0 | |
| F1-06 | PG division rate (PG pulse monitor) | 1 | |
| F1-07 | Integral value during accel/decel enable/disable | 0 | |
| F1-08 | Overspeed detection level | 115 % | |
| F1-09 | Overspeed detection delay time | 1.0 s | |
| F1-10 | Excessive speed deviation detection level | 10 % | |
| F1-11 | Excessive speed deviation detection delay time | 0.5 s | |
| F1-12 | Number of PG gear teeth 1 | 0 | |
| F1-13 | Number of PG gear teeth 2 | 0 | |
| F1-14 | PG open-circuit detection delay time | 2.0 s | |
| F6-01 | Operation selection after communications error | 1 | |
| F6-02 | Input level of external error from Communications Option Card | 0 | |
| F6-03 | Stopping method for external error from Communications Option Card | 1 | |
| F6-04 | Trace sampling from Communications Option Card | 0 | |
| F6-05 | I monitor unit selection | 1 | |
| H1-01 | Terminal S3 function selection | 24 | |
| H1-02 | Terminal S4 function selection | 14 | |
| H1-03 | Terminal S5 function selection | 3 (0)*8 | |
| H1-04 | Terminal S6 function selection | 4 (3)*8 | |

Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| H1-05 | Terminal S7 function selection | 6 (4)*8 | |
| H2-01 | Terminal M1-M2 function selection | 0 | |
| H2-02 | Terminal M3-M4 function selection | 1 | |
| H2-03 | Terminal M5-M6 function selection | 2 | |
| H3-01 | Analog input A1 Signal level selection | 0 | |
| H3-02 | Gain (terminal A1) | 100.0 % | |
| H3-03 | Bias (terminal A1) | 0.0 % | |
| H3-08 | Multi-function analog input terminal A2 signal level selection | 2 | |
| H3-09 | Multi-function analog input terminal A2 function selection | 0 | |
| H3-10 | Gain (terminal A2) | 100.0 % | |
| H3-11 | Bias (terminal A2) | 0.0 % | |
| H3-12 | Analog input filter time constant | 0.00 s | |
| H3-13 | Terminal A1/A2 switching | 0 | |
| H4-01 | Monitor selection (terminal FM) | 2 | |
| H4-02 | Gain (terminal FM) | 100 % | |
| H4-03 | Bias (terminal FM) | 0.0 % | |
| H4-04 | Monitor selection (terminal AM) | 3 | |
| H4-05 | Gain (terminal AM) | 50 % | |
| H4-06 | Bias (terminal AM) | 0.0 % | |
| H4-07 | Analog output 1 signal level selection | 0 | |
| H4-08 | Analog output 2 signal level selection | 0 | |
| H5-01 | Station address | 1F | |
| H5-02 | Communications speed selection | 3 | |
| H5-03 | Communications parity selection | 0 | |
| H5-04 | Stopping method after communications error | 3 | |
| H5-05 | Communications error detection selection | 1 | |
| H5-06 | Send wait time | 5 ms | |
| H5-07 | RTS control ON/OFF | 1 | |
| H6-01 | Pulse train input function selection | 0 | |
| H6-02 | Pulse train input scaling | 1440 Hz | |
| H6-03 | Pulse train input gain | 100.0 % | |
| H6-04 | Pulse train input bias | 0.0 % | |
| H6-05 | Pulse train input filter time | 0.10 s | |
| H6-06 | Pulse train monitor selection | 2 | |
| H6-07 | Pulse train monitor scaling | 1440 Hz | |
| L1-01 | Motor protection selection | 1 | |
| L1-02 | Motor protection time constant | 1.0 min | |
| L1-03 | Alarm operation selection during motor overheating | 3 | |
| L1-04 | Motor overheating operation selection | 1 | |
| L1-05 | Motor temperature input filter time constant | 0.20 s | |
| L2-01 | Momentary power loss detection | 0 | |
| L2-02 | Momentary power loss ridethru time | 0.1 s*4 | |
| L2-03 | Min. baseblock time | 0.1s *4 | |
| L2-04 | Voltage recovery time | 0.3 s *4 | |
| L2-05 | Undervoltage detection level | 190 V*5 | |
| L2-06 | KEB deceleration time | 0.0 s | |

Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| L2-07 | Momentary recovery time | 0 s*9 | |
| L2-08 | Frequency reduction gain at KEB start | 100 | |
| L3-01 | Stall prevention selection during acceleration | 1 | |
| L3-02 | Stall prevention level during acceleration | 120 % | |
| L3-03 | Stall prevention limit during accel | 50 % | |
| L3-04 | Stall prevention selection during decel | 1 | |
| L3-05 | Stall prevention selection during running | 1 | |
| L3-06 | Stall prevention level during running | 120 % | |
| L4-01 | Speed agreement detection level | 0.0 Hz | |
| L4-02 | Speed agreement detection width | 2.0 Hz | |
| L4-03 | Speed agreement detection level (+/-) | 0.0 Hz | |
| L4-04 | Speed agreement detection width (+/-) | 2.0 Hz | |
| L4-05 | Operation when frequency reference is missing | 0 | |
| L4-06 | $F_{ref}$ @ $F_{ref}$ Loss | 80 % | |
| L5-01 | Number of auto restart attempts | 0 | |
| L5-02 | Auto restart operation selection | 0 | |
| L6-01 | Torque detection selection 1 | 0 | |
| L6-02 | Torque detection level 1 | 150 % | |
| L6-03 | Torque detection time 1 | 0.1 s | |
| L6-04 | Torque detection selection 2 | 0 | |
| L6-05 | Torque detection level 2 | 150 % | |
| L6-06 | Torque detection time 2 | 0.1 s | |
| L7-01 | Forward drive torque limit | 200 % | |
| L7-02 | Reverse drive torque limit | 200 % | |
| L7-03 | Forward regenerative torque limit | 200 % | |
| L7-04 | Reverse regenerative torque limit | 200 % | |
| L8-01 | Protect selection for internal DB resistor (Type ERF) | 0 | |
| L8-02 | Overheat pre-alarm level | 95 °C | |
| L8-03 | Operation selection after overheat pre-alarm | 3 | |
| L8-05 | Input open-phase protection selection | 1 | |
| L8-07 | Output open-phase protection selection | 0 | |
| L8-09 | Ground protection selection | 1 | |
| L8-10 | Cooling fan control selection | 0 | |
| L8-11 | Cooling fan control delay time | 60 s | |
| L8-12 | Ambient temperature | 45 °C | |
| L8-15 | OL2 characteristics selection at low speeds | 1 | |
| L8-19 | Soft CLA selection | 1 | |
| N1-01 | Hunting-prevention function selection | 1 | |
| N1-02 | Hunting-prevention gain | 1.00 | |
| N2-01 | Speed feedback detection control (AFR) gain | 1.00 | |
| N2-02 | Speed feedback detection control (AFR) time constant | 50 ms | |
| N2-03 | Speed feedback detection control (AFR) time constant 2 | 750 ms | |
| N3-01 | High-slip braking deceleration frequency width | 5 % | |
| N3-02 | High-slip braking current limit | 150 % | |
| N3-03 | High-slip braking stop dwell time | 1.0 s | |
| N3-04 | High-slip braking OL time | 40 s | |
| o1-01 | Monitor selection | 6 | |
| o1-02 | Monitor selection after powerup | 1 | |
| o1-03 | Frequency units of reference setting and monitor | 0 | |

Table 10.1 User Constants

| No. | Name | Factory Setting | Setting |
|---|---|---|---|
| o1-05 | LCD Focus | 3 | |
| o2-01 | LOCAL/REMOTE key enable/disable | 1 | |
| o2-02 | STOP key during control circuit terminal operation | 1 | |
| o2-03 | User constant initial value | 0 | |
| o2-04 | kVA selection | 0 *4 | |
| o2-05 | Frequency reference setting method selection | 0 | |
| o2-06 | Operation selection when digital operator is disconnected | 0 | |
| o2-07 | Cumulative operation time setting | 0 hr | |
| o2-08 | Cumulative operation time selection | 0 | |
| o2-09 | Initialize mode | 2 | |
| o2-10 | Fan operation time setting | 0 hr | |
| o2-12 | Fault trace initialisation | 0 | |
| o3-01 | Copy function selection | 0 | |
| o3-02 | Read permition selection | 0 | |
| T1-00 | Motor 1/2 selection | 1 | |
| T1-01 | Autotuning mode selection | 0 | |
| T1-02 | Motor output power | 0.40 kW *4 | |
| T1-03 | Motor rated voltage | 200.0 V *5 | |
| T1-04 | Motor rated current | 1.90 A *4 | |
| T1-05 | Motor base frequency | 50 Hz | |
| T1-06 | Number of motor poles | 4 | |
| T1-07 | Motor base speed | 1450 rpm | |

* 1. Factory setting depends on the control method (A1-02).
* 2. For V/f with PG control: 1.0
* 3. For Inverters with a capacity of 55 kW or more: 2.00
* 4. Initial setting depends on Inverter capacity.
* 5. Setting for 200 V class Inverters. For 400 V class Inverters, double the value.
* 6. The contents is ignored if the setting is 0.0.
* 7. E1-13 will have the same value as E1-05 after autotuning.
* 8. Factory setting in the parentheses is for 3-wire sequence.
* 9. If the set value is 0, acceleration will be to the speeds for the acceleration times (C1-01 to C1-08)

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