# FRENIC 5000VG7S USER'S MANUAL

High-performance, Vector Control Inverter

FRENIC

5000VG7S Series

MEH407

# Introduction

Thank you for choosing our high-performance vector control inverter FRENIC5000VG7S series. This user's manual provides all the information on FRENIC5000VG7S including its installation, standard functions, and optional functions. Carefully read this manual for proper use. Incorrect handling of the inverter will prevent proper operation of the inverter or related equipment, shorten their lives, or cause troubles.
The table below lists the other manuals related with FRENIC5000VG7S. Read them in conjunction with this manual if necessary.

| Name | Manual No. | Description |
|---|---|---|
| Catalog | MEH405 | General description, specifications, and external drawings of the product |
| Instruction manual | INR-HF51306 | - Inspections and installation of the product<br>- Periodic maintenance and inspection<br>- Method of using KEYPAD panel<br>- Troubleshooting |


(2) The information contained herein such as specifications is subject to change without prior notice for improvement of the products.
(3) This manual is intended to provide accurate information on Fuji inverters. If you find any errors or omissions, please feel free to send you comments to our sale office described on the back cover of this manual.


Manuals are revised whenever necessary. Read the manuals of the latest edition.

# Introduction

## Safety Instructions

Read this manual carefully before installing, connecting (wiring), operating, servicing, or inspecting the inverter.
Familiarize yourself with all safety features before using the inverter.
In this manual, safety messages are classified as follows:

| | |
|---|---|
| ⚠WARNING | Improper operation may result in serious personal injury or death. |
| ⚠CAUTION | Improper operation may result in slight to medium personal injury or property damage. |

Situations more serious than those covered by CAUTION will depend on prevailing circumstances.
Always follow instructions.

### Instructions on use

**⚠WARNING**

- This inverter is designed to drive a 3-phase induction motor and is not suitable for a single-phase motor or others, **as fire may result.**
- This inverter may not be used (as is) as a component of a life-support system or other medical device directly affecting the personal welfare of the user.
- This inverter is manufactured under strict quality control standards. However, safety equipment must be installed if the failure of this device may result in personal injury and/or property damage.

**There is a risk of accident.**

### Instructions on installation

**⚠CAUTION**

- Mount this inverter on an incombustible material such as metal.

**There is a risk of fire.**

- Do not place combustible or flammable material near this inverter, **as fire may result.**
- The inverter housed in IP00 (18.5kW or over) should be installed in a place where no one can touch it easily.

**Electric shock or injury may result.**

**⚠CAUTION**

- Do not hold or carry this inverter by the surface cover. Inverter may be dropped **causing injury.**
- Ensure that the inverter and heat sink surfaces are kept free from foreign matter (lint, paper dust, small chips of wood or metal chips), **as fire or accident may result.**
- Do not install or operate a damaged inverter or an inverter with missing parts, **as injury may result.**
- When changing installation bracket position, use the attached screws, **as injury may result.**

## Instructions on wiring

| ⚠WARNING |
|---|
| • Connect the inverter to power via a line-protection molded-case circuit breaker or earth-leakage circuit breaker, **as fire may result.**<br>• Use the cables of the specified size, **as fire may result.**<br>• Always connect a ground wire, **as electric shock or fire may result.**<br>• A licensed specialist must perform the wiring works, **as electric shock may result.**<br>• Turn off the power before starting the wiring work, **as electric shock may result.**<br>• Wire the inverter after installation is complete, **as electric shock or injury may occur.**<br>• Do not supply power to any inverter of which parts are broken, omitted, or damage in transportation, **as electrical shock or fire may result.** |

| ⚠CAUTION |
|---|
| • Confirm that the phases and rated voltage of this product match those of the AC power supply, **as injury may result.**<br>• Do not connect the AC power supply to the output terminals (U, V, and W), **as injury may result.**<br>• Do not connect a braking resistor directly to the DC terminals (P(+) and N(–)), **as fire may result.**<br>• When using DC power input, ensure that the fan power switching connector (CNRXTX) is correctly engaged in the inverter **as a trouble may occur.**<br>• When using DC power input of 18.5kW or larger inverter, be sure to connect AC power to terminals R0 and T0 for a power supply of fan **as a trouble may occur.**<br>• Ensure that the noise generated by the inverter, motor, or wiring does not adversely affect peripheral sensors and equipment, **as accident may result.** |

# Introduction

## Instructions on operation

| ⚠WARNING |
|---|
| • Be sure to install the surface cover before turning on the power (closed). Do not remove the cover while power to the inverter is turned on.<br>**Electric shock may occur.**<br>• Do not operate switches with wet hands, **as electric shock may result.**<br>• When the retry function is selected, the inverter may restart automatically after tripping. (Design the machine to ensure personal safety in the event of restart)<br>**Accident may result.**<br>• When the torque limiting function is selected, operating conditions may differ from preset conditions (acceleration/deceleration time or speed). In this case, personal safety must be assured.<br>**Accident may result.**<br>• As the STOP key is effective only when a function setting has been established, install an emergency switch independently, and when an operation via the external signal terminal is selected, the STOP key on the keypad panel will be disabled.<br>**Accident may result.**<br>• As operations start suddenly if alarm is reset with a running signal input, confirm that no running signal is input before resetting alarm.<br>**Accident may result.**<br>• When an alarm is activated, the motor coasts. If the motor needs to be stopped in such a case, install a brake to the machine with the motor.<br>**Accident may result.**<br>• If AUTO RESTART is selected in the restart mode after momentary power failure (function code F14), the inverter restarts automatically starting the motor rotation when the power is recovered.<br>**Accident may result.**<br>• When the tuning (function code H01) is started, the motor, machine or equipment starts and stops repeatedly. Ensure safety before performing tuning.<br>**Accident may result.**<br>• If the user set the function codes wrongly or without completely understanding this user’s manual, the motor may rotate with a torque or at a speed not permitted for the machine.<br>**Accident or injury may result.**<br>• Do not touch inverter terminals when energized even if inverter has stopped.<br>**Electric shock may result.** |

| ⚠CAUTION |
|---|
| • Do not start or stop the inverter using the main circuit power.<br>**Failure may result.**<br>• Do not touch the heat sink or braking resistor because they become very hot.<br>**Burns may result.**<br>• As the inverter can set high speed operation easily, carefully check the performance of motor or machine before changing speed settings.<br>**Injury may result.**<br>• Do not use the inverter braking function for mechanical holding.<br>**Injury may result.**<br>• During pre-excitation, the speed adjuster does not function and the motor may be rotated by load disturbance. When using pre-excitation, therefore, also use the mechanical brake.<br>**Injury may result.**<br>• If improper data is set at the function code related with speed adjuster as in the case of setting high gain abruptly, the motor may hunt.<br>**Injury may result.** |

## Instructions on maintenance, inspection, and replacement

| ⚠WARNING |
| --- |
| • Wait a minimum of five minutes (15kW or less) or ten minutes (18.5kW or more) after power has been turned off (open) before starting inspection. (Also confirm that the charge lamp is off and that DC voltage between terminals P(+) and N(–) does not exceed 25V.)<br>**Electric shock may result.**<br>• Only authorized personnel should perform maintenance, inspection, and replacement operations. (Take off metal jewelry, such as watches and rings. Use insulated tools.)<br>**Electric shock or injury may result.** |

## Instructions on disposal

| ⚠CAUTION |
| --- |
| • Treat as industrial waste when disposing it.<br>**Injury may result.** |

## Other instructions

| ⚠WARNING |
| --- |
| • Never modify the product.<br>**Electric shock or injury may result.** |

## Conformity to Low Voltage Directive in Europe

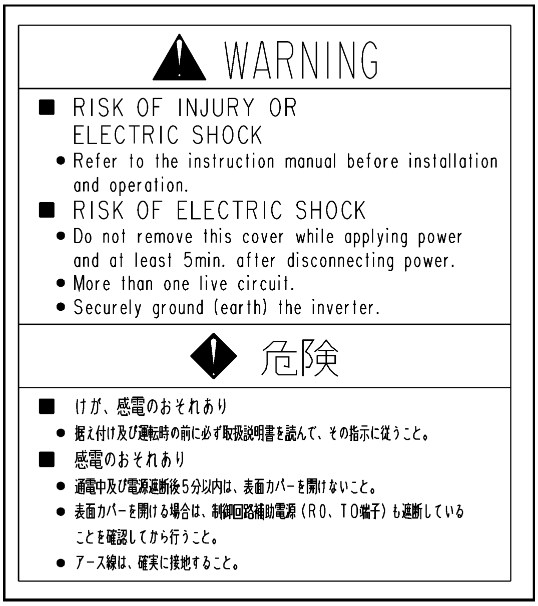
| ⚠CAUTION |
| --- |
| • The contact capacity of alarm output for any fault (30A, B, C) and relay signal output (Y5A, Y5C) is 0.5A at 48V DC.<br>• The inverter must be securely grounded. Besides installation of the earth leakage circuit breaker (ELCB), this grounding work is necessary for protection against electrical shock.<br>• Use a crimp terminal to connect a cable to the main circuit terminal or inverter ground terminal.<br>• Use a single cable to connect the ⏚ G inverter ground terminal. (Do not connect two or more cables to the inverter ground terminal.)<br>• Use a molded-case circuit breaker (MCCB) and magnetic contractor (MC) that conform to EN or IEC standards.<br>• Use the inverter under over-voltage category III conditions and maintain Pollution degree 2 or better as specified in IEC664. To maintain Pollution degree 2 or more, install the inverter in the control panel (IP54 or higher level) having structure free from water, oil, carbon, dust, etc.<br>• For the input-output wiring of the inverter, use cable (diameter and type) as specified in Appendix C in EN60204.<br>• To ensure safety, install an optional AC reactor, DC REACTOR, or external braking resistor as follows:<br>1) Install inside an IP4X cabinet or barrier if electrical parts are exposed.<br>2) Install inside an IP2X cabinet or barrier if electrical parts are not exposed. |

| General Instructions |
| --- |
| Although figures in this manual may show the inverter with covers and safety screens removed for explanation purposes, do not operate the device until all such covers and screens have been replaced. |

# Introduction

## Warning label positions

Inverter with a small capacity (15kW or lower)

WARNING

■ RISK OF INJURY OR ELECTRIC SHOCK
- Refer to the instruction manual before installation and operation.

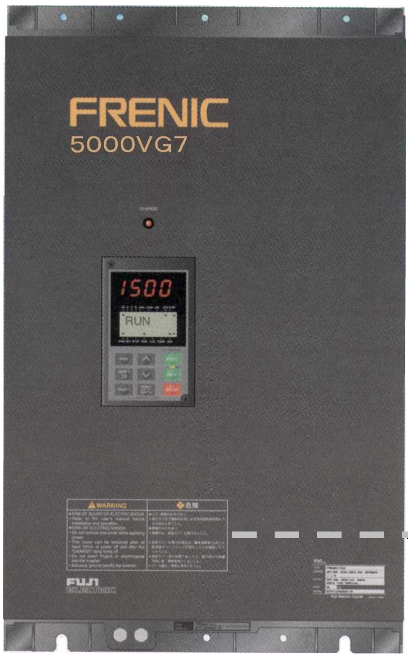
■ RISK OF ELECTRIC SHOCK
- Do not remove this cover while applying power and at least 5min. after disconnecting power.
- More than one live circuit.
- Securely ground (earth) the inverter.

危険

■ けが、感電のおそれあり
- 据え付け及び運転時の前に必ず取扱説明書を読んで、その指示に従うこと。

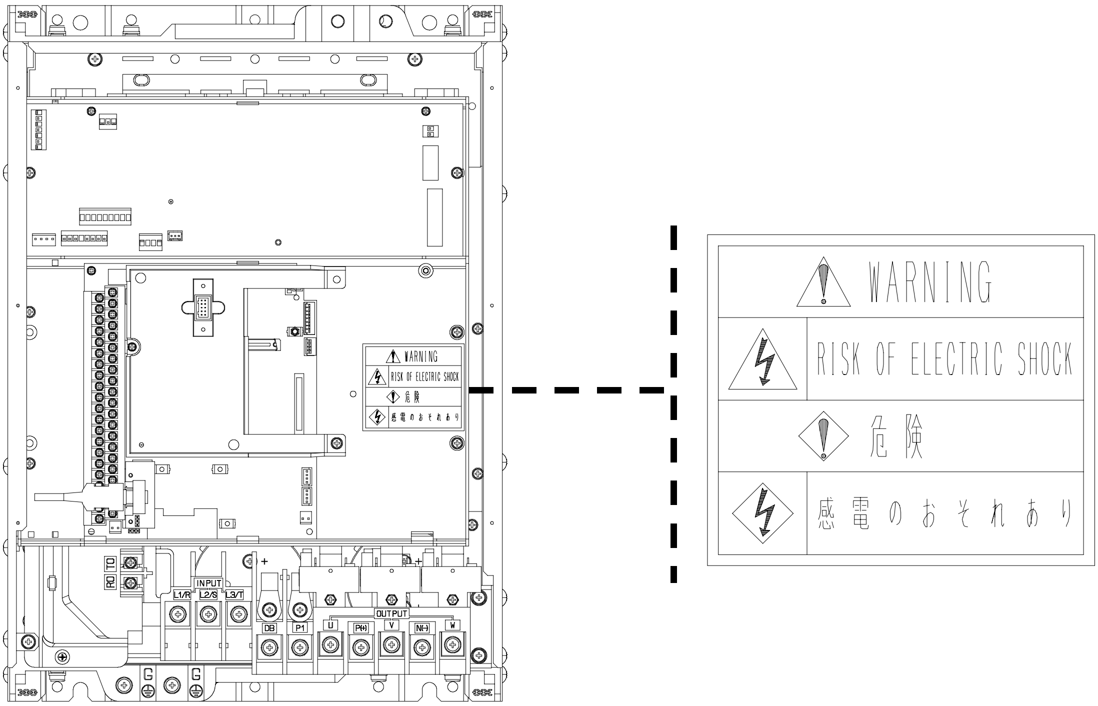
■ 感電のおそれあり
- 通電中及び電源遮断後5分以内は、表面カバーを開けないこと。
- 表面カバーを開ける場合は、制御回路補助電源（R0、T0端子）も遮断していることを確認してから行うこと。
- アース線は、確実に接地すること。

Inverter with a middle capacity (18.5kW or higher)




| WARNING | 危険 |
|---|---|
| ■ RISK OF INJURY OR ELECTRIC SHOCK<br>• Refer to the instruction manual before installation and operation.<br>■ RISK OF ELECTRIC SHOCK<br>• Do not remove this cover while applying power.<br>• This cover can be removed after at least 10min of power off and after the "CHARGE" lamp turns off.<br>• More than one live circuit.<br>• Do not insert fingers or anythingelse into the inverter.<br>• Securely ground (earth) the inverter. | ■ けが、感電のおそれあり<br>• 据え付け及び運転時の前に必ず取扱説明書を読んで、その指示に従うこと。<br>■ 感電のおそれあり<br>• 通電中は、表面カバーを開けないこと。<br>• 表面カバーを開ける場合は、電源遮断後１０分以上経過後チャージランプが消灯したのを確認してから行うこと。<br>• 表面カバーを開ける場合は、制御回路補助電源（R0、T0端子）も遮断していることを確認してから行うこと。<br>• 表面カバー取付状態であっても、開口部より装置内部に指・異物等挿入しないこと。<br>• アース線は、確実に接地すること。 |

Inside the inverter



# CONTENTS

THE INVERTER

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# Ⅰ. Vector Control Inverter System FRENIC5000VG7S

# 1. Vector Control Inverter System FRENIC5000VG7S

## 1.1 Outline

### 1.1.1 The Industry's Best Control Capability

- The multi-drive functions have vector control, sensorless vector control, V/f control and vector control for synchronous motors.
- Vector control with dedicated motors has attained the industry's best control capabilities such as; speed control accuracy of ±0.005%, speed response of 100Hz, current response of 800Hz and torque control accuracy (linearity) of ±3%.

### 1.1.2 System Integration

- UPAC, the optional card incorporating user-programmable functions, enables user-original system configuration and construction. Dedicated package software products are also available.
- The RS485 communication function is provided as standard and T-Link and SX bus communication functions are available as options.
- Inverter support loader for Windows is supplied to facilitate function code setting.

### 1.1.3 A Wealth of Integrated Functions

- The tuning function has been enhanced to optimally control different motors.
- Load vibration suppressing observer and load adaptive control functions are built in.
- Position control functions, such as zero speed locking control, have been upgraded.
- Position synchronization control using pulse train input is built in.
- Orientation control is available as an option.

### 1.1.4 A Wide Range of Capacities and Applications

- A single specification with a capacity range from 0.75kW to 400kW makes system construction simple.
- Optimal control is achieved with the CT use (constant torque) for 150% overload capability, the VT use (variable torque) for 110% overload capability and the HT use for 200%/170% overload torque.

### 1.1.5 Global Products

- A standard product that conforms to UL/cUL and CE marking, allowing unification of devices and machines made at home and abroad.
- The KEYPAD panel is set for 7 languages as standard to make exporting simple.
- Various options to connect to all types of the field bus are available

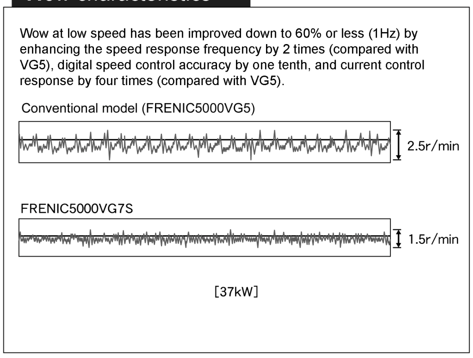
## 1.2 Features

High-performance vector control inverter capable of controlling motor speed and torque at will.

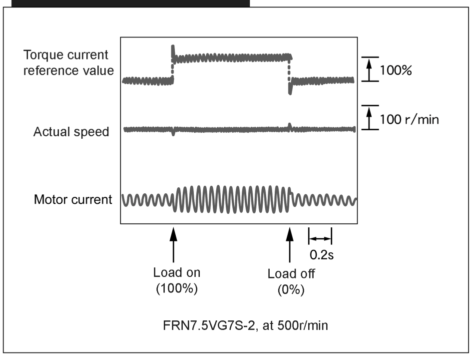
### 1.2.1 The Industry's Best Control Capability

- Speed control accuracy of ±0.005% (tested with a dedicated motor with PG under vector control: one half compared to our conventional model).
- Speed response of 100Hz (tested with a dedicated motor with PG under vector control: two times compared to our conventional model).
- Current response of 800Hz (tested with a dedicated motor with PG under vector control: four times compared to our conventional model).
- Torque control accuracy (linearity) of ±3%.

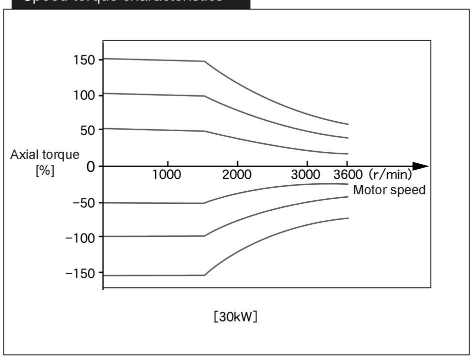
Wow characteristics



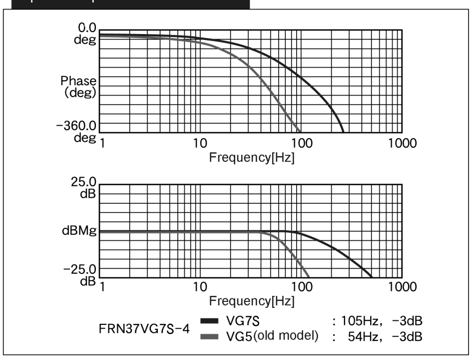

Follow-up characteristics under impact load




Speed-torque characteristics




Speed response characteristics




### 1.2.2 Use with Different Control Types (Multi-drive Function)

- You can select from four types of control for different motors; vector control, senserless vector control, V/f control for induction motors, and vector control for synchronous motors (optional card required).

### 1.2.3 A Wide Range of Capacity/flexible Applications

- Simple system construction based on a single specification with a capacity range from 0.75kW to 400kW.
- A standard product that meets three specifications.

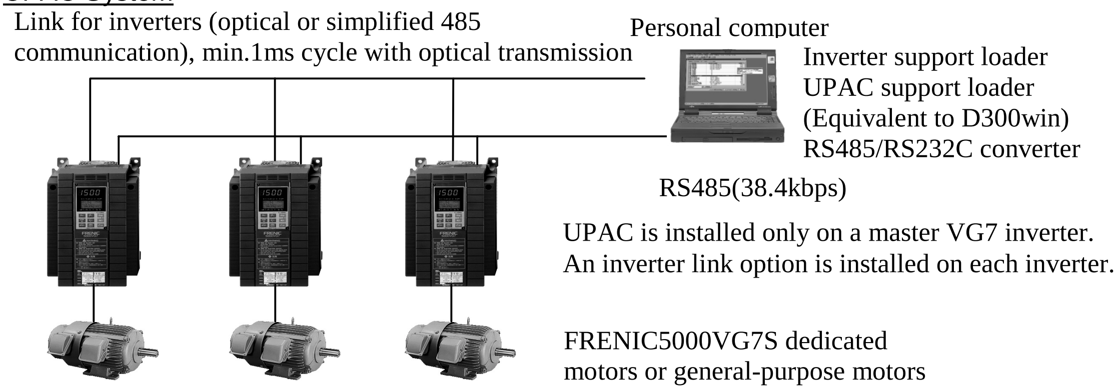
| Specification type | Overload | Main application | Carrier frequency |
|---|---|---|---|
| CT | 150% | Constant torque applications | High frequency |
| VT(*) | 110% | Variable torque applications | Low frequency |
| HT | 200% / 170% | Vertical transfer applications | High frequency |

(*) One class smaller model applicable.

## 1.2.4 Built-in User-programmable Functions (Option as UPAC)

- Users can personalize inverter control and terminal functions in order to build an original system using the programmable functions of UPAC (User Programmable Application Card).
- Dedicated package software products for tension control, dancer control and position control are provided (available soon).

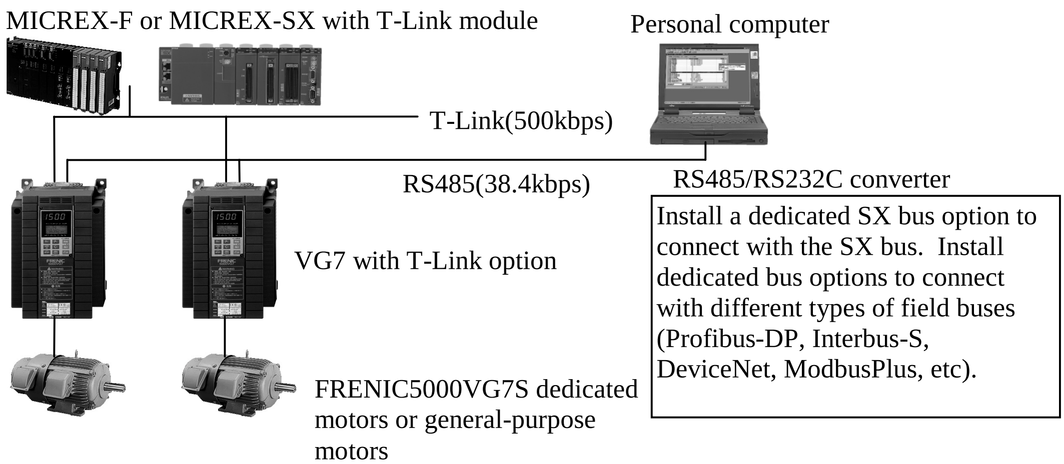
UPAC System




## 1.2.5 Enhanced Network Readiness

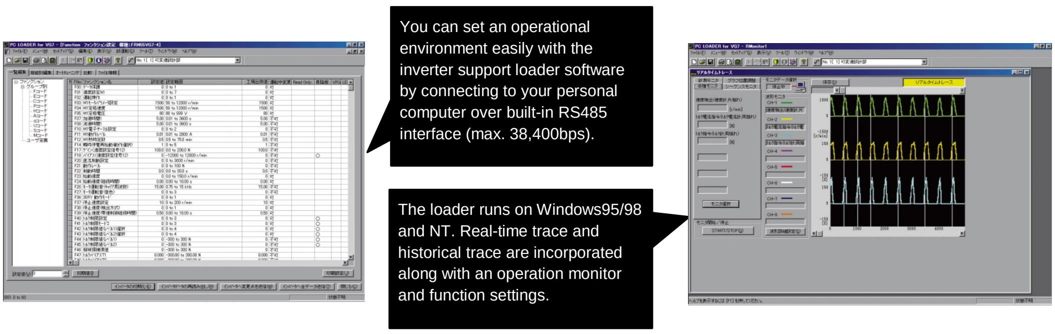
- The RS485 communication function is provided as standard, and the T-Link and SX bus (available soon) functions are provided as options.
- Different field bus types (Profibus-DP, DeviceNet, Interbus-S, ModbusPlus, and CAN Open) can also be used (available soon).

T-Link System




## 1.2.6 Inverter Support Loader Provided

- An inverter support loader for Windows is available as an option to facilitate function code setting.



## 1.2.7 Enhanced Built-in Functions

- Improved tuning function
  Motor parameters can be tuned while the motor is stopped.
- Built-in observer function for load vibration suppressing
- Equipped with load adaptive control function
  Steeples variable double-speed control is possible at low speed.
- Increased position control
  - Zero-speed locking control is possible.
  - Position synchronizing control with pulse train input is possible as an option (available soon).
  - Orientation control is possible as an option (available soon).
- Vector control is applicable to two types of motors. Also, V/f control is applicable to the third motor.
- Built-in braking unit
  Built-in braking unit for 55kW or smaller models (200V series) and for 110kW or smaller models (400V series) allows for downsizing machines and devices.
- 23 I/O terminal points

| | Input | Output |
|---|---|---|
| Analog | 3 points | 3 points |
| Digital | 11 points | 6 points |

- Built-in PG feedback card
  - Both 12V and 15V voltage inputs are accepted.
  - The card can handle line drivers as an option (available soon).

## 1.2.8 Upgraded Maintenance/protective Functions

- I/O terminal checking function
- Main circuit capacitor life judgment
- Inverter load factor measure
- Records and displays accumulated operation time
- Displays operating conditions, such as output voltage, heat sink temperature and calculated torque value
- Detailed data is recorded on the inverter trip
- Setting the thermal time constant of the electronic thermal overload relay makes different motors applicable.
- Standard protective function against input phase loss. Protects the inverter from damage caused by power line disconnection
- Motor protection with PTC thermistor
- Equipped with terminals for connecting DC REACTOR that can suppress harmonics

## 1.2.9 Interactive KEYPAD Panel for Simple Operation

- Standard copy function
- Easily copies function code data to other inverters.
- Remote operation capability
- The KEYPAD panel is detachable for remote operation using an optional cable.
- 7 standard language operation (English, German, French, Italian, Spanish, Chinese and Japanese)
- Jogging operation from the KEYPAD panel or with input from an external signal
- Switching between KEYPAD operations (LOCAL) and external signal input operations (REMOTE) using the KEYPAD panel


## 1.2.10 Conformity to World Standards

- Standard conformity to EC Directive (CE marking), UL and cUL standards
- (application pending) enables unification of specifications at home and abroad
- Conforms to the European EMC Directive with optional EMC filters

| Europe | North America/Canada |
|---|---|
| EC Directive (CE marking) | UL and cUL standards |
| CE | c UL us LISTED |

# 1.3 Control Systems

## 1.3.1 Features and Applications of Different Control Systems

The AC motor control inverters are most widely used for controlling the rotational speed of the load. This subsection describes the basic configuration and features of different speed control systems and tips for using them for various applications.

The speed control systems are roughly divided into open loop and closed loop types (see Figure 1-3-1).

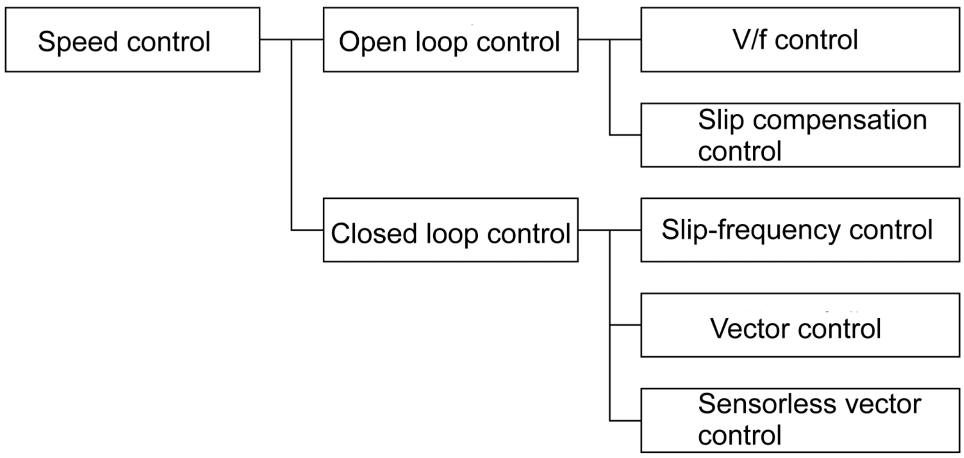



Figure 1-3-1 Speed Control Systems

### 1.3.1.1 Open Loop Speed Control System

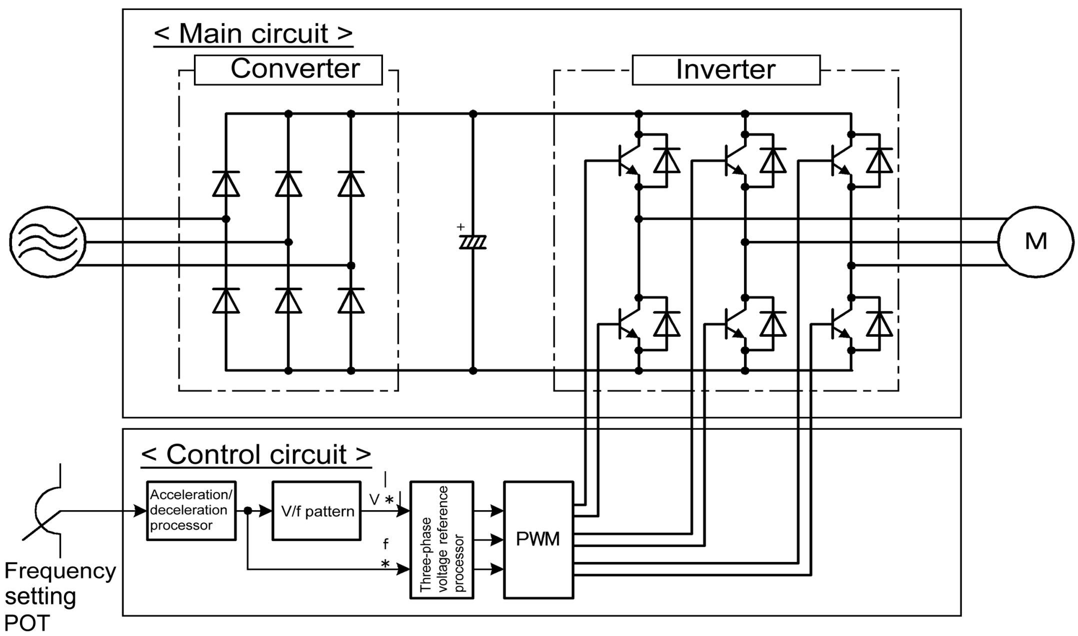



Figure 1-3-2 Basic Configuration of Open Loop Speed Control System

As recognized from the basic configuration of the open loop control system in Figure 1-3-2, the speed information is not fed back to the system and the rotational speed of the load is controlled according to the frequency applied by the inverter. As shown in Figure 1-3-3, the induction motor speed is almost constant against the torque variation at each of frequency levels $f_1$ to $f_6$. This means that, with constant voltage and frequency applied to the motor, the motor speed remains almost unchanged if the load torque changes. For example, the slip is less than 10% at the rated torque. In other words, to control the motor speed by changing the inverter output frequency, the ratio control of motor terminal voltage to applied frequency, V/f control is used.

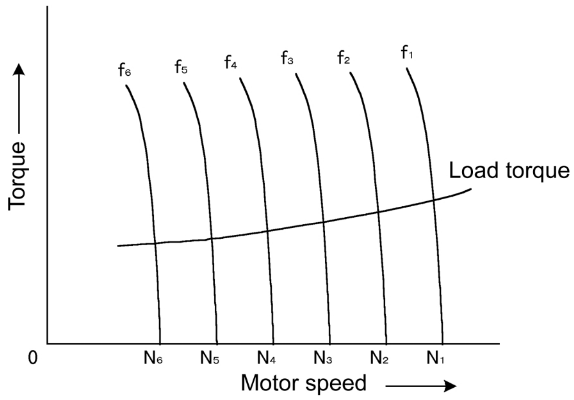



Figure 1-3-3 Motor Speed vs Torque

The open loop control system does not need any speed sensor and is primarily used for general-purpose inverters. This system is suitably used for changing the speeds of existing motors and for variable torque loads not requiring so quick a response such as fans and pumps.

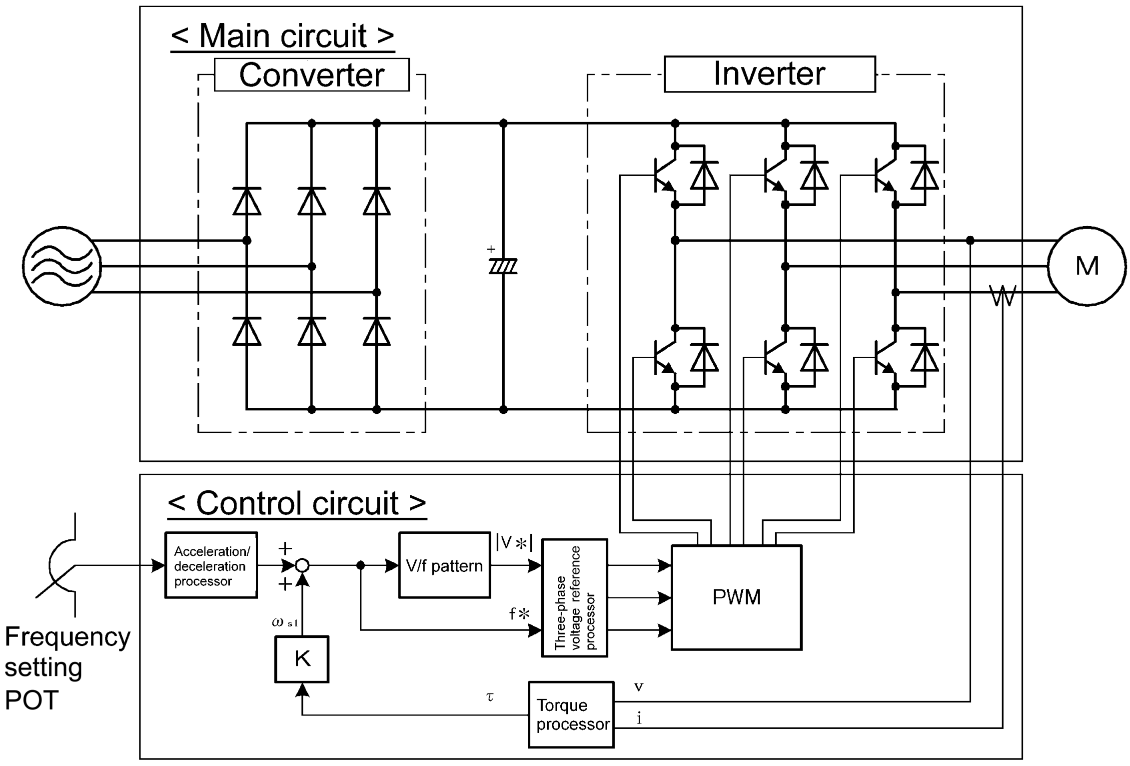



Figure 1-3-4 Slip Compensation Speed Control System

The motor speed accuracy guaranteed by the open loop speed control system depends on the load torque variation, output frequency accuracy, supply voltage variation, etc. The 'slip compensation speed control' is provided to maintain the motor speed against the torque variation by adjusting the inverter output frequency according to the output torque calculated from the motor terminal voltage and primary current as shown in Figure 1-3-4.

## 1.3.1.2 Closed Loop Speed Control Systems

The closed loop speed control system compensates for speed variation according to the speed information fed back to the system.
This system ensures a very precise speed control based on the actual rotational speed of the load under control and applies to paper machines and machine tools.

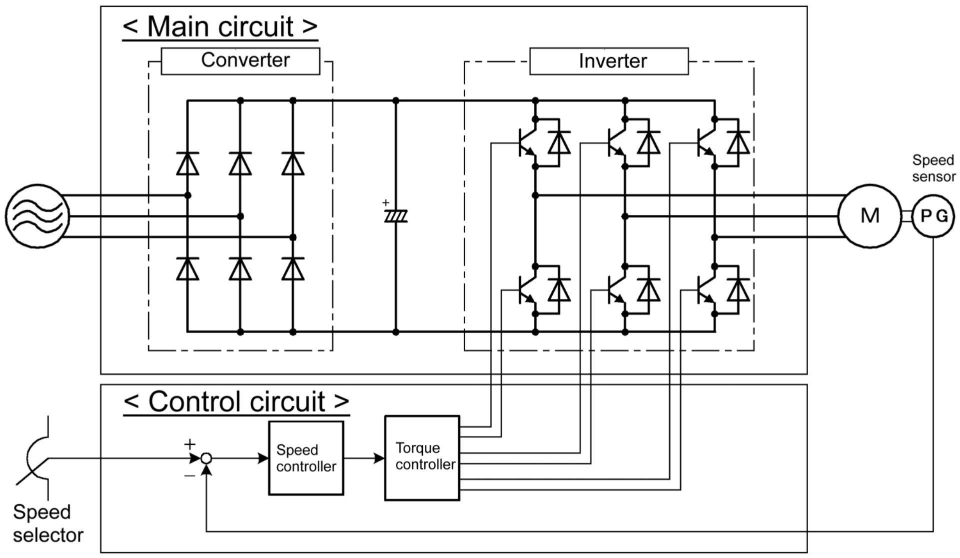



Figure 1-3-5 Basic Configuration of Closed Loop Speed Control System

The basic configuration of the closed loop speed control system is shown in Figure 1-3-5. The speed information is fed back from a speed sensor such as pulse encoder (PG) and compared with the speed reference to control the inverter output frequency so that the speed reference will agree to the speed sensor reading.
The slip-frequency, vector, or sensorless vector control system is used for speed control. A brief description of each control system is given below.
The FRENIC 5000VG7S series high-performance vector control inverters use a closed loop vector control system for speed control.

(1) Slip-frequency Control System

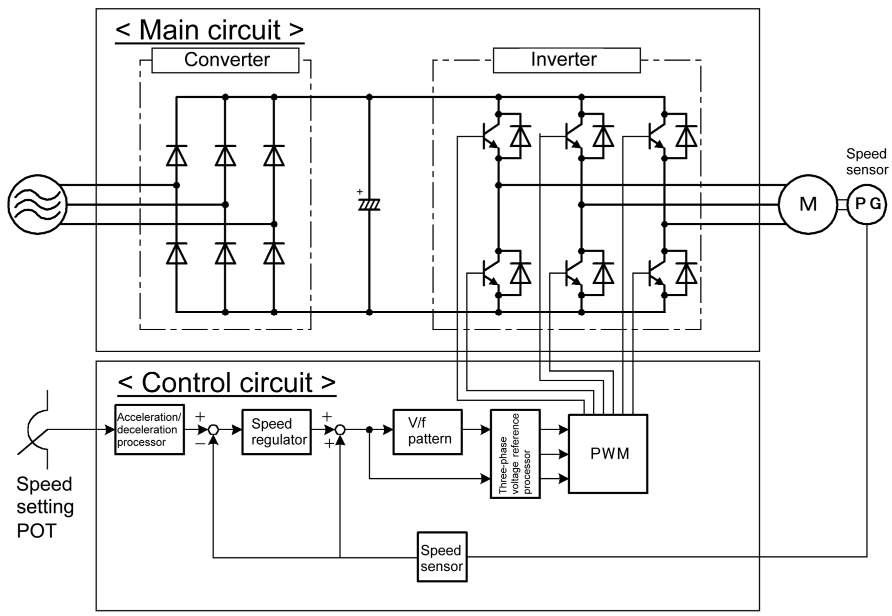



Figure 1-3-6 Configuration of Slip-frequency Control System

The configuration of the slip-frequency control system is shown in Figure 1-3-6. The speed regulator outputs a slip-frequency corresponding to the load and compensates for speed variation by adding to the actual speed. This control system is relatively simple and, therefore, used for the speed control system of general-purpose inverters. As it is based on the V/f control, however, it is not suitable for applications requiring a quick response.

(2) Vector Control system

The vector control system ensures a quick response from an AC motor. This system controls the primary current of the AC motor as divided into magnetic flux and torque components to provide a control performance equivalent to that as would be obtained with DC motors.
Compared with the V/f control system, the vector control system has the following features and is suitable for applications requiring a quick response and high precision.

1) An excellent acceleration/deceleration performance
2) A wider speed control range
3) The torque can be controlled.
4) A quick control response

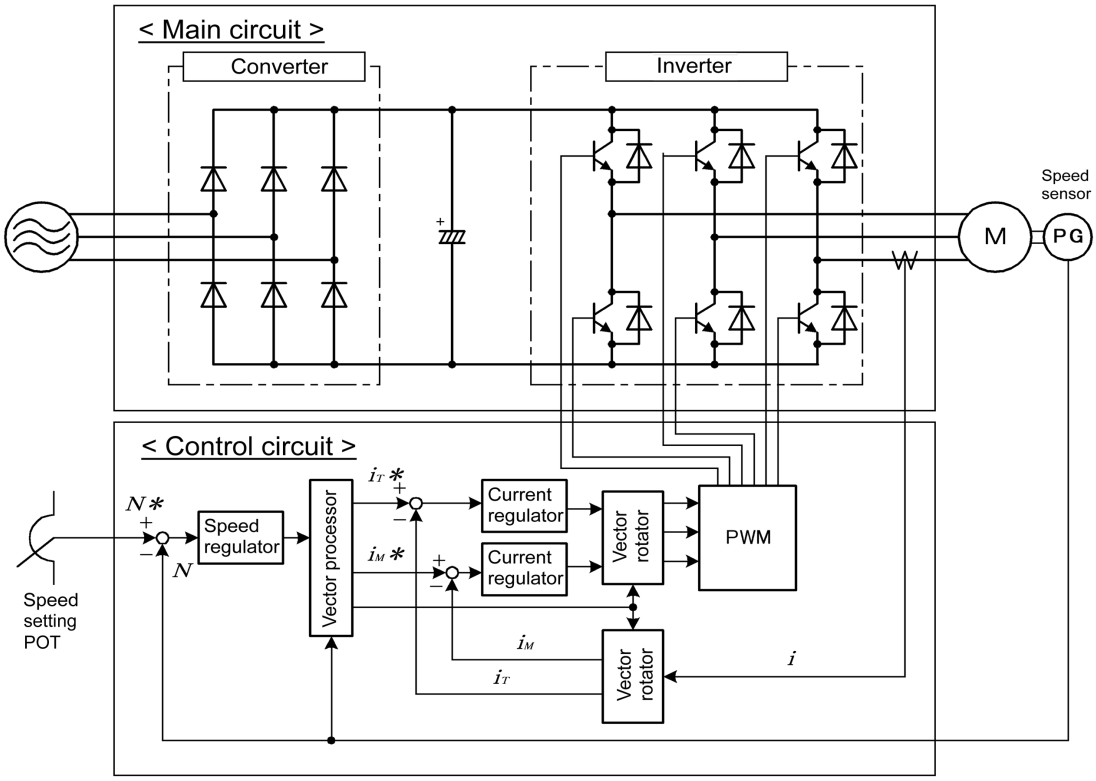



Figure 1-3-7 Example of Configuration of Vector Control System

An example of configuration of the vector control system is given in Figure 1-3-7. The motor parameters are used by the vector processor and, therefore, the performance greatly depends on the parameter detection accuracy. The parameter variation due to the changing ambient conditions also affects the performance in a significant manner. Because of its complexity, this system is mostly used as a combination of dedicated inverter and dedicated motor.

(3) Sensorless Vector Control System

The vector control system ensures a quick response and high accuracy but requires a speed sensor, which may cause a problem when installed or wired. On the other hand, the sensorless vector control system does not require any sensor although it is slightly inferior in performance. This system estimates the motor speed from the motor terminal voltage and primary current and controls the speed using the estimated speed as speed feedback signal.

An example of configuration of the sensorless vector system is given in Figure 1-3-8.

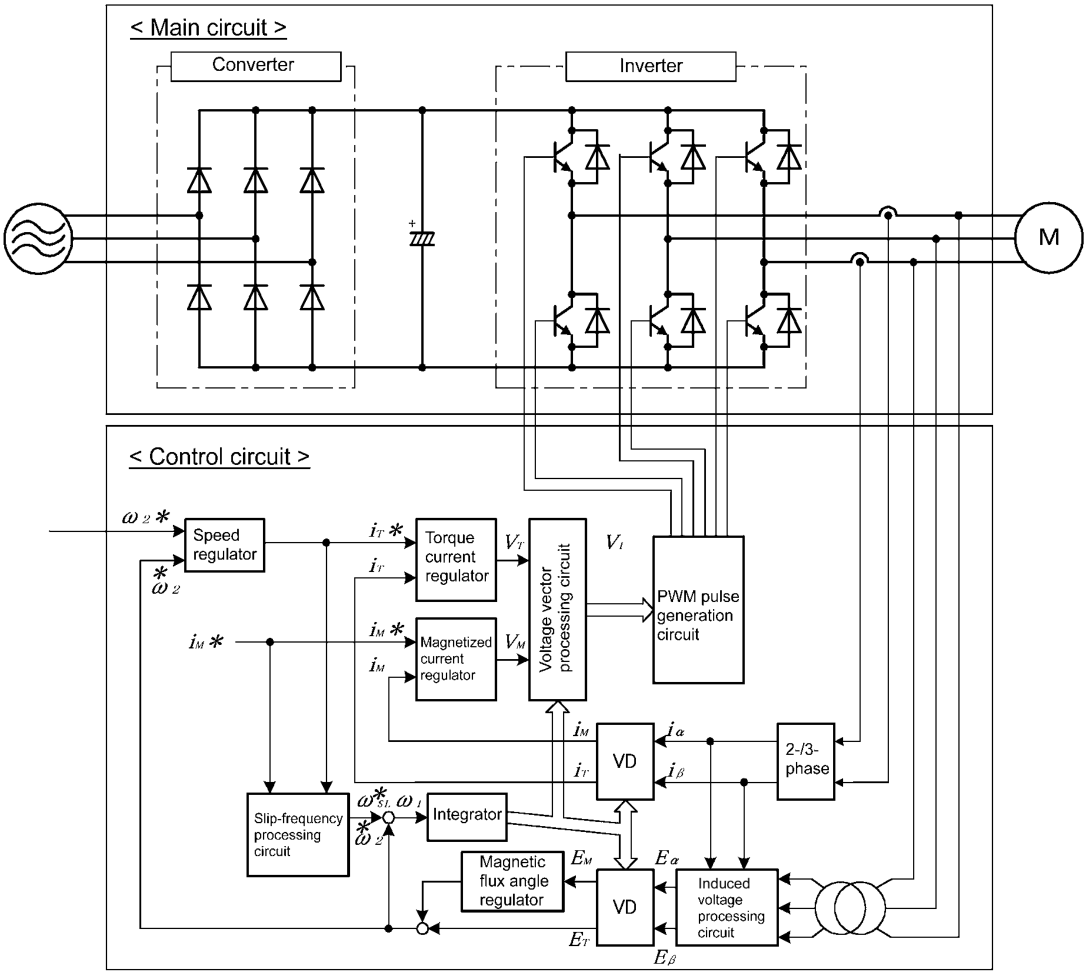



Figure 1-3-8 Example of Construction of Sensorless Vector Control System

The FRENIC 5000VS7S series can also be combined with a general-purpose motor but with a lower control performance than combined with a dedicated motor.

- MEMO -

THE INVERTER

# Ⅱ. Specifications

# 2. Specifications

## 2.1 Standard Specifications

### 2.1.1 CT Use (For Constant Torque, Overload Capability: 150%– 1min.)

● Three-phase 200V series

| Type FRN□VG7S-2 | | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal applied motor [kW] | | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| Rated capacity [kVA] (*1) | | 1.9 | 3.0 | 4.1 | 6.8 | 10 | 14 | 18 | 24 | 28 | 34 | 44 | 55 | 68 | 81 | 107 | 131 |
| Rated current | (Continuous) | 5 | 8 | 11 | 18 | 27 | 37 | 49 | 63 | 74 | 90 | 116 | 145 | 180 | 215 | 283 | 346 |
| | (1min.) | 7.5 | 12 | 16.5 | 27 | 40.5 | 55.5 | 73.5 | 94.5 | 111 | 135 | 174 | 217.5 | 270 | 333 | 441 | 519 |
| Input ratings | Phase, Voltage, Frequency | 3-phase 200 to 230V, 50Hz/60Hz | | | | | | | | 3-phase 200 to 220V/50Hz, 200 to 230V/60Hz (*2) | | | | | | | |
| Input ratings | Voltage/frequency variation | Voltage: +10 to –15%, Frequency: +5 to –5%, Voltage,.3 unbalance: 2% or less (*3) | | | | | | | | | | | | | | | |
| Input ratings | Momentary voltage dip capability (*4) | When voltage drops from the rated voltage, the inverter will continue operation if the voltage is more than 165V. If the voltage is less than 165V, the inverter can be operated for 15ms. | | | | | | | | | | | | | | | |
| Input ratings | Rated current [A] (*7) (with DCR) | 3.1 | 5.7 | 8.3 | 14.0 | 19.7 | 26.9 | 39.0 | 54.0 | 66.2 | 78.8 | 109 | 135 | 163 | 199 | 272 | 327 |
| Input ratings | Rated current [A] (*7) (without DCR) | 6.4 | 11.1 | 16.1 | 25.5 | 40.8 | 52.6 | 76.9 | 98.5 | 117 | 136 | 168 | 204 | 243 | 291 | – | – |
| Input ratings | Required power supply capacity [kVA] (*5) | 1.1 | 2.0 | 2.9 | 4.9 | 6.9 | 9.4 | 14 | 19 | 23 | 28 | 38 | 47 | 57 | 69 | 95 | 114 |
| Braking method /braking torque | | Braking resistor discharge control: 150% braking torque, Separately installed braking resistor (option), Separately installed braking unit(option for 75KW or more) | | | | | | | | | | | | | | | |
| Carrier frequency [kHz] (*6) | | 0.75 to 15 | | | | | | | | | | | | | | 0.75 to 10 | |
| Mass [kg] | | 7 | 7 | 7 | 8 | 8 | 8 | 12.5 | 12.5 | 25 | 25 | 30 | 37 | 46 | 48 | 70 | 115 |
| Enclosure | | IP20 | | | | | | | | IP00(IP20:option) | | | | | | | |

*1) Inverter output capacity [kVA] at 220V.
*2) Order individually for 220 to 230V/50Hz.
*3) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same as for FUJI's conventional models).
Voltage unbalance [%] = (Max. voltage [V] − Min. voltage [V])/Three-phase average voltage [V] × 67
*4) Tested at the standard load condition (85% load of nominal applied motor) prescribed by JEMA.
*5) When power-factor correcting DC REACTOR is used. (Optional for 55kW or less model).
*6) The inverter may automatically reduce carrier frequency in accordance with ambient temperature or output current in order to protect itself.
*7) This value is obtained by using a FUJI original calculation method.
*8) Use the function code F80 to switch between CT, VT and HT uses.

● Three-phase 400V series

| Type FRN□VG7S-4 | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 | 160 | 200 | 220 | 280 | 315 | 355 | 400 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal applied motor [kW] | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 | 160 | 200 | 220 | 280 | 315 | 355 | 400 |
| Rated capacity [kVA] (*1) | | 6.8 | 10 | 14 | 18 | 24 | 29 | 34 | 45 | 57 | 69 | 85 | 114 | 134 | 160 | 192 | 231 | 287 | 316 | 396 | 445 | 495 | 563 |
| Rated current | (Continuous) | 9.0 | 13.5 | 18.5 | 24.5 | 32.0 | 39.0 | 45.0 | 60.0 | 75.0 | 91.0 | 112 | 150 | 176 | 210 | 253 | 304 | 377 | 415 | 520 | 585 | 650 | 740 |
| | (1min.) | 13.5 | 20.0 | 27.5 | 36.5 | 48.0 | 58.5 | 67.5 | 90.0 | 113 | 137 | 168 | 225 | 264 | 315 | 380 | 456 | 566 | 623 | 780 | 878 | 975 | 1110 |
| Input ratings | Phase, Voltage, Frequency | 3-phase 380 to 480V, 50Hz/60Hz | | | | | 3-phase 380 to 440V/50Hz, 380 to 480V/60Hz (*8) | | | | | | | | | | | | | | | | |
| Input ratings | Voltage/frequency variation | Voltage: +10 to –15%, Frequency: +5 to –5%, Voltage unbalance: 2% or less (*2) | | | | | | | | | | | | | | | | | | | | | |
| Input ratings | Momentary voltage dip capability (*3) | When voltage drops from the rated voltage, the inverter will continue operation if the voltage is more than 310V. If the voltage is less than 310V, the inverter can be operated for 15ms. | | | | | | | | | | | | | | | | | | | | | |
| Input ratings | Rated current [A] (*6) (with DCR) | 7.1 | 10 | 13.5 | 19.8 | 26.8 | 33.2 | 39.3 | 54 | 67 | 81 | 100 | 134 | 160 | 196 | 232 | 282 | 352 | 385 | 491 | 552 | 624 | 704 |
| Input ratings | Rated current [A] (*6) (without DCR) | 14.9 | 21.5 | 27.9 | 39.1 | 50.3 | 59.9 | 69.3 | 86 | 104 | 124 | 150 | – | – | – | – | – | – | – | – | – | – | – |
| Input ratings | Required power supply capacity [kVA] (*4) | 5.0 | 7.0 | 9.4 | 14 | 19 | 24 | 28 | 38 | 47 | 57 | 70 | 93 | 111 | 136 | 161 | 196 | 244 | 267 | 341 | 383 | 432 | 488 |
| Braking method/braking torque | | Braking resistor discharge control: 150% braking torque, Separately installed braking resistor (option), Separately installed braking unit (option for 132kW or more) | | | | | | | | | | | | | | | | | | | | | |
| Carrier frequency [kHz] (*5) | | 0.75 to 15 | | | | | | | | | | | 0.75 to 10 | | | | | | | | | | |
| Mass [kg] | | 8 | 8 | 8 | 12.5 | 12.5 | 25 | 25 | 30 | 35 | 40 | 41 | 50 | 72 | 72 | 100 | 100 | 140 | 140 | 250 | 250 | 360 | 360 |
| Enclosure | | IP20 | | | | | IP00 (IP20: option) | | | | | | | | | | | | | | | | |

*1) Inverter output capacity [kVA] at 440V.
*2) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same as for FUJI's conventional models).
Voltage unbalance [%] = (Max. voltage [V] − Min. voltage [V])/Three-phase average voltage [V] × 67
*3) Tested at the standard load condition (85% load of nominal applied motor) prescribed by JEMA.
*4) When power-factor correcting DC REACTOR is used. (Optional for 55kW or less model)
*5) The inverter may automatically reduce carrier frequency in accordance with ambient temperature or output current in order to protect itself.
*6) This value is obtained by using a FUJI original calculation method.
*7) Use the function code F80 to switch between CT, VT and HT uses.
*8) When the input voltage is 380 to 398V/50Hz or 380 to 430V/60Hz, a connector inside the inverter must be switched.

## 2.1.2 VT Use (For Variable Torque, Overload Capability: 110%– 1min.)

### ● Three-phase 200V series

| Type FRN☐VG7S-2 | | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal applied motor [kW] | | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 |
| Rated capacity [kVA] (*1) | | 3.0 | 4.1 | 6.8 | 10 | 14 | 18 | 24 | 28 | 34 | 44 | 55 | 68 | 81 | 107 | 131 | 158 |
| Rated current (Continuous) | | 8 | 11 | 18 | 27 | 37 | 49 | 63 | 74 | 90 | 116 | 145 | 180 | 215 | 283 | 346 | 415 |
| Rated current (1min.) | | 8.8 | 12.1 | 19.8 | 29.7 | 40.7 | 53.9 | 69.3 | 81.4 | 99 | 128 | 160 | 198 | 237 | 311 | 381 | 457 |
| Input ratings | Phase, Voltage, Frequency | 3-phase 200 to 230V, 50Hz/60Hz | | | | | | | | 3-phase 200 to 220V/50Hz, 200 to 230V/60Hz (*2) | | | | | | | |
| Input ratings | Voltage/frequency variation | Voltage: +10 to –15%, Frequency: +5 to –5%, Voltage unbalance: 2% or less (*3) | | | | | | | | | | | | | | | |
| Input ratings | Momentary voltage dip capability (*4) | When voltage drops from the rated voltage, the inverter will continue operation if the voltage is more than 165V. If the voltage is less than 165V, the inverter can be operated for 15ms. | | | | | | | | | | | | | | | |
| Input ratings | Rated current [A] (*7) (with DCR) | 5.7 | 8.3 | 14.0 | 19.7 | 26.9 | 39.0 | 54.0 | 66.2 | 78.8 | 109 | 135 | 163 | 199 | 272 | 327 | 400 |
| Input ratings | Rated current [A] (*7) (without DCR) | 11.1 | 16.1 | 25.5 | 40.8 | 52.6 | 76.9 | 98.5 | 117 | 136 | 168 | 204 | 243 | 291 | – | – | – |
| Input ratings | Required power supply capacity [kVA] (*5) | 2.0 | 2.9 | 4.9 | 6.9 | 9.4 | 14 | 19 | 23 | 28 | 38 | 47 | 57 | 69 | 95 | 114 | 139 |
| Braking method/braking torque | | Braking resistor discharge control: 110% braking torque, Separately installed braking resistor (option), Separately installed braking unit (option for 75kW or more) | | | | | | | | | | | | | | | |
| Carrier frequency [kHz] (*6) | | 0.75 to 10 | | | | | | | | | | | | | | 0.75 to 6 | |
| Mass [kg] | | 7 | 7 | 7 | 7 | 8 | 8 | 12.5 | 12.5 | 25 | 25 | 30 | 37 | 46 | 48 | 70 | 115 |
| Enclosure | | IP20 | | | | | | | | IP00 (IP20: option) | | | | | | | |

*1) Inverter output capacity [kVA] at 220V.
*2) Order individually for 220 to 230V/50Hz.
*3) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same as for FUJI's conventional models).
Voltage unbalance [%] = (Max. voltage [V] − Min. voltage [V])/Three-phase average voltage [V] × 67
*4) Tested at the standard load condition (85% load of nominal applied motor) prescribed by JEMA.
*5) When power-factor correcting DC REACTOR is used. (Optional for 55kW or less model)
*6) The inverter may automatically reduce carrier frequency in accordance with ambient temperature or output current in order to protect itself.
*7) This value is obtained by using a FUJI original calculation method.
*8) Use the function code F80 to switch between CT, VT and HT uses.

### ● Three-phase 400V series

| Type FRN☐VG7S-4 | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 | 160 | 200 | 220 | 280 | 315 | 355 | 400 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal applied motor [kW] | | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 | 160 | 200 | 220 | 280 | 315 | 355 | 400 | 500 |
| Rated capacity [kVA] (*1) | | 10 | 14 | 18 | 24 | 29 | 34 | 45 | 57 | 69 | 85 | 114 | 134 | 160 | 192 | 231 | 287 | 316 | 396 | 445 | 495 | 563 | 731 |
| Rated current (Continuous) | | 13.5 | 18.5 | 24.5 | 32.0 | 39.0 | 45.0 | 60.0 | 75.0 | 91.0 | 112 | 150 | 176 | 210 | 253 | 304 | 377 | 415 | 520 | 585 | 650 | 740 | 960 |
| Rated current (1min.) | | 14.9 | 20.4 | 27 | 35.2 | 42.9 | 49.5 | 66 | 82.5 | 100 | 123 | 165 | 194 | 231 | 278 | 334 | 415 | 457 | 583 | 655 | 737 | 847 | 1056 |
| Input ratings | Phase, Voltage, Frequency | 3-phase 380 to 480V, 50Hz/60Hz | | | | | 3-phase 380 to 440V/50Hz, 380 to 480V/60Hz (*8) | | | | | | | | | | | | | | | | |
| Input ratings | Voltage/frequency variation | Voltage: +10 to –15%, Frequency: +5 to –5%, Voltage unbalance: 2% or less (*2) | | | | | | | | | | | | | | | | | | | | | |
| Input ratings | Momentary voltage dip capability (*3) | When voltage drops from the rated voltage, the inverter will continue operation if the voltage is more than 310V. If the voltage is less than 310V, the inverter can be operated for 15ms. | | | | | | | | | | | | | | | | | | | | | |
| Input ratings | Rated current [A] (*6) (with DCR) | 10 | 13.5 | 19.8 | 26.8 | 33.2 | 39.3 | 54 | 67 | 81 | 100 | 134 | 160 | 196 | 232 | 282 | 352 | 385 | 491 | 552 | 624 | 704 | 880 |
| Input ratings | Rated current [A] (*6) (without DCR) | 21.5 | 27.9 | 39.1 | 50.3 | 59.9 | 69.3 | 86 | 104 | 124 | 150 | – | – | – | – | – | – | – | – | – | – | – | – |
| Input ratings | Required power supply capacity [kVA] (*4) | 7.0 | 9.4 | 14 | 19 | 24 | 28 | 38 | 47 | 57 | 70 | 93 | 111 | 136 | 161 | 196 | 244 | 267 | 341 | 383 | 432 | 488 | 610 |
| Braking method/braking torque | | Braking resistor discharge control: 110% braking torque, Separately installed braking resistor (option), Separately Installed braking unit (option for 132KW or more) | | | | | | | | | | | | | | | | | | | | | |
| Carrier frequency [kHz] (*5) | | 0.75 to 10 | | | | | | | | | | | 0.75 to 6 | | | | | | | | | | |
| Mass [kg] | | 8 | 8 | 8 | 12.5 | 12.5 | 25 | 25 | 30 | 35 | 40 | 41 | 50 | 72 | 72 | 100 | 100 | 140 | 140 | 250 | 250 | 360 | 360 |
| Enclosure | | IP20 | | | | | IP00 (IP20: option) | | | | | | | | | | | | | | | | |

*1) Inverter output capacity [kVA] at 440V
*2) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same as for FUJI's conventional models).
Voltage unbalance [%] = (Max. voltage [V] − Min. voltage [V])/Three-phase average voltage [V] × 67
*3) Tested at the standard load condition (85% load of nominal applied motor) prescribed by JEMA.
*4) When power-factor correcting DC REACTOR is used. (Optional for 55kW or less model)
*5) The inverter may automatically reduce carrier frequency in accordance with ambient temperature or output current in order to protect itself.
*6) This value is obtained by using a FUJI original calculation method.
*7) Use the function code F80 to switch between CT, VT and HT uses.
*8) When the input voltage is 380 to 398V/50Hz or 380 to 430V/60Hz, a connector inside the inverter must be switched.

# 2. Specifications

## 2.1.3 HT Use (For Vertical Transfer Application, Overload Torque: 200%/170%– 10s)

### ● Three-phase 200V series

| Type FRN☐VG7S-2 | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal applied motor [kW] | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 |
| Rated capacity [kVA] (*1) | | 6.8 | 10 | 14 | 18 | 24 | 28 | 34 | 44 | 55 | 68 | 81 |
| Rated current (*2) | (Continuous) | 18 | 27 | 37 | 49 | 63 | 74 | 90 | 116 | 145 | 180 | 215 |
| | (1min.) | 27 | 40.5 | 55.5 | 73.5 | 94.5 | 111 | 135 | 174 | 217.5 | 270 | 333 |
| | (10s) | 32.4 | 45.7 | 63.3 | 85.8 | 111 | 142 | 170 | 194 | 246 | 290 | 360 |
| Input ratings | Phase, Voltage, Frequency | 3-phase 200 to 230V, 50Hz/60Hz | | | | | 3-phase 200 to 220V/50Hz, 200 to 230V/60Hz (*3) | | | | | |
| | Voltage/frequency variation | Voltage: +10 to –15%, Frequency: +5 to –5%, Voltage unbalance: 2% or less (*4) | | | | | | | | | | |
| | Momentary voltage dip capability (*5) | When voltage drops from the rated voltage, the inverter will continue operation if the voltage is more than 165V. If the voltage is less than 165V, the inverter can be operated for 15ms. | | | | | | | | | | |
| | Rated current [A] (*8) (with DCR) | 14.0 | 19.7 | 26.9 | 39.0 | 54.0 | 66.2 | 78.8 | 109 | 135 | 163 | 199 |
| | Rated current [A] (*8) (without DCR) | 25.5 | 40.8 | 52.6 | 76.9 | 98.5 | 117 | 136 | 168 | 204 | 243 | 291 |
| | Required power supply capacity [kVA] (*6) | 4.9 | 6.9 | 9.4 | 14 | 19 | 23 | 28 | 38 | 47 | 57 | 69 |
| Carrier frequency [kHz] (*7) | | 0.75 to 15 | | | | | | | | | | |
| Mass [kg] | | 8 | 8 | 8 | 12.5 | 12.5 | 25 | 25 | 30 | 37 | 46 | 48 |
| Enclosure | | IP20 | | | | | IP00 (IP20: option) | | | | | |
| Torque | Continuous [%] (*9) | 100% | | | | | | | | | | |
| | 1min. rating [%] (*9) | 150% | | | | | | | | | | |
| | 10s rating [%] (*9) | 200% (at 80% or less of rated speed)/170% (at rated speed) | | | | | | | 170% | | | |
| Braking method/braking torque | | Braking resistor discharge control: 150% braking torque, Separately installed braking resistor (option) | | | | | | | | | | |

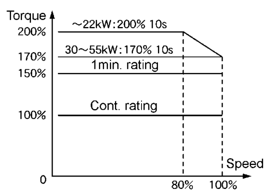
*1) Inverter output capacity [kVA] at 220V.
*2) Select the inverter capacity such that the square average current in cycle operation is 80% or less of the rated current of an inverter.
*3) Order individually for 220 to 230V/50Hz.
*4) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same as for FUJI's conventional models).
Voltage unbalance [%] = (Max. voltage [V] – Min. voltage [V])/Three-phase average voltage [V] × 67
*5) Tested at the standard load condition (85% load of nominal applied motor) prescribed by JEMA.
*6) When power-factor correcting DC REACTOR (option) is used.
*7) The inverter may automatically reduce carrier frequency in accordance with ambient temperature or output current in order to protect itself.
*8) This value is obtained by using a FUJI original calculation method.
*9) These torque characteristics are obtained when combined with a dedicated motor.
*10) Use the function code F80 to switch between CT, VT and HT uses.

### ● Three-phase 400V series

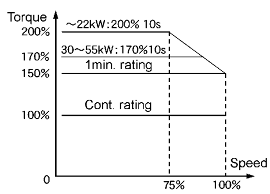
| Type FRN☐VG7S-4 | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal applied motor [kW] | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 |
| Rated capacity [kVA] (*1) | | 6.8 | 10 | 14 | 18 | 24 | 29 | 34 | 44 | 57 | 69 | 85 |
| Rated current (*2) | (Continuous) | 9.0 | 13.5 | 18.5 | 24.5 | 32.0 | 39.0 | 45.0 | 58.0 | 75.0 | 91.0 | 112 |
| | (1min.) | 13.5 | 20.0 | 27.5 | 36.5 | 48.0 | 58.5 | 67.5 | 90.0 | 113 | 137 | 168 |
| | (10s) | 16 | 22.7 | 31.6 | 42.9 | 59.1 | 73.5 | 85.1 | 96.0 | 120 | 150 | 182 |
| Input ratings | Phase, Voltage, Frequency | 3-phase 380 to 480V, 50Hz/60Hz | | | | | 3-phase 380 to 440V/50Hz, 380 to 480V/60Hz (*9) | | | | | |
| | Voltage/frequency variation | Voltage: +10 to –15%, Frequency: +5 to –5%, Voltage unbalance: 2% or less (*3) | | | | | | | | | | |
| | Momentary voltage dip capability (*4) | When voltage drops from the rated voltage, the inverter will continue operation if the voltage is more than 310V. If the voltage is less than 310V, the inverter can be operated for 15ms. | | | | | | | | | | |
| | Rated current [A] (*7) (with DCR) | 7.1 | 10 | 13.5 | 19.8 | 26.8 | 33.2 | 39.3 | 54 | 67 | 81 | 100 |
| | Rated current [A] (*7) (without DCR) | 14.9 | 21.5 | 27.9 | 39.1 | 50.3 | 59.9 | 69.3 | 86 | 104 | 124 | 150 |
| | Required power supply capacity [kVA] (*5) | 5.0 | 7.0 | 9.4 | 14 | 19 | 24 | 28 | 38 | 47 | 57 | 70 |
| Carrier frequency [kHz] (*6) | | 0.75 to 15 | | | | | | | | | | |
| Mass [kg] | | 8 | 8 | 8 | 12.5 | 12.5 | 25 | 25 | 30 | 35 | 40 | 41 |
| Enclosure | | IP20 | | | | | IP00 (IP20: option) | | | | | |
| Torque | Continuous [%] (*8) | 100% | | | | | | | | | | |
| | 1min. rating[%] (*8) | 150% | | | | | | | | | | |
| | 10s rating[%] (*8) | 200% (at 80% or less of rated speed)/170% (at rated speed) | | | | | | | 170% | | | |
| Braking method/braking torque | | Braking resistor discharge control: 150% braking torque, Separately installed braking resistor (option) | | | | | | | | | | |

*1) Inverter output capacity [kVA] at 440V.
*2) Select the inverter capacity such that the square average current in cycle operation is 80% or less of the rated current of an inverter.
*3) Use a DC REACTOR if the voltage unbalance exceeds 2% (this is the same as for FUJI's conventional models).
Voltage unbalance [%] = (Max. voltage [V] – Min. voltage [V])/Three-phase average voltage [V] ×67
*4) Tested at the standard load condition (85% load of nominal applied motor) prescribed by JEMA.
*5) When power-factor correcting DC REACTOR (option) is used.
*6) The inverter may automatically reduce carrier frequency in accordance with ambient temperature or output current in order to protect itself.
*7) This value is obtained by using a FUJI original calculation method.
*8) These torque characteristics are obtained when combined with a dedicated motor.
*9) When the input voltage is 380 to 398V/50Hz or 380 to 430V/60Hz, a connector inside the inverter must be switched.
*10) Use the function code F80 to switch between CT, VT and HT uses.

Torque characteristics of HT use (for vertical transfer application, overload torque: 200%/170%) (Common to 3-phase 200V/400V)




< Driving torque characteristics >




< Braking torque characteristics >

# 2.2 Common Specifications

## 2.2.1 CT Use, VT Use and HT Use

| Item | | | Explanation |
|---|---|---|---|
| Main circuit type | | | Voltage type IGBT sinusoidal PWM inverter |
| Motor control method | | | Vector control<br>Sensorless vector control<br>V/f control<br>Vector control (synchronous motors)<br>Simulated operation mode |
| Speed control | Maximum speed | | 200Hz in terms of inverter output frequency — 2P: 12000r/min; 4P: 6000r/min where PG frequency is 100kHz or less; 6P: 4000r/min<br>400Hz for V/f control |
| | Control range | Vector control | 1:1000 (Min. speed, base speed: 1.5 to 1500 r/min in terms of 4P with PG of 1024P/R)<br>1:4 (Constant torque range, constant output range) |
| | | Sensorless control<br>V/f control | 1:100 (Min. speed, base speed: 15 to 1500 r/min in terms of 4P)<br>1:4 (Constant torque range, constant output range) |
| | Control response | Vector control | 100Hz (max.) |
| | | Sensorless control | 20Hz (max.) |
| | Control accuracy | Vector control | Analog setting: ±0.1% of max. speed (25±10°C)<br>Digital setting:±0.005% of max. speed (–10 to +50°C) |
| | | Sensorless control | Analog setting:±0.5% of max. speed (25±10°C)<br>Digital setting: ±0. 5% of max. speed (–10 to +50°C) |
| | Setting resolution | | 0.005% of max. speed |
| Control | Operation method | | KEYPAD operation: FWD or REV key, STOP key<br>Digital input signal operation: FWD or REV command, Coast–to–stop command, reset input, multistep speed selection command, etc. |
| | Speed setting | | KEYPAD operation: ∧ or ∨ key<br>External potentiometer: three terminals, 1 to 5kΩ<br>Analog input: 0 to ±10V<br>UP/DOWN control: Speed increases when UP signal (DI) is ON, and decreases when DOWN signal (DI) is ON.<br>Multistep speed: Up to 15 different speeds can be selected by combining four external input signals (DI).<br>Digital signal: Setting with an option card's 16-bit parallel signal<br>Serial link operation: RS485 (standard). Setting through different communication options is possible.<br>Jogging operation: FWD or REV key, FWD or REV terminals in jogging mode |
| | Running status signal | | Transistor output: Inverter running, Speed equivalence, Speed detection, inverter overload early warning, torque limiting, etc.<br>Analog output: Motor speed, Output voltage, Torque, Load factor, etc. |
| | Acceleration/Deceleration time | | 0.01 to 3600s (4 independent settings for acceleration and deceleration selectable with external signals)<br>(S-curve acceleration/deceleration in addition to linear acceleration/deceleration) |
| | Gain for speed setting | | Sets the proportional relationship between analog speed setting and motor speed in the range of 0 to 200%. |
| | Jump speed | | Jump speed (3 points) and jump hysteresis width (1 point) can be set. |
| | Rotating motor pick up (Flying start) | | A rotating motor can be smoothly picked up by the inverter without stopping. (Vector control and sensorless vector control) |
| | Auto-restart after momentary power failure | | Automatic restart is available without stopping the motor after a momentary power failure. |
| | Slip compensation | | Compensates for the decrease of speed due to load and realizes stable operation (V/f control). |
| | Droop control | | The motor speed droops in proportion to output torque |
| | Torque limiting | | Limits the torque to predetermined values (selectable from "common to 4 quadrants", "independent driving and braking", etc. )<br>Analog and external signal (2 steps) settings are available (vector control and senseless vector control). |
| | PID control | | PID control with analog input |
| | Fan stop operation | | Stops the cooling fan at low temperatures to reduce noise. |
| | Torque bias | | Fixed value (1 step, with polarity select function by motor rotation direction), internal setting (3 steps by combining external input signals DI), and analog setting (with holding function) are available. |
| | Speed limiting | | Limiting methods; common to forward/reverse, individual setting of high/low, or forward/reverse. Speed limiting is available even in torque limiting mode. |
| | Motor selection | | Select from three types. |
| | Multiple winding motor drive | | Optional |
| | UP/DOWN control | | Sets speed by combining UP command, DOWN command, and clear to zero command using external input signals (DI). |
| | Stopping function | | Three types of stopping functions, STOP 1, 2 and 3 |
| | PG pulse output | | Divides PG signal for output. |
| | Observer | | Suppresses load disturbances and vibrations |
| | Position control | | Optional |
| | Synchronized operation | | Optional |

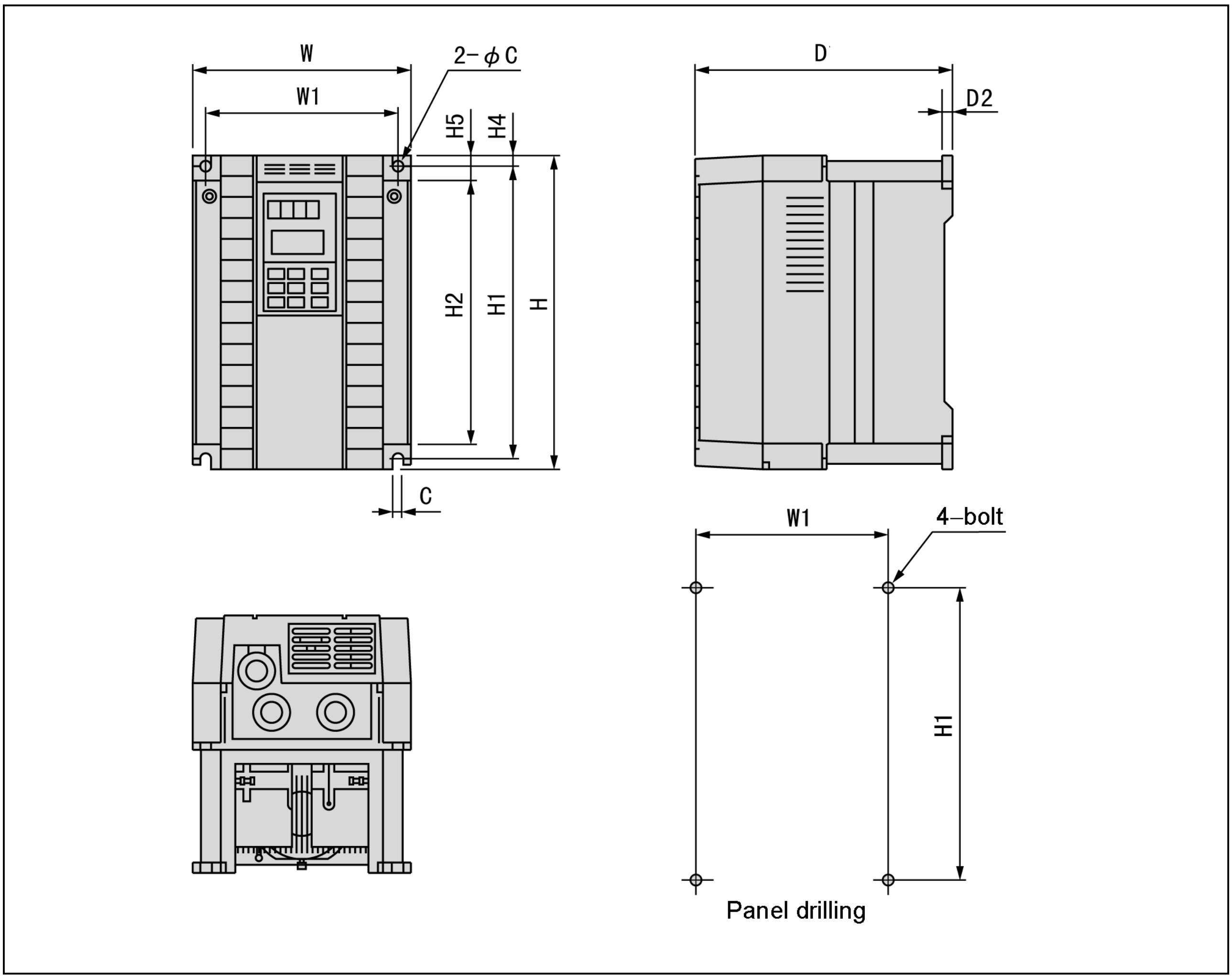
# 2. Specifications

| Item | | Explanation |
|---|---|---|
| Indication | Running/Stopping | · Detected speed value · Speed reference value · Output frequency · Torque current reference value<br>· Torque reference value · Torque calculation value · Motor output · Output current<br>· Output voltage · DC link circuit voltage · Magnetic-flux reference value · Magnetic-flux calculation value<br>· Load shaft speed · PID reference value · PID feedback value · PID output value<br>· Ai adjusted value (12) · Ai adjusted value (Ai1) · Ai adjusted value (Ai2) · Ai adjusted value (Ai3)<br>· Ai adjusted value (Ai4) · Optional monitor 1 · Optional monitor 2 · Optional monitor 3<br>· Optional monitor 4 · Optional monitor 5 · Optional monitor 6 · Presence of digital input/output signal<br>· Motor temperature · Heat sink temperature · Load factor · Operation time, etc. |
| | Programming | Displays function codes, names, and data.<br>Multi-language display: English, French, Spanish, German, Italian, Chinese and Japanese. |
| | Trip mode | Displays the following trip codes;<br>·dbH Overheat at the DB circuit ·dCF DC fuse blown ·EF Ground fault<br>·P9 PG error ·Er1 Memory error ·Er2 KEYPAD panel communication error<br>·d0 Excessive position devitation ·Er4 Network error ·Er5 RS485 error<br>·Er6 Operation procedure error ·Er3 CPU error ·Er8 A/D converter error<br>·Er9 Speed disagreement ·ErA UPAC error ·Er7 Output wiring error<br>·Lin Input phase loss ·LU Undervoltage ·Erb Inter-inverter communication error<br>·OC Overcurrent ·OH1 Overheating at heat sink ·OH2 External alarm input<br>·nrb NTC thermistor disconnection ·OH4 Motor overheat ·OL1 Motor 1 overload<br>·OL2 Motor 2 overload ·OH3 Inverter internal overheat ·OLU Inverter unit overload<br>·OS Overspeed ·OU Overvoltage ·OL3 Motor 3 overload<br>·PbF Charging circuit error |
| | Running/Trip mode | Stores and displays data for the last ten trips.<br>Stores and displays the detailed cause of the last trip. |
| | Charge lamp | ON when there is residual voltage in the main circuit capacitors. |
| Protection | Overload | Protects the inverter by electronic thermal overload relay and the detection of inverter temperature. |
| | Overvoltage | Detects DC link circuit overvoltage and stops the inverter. |
| | Incoming surge | Protects the inverter from surge voltage between the main circuit power lines and the ground. |
| | Undervoltage | Detects DC link circuit undervoltage and stops the inverter. |
| | Overheat | Stops the inverter by detecting the inverter internal temperature. |
| | Short-circuit | Protects the inverter from overcurrent due to a short-circuit in the output circuit. |
| | Ground fault | Protects the inverter from overcurrent due to a ground fault in the output circuit. |
| | Motor protection | Protects the motor with NTC thermistor and PTC thermistor.<br>Protects the motor with electronic thermal overload relay.<br>Overload early warning: Overload early warning can be issued at a predetermined level before stopping the inverter.<br>(The electronic thermal overload relay and the overload early warning can be set for motor 1 to 3 individually) |
| | DB resistor overheating | · Protects through internal functions of the inverter.<br>· For the optional DB resistor, an external alarm signal issued from the built-in temperature sensor stops the inverter. |
| | Input phase loss | Protects the inverter from damage due to input phase loss |
| | Output phase loss | Detects impedance unbalance in the output circuit and issues an alarm (under tuning operation). |
| | Retry | Sets the retry numbers and retry waiting time for stoppage due to an alarm (only for OV, OC, LU, OH1, OH3, OLU, OL, dbH). |
| Conditions | Installation location | Indoor use only. Free from corrosive and flammable gases, dusts, and direct sunlight. |
| | Ambient temperature | –10 to 50°C |
| | Ambient humidity | 5 to 95%RH (no condensing) |
| | Altitude | 3000m or less, with some power derating from 1,001 to 3,000m. |
| | Vibration | Amplitude: 3mm at 2 to 9Hz, 9.8m/s$^2$ at 9 to 20Hz. 2m/s$^2$ at 20 to 55Hz, 1m/s$^2$ at 55 to 200Hz |
| | Storage temperature | –25 to 55°C |
| | Storage humidity | 5 to 95%RH |
| Maintenance | Main circuit capacitor life | Life judgment function installed |
| | Common functions | · Displays and records accumulated time for capacitor life and cooling fan operation time in the control power.<br>· Displays and records inverter operation time.<br>· Displays and records the maximum output current and the maximum internal temperature for the past one year. |
| RS485 | | Provided as standard |

- MEMO -

## 2.2.2 External Dimensions

● Internal mounting type




● 200V series

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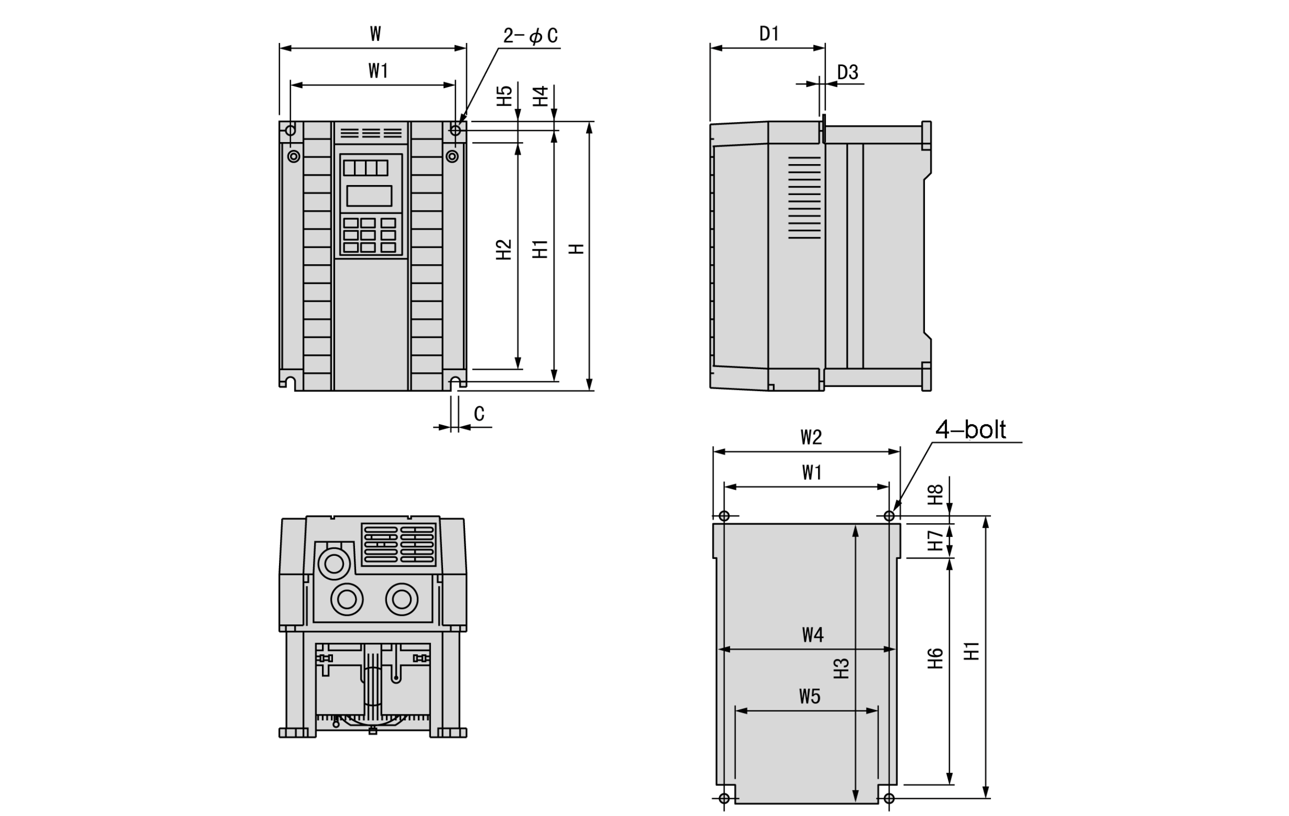
● External cooling type



Panel cutting

● 200V series

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# 2. Specifications

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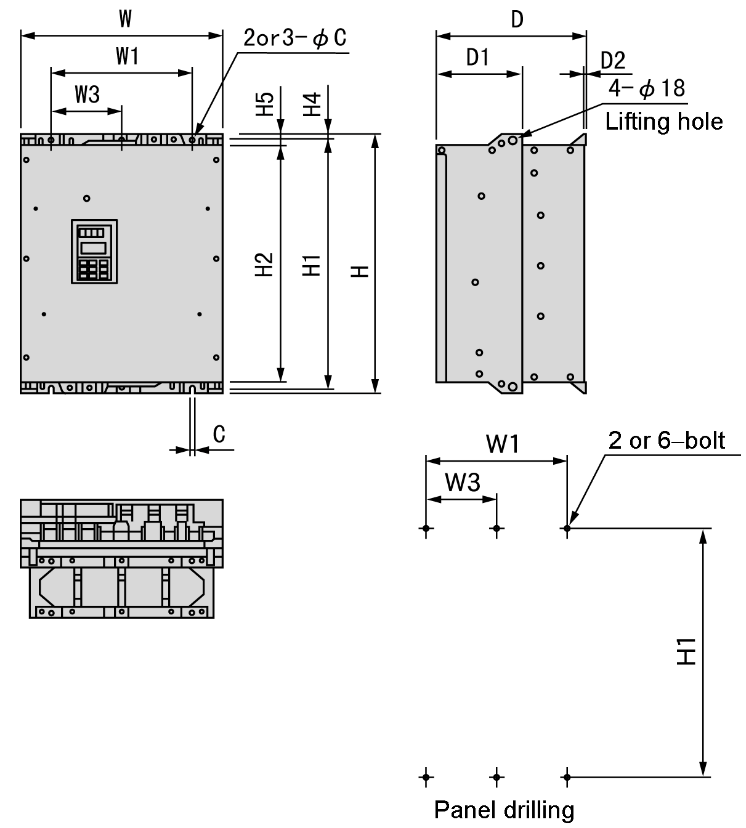


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<tr><td>FRN75VG7S-2</td><td>530</td><td>430</td><td>750</td><td>720</td><td>685</td><td rowspan="2">15.5</td><td rowspan="2">32.5</td><td>285</td><td>145</td><td rowspan="2">15</td><td rowspan="2">M12</td><td>70</td></tr>
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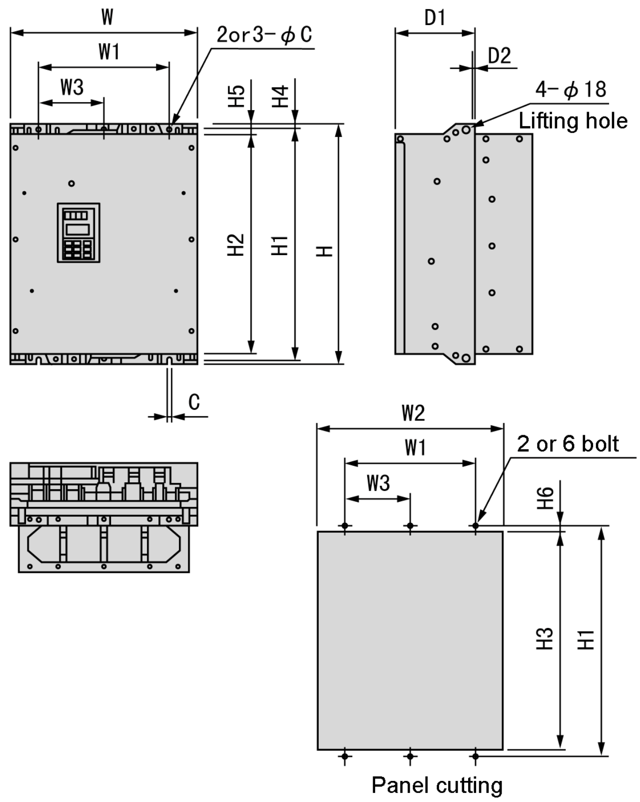
● External cooling type

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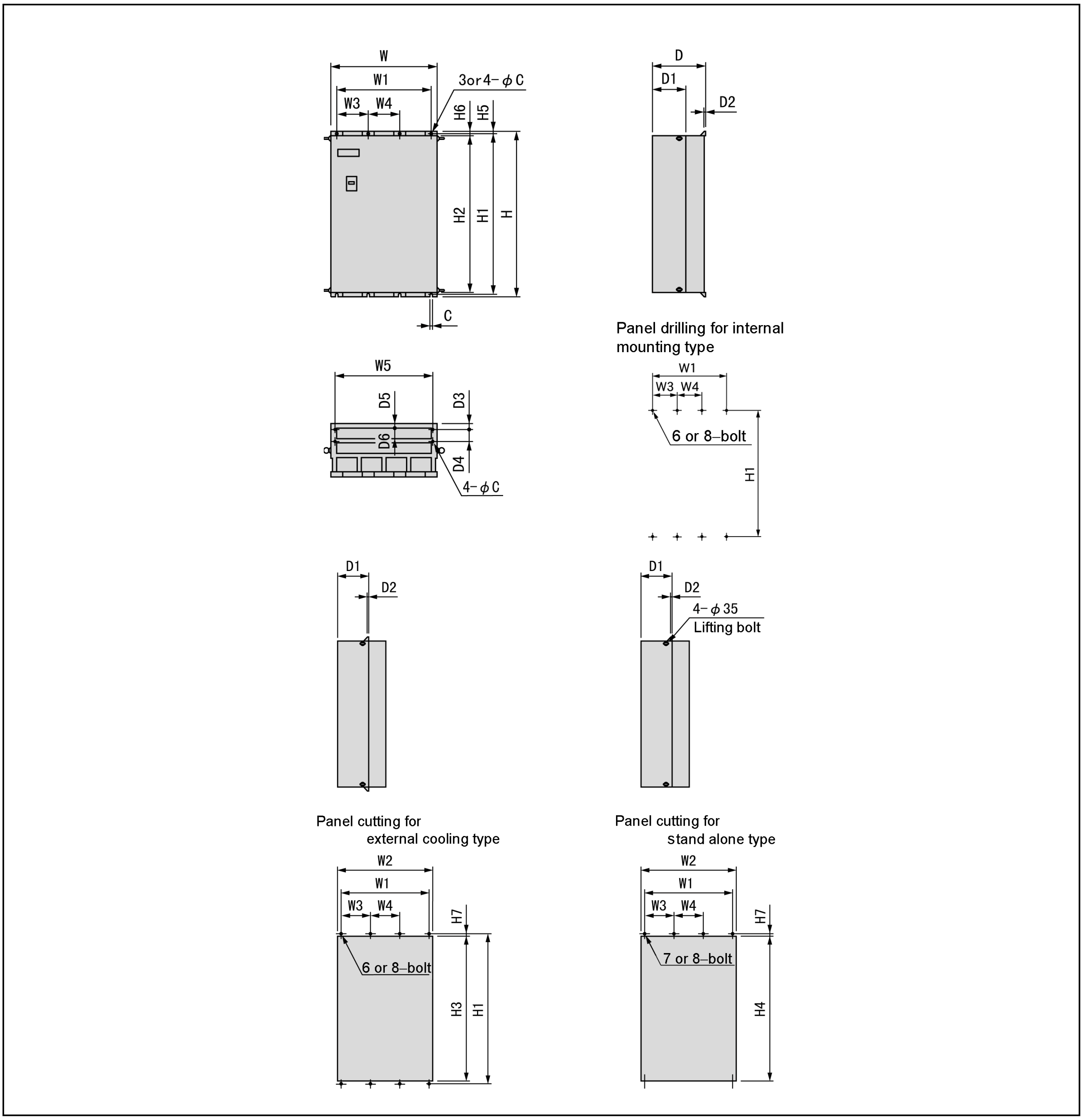
<tr><td>FRN30VG7S-4</td><td rowspan="2">550</td><td rowspan="2">530</td><td rowspan="2">500</td><td rowspan="2">512</td><td>30</td></tr>
<tr><td>FRN37VG7S-4</td><td rowspan="4">375</td><td rowspan="4">275</td><td rowspan="4">361</td><td>35</td></tr>
<tr><td>FRN45VG7S-4</td><td rowspan="2">675</td><td rowspan="2">655</td><td rowspan="2">625</td><td rowspan="2">637</td><td>40</td></tr>
<tr><td>FRN55VG7S-4</td><td>41</td></tr>
<tr><td>FRN75VG7S-4</td><td>740</td><td>720</td><td>690</td><td>702</td><td>50</td></tr>
<tr><td>FRN90VG7S-4</td><td rowspan="4">530</td><td rowspan="4">430</td><td rowspan="4">510</td><td rowspan="2">740</td><td rowspan="2">710</td><td rowspan="2">675</td><td rowspan="2">685</td><td rowspan="6">15.5</td><td rowspan="6">32.5</td><td rowspan="6">12.5</td><td rowspan="2">175</td><td rowspan="6">15</td><td rowspan="6">M12</td><td rowspan="2">72</td></tr>
<tr><td>FRN110VG7S-4</td></tr>
<tr><td>FRN132VG7S-4</td><td rowspan="4">1000</td><td rowspan="4">970</td><td rowspan="4">935</td><td rowspan="4">945</td><td rowspan="4">220</td><td rowspan="2">100</td></tr>
<tr><td>FRN160VG7S-4</td></tr>
<tr><td>FRN200VG7S-4</td><td rowspan="2">680</td><td rowspan="2">580</td><td rowspan="2">660</td><td rowspan="2">290</td><td rowspan="2">140</td></tr>
<tr><td>FRN220VG7S-4</td></tr>
</table>

# 2. Specifications

● Type common to internal mounting, external cooling ,and stand alone




● 400V series

| Inverter type | W | W1 | W2 | W3 | W4 | W5 | H | H1 | H2 | H3 | H4 | H5 | H6 | H7 | D | D1 | D2 | D3 | D4 | D5 | D6 | C | Mtg. bolt | Approx. mass [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dimensions [mm] | | | | | | | | | | | | | | | | | | | | | | | |
| FRN280VG7S-4 | 680 | 580 | 660 | 290 | – | 610 | 1400 | 1370 | 1330 | 1340 | 1335 | 15.5 | 3.5 | 14.5 | 450 | 285 | 6.4 | 50 | 100 | 35 | 115 | 15 | M12 | 250 |
| FRN315VG7S-4 | | | | | | | | | | | | | | | | | | | | | | | | |
| FRN355VG7S-4 | 880 | 780 | 860 | 260 | 260 | 810 | | | | | | | | | | | | | | | | | | 360 |
| FRN400VG7S-4 | | | | | | | | | | | | | | | | | | | | | | | | |

## 2.2.3 Dedicated Motor Specifications

### ● Three-phase 200V series standard specifications

| Item | | Specifications | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dedicated motor rated output [kW] | | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| Applicable motor type (MVK_A-C) | | 6096 | 6097 | 6107 | 6115 | 6133 | 6135 | 6165 | 6167 | 6184 | 6185 | 6206 | 6207 | 9221 (6208) | 9250 | 9252 | 9280 |
| Moment of inertia of rotor [kg• $m^2$] | | 0.009 | 0.009 | 0.009 | 0.016 | 0.030 | 0.037 | 0.085 | 0.11 | 0.21 | 0.23 | 0.34 | 0.41 | 0.84(0.47) | 0.80 | 0.95 | 1.37 |
| Base speed/Max. speed [r/min] | | 1500/3600 | | | | | | | | | | 1500/3000 | | 1500/2400 | | | 1500/ 2000 |
| Vibration | | V10 or less | | | | | | | | | | | | | V15 or less | | |
| Cooling fan | Voltage [V] | 200 to 210V/50Hz, 200 to 230V/60Hz | | | | | | | | | | | | | | | |
| | Number of phases/poles | 1-phase/4P | | | | | | 3-phase/4P | | | | | | | | | |
| | Input power [W] | 40/50 | | | | | | 90/120 | | 150/210 | | | | | 360/570 to 650 | | |
| | Current [A] | 0.29/0.27 to 0.31 | | | | | | 0.49/0.44 to 0.48 | | 0.75/0.77 to 0.8 | | | | | 2.0/2.0 to 2.0 | | |
| Approx. mass [kg] | | 28 | | 32 | 46 | 63 | 73 | 111 | 133 | 190 | 197 | 254 | 280 | 350(296) | 490 | 545 | 710 |

### ● Three-phase 400V series standard specifications

| Item | | Specifications | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dedicated motor rated output [kW] | | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 | 110 | 132 | 160 | 200 | 220 |
| Applicable motor type (MVK_A-C) | | 6115 | 6133 | 6135 | 6165 | 6167 | 6184 | 6185 | 6206 | 6207 | 9221(6208) | 9250 | 9252 | 9280 | 9282 | 9310 | 9312 | 9316 | 9318 |
| Moment of inertia of rotor [kg• $m^2$] | | 0.016 | 0.030 | 0.037 | 0.085 | 0.11 | 0.21 | 0.23 | 0.34 | 0.41 | 0.48(0.47) | 0.80 | 0.95 | 1.37 | 1.60 | 2.68 | 3.22 | 3.9 | 4.26 |
| Base speed/Max. speed [r/min] | | 1500/3600 | | | | | | | 1500/3000 | | 1500/2400 | | | 1500/2000 | | | | | |
| Vibration | | V10 or less | | | | | | | | | | V15 or less | | | | | | | |
| Cooling fan | Voltage [V] | 200 to 210V/50Hz, 200 to 230V/60Hz | | | 400 to 420V/50Hz, 400 to 440V/60Hz | | | | | | | | | | | | | | |
| | Number of phases/poles | 1-phase/4P | | | 3-phase/4P | | | | | | | | | | | | | | |
| | Input power [W] | 40/50 | | | 90/120 | | 150/210 | | | | 150/200 to 210 (150/210) | 360/570 to 580 | | | | 4405/4330 | | | |
| | Current [A] | 0.29/0.27 to 0.31 | | | 0.27/0.24 to 0.25 | | 0.38/0.39 to 0.4 | | | | 0.38/0.4 to 0.4 (0.38/0.39 to 0.4) | 1.0/1.0 to 1.0 | | | | 7.5/6.8 | | | |
| Approx. mass [kg] | | 46 | 63 | 73 | 111 | 133 | 190 | 197 | 254 | 280 | 350(296) | 490 | 545 | 710 | 765 | 1250 | 1450 | 1550 | 1640 |

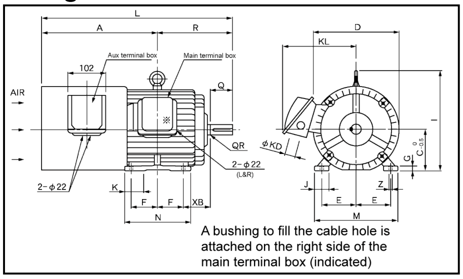
### ● Common specifications

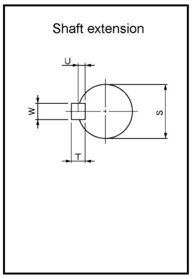
| Item | Specifications |
|---|---|
| Insulation class/Number of poles | Class F/4P |
| Terminal design | Main terminal box (lug type): 3 or 6 main circuit terminals, 3 NTC thermistor terminals (1 is reserved)<br>Auxiliary terminal box (terminal block): Pulse generator (PGP, PGM, PA, PB, SS), cooling fan (FU, FV or FU, FV, FW) |
| Mounting method | Foot mounted with bracket (IMB3), Note: Contact FUJI for other methods. |
| Degree of protection, Cooling method | JP44, Totally enclosed forced-ventilation system with cooling fan motor. A cooling fan blows air over the motor toward the drive-end. |
| Installation location | Indoor, 1000m or less in altitude. |
| Ambient temperature, humidity | -10 to +40°C, 90%RH or less (no condensation) |
| Finishing color | Munsell N5 |
| Standard conformity | JEM1446 |
| Standard accessories | Pulse generator (1024P/R, +15V, complementary output), NTC thermistors (2), cooling fan. |

Note : Contact a FUJI representative for dedicated motors other than those with 4-pole and a base speed of 1500 [r/min].

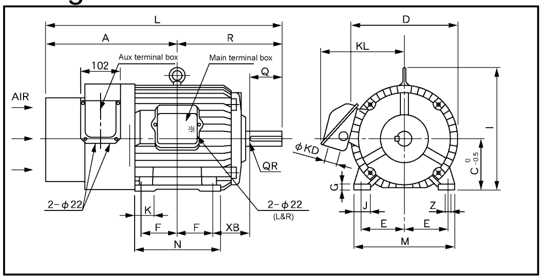
# 2. Specifications

● Fig. A

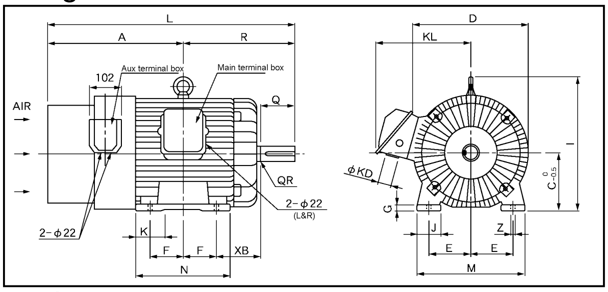


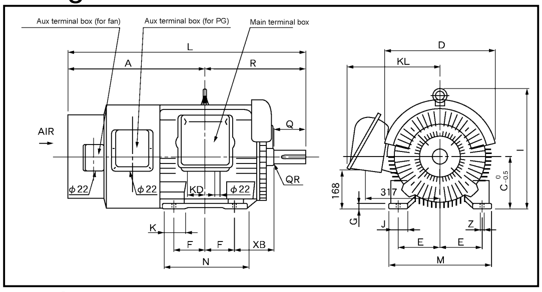

● Fig. B



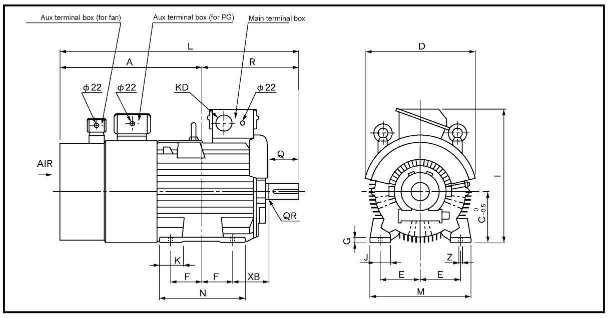

● Fig. C



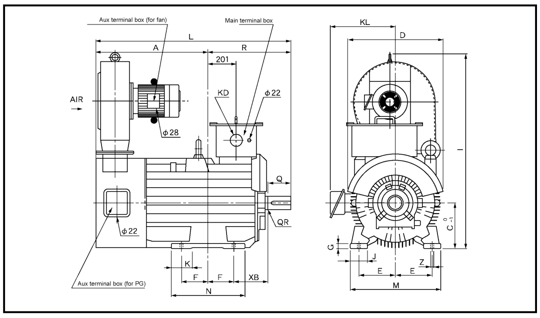

● Fig. D




● Fig. E




● Fig. F




● Common dimensions to 200V and 400V series

| Motor rated output [kW] | Motor type | Fig. | Dimensions [mm] | | | | | | | | | | | | | | | | | Shaft extension [mm] | | | | | | Approx. mass [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | C | D | E | F | G | I | J | K | KD | KL | L | M | N | R | XB | Z | Q | QR | S | T | U | W | |
| 0.75 | FMVK6096A–C | | 277.5 | 90 | 203 | 70 | 62.5 | 10 | 229 | 35.5 | 35.5 | 27 | 190 | 446 | 170 | 150 | 168.5 | 58 | 10 | 50 | 0.5 | 24j6 | 7 | 4 | 8 | 28 |
| 1.5 | MVK6097A–C | A | | | | | | | | | | | | | | | | | | | | | | | | 28 |
| 2.2 | MVK6107A–C | | 292 | 100 | | 80 | 70 | 12.5 | 238 | 40 | 40 | | | 485 | 195 | 170 | 193 | 63 | 12 | 60 | | 28j6 | | | | 32 |
| 3.7 | MVK6115A–C | | 299 | 112 | 236 | 95 | | 14 | 270 | | 50 | | 205 | 499 | 224 | 175 | 200 | 70 | | | | | | | | 46 |
| 5.5 | MVK6133A–C | B | 309 | 132 | 273 | 108 | | 17 | 311 | 45 | | 34 | 223 | 548 | 250 | 180 | 239 | 89 | | 80 | | 38j6 | 8 | 5 | 10 | 63 |
| 7.5 | MVK6135A–C | | 328 | | | | 89 | | | | | | | 586 | | 212 | 258 | | | | | | | | | 73 |
| 11 | MVK6165A–C | A | 400 | 160 | 321 | 127 | 105 | 18 | 376 | 50 | 63 | 48 | 272 | 723 | 300 | 250 | 323 | 108 | 14.5 | 110 | 1 | 42j6 | | | 12 | 111 |
| 15 | MVK6167A–C | | 422 | | | | 127 | | | | | | | 767 | | 300 | 345 | | | | | | | | | 133 |
| 18.5 | MVK6184A–C | C | 425 | 180 | 376 | 139.5 | 120.5 | 20 | 428 | 75 | 75 | | 305 | 776.5 | 350 | 292 | 351.5 | 121 | 14.5 | 110 | 1.5 | 48j6 | 9 | 5.5 | 14 | 190 |
| 22 | MVK6185A–C | | | | | | | | | | | | | | | | | | | | | | | | | 197 |
| 30 | MVK6206A–C | | 490 | 200 | 411 | 159 | 152.5 | 25 | 466 | 80 | 85 | 80 | 364 | 915.5 | 390 | 360 | 425.5 | 133 | 18.5 | 140 | 2 | 60m6 | 11 | 7 | 18 | 254 |
| 37 | MVK6207A–C | | | | | | | | | | | | | | | | | | | | | | | | | 280 |
| 45 | (MVK6208A–C) | | | | | | | | | | | | | | | | | | | | | | | | | 296 |
| | MVK9221A–C | D | 593 | 225 | 475 | 178 | 143 | | 515 | | 95 | | 387 | 1025 | 436 | 366 | 432 | 149 | | | 1 | | | | | 350 |
| 55 | MVK9250A–C | E | 693.5 | 250 | 535 | 203 | 155.5 | 30 | 653 | 100 | 120 | | | 1157 | 506 | 411 | 463.5 | 168 | 24 | | 2 | 75m6 | 12 | 7.5 | 20 | 490 |
| 75 | MVK9252A–C | | 712.5 | | | | 174.5 | | | | | | | 1195 | | 449 | 482.5 | | | | | | | | | 545 |
| 90 | MVK9280A–C | | 766 | 280 | 605 | 228.5 | 184 | 35 | 807 | | | | | 1310 | 557 | 468 | 544 | 190 | | 170 | | 85m6 | 14 | 9 | 22 | 710 |
| 110 | MVK9282A–C | F | 790.5 | | | | 209.5 | | | | | | | 1360 | | 519 | 569.5 | | | | | | | | | 765 |
| 132 | MVK9310A–C | | 798 | 315 | 675 | 254 | 203 | 42 | 1367 | 120 | 145 | 90 | | 1387 | 628 | 526 | 589 | 216 | 28 | | | 95m6 | | | 25 | 1250 |
| 160 | MVK9312A–C | | 822.5 | | | | 228.5 | | | | | | | 1437 | | 577 | 614.5 | | | | | | | | | 1450 |
| 200 | MVK9316A–C | | 922.5 | | | | | | | | | | 460 | 1537 | | | | | | | | | | | | 1550 |
| 220 | MVK9318A–C | | 947 | | | | 254 | | | | | | | 1587 | | 628 | 640 | | | | | | | | | 1640 |

## 2.2.4 Protective Functions

| Function | Description | LED monitor | Related function code |
|---|---|---|---|
| DB resistor overheating | When the built-in braking resistor overheats, the inverter stops discharging and running.<br>Function codes E35 to 37 corresponding to the resistor (built-in/external) must be set. | dbH | E35-37 |
| DC fuse blown | When a fuse at the main DC circuit blows due to a short-circuit in the IGBT circuit, the inverter stops operation. | dCF | |
| Ground fault | Activated by a ground fault in the inverter output circuit. Connect a separate earth-leakage protective relay or an earth-leakage circuit breaker for accident prevention such as human damage and fire. | EF | |
| Excessive position deviation | Activated when the position deviation between the reference and the detected values exceeds the function code o18 "Excessive deviation value" in synchronized operation.<br>The option code "o" becomes valid and is displayed on the KEYPAD panel after installing options. | d0 | o18 |
| Memory error | Activated when a fault such as "write error" occurs in the memory. | Er 1 | |
| KEYPAD panel communication error | Activated if a communication error is detected between the inverter control circuit and the KEYPAD panel when the start/stop command from the KEYPAD is valid (function code F02=0).<br>Note: KEYPAD panel communication error does not indicate the alarm display and issue the alarm relay output when the inverter is operated by external signal input or the link function. The inverter continues operating. | Er 2 | F02 |
| CPU error | Activated when a CPU error occurs due to noise. | Er 3 | |
| Network error | Activated if a communication error occurs due to noise when the inverter is operated through T- Link, SX bus or field bus. | Er 4 | o30,31 |
| RS485 communication error | Activated if:<br>The function code H32 is set to 0 to 2, or a disconnection continues for more than the specified period of 0.1 to 60.0 with the function code H38. | Er 5 | H32,H33<br>H38 |
| Operation procedure error | Activated if multiple network options (T-Link, SX bus, and field bus) are installed. Though you can install multiple SI, DI and PG options, this error is issued if the two SW settings are identical. | Er 6 | |
| Output wiring error | Activated when the measured data are out of the motor characteristic data range during executing tuning or the wires are not connected in the inverter output circuit. | Er 7 | H01,H71 |
| A/D converter error | Activated when an error occurs in the A/D converter circuit. | Er 8 | |
| Speed disagreement | Activated when the deviation between the speed reference (speed setting) and the motor speed (detected speed, predicted speed) becomes excessive. | Er 9 | |
| UPAC error | Activated on a hardware fault in the UPAC option or a communication error between the inverter control circuit and the UPAC option. | ErA | |
| Inter-inverter communication error | Activated if a communication error occurs in inter-inverter communication over the optical option or simplified RS485. | Erb | |
| Input phase loss | The inverter is protected from being damaged due to input phase loss. | Lin | |
| Undervoltage | Activated if the DC link circuit voltage decreases to the undervoltage level due to a reduction in the supply voltage.<br>The alarm output is not issued when the DC link circuit voltage decreases and the "function code F14" is set to "3 to 5".<br>• Undervoltage detection level:<br>200V series: 186V dc, 400V series: 371V dc.Activated when the power supply *phase is unbalunced. | LU | F14 |
| NTC thermistor disconnection | Activated if the thermistor circuit is disconnected when the application of NTC thermistors to corresponding motors (M1, 2, 3) is specified with the function codes P30, A31 and A47. | nrb | P30,A31,A47 |
| Overcurrent | Activated if the momentary value of the inverter output current exceeds the overcurrent detection level due to a short-circuit or ground fault. | OC | |
| Overheating at heat sink | Activated if the temperature of the heat sink to cool the rectifier diodes and the IGBTs increases due to colling fan stoppage. | OH 1 | |
| External alarm | The inverter stops on receiving the external alarm signal (THR).<br>It is activated by a terminal signal when the control circuit terminals (THR assignment) are connected to alarm terminals of external devices such as a braking unit or a braking resistor. | OH 2 | E01-E14 |
| Inverter internal overheat | Activated if the ambient temperature of the control PC board increases due to poor ventilation of the inverter. | OH 3 | |
| Motor overheat | Activated if the detected temperature of the built-in NTC thermistor for motor temperature detection exceeds the data of the "function code E30 Motor overheat protection". | OH 4 | E30,E31 |
| Motor 1 overload | Activated when the motor 1 current (inverter output current) exceeds the operation level set by "function code F11". | OL 1 | F11 |
| Motor 2 overload | Activated when the motor 2 current (inverter output current) exceeds the operation level set by "function code A33". | OL 2 | A33 |
| Motor 3 overload | Activated when the motor 3 current (inverter output current) exceeds the operation level set by "function code A49". | OL 3 | A49 |
| Inverter unit overload | Activated if the output current exceeds the overload characteristic of the inverse time characteristic. | OLU | |
| Overspeed | Activated if the motor speed (detected speed value/predicted speed value) exceeds 120% of the specified value by the function code "maximum speed". | OS | F03,A06,A40 |
| Overvoltage | Activated if the DC link circuit voltage exceeds the overvoltage level due to an increase of supply voltage or regenerative braking current from the motor. However, the inverter cannot be protected from excessive voltage (high voltage, for example) supplied by mistake.<br>• Overvoltage detection level<br>200V series: 400V dc, 400V series: 800V dc | OU | |
| PG error | Activated when the pulse generator terminal PA/PB circuits are disconnected. It is not activated when the sensorless control or the V/f control is selected. | P9 | |
| Charging circuit error | Activated if the bypass circuit of the DC link circuit is not formed (the magnetic contactor for the charging circuit bypass is not closed) two minutes after power is supplied. | PbF | |

Note 1: All protective functions are reset automatically if the control power voltage decreases to where maintaining the operation of the inverter control circuit is impossible.

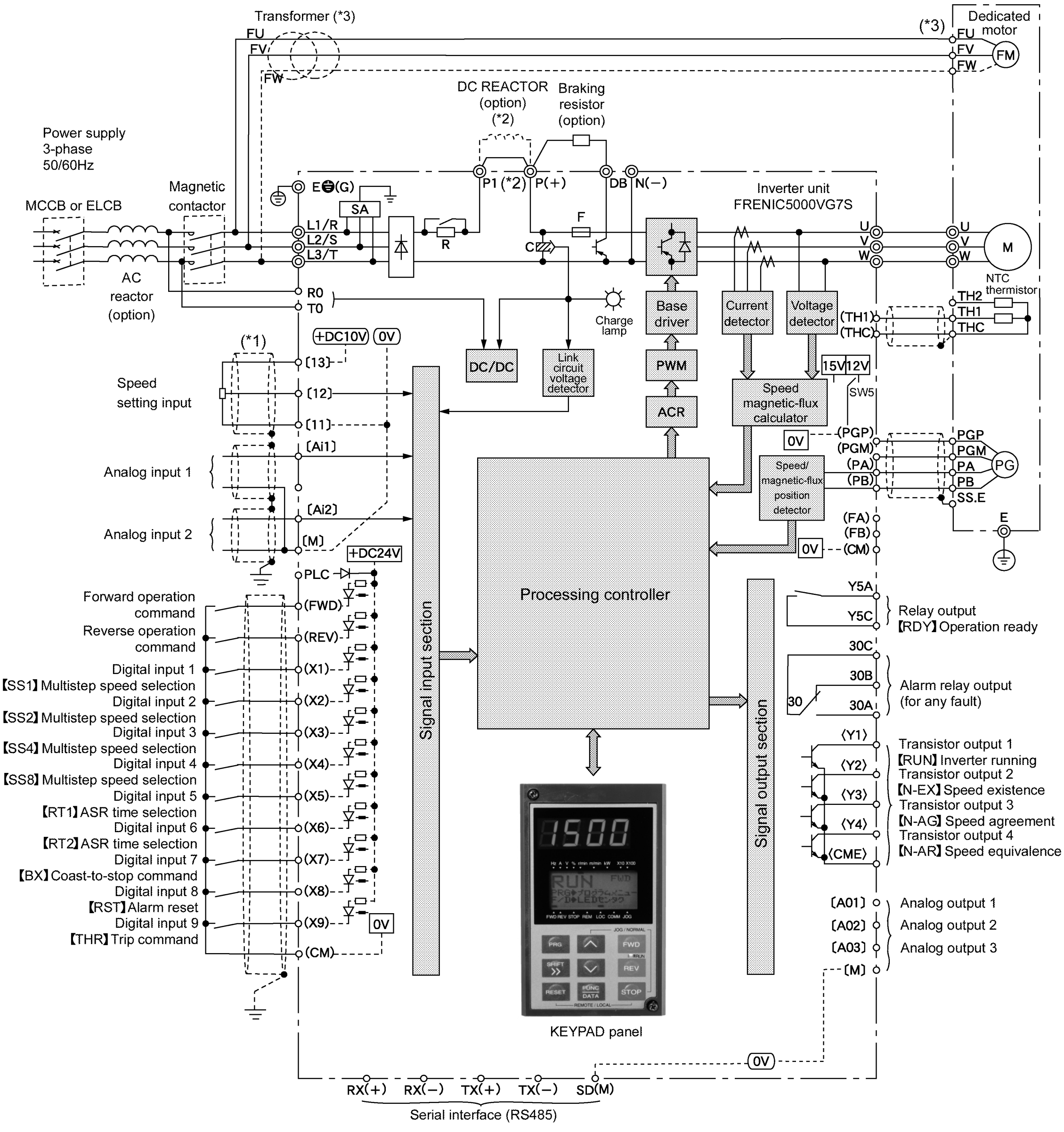
Note 2: Fault history data is stored for the last ten trips.

Note 3: Stoppage due to a protective function can be reset by the RST key of the KEYPAD or turning OFF and then ON between the X terminal (RST assigning) and the CM. This action is invalid if the cause of an alarm is not found and resolved.

Note 4: In addition to these protective functions, there can be further protective from surge voltage by connecting surge suppressors to the main circuit power terminals (L1/R, L2/S, L3/T) and the auxiliary control power terminals (R0, T0).

## 2.3 Basic Wiring Diagram and Terminal Functions

### 2.3.1 Basic Wiring Diagram




(*1) Use twisted cables or shielded cables for the wire indicated with [dashed box].
The shielded wires should be basically grounded. However, when the wires are influenced by induction noise from external devices, they may be connected to 0V (【M】,【11】,【THC】), or 0V (【CM】) to reduce such influence.

(*2) When connecting a DC REACTOR, remove the jumper wire between the P1 and P (+) terminals.
The DC REACTOR comes with 7.5kW or larger inverters as a standard accessory (supplied separately from the unit). Be sure to connect the REACTOR to the inverter.

(*3) The power supply for cooling fan for motors of 7.5kW or less is single-phase. Connect to the FU and the FV terminals.
The cooling fan for models of 7.5kW or less for the 400V series is 200V/50Hz or 200 to 230V/60Hz.
The cooling fan for models of 11kW or more for the 400V series is 400 to 420V/50Hz or 400 to 440/60Hz.
Obtain a transformer when using the fan for the power supply voltage that is not mentioned above.

(*4) The 24V power system and the 15V power system are insulated inside the inverter unit.

## 2.3.2 Terminal Functions

| | Symbol | Terminal name | Function |
|---|---|---|---|
| Main circuit | L1/R, L2/S,L3/T | Power input | Connects a 3-phase power supply. |
| | U, V, W | Inverter output | Connects a 3-phase motor. |
| | P (+), P1 | For DC REACTOR | Connects a DC REACTOR.<br>A DC REACTOR is optional for 55kW or less and standard for 75kW or more. |
| | P(+), N(–) | For BRAKING UNIT | Connects a braking resistor via the braking unit.<br>Used for a DC bus connection system. |
| | P(+), DB | For EXTERNAL BRAKING RESISTOR | Connects an external braking resistor (optional). |
| | ⏚ | Grounding | Ground terminal for inverter chassis (housing). |
| | R0, T0 | Auxiliary control power supply | Connects the same AC power supply as that of the main circuit to back up the control circuit power supply. |
| Speed setting | 13 | Potentiometer power supply | Used for power supply for a speed setting POT (variable resistor: 1 to 5kΩ). 10V DC 10mA Max. |
| | 12 | Voltage input for speed setting | Used for analog reference voltage input.<br>Reversible operation can be selected by a ± signal: 0 to ±10V DC/0 to ± Max. speed. |
| | 11 | Analog input common | Common terminal to input signals. |
| Analog input | Ai1 | Analog input 1 | Select and set the following based on the analog input voltage.<br>0: Input signal off [OFF] 1: Auxiliary speed setting 1 [AUX-N1] 2: Auxiliary speed setting 2 [AUX-N2]<br>3: Torque limiter (level 1) [TL-REF1] 4: Torque limiter (level 2) [TL-REF2]<br>5: Torque bias reference [TB-REF] 6: Torque reference [T-REF] 7: Torque current reference [IT-REF]<br>8: Creep speed 1 in UP/DOWN setting [CRP-N1] 9: Creep speed 2 in UP/DOWN setting [CRP-N2]<br>10: Magnetic-flux reference [MF-REF] 11: Detected speed [LINE-N] 12: Motor temperature [M-TMP]<br>13: Speed override [N-OR] 14: Universal Ai [U-AI] 15: PID feedback value [PID-FB]<br>16: PID reference value [PID-REF] 17: PID correction value [PID-G] 18: Option Ai [O-AI] |
| | Ai2 | Analog input 2 | |
| | M | Analog input common | Common terminal to input signals. |
| Digital input | FWD | Forward operation command | FWD - CM: ON... The motor runs in the forward direction.<br>FWD - CM: OFF...The motor decelerates and stops. |
| | REV | Reverse operation command | REV - CM: ON... The motor runs in the reverse direction.<br>REV - CM: OFF...The motor decelerates and stops. |
| | X1 | Digital input 1 | 0, 1, 2, 3: Multistep speed selection (step 1 to 15) [0: SS1, 1: SS2, 2: SS4, 3: SS8]<br>4, 5: ASR, ACC/DEC time selection (4 steps) [4: RT1, 5: RT2]<br>6: 3-wire operation stop command [HLD] 7: Coast-to-stop command [BX] 8: Alarm reset [RST]<br>9: Trip command (External fault) [THR]<br>10: Jogging operation [JOG] 11: Speed setting N2/Speed setting N1 [N2/N1]<br>12: Motor M2 selection [M-CH2] 13: Motor M3 selection [M-CH3] 14: DC brake command [DCBRK]<br>15: ACC/DEC cleared to zero [CLR] 16: Creep speed switching in UP/DOWN setting [CRP-N2/N1]<br>17: UP command in UP/DOWN setting [UP] 18: DOWN command in UP/DOWN setting [DOWN]<br>19: Write enable for KYEPAD (data can be changed) [WE-KP] 20: PID control cancel [KP/PID]<br>21: Inverse mode change over [IVS] 22: Interlock signal for 52-2 [IL]<br>23: Write enable through link [WE-LK] 24: Operation selection through link [LE]<br>25: Universal DI [U-DI] 26: Pick up start mode [STM] 27: Synchronization command [SYC]<br>28: Zero speed locking command [LOCK] 29: Pre-exciting command [EXITE]<br>30: Speed reference cancel [N-LIM] 31: H41 (torque reference) cancel [H41-CCL]<br>32: H42 (torque current reference) cancel [H42-CCL]<br>33: H43 (magnetic-flux reference) cancel [H43-CCL] 34: F40 (torque limiter mode 1) cancel [F40-CCL]<br>35: Torque limiter (level1, lecel2 selection) [TL2/TL1] 36: Bypass [BPS]<br>37, 38: Torque bias reference 1/2 [37:TB1, 38:TB2] 39: Droop selection [DROOP]<br>40: Ai1 zero hold [ZH-AI1] 41: Ai2 zero hold [ZH-AI2] 42: Ai3 zero hold [ZH-AI3]<br>43: Ai4 zero hold [ZH-AI4] 44: Ai1 polarity change [REV-AI1]<br>45: Ai2 polarity change [REV-AI2] 46: Ai3 polarity change [REV-AI3]<br>47: Ai4 polarity change [REV-AI4]<br>48: PID output inverse changeover [PID-INV] 49: PG alarm cancel [PG-CCL]<br>50: Undervoltage cancel [LU-CCL]<br>51: Ai torque bias hold [H-TB] 52: STOP1 (The motor stops with standard deceleration time) [STOP1]<br>53: STOP2 (The motor decelerates and stops with deceleration time 4) [STOP2]<br>54: STOP3 (The motor stops with torque limiter) [STOP3] 55: DIA card enable [DIA]<br>56: DIB card enable [DIB] 57: Multi-winding motor control cancel [MT-CCL]<br>58, 59, 60, 61, 62, 63: Option Di 1/2/3/4/5/6 [O-DI1 to 6] |
| | X2 | Digital input 2 | |
| | X3 | Digital input 3 | |
| | X4 | Digital input 4 | |
| | X5 | Digital input 5 | |
| | X6 | Digital input 6 | |
| | X7 | Digital input 7 | |
| | X8 | Digital input 8 | |
| | X9 | Digital input 9 | |
| | PLC | PLC signal power supply | Connects to the PLC output signal power supply. |
| | CM | Digital input common | Common terminal to digital input signals. |

# 2. Specifications

| | Symbol | Terminal name | Function |
|---|---|---|---|
| Analog output | AO1 | Analog output 1 | • Provides the monitor signal of 0 to ±10V DC for signals from the following: |
| | AO2 | Analog output 2 | 0: Detected speed (Speedometer, one-way deflection) [N-FB1+] |
| | AO3 | Analog output 3 | 1: Detected speed (Speedometer, two-way deflection) [N-FB1±]<br>2: Speed setting 2 (Before acceleration/deceleration calculation) [N-REF2]<br>3: Speed setting 4 (ASR input) [N-REF4] 4: Detected speed [N-FB2±]<br>5: Detected line speed [LINE-N±]<br>6: Torque current reference (Torque ammeter, two-way deflection) [IT-REF±]<br>7: Torque current reference (Torque ammeter, one-way deflection) [IT-REF+]<br>8: Torque reference (Torque meter, two-way deflection) [T-REF±]<br>9: Torque reference (Torque meter, one-way deflection) [T-REF+]<br>10: Motor current rms value [I-AC] 11: Motor voltage rms value [V-AC] 12: Input power [PWR]<br>13: DC link circuit voltage [V-DC] 14: +10V output test [P10] 15: –10V output test [M10]<br>30: Universal AO [U-AO] 31: Optional AO [O-AO] |
| | M | Analog output common | Common terminal to analog output signals. |
| Transistor output | Y1 | Transistor output 1 | • Outputs the selected signals from the following items: |
| | Y2 | Transistor output 2 | 0: Inverter running [RUN] 1: Speed existence [N-EX] 2: Speed agreement [N-AG] |
| | Y3 | Transistor output 3 | 3: Speed equivalence [N-AR] 4, 5, 6: Detected speed 1/ 2/ 3 [4: N-DT1, 5: N-DT2, 6: N-DT3] |
| | Y4 | Transistor output 4 | 7: Stopping on undervoltage [LU] 8: Detected torque polarity (braking/driving) [B/D]<br>9: Torque limiting [TL] 10, 11: Detected torque [10: T-DT1, 11: T-DT2]<br>12: KEYPAD operation mode [KP] 13: Inverter stopping [STOP]<br>14: Operation ready output [RDY] 15: Magnetic-flux detection signal [MF-DT]<br>16: Motor M2 selection status [16: SW-M2] 17: Motor M3 selection status [16: SW-M3]<br>18: Brake release signal [BRK] 19: Alarm indication1 [AL1] 20: Alarm indication 2 [AL2]<br>21: Alarm indication 3 [AL4] 22: Alarm indication 4 [AL8] 23: Fan operation signal [FAN]<br>24: Auto-resetting [TRY] 25: Universal DO [U-DO] 26: Heat sink overheat early warning [INV-OH]<br>27: Synchronization completion signal [SY-C] 28: Lifetime alarm [LIFE]<br>29: Under accelerating [U-ACC] 30: Under decelerating [U-DEC]<br>31: Inverter overload early warning [INV-OL] 32: Motor temperature early warning [M-OH]<br>33: Motor overload early warning [M-OL] 34: DB overload early warning [DB-OL]<br>35: Link transmission error [LK-ERR] 36: Under ORT [U-ORT]<br>37: ORT completion [ORT-C] 38: Load adaptive control under limiting [ANL]<br>39: Load adaptive control under calculation [ANC] 40: Analog torque bias hold [TBH]<br>41, 42, 43, 44, 45, 46, 47: Optional Do 1/2/3/4/5/6 [O-DO1 to 7] |
| | CME | Transistor output common | Common terminal to transistor output. |
| Relay output | Y5A,Y5C | Relay output | Functions can be selected for signals like Y1 to Y4. |
| | 30A,30B,30C | Alarm relay output<br>(for any fault) | Outputs a non-voltage contact signal (1SPDT) when a protective function is activated to stop inverter.<br>Can select alarm for exciting or non exciting conditions. |
| Commu-nication | RX(+),RX(–)<br>TX(+),TX(–) | RS485 communication input/output | Input/output terminals for RS485 communication.<br>Can connect up to 31 inverters through a multidrop (daisy chain) connection. |
| | SD(M) | Communication shield cable connection | Connects to the shield cable. |
| Speed detection | PA,PB | Pulse generator<br>2-phase signal input | Terminals for connecting 2-phase signal of pulse generator. |
| | PGP,PGM | Pulse generator power supply | +15V DC pulse generator power supply (or can be switched to +12V). |
| | FA,FB | Pulse generator output | Outputs pulse generator signal by dividing by n. The "n" can be changed by function setting. |
| | CM | Pulse generator output common | Common terminals to FA and FB. |
| Temperature detection | TH1,THC | NTC Thermistor<br>PTC Thermistor | Motor temperature can be detected with the NTC and the PTC thermistors.<br>The motor overheat protective level can be specified by the PTC thermistor function. |

## 2.3.3 Terminal Arrangement

### 2.3.3.1 Terminal Arrangement

| Norminal applied motor [kW] | Three-phase 200V series | | Three-phase 400V series | |
|---|---|---|---|---|
| | Inverter type | Fig. | Inverter type | Fig. |
| 0.75 | FRN0.75VG7S–2 | 1 | – | – |
| 1.5 | FRN1.5VG7S–2 | | | |
| 2.2 | FRN2.2VG7S–2 | | | |
| 3.7 | FRN3.7VG7S–2 | 2 | FRN3.7VG7S–4 | 2 |
| 5.5 | FRN5.5VG7S–2 | | FRN5.5VG7S–4 | |
| 7.5 | FRN7.5VG7S–2 | | FRN7.5VG7S–4 | |
| 11 | FRN11VG7S–2 | 3 | FRN11VG7S–4 | 3 |
| 15 | FRN15VG7S–2 | | FRN15VG7S–4 | |
| 18.5 | FRN18.5VG7S–2 | 4 | FRN18.5VG7S–4 | 4 |
| 22 | FRN22VG7S–2 | | FRN22VG7S–4 | |
| 30 | FRN30VG7S–2 | 5 | FRN30VG7S–4 | 5 |
| 37 | FRN37VG7S–2 | 6 | FRN37VG7S–4 | |
| 45 | FRN45VG7S–2 | | FRN45VG7S–4 | |
| 55 | FRN55VG7S–2 | | FRN55VG7S–4 | |
| 75 | FRN75VG7S–2 | 7 | FRN75VG7S–4 | 6 |
| 90 | FRN90VG7S–2 | 8 | FRN90VG7S–4 | |
| 110 | – | – | FRN110VG7S–4 | |
| 132 | | | FRN132VG7S–4 | 8 |
| 160 | | | FRN160VG7S–4 | |
| 200 | | | FRN200VG7S–4 | |
| 220 | | | FRN220VG7S–4 | |
| 280 | | | FRN280VG7S–4 | 9 |
| 315 | | | FRN315VG7S–4 | |
| 355 | | | FRN355VG7S–4 | 10 |
| 400 | | | FRN400VG7S–4 | |

Fig. 1

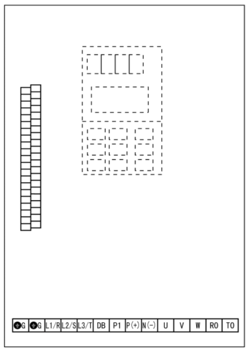


Fig. 2

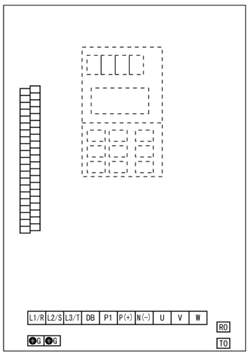


Fig. 3

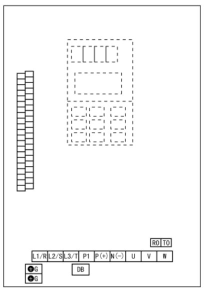


Fig. 4

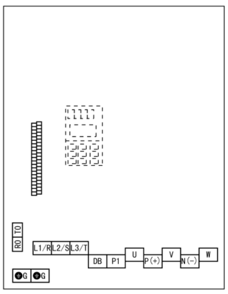


Fig. 5

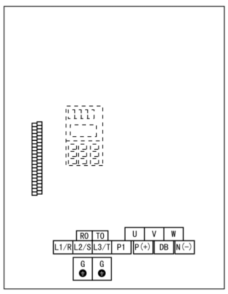


Fig. 6

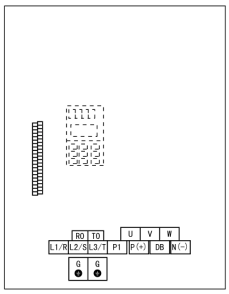


Fig. 7

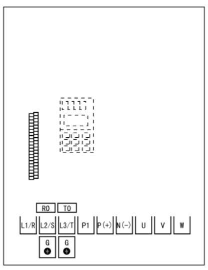


Fig. 8

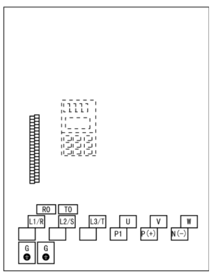


Fig. 9

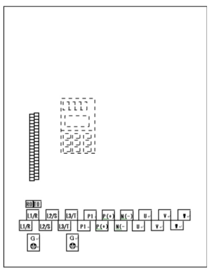
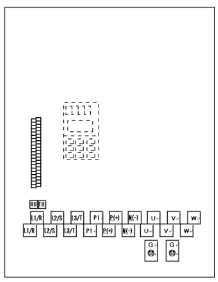


Fig. 10



See the next page for details of terminal arrangement.

## 2.3.3.2 Terminal Arrangement Chart

● Main circuit terminals

Three-phase 200V series

| Nominal applied motor [kW] | Inverter type | Fig. | Nominal applied motor [kW] | Inverter type | Fig. |
|---|---|---|---|---|---|
| 0.75 | FRN0.75VG7S–2 | 1 | 18.5 | FRN18.5VG7S–2 | 4 |
| 1.5 | FRN1.5VG7S–2 | | 22 | FRN22VG7S–2 | |
| 2.2 | FRN2.2VG7S–2 | | 30 | FRN30VG7S–2 | 5 |
| 3.7 | FRN3.7VG7S–2 | 2 | 37 | FRN37VG7S–2 | 6 |
| 5.5 | FRN5.5VG7S–2 | | 45 | FRN45VG7S–2 | |
| 7.5 | FRN7.5VG7S–2 | | 55 | FRN55VG7S–2 | |
| 11 | FRN11VG7S–2 | 3 | 75 | FRN75VG7S–2 | 7 |
| 15 | FRN15VG7S–2 | | 90 | FRN90VG7S–2 | 8 |

Fig. 1

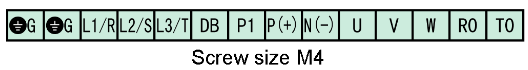



Fig. 2

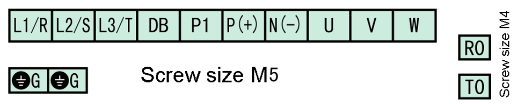



Fig. 3

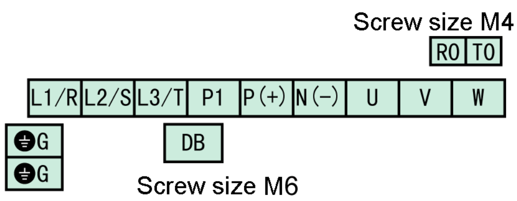



Fig. 4

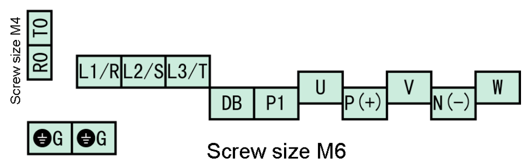



Fig. 5

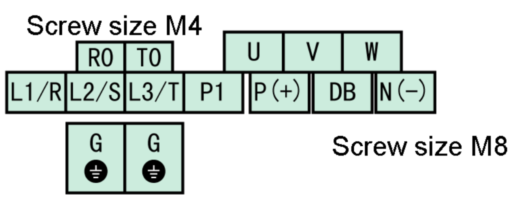



Fig. 6

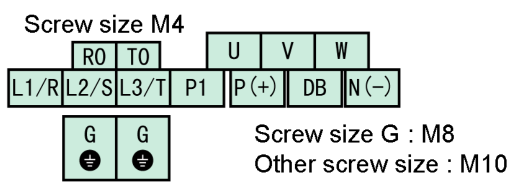



Fig. 7

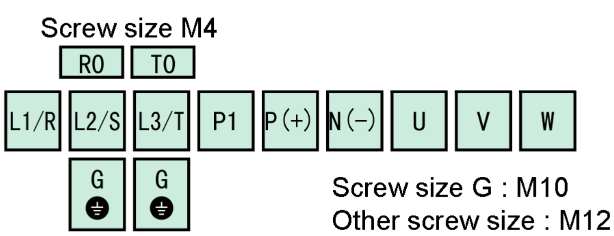
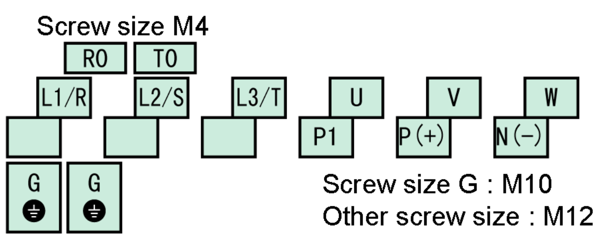



Fig. 8



## Three-phase 400V series

| Nominal applied motor [kW] | Inverter type | Fig. | Nominal applied motor [kW] | Inverter type | Fig. |
|---|---|---|---|---|---|
| 3.7 | FRN3.7VG7S–4 | 1 | 75 | FRN75VG7S–4 | 5 |
| 5.5 | FRN5.5VG7S–4 | | 90 | FRN90VG7S–4 | |
| 7.5 | FRN7.5VG7S–4 | | 110 | FRN110VG7S–4 | |
| 11 | FRN11VG7S–4 | 2 | 132 | FRN132VG7S–4 | 6 |
| 15 | FRN15VG7S–4 | | 160 | FRN160VG7S–4 | |
| 18.5 | FRN18.5VG7S–4 | 3 | 200 | FRN200VG7S–4 | |
| 22 | FRN22VG7S–4 | | 220 | FRN220VG7S–4 | |
| 30 | FRN30VG7S–4 | 4 | 280 | FRN280VG7S–4 | 7 |
| 37 | FRN37VG7S–4 | | 315 | FRN315VG7S–4 | |
| 45 | FRN45VG7S–4 | | 355 | FRN355VG7S–4 | 8 |
| 55 | FRN55VG7S–4 | | 400 | FRN400VG7S–4 | |

Fig. 1

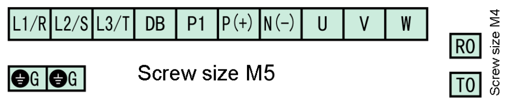



Fig. 2

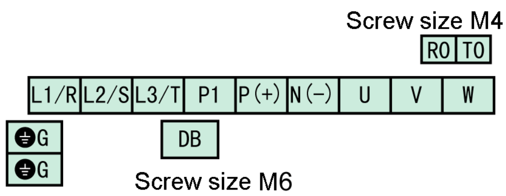



Fig. 3

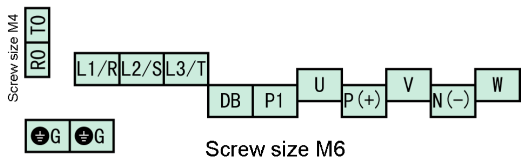



Fig. 4

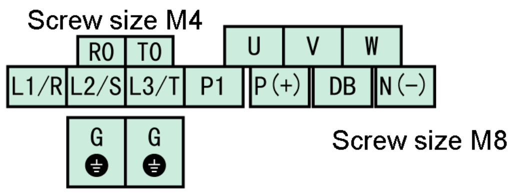



Fig. 5

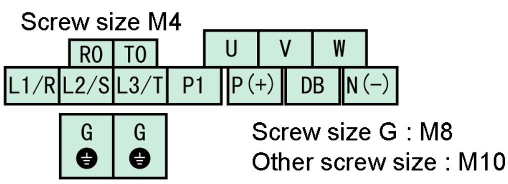



Fig. 6

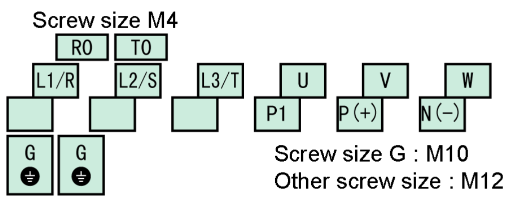



Fig. 7

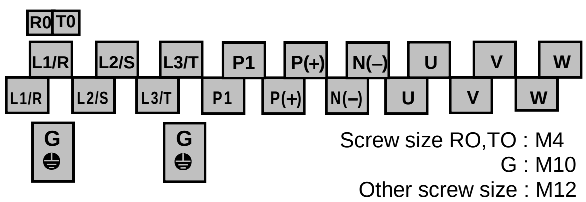
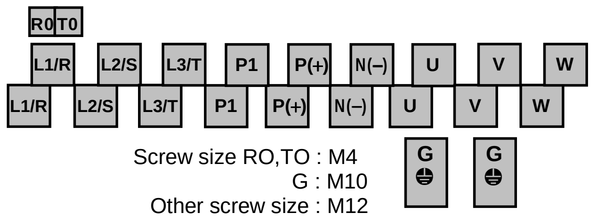
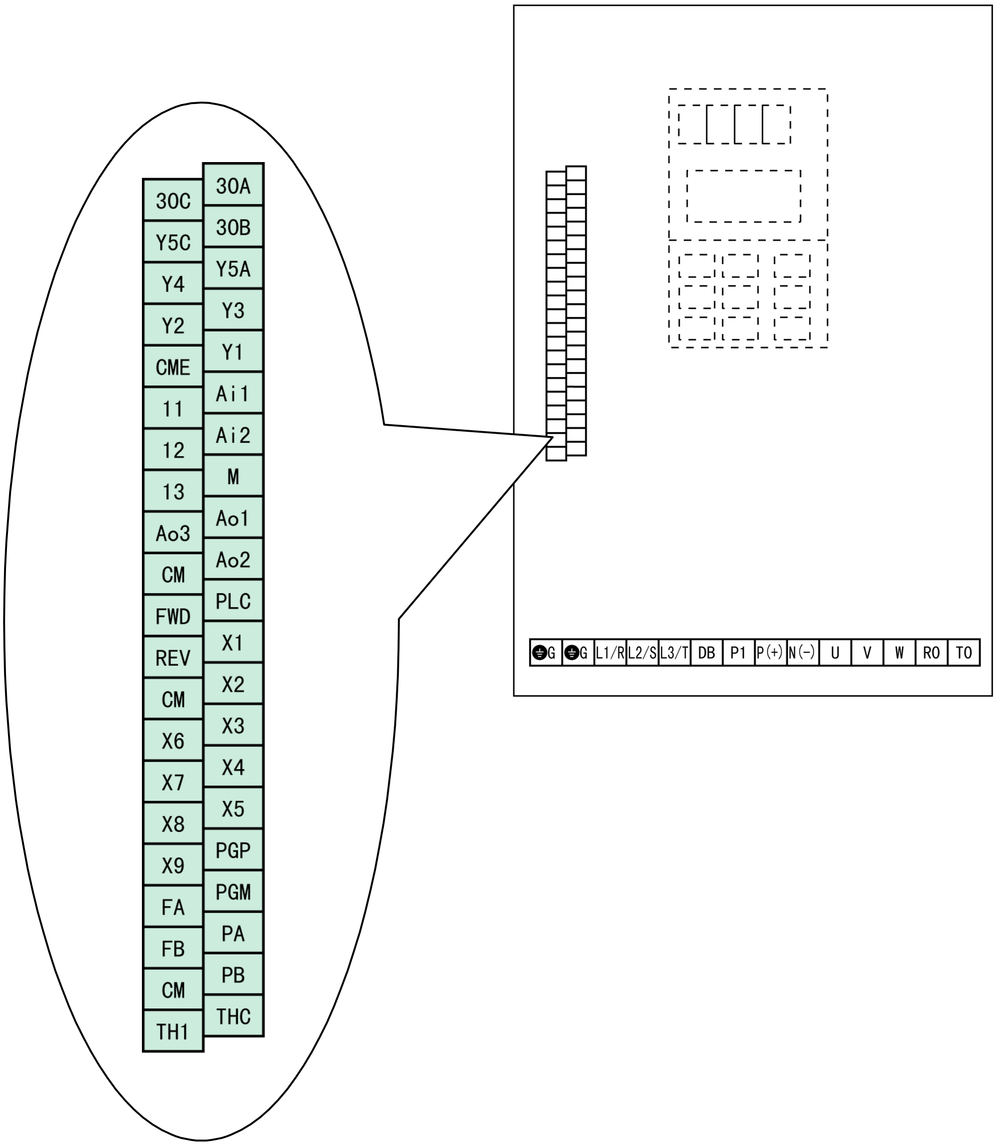



Fig. 8



- Control circuit terminals



## 2.3.3.3 Terminal Size

● Main circuit terminals

| Power suplly voltage | Nominal applied motor [kW] | Inverter type | Size | | |
|---|---|---|---|---|---|
| | | | L1/R,L2/S,L3/T,DB,P1, P(+),N(–),U,V,W | G | R0,T0 |
| Three-phase 200V series | 0.75 | FRN0.75VG7S–2 | M4 | M4 | M4 |
| | 1.5 | FRN1.5VG7S–2 | | | |
| | 2.2 | FRN2.2VG7S–2 | | | |
| | 3.7 | FRN3.7VG7S–2 | M5 | M5 | M4 |
| | 5.5 | FRN5.5VG7S–2 | | | |
| | 7.5 | FRN7.5VG7S–2 | | | |
| | 11 | FRN11VG7S–2 | M6 | M6 | M4 |
| | 15 | FRN15VG7S–2 | | | |
| | 18.5 | FRN18.5VG7S–2 | M6 | M6 | M4 |
| | 22 | FRN22VG7S–2 | | | |
| | 30 | FRN30VG7S–2 | M8 | M8 | M4 |
| | 37 | FRN37VG7S–2 | M10 | M8 | M4 |
| | 45 | FRN45VG7S–2 | | | |
| | 55 | FRN55VG7S–2 | | | |
| | 75 | FRN75VG7S–2 | M12 | M10 | M4 |
| | 90 | FRN90VG7S–2 | M12 | M10 | M4 |
| Three-phase 400V series | 3.7 | FRN3.7VG7S–4 | M5 | M5 | M4 |
| | 5.5 | FRN5.5VG7S–4 | | | |
| | 7.5 | FRN7.5VG7S–4 | | | |
| | 11 | FRN11VG7S–4 | M6 | M6 | M4 |
| | 15 | FRN15VG7S–4 | | | |
| | 18.5 | FRN18.5VG7S–4 | M6 | M6 | M4 |
| | 22 | FRN22VG7S–4 | | | |
| | 30 | FRN30VG7S–4 | M8 | M8 | M4 |
| | 37 | FRN37VG7S–4 | | | |
| | 45 | FRN45VG7S–4 | | | |
| | 55 | FRN55VG7S–4 | | | |
| | 75 | FRN75VG7S–4 | M10 | M8 | M4 |
| | 90 | FRN90VG7S–4 | | | |
| | 110 | FRN110VG7S–4 | | | |
| | 132 | FRN132VG7S–4 | M12 | M10 | M4 |
| | 160 | FRN160VG7S–4 | | | |
| | 200 | FRN200VG7S–4 | | | |
| | 220 | FRN220VG7S–4 | | | |
| | 280 | FRN280VG7S–4 | | | |
| | 315 | FRN315VG7S–4 | | | |
| | 355 | FRN355VG7S–4 | | | |
| | 400 | FRN400VG7S–4 | | | |

● Control circuit terminals

M3 : Common to all types.

- MEMO -

THE INVERTER

# Ⅲ. Preparatory Operations and Test Run

# 3. Preparatory Operations and Test Run

## 3.1 Before Use

### 3.1.1 Inspection After Receipt

Unpackage the product and perform the following checks.
If the product is found to have a fault, please contact the dealer from which you purchased the product or the nearest sales office of Fuji Electric.
(1) Read the nameplate to check that the product is the same thing as ordered.

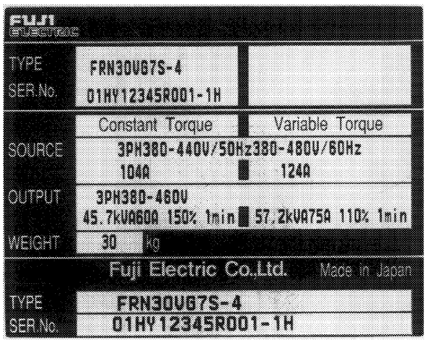



Figure 3-1-1 Nameplate

TYPE: Inverter type
FRN 30 VG7S - 4
- 4: Voltage class: 2 for 200V or 4 for 400V
- VG7S: Series name: VG7S
- 30: Applicable motor capacity: 30 for 30 kW
- FRN: Model :FRENIC5000

SOURCE : Power ratings
OUTPUT : Rated output
MASS : Mass
SER.No. : Serial No.

0 1 HY12345R001 - 1H
- 1H: Product No.
- HY12345R001: Serial lot No.
- 1: Month of manufacture:1 to 9 for January to September, X for October, Y for November,or Z for December
- 0: Year of manufacture:Last digit of A.D. (0 for 2000)

(2) Check for broken or missing parts and damage caused to the cover/body during transportation.
(3) In addition to the inverter body and instruction manual, a rubber bushing is included in the package (for 15kW or lower inverters).

| ⚠WARNING |
|---|
| • Do not energize a product with broken or missing parts or damaged during transportation. **Doing so may lead to electric shock or fire.** |

### 3.1.2 External View of the Product

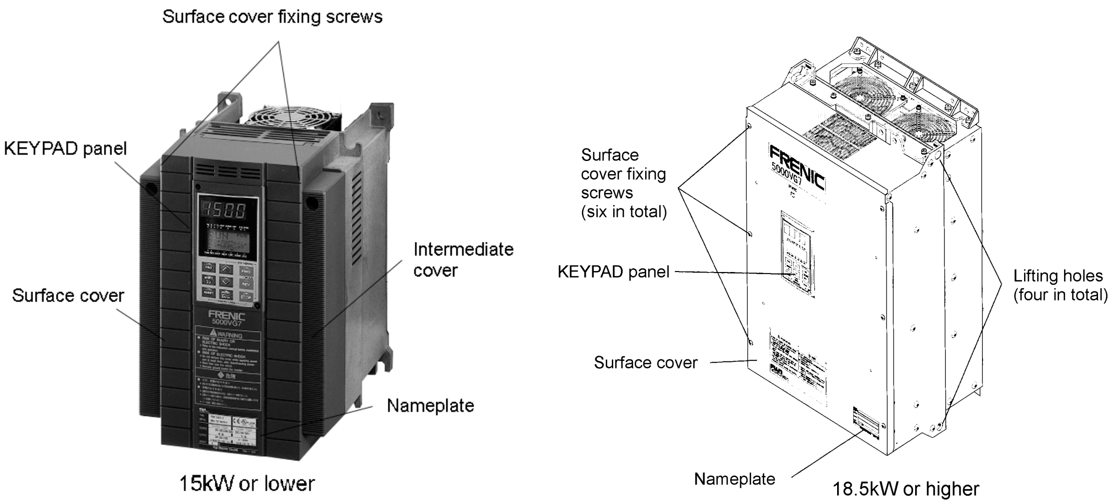



Figure 3-1-2 External View of the Product

## 3.1.3 Handling of the Product

(1) Removal of Surface Cover

Loosen the surface cover fixing screws. Remove the cover by pulling the top of the cover as shown in Figure 3-1-3.

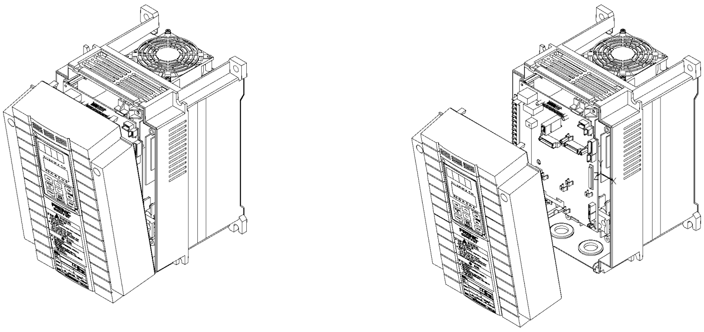


Figure 3-1-3 Removal of Surface Cover (15 kW or lower)

Remove the six surface cover fixing screws. Remove the surface cover.

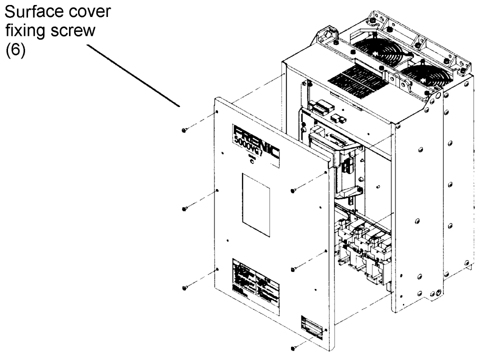



Figure 3-1-4 Removal of Surface Cover (18.5 kW or higher)

(2) Removal of KEYPAD Panel

After removing the face cover in step (1), loosen the KEYPAD panel fixing screws. Remove the KEYPAD panel as shown in Figure 1-3-3.

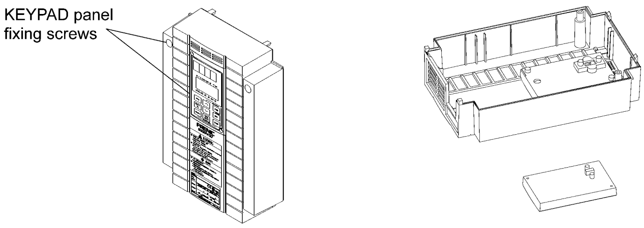



Figure 3-1-5 Removal of KEYPAD Panel (15 kW or lower)

Loosen the KEYPAD panel fixing screws. Carefully remove the KEYPAD panel with your fingers inserted to the cutouts at the side of the KEYPAD panel. Careless handling may break connectors.

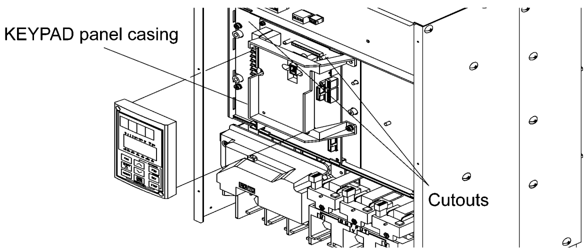



Figure 3-1-6 Removal of KEYPAD Panel (18.5 kW or higher)

## 3.1.4 Transportation

Always hold the body during transportation.
Do not hold the cover or any other part. Doing so may break or fall the product.
When using a hoist or crane to transport a product with lifting holes, hang hooks and ropes to the holes.

## 3.1.5 Storage

### *Temporary Storage*

Store the product under the conditions specified on Table 3-1-1.

Table 3-1-1 Storage Conditions

| Item | Requirement | |
|---|---|---|
| Ambient temperature | -10 to +50 °C | No condensation or freezing should occur due to sudden temperature changes. |
| Storage temperature [See Note 1] | -25 to +65 °C | |
| Relative humidity | 5% to 95% [See Note 2] | |
| Atmosphere | The product should not be exposed to dust, direct sunlight, corrosive or combustible gas, oil mist, vapor, waterdrops, vibration, or air containing much salt. | |

Note 1: The storage temperature applies to the temporary storage during transportation, for example.
Note 2: Do not store the product in a place where the temperature significantly changes as this may cause condensation or freezing even if the humidity requirement is satisfied.

(1) Do not place the product directly on the floor.
(2) Pack the product with a plastic sheet or such if stored under undesirable conditions.
(3) Seal in a desiccative such as silica gel when packing the product if it may be affected by moisture.

### *Extended Storage*

The requirements to be satisfied when storing the product for an extended period after purchased greatly depend on the environment. General requirements are listed below.

(1) Satisfy the requirements for temporary storage.
If the storage period exceeds three months, the ambient temperature should be kept below 30 °C to protect the dead electrolytic capacitor from deterioration.
(2) Carefully pack the product to prevent the intrusion of moisture, etc. Seal in a desiccant to keep the relative humidity inside the pack below 70%, as a guide.
(3) The product will be often exposed to moisture or dust if left mounted on an unit or console, especially in a building under construction. In such a case, remove the product and relocate in a well-conditioned place.
The electrolytic capacitor will be deteriorated if left dead for an extended period. Do not leave it dead for a period exceeding a year.

## 3.2 Installation and Connection

### 3.2.1 Operating Conditions

Install the product under the conditions specified in Table 3-2-1.

Table 3-2-1 Operating Conditions

| Item | Requirement |
|---|---|
| Place | Indoor |
| Ambient temperature | -10 to +50 °C |
| Relative humidity | 5% to 95% (no condensation allowed) |
| Atmosphere | The product should not be exposed to dust, direct sunlight, corrosive gas, oil mist, vapor, waterdrops, or air containing much salt.<br>No condensation should occur due to sudden temperature changes. |
| Altitude | 1,000m or less (if more than 1,000m, see Table 2-1-2) |
| Vibration | 2 to 9Hz: 3mm amplitude<br>9 to 20Hz: 9.8m/s$^2$ (or 2m/s$^2$ for 200V, 75kW or higher and 400V, 90kW or higher inverters) |
| | 20 to 55Hz: 2m/s$^2$<br>55 to 200Hz: 1m/s$^2$ |

Table 3-2-2 Output Reduction Rates at Higher Altitudes

| Altitude | Output Current Reduction Rate |
|---|---|
| 1,000m or less | 1.00 |
| 1,000-1,500m | 0.97 |
| 1,500-2,000m | 0.95 |
| 2,000-2,500m | 0.91 |
| 2,500-3,000m | 0.88 |

## 3.2.2 Installation Procedure

(1) Install the product onto a rigid structure in the vertical direction with the letters, FRENIC5000 VG7S, seen from the front and fix with specified bolts. Do not install upside down or in the horizontal direction.

| ⚠CAUTION |
|---|
| **Failure to do so may lead to injury.** |

(2) The inverter generates heat during operation. Reserve a space as shown in Figure 3-2-1 to ensure a sufficient flow of cooling air. The heat is radiated from the top. Do not install the inverter under any unit susceptible to heat.

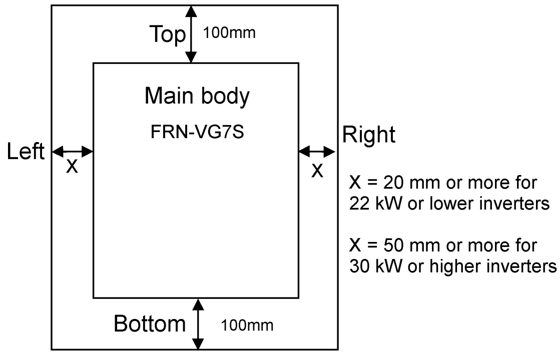



Figure 3-2-1

(3) The cooling fins (heat sink) are heated to almost 90 °C during operation of the inverter. The inverter mounting surface should be made of a material capable of withstanding this temperature rise.

| ⚠CAUTION |
|---|
| **The fins may burn your skin.** |

| ⚠WARNING |
|---|
| • Install the inverter onto an incombustible material such as metal.<br>**Failure to do so may lead to fire.** |

(4) When storing the inverter in a control panel, for example, sufficiently ventilate the inverter so that its ambient temperature will not exceed the specified limit. Do not store the inverter in a small closed box that does not radiate heat well.

(5) When storing two or more inverters in a unit or control panel, they are desirably arranged side by side to minimize the thermal effect on each other. If they are inevitably arranged with one above another, separating plate should be provided to prevent the heat transfer from the bottom side inverter to the above.

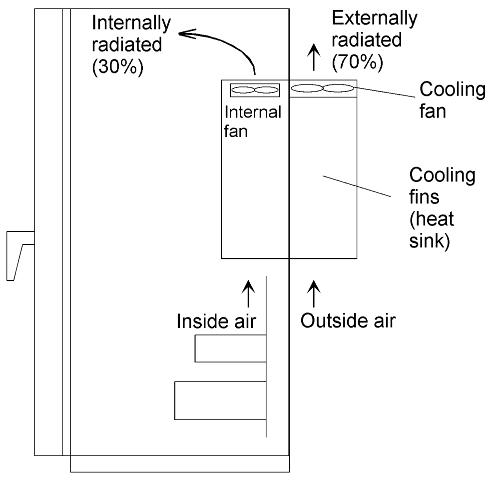



Figure 3-2-2 External Cooling System

(6) The inverter is prepared to be mounted in a control panel when delivered. It may be externally cooled using the optional adapter if 15kW or lower or with the mounting legs relocated if 18.5kW or higher. With the inverter externally cooled, the heat generated inside the unit or control panel is dissipated because the cooling fins, which radiate 70% of the generated heat, are excluded from the unit or control panel.
Do not exclude the cooling fins where they may be clogged with lint or damp dust.

| ⚠CAUTION |
|---|
| • Do not admit lint, paper, wooden chips, dust, metallic pieces, and any other foreign matters into the inverter or allow them to stick to the cooling fins.<br>**Doing so may lead to fire or accident.** |

To externally cool a 18.5kW or higher inverter, relocate the upper and lower mounting legs as shown in Figure 3-2-3. Remove the mounting leg fixing screws, relocate the legs, and fix with casing fixing screws. (The casing fixing screws cannot be directly used for some models. See the following table.) The mounting leg fixing screws become unnecessary after the legs are relocated.

Number and Size of Fixing Screws

| Voltage class | Inverter model | Mounting leg fixing screws | Casing fixing screws |
|---|---|---|---|
| 200V | FRN18.5VG7S-2~FRN55VG7S-2 | 5(M6 × 20) | 5(M5 × 16) |
| | FRN75VG7S-2 | 7(M6 × 20) | 7(M5 × 16) |
| | FRN90VG7S-2 | 6(M6 × 20) | 6(M5 × 16) |
| 400V | FRN18.5VG7S-4~FRN75VG7S-4 | 5(M6 × 20) | 5(M5 × 16) |
| | FRN90VG7S-4~FRN110VG7S-4 | 7(M6 × 20) | 7(M5 × 16) Note 1 |
| | FRN132VG7S-4~FRN160VG7S-4 | 7(M6 × 20) | 7(M5 × 16) |
| | FRN200VG7S-4~FRN220VG7S-4 | 6(M6 × 20) | 6(M5 × 16) Note 1 |
| | FRN280VG7S-4~FRN315VG7S-4 Note 3 | 6(M8 × 20) | – Note 2 |
| | FRN355VG7S-4~FRN400VG7S-4 Note 3 | 8(M8 × 20) | |

| ⚠CAUTION |
|---|
| • Do not use any screws other than specified.<br>**Doing so may lead to fire or accident.** |

Note 1: Fix the legs with M5 × 20 screws.
Note 2: Fix the legs with leg fixing screws.
Note 3: The lower leg becomes unnecessary when the inverter is installed on its bottom.

Preparatory Operations and Test Run

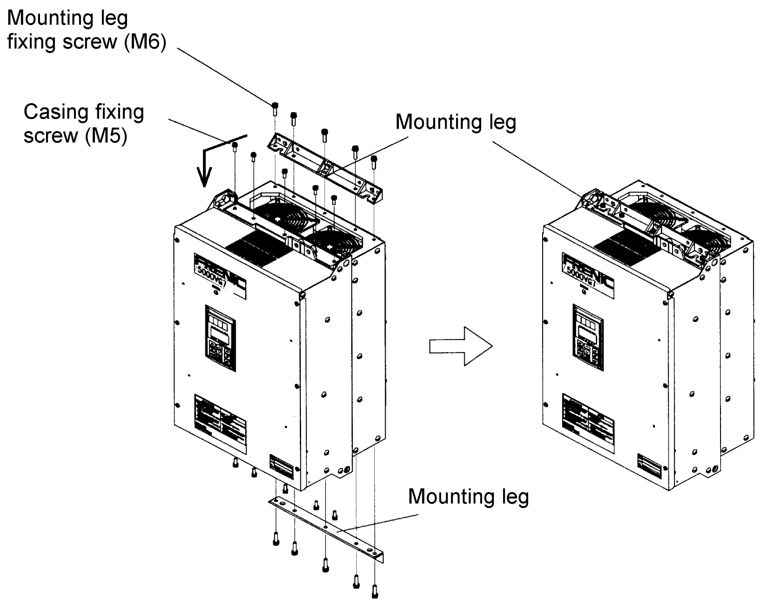



Figure 3-2-3

| ⚠CAUTION |
|---|
| • Use the screws provided with the inverter when relocating the mounting legs.<br>**Failure to do so may lead to injury.** |

# 3.3 Electric Connections

Removing the surface cover exposes the terminal blocks. Correctly wire them after reading the following instructions.

## 3.3.1 Basic Connections

(1) Connect power supply leads to the main circuit power terminals, L1/R, L2/S, and L3/T. Connecting any power supply lead to another terminal may fail the inverter. Check that the supply voltage does not exceed the permissible limit indicated on the nameplate, etc.
(2) The grounding terminal must be grounded to prevent disasters such as electric shock and fire and reduce the noise.
(3) Use a reliable crimp terminal to connect each lead.
(4) After making connections (wiring), check that:
1) leads are correctly connected,
2) all necessary connections are made, and
3) no terminal or wire is short-circuited or grounded.
(5) When any connection is changed after the inverter is energized:
It takes a long time for the smoothing capacitor in the DC link circuit of the main circuit to be discharged after the power supply is shut off. After the CHARGE lamp goes off, check with a multimeter or such that the DC voltage has been reduced to a safe level (25V DC or less). Short-circuiting a circuit in which a voltage (potential) still remains may generate sparks. Wait until the voltage goes away.

| ⚠WARNING |
|---|
| • Always connect the grounding lead.<br>**Failure to do so may lead to electric shock or fire.**<br>• The wiring work should be performed by qualified persons.<br>• Before working, check that the power supply is shut off (open).<br>**Failure to do so may lead to electric shock.**<br>• Do not use any lead size other than specified.<br>**Doing so may lead to fire.** |

The basic connection diagram is given in Subsection 2.3.1.

## 3.3.2 Wiring of Main Circuit and Grounding Terminals

Table 3-3-1 Functions of Main Circuit and Grounding Terminals

| Terminal symbol | Terminal name | Description |
|---|---|---|
| L1/R,L2/S,L3/T | Main circuit power input terminals | Connected with three-phase power source. |
| U,V,W | Inverter output terminals | Connected with three-phase motor. |
| R0,T0 | Auxiliary control power input terminals | Connected with the same AC power source as used for main circuit, as back-up power source for control circuit. |
| P1,P(+) | DC REACTOR connecting terminals | Connected with (optional) input power-factor correcting DC REACTOR. |
| P(+),DB | Braking resistor connecting terminals | Connected with (optional) braking resistor. |
| P(+),N(-) | DC link circuit terminals | Supplies DC link circuit voltage. Connected with (optional) external braking unit or (optional) power regenerative unit. |
| ⏚ G | Inverter grounding terminals | Grounds inverter chassis (casing). Connected with earth. |

(1) Main circuit power input terminals (L1/R, L2/S, and L3/T)

1) The main circuit power input terminals, L1/R, L2/S, and L3/T should be connected with the power source via earth-leakage circuit breaker for line protection. Any phase may be connected to any lead. If the zero-phase current is detectable by the upstream system, however, ordinary circuit breakers may be used.
2) Connect a magnetic contactor so that the inverter can be disconnected from the power source to minimize the influence of any failure when the inverter protective function is activated.
3) Do not start or stop the inverter by turning the main power switch on or off. Use the control circuit terminals, FWD and REV, or the FWD, REV, and STOP keys on the KEYPAD panel to start or stop the inverter. When the inverter is inevitably started or stopped using the main power switch, do not turn it on or off more than once per hour.
4) Do not connect any terminal to a single-phase power source.

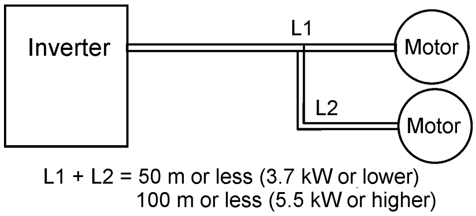
(2) Inverter output terminals (U, V, and W)

1) Connect three-phase motor leads to the inverter output terminals, U, V, and W with care not to connect a wrong phase.

2) Do not connect a phase advancing capacitor or surge absorber (suppressor) to the inverter output terminals.

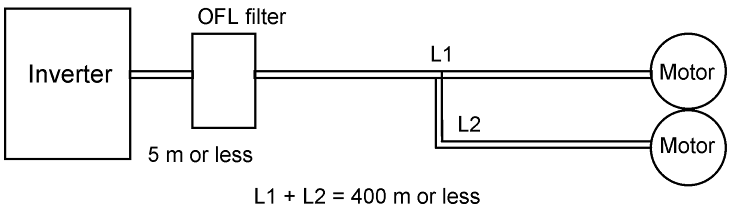
3) If the wiring between the inverter and the motor is too long, a high-frequency current will run through the wiring due to floating capacity to trip the inverter because of overcurrent, increase the leakage current, and/or deteriorate the current indication accuracy. Therefore, the motor wiring length should not exceed 50m for 3.7kW or lower inverters or 100m for others, as a guide. Connect the optional output circuit filter (OFL filter) if the wiring is too long.

Without output circuit filter




When two or more motors are to be driven, the total length of wirings to those motors should not exceed 50m for 3.7kW or lower inverters or 100m for 5.5kW or higher ones.

With output circuit filter




When two or more motors are to be driven, the total length of wirings to those motors should not exceed 400m.

Note: When a thermal relay is used between the inverter and the motor, especially for 400V series, the thermal relay may malfunction even with a wiring length less than 50m. In this case, connect an OFL filter or reduce the inverter operation noise (carrier frequency) using function code F26 (motor sound (carrier frequency)).

• **Driving a 400V motor with an inverter**

If a motor is driven with a PWM inverter, the surge voltage generated by switching inverter elements is overlapped as applied to the motor terminals. Especially for 400V motors, the motor insulation may be deteriorated by the surge voltage if the motor wiring is too long. Therefore, any of the following measures should be taken when a 400V motor is to be driven with an inverter.

1) Use a motor with reinforced insulation (all the Fuji Electric's general-purpose motors have reinforced insulation).

2) Connect the optional output circuit filter (OFL filter) to the inverter output terminals.

3) Shorten the wiring between the inverter and the motor as short as possible (to10 to 20m or less).

(3) Auxiliary control power input terminals (R0 and T0)
If the magnetic contactor in the power supply circuit to the inverter is turned off (open) when the protection circuit is activated, the inverter control power supply is shut off. As a result, alarm outputs (30A, B, and C) are no longer retained and indications on the KEYPAD panel go away. To prevent this, the same AC voltage as used for the main circuit is applied to the auxiliary control power input terminals, R0 and T0.
Although the inverter functions with no voltage applied to these terminals, it is strongly recommended to connect the voltage to R0 and T0 to ensure safe operation.

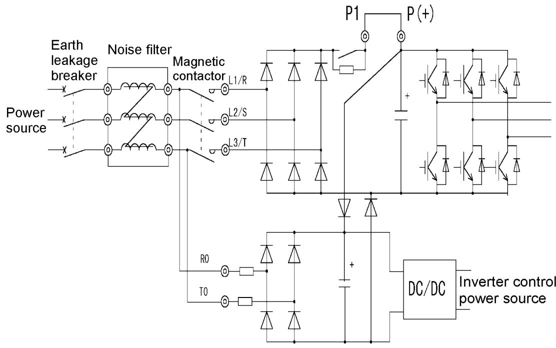



Figure 3-3-1 Wiring of Auxiliary Control Power Input Terminals

1) When a radio noise filter is used, the power to be connected to the auxiliary control power input terminals, R0 and T0, should be taken from a point downstream the filter.
If it is taken from a point upstream the filter, the noise reduction effect is impaired.

(4) DC REACTOR connecting terminals (P1 and P(+))
1) These terminals are provided to connect the optional input power-factor correcting DC REACTOR. A jumper is connected between the terminals before delivery from the factory. **Remove the jumper before connecting the DC REACTOR.**
2) Do not remove the jumper when the DC reactor is not used.

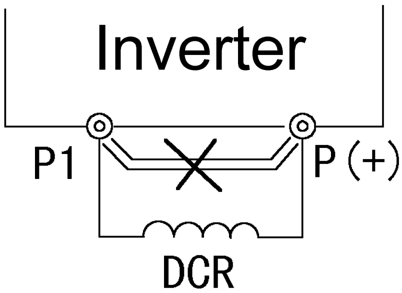



Figure 3-3-2

Note: The DC REACTORS are (externally) provided as standard equipment for 75 kW or higher inverters. Always use the DC REACTOR for those inverters.

(5) Braking resistor connecting terminals (P(+) and DB)

The optional braking resistor may be externally mounted. It is required when the inverter is operated frequently or under heavy inertia.

1) Connect the braking resistor terminals, P(+) and DB, to the inverter terminals, P(+) and DB.
2) Lay out so that the wiring length will not exceed 5m. The two leads should be twisted or in close contact (parallel).

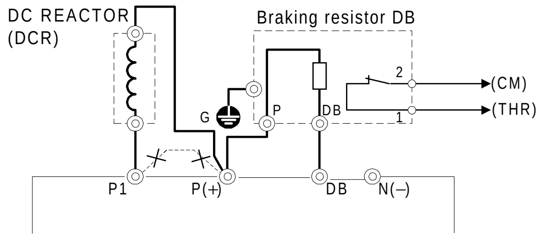



Figure 3-3-3 Connection Diagram
(For 200V, 55kW or Lower and 400V, 110kW or Lower Inverters)

| ⚠CAUTION |
|---|
| • Do not directly connect the braking resistor to the DC terminals, P(+) and N(–).<br>**Doing so may lead to fire.** |

(6) DC link circuit terminals (P(+) and N(–))

The 200V series, 75kW or higher and 400V series, 132kW or higher inverters contain no braking resistor drive circuit. When the braking resistor is required, a braking unit should be used.

1) Connect the braking unit terminals, P(+) and N(–), to the inverter terminals, P(+) and N(–). Lay out so that the wiring length will not exceed 5m. The two leads should be twisted or in close contact (parallel).
2) Connect the braking resistor terminals, P (+) and DB, to the braking unit terminals, P (+) and DB. Lay out so that the wiring length will not exceed 10m.
   The two leads should be twisted or in close contact (parallel).
   When the inverter terminals, P(+) and N(–), are not used, they should be left open. Never short these terminals or directly connect the braking resistor.
   Doing so may break the inverter.
3) Auxiliary contacts 1 and 2 of the braking unit have polarity. When connecting a power regenerative unit, see the instruction manual for the unit.

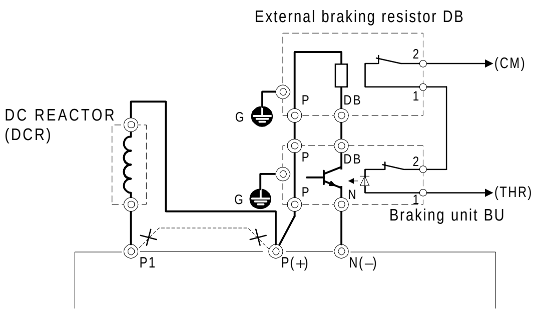



Figure 3-3-4 Connection Diagram
(200V, 75kW or Higher and 400V, 132kW or Higher Inverters)

(7) Inverter grounding terminals (⏚ G)

The inverter grounding terminals, ⏚ G, must be grounded to ensure your safety and for noise measures. The Technical Standards for Electric Equipment requires metallic frames of electric equipment be grounded to prevent disasters such as electric shock and fire. Connect the terminals as described below.

1) Connect to type D grounded poles for 200V series or type C grounded poles for 400V series according to the Technical Standards for Electric Equipment.
2) Connect the earth terminal to the dedicated grounding pole of the inverter system using a thick, short lead.

Table 3-3-2

| Voltage class | Grounding work class | Grounding resistance |
|---|---|---|
| 200V | Type D | 100 Ω or less |
| 400V | Type C | 10 Ω or less |

(8) Auxiliary power switching connector (CN UX) (18.5kW or higher)

For 18.5kW or higher inverters, if the supply voltage to the main circuit is within the range shown in Table 3-3-3, reconnect the auxiliary power switching connector, CN UX, to U2. For other inverters, leave the connector connected to U1. For details, see Figure 3-3-7.

Table 3-3-3 Voltage Ranges Requiring Reconnection of Auxiliary Power Switching Connector

| Frequency [Hz] | Supply voltage range [ V ] |
|---|---|
| 50 | 380 to 398 |
| 60 | 380 to 430 |

⚠CAUTION

- Check that the number of phases and rated voltage of the product agree with those of the AC power source.
- Do not connect any AC power source to the output terminals, U, V, and W.

**Doing so may lead to injury.**

(9) Fan power switching connector (CN RXTX) (18.5kW or higher)

The VG7S accepts DC power inputs through a common DC terminal without using any optional equipment when combined with a power regenerative converter (RHC series) as shown in Figure 3-3-6.

However, 18.5kW or higher inverters contain AC power operated parts such as AC cooling fan. When such DC power inputs are used, reconnect the fan power switching connector, CN RXTX, inside the inverter to R0-T0 as shown in Figure 3-3-5 and apply an AC power to the terminals, R0 and T0.

For details, see Figure 3-3-7.

Note: The fan power switching connector, CN RXTX, is normally connected to L1/R-L3/T. Do not reconnect the connector when no DC power inputs are used.
Always connect the same AC voltage as used for the main circuit to the auxiliary control power input terminals, R0 and T0. Failure to do so deactivates the fan, which may overheat (OH1) and then fail the inverter.

⚠CAUTION

- Do not connect the fan power switching connector, CN RXTX, inside the inverter to a wrong terminal.

**Doing so may fail the inverter.**

- When DC power inputs are used, apply an AC power to R0 and T0 to drive the fan.

**Failure to do so may fail the inverter.**

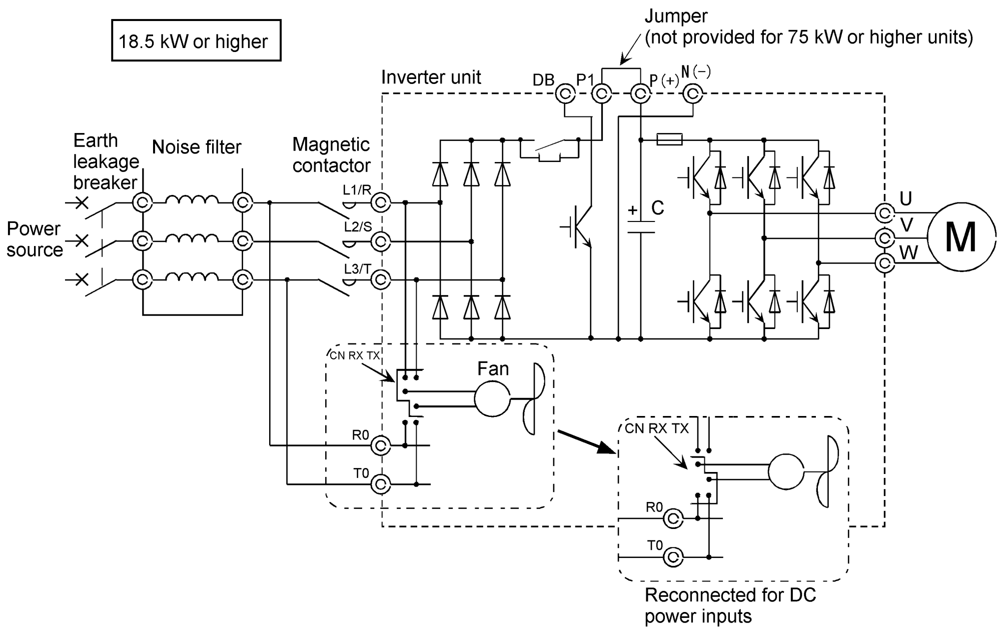



Figure 3-3-5 Reconnection of Fan Power Switching Connector

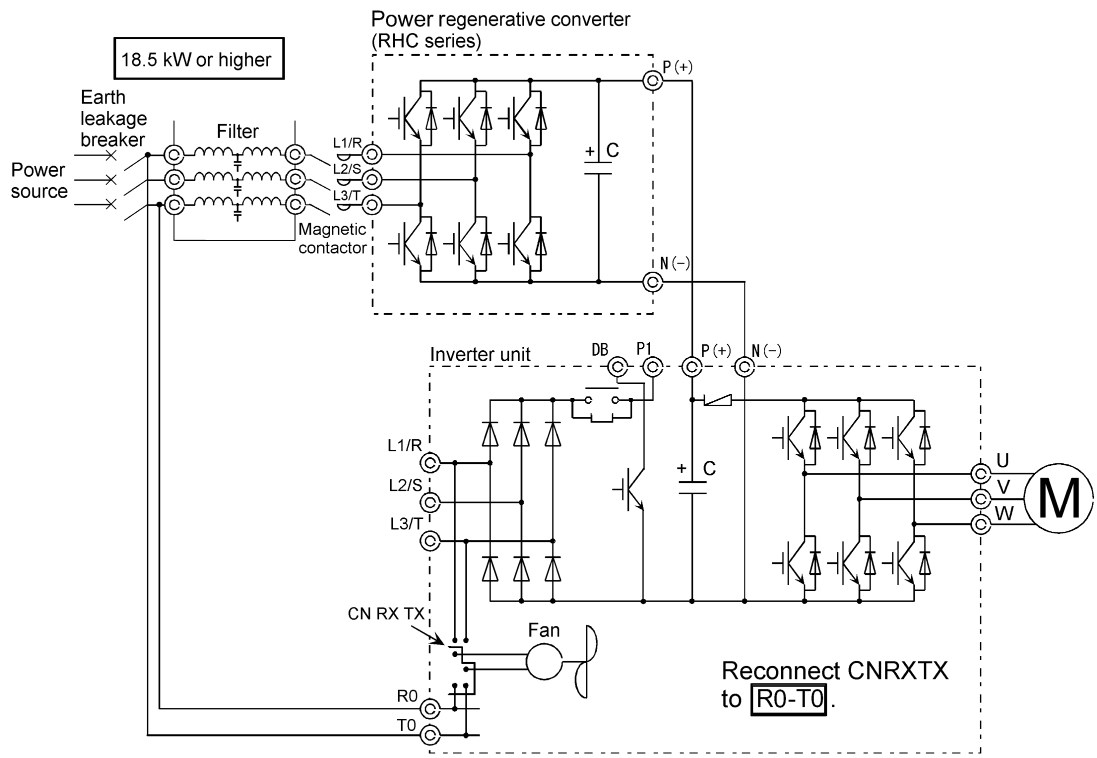


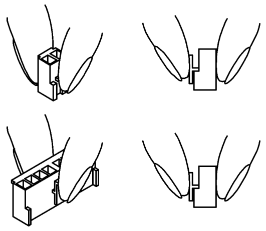

Figure 3-3-6 An Example of Wiring of Inverter Combined with Power Regenerative Converter

Note 1: When a 15 kW or lower inverter is combined with a power regenerative converter, do not directly connect any power source to the auxiliary control power input terminals, R0 and T0. If connected to these terminals, the power source should be insulated from the main power supply to the regenerative converter with insulating transformer.
Examples of wiring of the regenerative converter are given in the instruction manual for regenerative unit.

Note 2: 200 V, 75 kW or higher and 400 V, 132 kW or higher inverters contain no braking transistor.

# 3. Preparatory Operations and Test Run

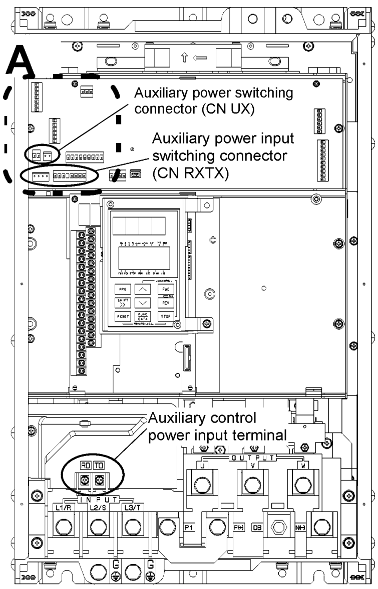
The switching connectors are mounted in the power PC board at the top of the control circuit PC board.



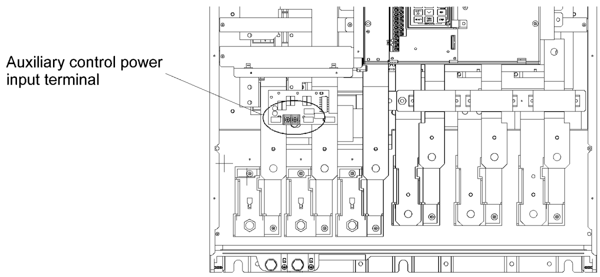
CNUX

CNRXTX

Note: When removing either connector, hold the top of the jaw between fingers to release the latch and remove by pulling upward.
When mounting, fully insert the connector and apply the latch until it clicks.

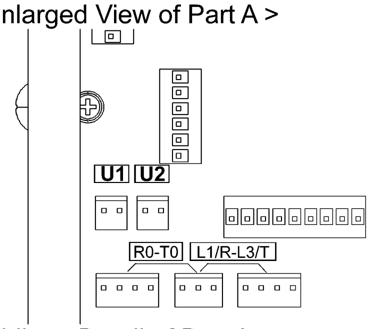



FRN18.5VG7S-2 to FRN55VG7S-2
FRN18.5VG7S-4 to FRN110VG7S-4




FRN75VG7S-2 to FRN90VG7S-2
FRN132VG7S-4 to FRN220VG7S-4

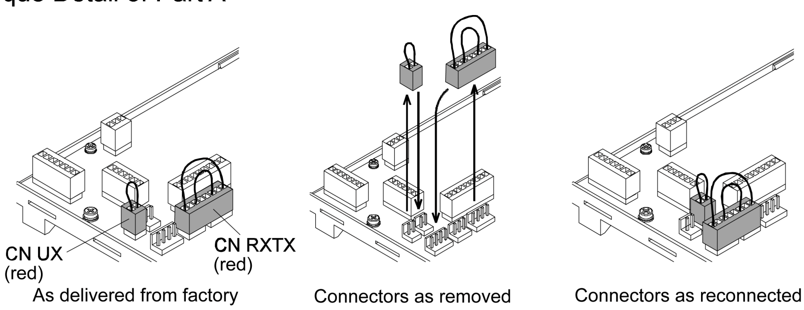
< Enlarged View of Part A >




CN UX is connected to U1

and CN RXTX to L1/R-L3/T before factory shipment.

< Oblique Detail of Part A >




CNUX : U1

CNRXTX : L1/R-L3/T

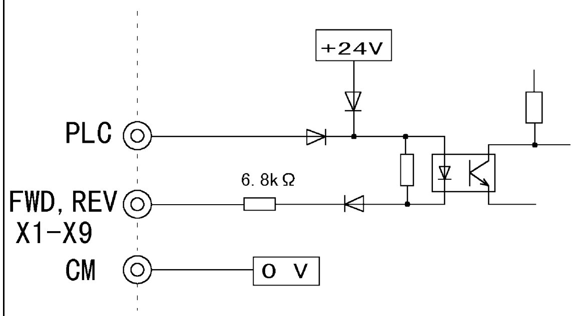
The Figure applies when the inverter is used with DC power inputs at a supply voltage of 380-398 V, 50 Hz or 380-430 V, 60 Hz.

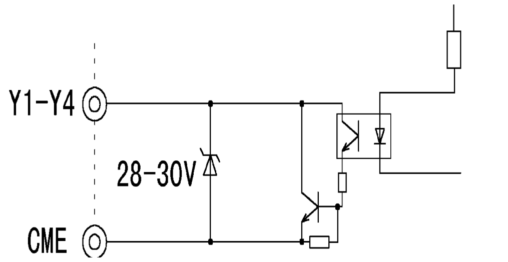
Figure 3-3-7 Power Switching Connectors (18.5 kW or Higher Inverters Only)

## 3.3.3 Wiring of Control Terminals

Functions of the control circuit terminals are described in Table 3-3-4. Each control terminal should be wired in different ways, depending on its setting.
Terminal arrangement is given in Section 2.3.3.

Table 3-3-4

<table>
<tr><th>Category</th><th>Terminal symbol</th><th>Terminal name</th><th>Function</th></tr>
<tr><td rowspan="6">Analog input</td><td>13</td><td>Potentiometer power supply</td><td>Supplies power (+10Vdc) to speed setting POT (1-5 kΩ).</td></tr>
<tr><td>12</td><td>Voltage input</td><td>Controls the speed according to the external analog input voltage command.<br>• 0 to +10V DC/0 to 100%<br>• Reversed operation with ± signals: 0 to ±10V DC/0 to ±100%</td></tr>
<tr><td>11</td><td>Analog input common</td><td>A common terminal for analog input signals</td></tr>
<tr><td>Ai1</td><td>Analog input 1</td><td rowspan="3">Inputs analog DC voltages between 0 to ±10V DC. For assignment of signals, see 2.3.2 'Functions of Terminals'.<br>* Input resistance: 10 kΩ</td></tr>
<tr><td>Ai2</td><td>Analog input 2</td></tr>
<tr><td>M</td><td>Analog input common</td></tr>
<tr><td rowspan="14">Digital input</td><td>FWD</td><td>Forward operation command</td><td>FWD-CM: ON... The motor runs in the forward direction.<br>FWD-CM: OFF... The motor decelerates and stops.</td></tr>
<tr><td>REV</td><td>Reverse operation command</td><td>REV-CM: ON... The motor runs in the reverse direction.<br>REV-CM: OFF... The motor decelerates and stops.</td></tr>
<tr><td>X1</td><td>Digital input terminal 1</td><td rowspan="10">Functions such as external coast-to-stop command, external alarm, alarm reset, and multi-speed control can be turned on or off with terminals X1 to X9. For details, see 2.3.2 'Functions of Terminals'.<br><Digital Input Circuit Specifications><br><table><tr><th colspan="2">Item</th><th>min.</th><th>typ.</th><th>max.</th></tr><tr><td rowspan="2">Operating voltage</td><td>ON level</td><td>0V</td><td>-</td><td>2V</td></tr><tr><td>OFF level</td><td>22V</td><td>24V</td><td>27V</td></tr><tr><td colspan="2">On-time operating current</td><td>-</td><td>3.2mA</td><td>4.5mA</td></tr><tr><td colspan="2">Off-time permissible leak current</td><td>-</td><td>-</td><td>0.5mA</td></tr></table><br><br></td></tr>
<tr><td>X2</td><td>Digital input terminal 2</td></tr>
<tr><td>X3</td><td>Digital input terminal 3</td></tr>
<tr><td>X4</td><td>Digital input terminal 4</td></tr>
<tr><td>X5</td><td>Digital input terminal 5</td></tr>
<tr><td>X6</td><td>Digital input terminal 6</td></tr>
<tr><td>X7</td><td>Digital input terminal 7</td></tr>
<tr><td>X8</td><td>Digital input terminal 8</td></tr>
<tr><td>X9</td><td>Digital input terminal 9</td></tr>
<tr><td></td><td></td></tr>
<tr><td>PLC</td><td>PLC signal power supply</td><td>Connected with output signal power source of PLC (Rated voltage: 24 (22-27) V DC ).</td></tr>
<tr><td>CM</td><td>Digital input common</td><td>A common terminal for digital input signals</td></tr>
<tr><td rowspan="5">Analog output</td><td>AO1</td><td>Analog output terminal 1</td><td rowspan="5">Outputs monitor signals at analog DC voltages between 0 and ± 10 V DC. For details of signals, see 2.3.2 'Functions of Terminals'.<br>* Connectable impedance: 3 kΩ min.</td></tr>
<tr><td>AO2</td><td>Analog output terminal 2</td></tr>
<tr><td>AO3</td><td>Analog output terminal 3</td></tr>
<tr><td>M</td><td>Analog output common</td></tr>
<tr><td></td><td></td></tr>
</table>

<table>
<tr><td rowspan="6">Transistor output</td><td>Y1</td><td>Transistor output 1</td><td rowspan="5">Outputs signals such as Running, Speed equivalence, Overload early warning, ... and ⊖ as transistor outputs from inverter to specified ports.<br>For details, see 2.3.2 'Functions of Terminals'.<br><Transistor Output Circuit Specifications><br><table><tr><td colspan="2">Item</td><td>min.</td><td>typ.</td><td>max.</td></tr><tr><td rowspan="2">Operating voltage</td><td>ON level</td><td>-</td><td>1V</td><td>2V</td></tr><tr><td>OFF level</td><td>-</td><td>24V</td><td>27V</td></tr><tr><td colspan="2">On-time max. load current</td><td>-</td><td>-</td><td>50mA</td></tr><tr><td colspan="2">Off-time permissible leak current</td><td>-</td><td>-</td><td>0.1mA</td></tr></table><br><br></td></tr>
<tr><td>Y2</td><td>Transistor output 2</td></tr>
<tr><td>Y3</td><td>Transistor output 3</td></tr>
<tr><td>Y4</td><td>Transistor output 4</td></tr>
<tr><td></td><td></td></tr>
<tr><td>CME</td><td>Transistor output common</td><td>A common terminal for transistor output terminals. Insulated from terminals CM and 11.</td></tr>
<tr><td rowspan="2">Relay output terminals</td><td>30A,30B, 30C</td><td>Alarm relay output (for any fault)</td><td>Outputs alarm signal as relay contact output (1SPDT) when inverter stops due to alarm.<br>Contact capacity: 250V AC, 0.3 A, cos ∅ = 0.3 (or 48 V DC, 0.5 A when conformed with Low Voltage Directive)<br>You may choose to close contacts under unusual or normal conditions.</td></tr>
<tr><td>Y5A,Y5C</td><td>Relay output</td><td>You may select a signal as you may with Y1 to Y4 terminals. Contact capacity is the same as with alarm relay output terminals.</td></tr>
<tr><td rowspan="2">Communication</td><td>RX(+), RX(–) TX(+),TX(–)</td><td>RS485 communication input/output</td><td>Input/output terminals for RS485 communication<br>Up to 31 inverters may be connected through multi-drop connections. Terminating resistor (100 Ω) can be connected via switch (SW3).</td></tr>
<tr><td>SD(M)</td><td>Communication shield cable connection</td><td>Connected with shielded wires.</td></tr>
<tr><td rowspan="4">Speed detection</td><td>PA,PB</td><td>Pulse generator 2-phase signal input</td><td>Connected with 2-phase signals from pulse generator</td></tr>
<tr><td>PGP,PGM</td><td>Pulse generator power supply</td><td>Supplies power (+15 V DC (switchable to +12 V DC)) to PG.</td></tr>
<tr><td>FA,FB</td><td>Pulse generator output</td><td>Output pulse generator signal with frequency divided to 1/n. (n is programmable with function code E29.)</td></tr>
<tr><td>CM</td><td>Pulse generator output common</td><td>A common terminal for FA and FB.</td></tr>
<tr><td>Temperature</td><td>TH1,THC</td><td>NTC/PTC thermistor connection terminals</td><td>Monitors motor temperature with NTC and PTC thermistors. For PTC thermistor, motor overheat protection level can be set with function code E32.</td></tr>
</table>

(1) Input terminals (13, 12, and 11)

1) Shielded wires as short as possible (20 m or less) should be used for cables because these terminals handle weak analog signals that are very susceptible to external noise. The shields should be grounded to the earth, as a rule. If the signals are greatly affected by external induction noise, however, connecting the shields to terminal 11 may be advantageous.

2) When relay contacts are required in this circuit, use twin contacts handling weak signals. Do not use contacts at terminal 11.

3) If any of these terminal is connected with an external analog signal output unit, it may malfunction due to the noise generated by the inverter, depending on the analog signal output circuit. In this case, connect a ferrite core or capacitor to the external analog signal output unit.

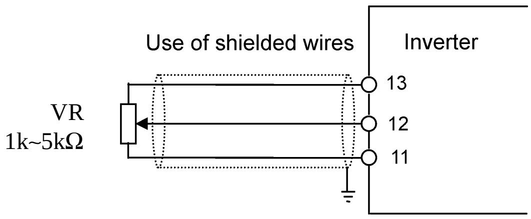



Figure 3-3-8

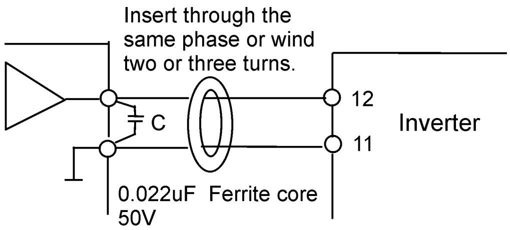



Figure 3-3-9
Protection against Noise (Example)

(2) Digital input terminals (FWD, REV, X1-X9, PLC, and CM)

1) The digital input terminals such as FWD, REV, and X1-X9 are generally turned on/off between the CM terminal. If turned on/off using an external power source and open collector outputs from the programmable logic controller, the terminals may malfunction due to current leak from the external power source. In this case, connect the external power source using the PLC terminal as shown in Figure 3-3-10.

2) When inputs are made through relay contacts, use a highly reliable relay contacts (Fuji Electric's HH54PW control relays, for example).

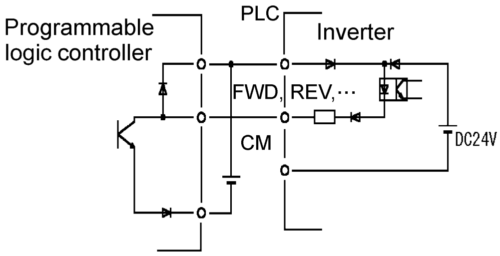



Figure 3-3-10
Protection against Current Leak from External Power Source

(3) Transistor output terminals (Y1-Y4 and CME)

1) A circuit configuration as shown in the 'Transistor Output Terminals' column of Table 3-3-4 is used. Take care not to connect external power leads with reversed polarity.

2) When control relays are used, connect a surge suppression diode to each end of the exciting coil.

(4) Pulse generator terminals (PGP, PGM, PA, and PB)
Connect each inverter terminal with a motor PG terminal with the same terminal code. Switch the PG power between +15 V and +12 V using SW5. The location of SW5 is shown on the next page.

(5) PG output terminals (FA, FB, and CM)
Open collector output signal. Connect these terminals as follows if used.

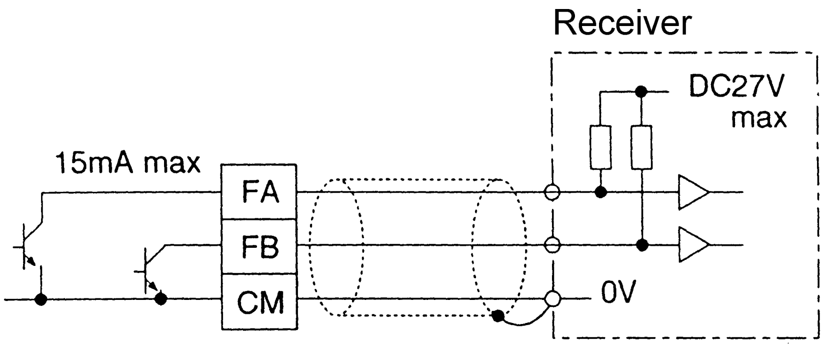



Figure 3-3-11 Wiring of PG Output Terminals

(6) Temperature detection terminals (THC and TH1)
Connect each thermistor connecting terminal with a motor terminal with the same code. The motor has a spare thirmistor terminal (TH2). If terminal TH1 becomes unusable due to a cut wire or for another reason, connect motor terminal TH2 to inverter terminal TH1.

(7) RS485 connector
A connector is located as shown in the Figure. For the connector shape, see the description of standard RS485. The terminating resistor should be switched with SW3. The location of SW3 is shown on the next page.
SW3 (short-circuit between 1 and 2 to turn terminal resistor on)
SW3 (short-circuit between 2 and 3 to turn it off)
SW3 : 1-2 short-circuit, using terminating resistor
SW3 : 2-3 short-circuit, without terminating resistor

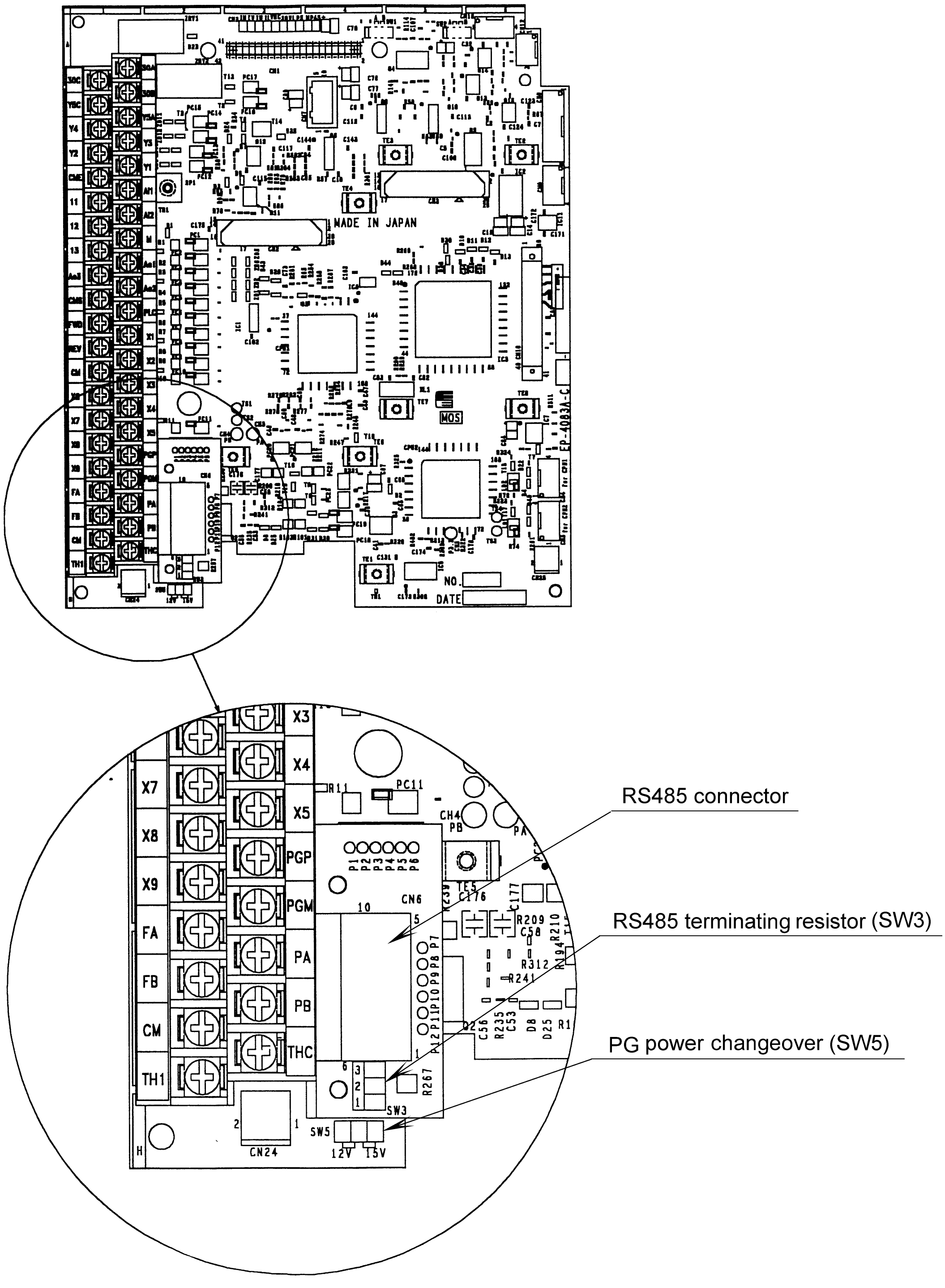



Figure 3-3-12
Layout of switch and connector

(8) Miscellaneous

1) The control terminal leads should be kept as apart from the main circuit leads as possible to prevent malfunction due to noise.
2) The control leads inside the inverter should be secured to prevent direct contact with the live part of the main circuit (the main circuit terminal blocks, for example).

| ⚠WARNING |
|---|
| • The shield of each control cable does not serve as a reinforced insulator. If the shield is broken for some reason, a high voltage in the main circuit may invade the control signal circuit. The Low Voltage Directive in Europe also prohibits the users to wire the inverter with a main circuit lead in contact with a control lead.<br>**Doing so may lead to electric shock.** |

| ⚠CAUTION |
|---|
| • Noise may be generated from the inverter, motor, and leads.<br>• Protect sensors and devices around the inverter from malfunction.<br>**Failure to do so may lead to accident.** |

(9) Wiring of Control Circuits

1) FRN18.5VG7S-2 to FRN55VG7S-2
   FRN18.5VG7S-4 to FRN110VG7S-4
   (a) Pull the wiring out along the left side panel of the inverter as shown in Figure 3-3-13.
   (b) Tie leads with bands (Insulock, for example) and secure to the hole (tie mounting hole A) on the left side wall of the main circuit terminal block on the way outward. The bands should be 3.5 mm or less in width and 1.5 mm or less in thickness as they are to be passed through the holes (4 mm dia.).
   (c) If an optional printed circuit board is mounted, secure signal leads to the tie mounting hole B.

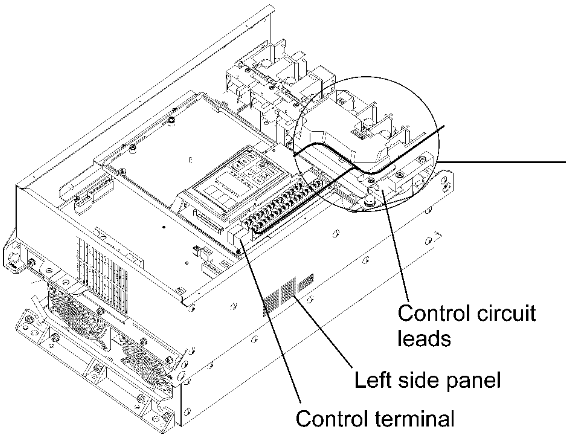



Figure 3-3-13
Routing Inverter (18.5 kW or Higher) Control Circuit Leads

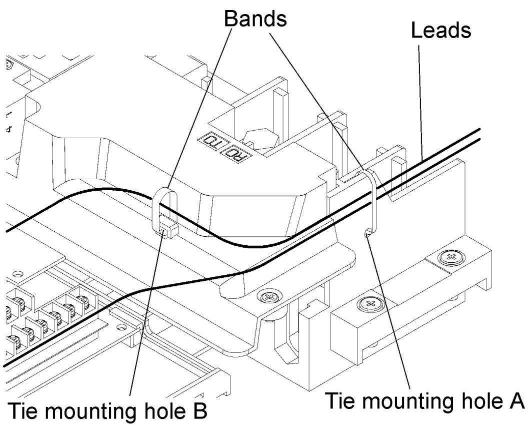
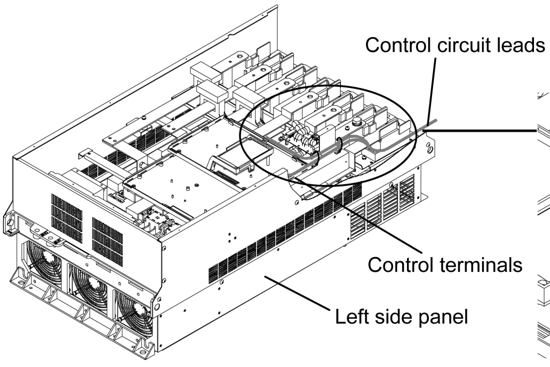



Figure 3-3-14
Securing Inverter (18.5 kW or Higher) Control Circuit Leads

2) FRN132VG7S-4 to FRN160VG7S-4

(a) Pull the wiring out along the left side panel as shown in Figure 3-3-15.

(b) Tie leads with bands (Insulock, for example) and secure with cable tie holders on the beams on the way outward. The bands should be 3.8 mm or less in width and 1.5 mm or less in thickness as they are to be passed through square holes (3.8 × 1.5).



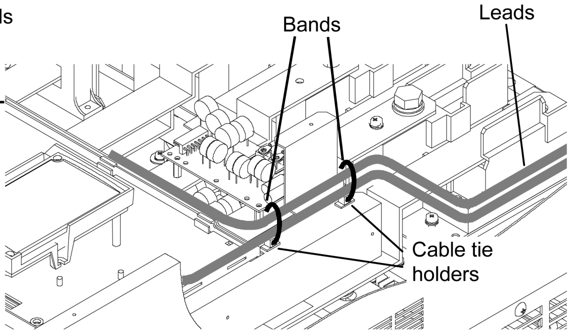



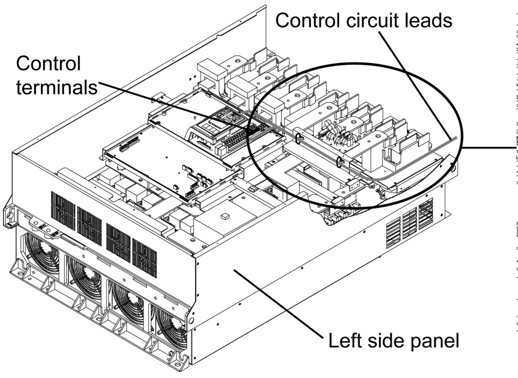

Figure 3-3-15
Routing Inverter Control Circuit Leads

Figure 3-3-16
Securing Inverter Control Circuit Leads

3) FRN75VG7S-2 to FRN90VG7S-2
FRN200VG7S-4 to FRN220VG7S-4

(a) Pull the wiring out along the left side panel as shown in Figure 3-3-17.

(b) Tie leads with bands (Insulock, for example) and secure with cable tie holders on the beams on the way outward. The bands should be 3.8 mm or less in width and 1.5 mm or less in thickness as they are to be passed through holes (3.8 × 1.5).



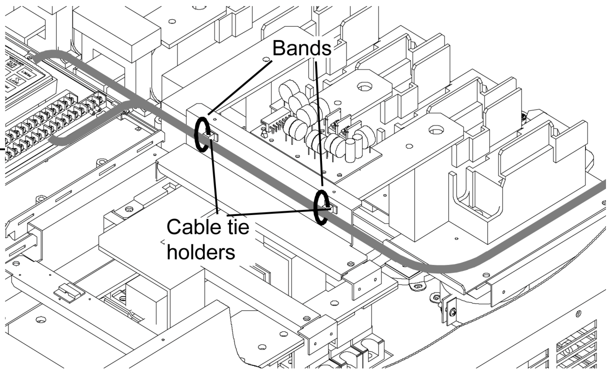




Figure 3-3-17
Routing Inverter Control Circuit Leads

Figure 3-3-18
Securing Inverter Control Circuit Leads

# 3. Preparatory Operations and Test Run

## 3.4 Test Run

### 3.4.1 Preliminary Check and Preparation

Perform the following checks before starting operation.

(1) Check that the inverter is correctly wired.
Most importantly, the inverter output terminals, U, V, and W should not be connected to a power source and the earth terminal should be correctly grounded.

(2) No terminal or exposed live part should be short-circuited or grounded.

(3) Check for loose terminals, connectors, and screws.

(4) Check that the motor is disconnected from mechanical devices.

(5) Turn all switches off so that the inverter will not start or malfunction when powered on.

(6) After power-up of the inverter, check that:
1) the KEYPAD panel gives indications as shown in Figure 3-4-2 (no alarm message), and
2) the inverter contained fan is rotating.

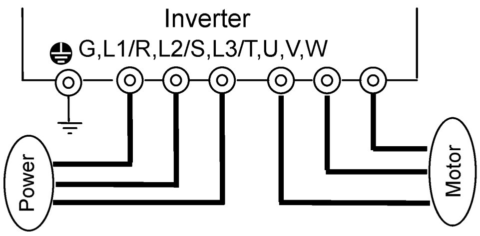



Figure 3-4-1
Inverter Connection Diagram


Figure 3-4-2
KEYPAD Panel Display with the Power ON

**⚠WARNING**

- Never turn the power switch on (closed) before mounting the face cover. Do not remove the cover while the inverter is energized.
- Do not handle the inverter with wet hand.

**Doing so may lead to electric shock.**

## 3.4.2 Operating Methods

There are many operating methods. Read this manual and select the one most suitable to the intended use and operating conditions. General operating methods are described in Table 3-4-1.

## 3.4.3 Test Run

After checking that no abnormal condition exists in 3.4.1, perform a test run.
Before delivery, the inverter is programmed to be operated from the KEYPAD panel (with function code F01 set to 0 and F02 to 0).

(1) Turn the power on. Check that the speed indicated by blinking LEDs is 0 r/min.

(2) Set the speed to a lower level around 100 r/min using the ∧ key.

(3) Press the FWD key to run the motor in the forward direction or the REV key to run in the reverse direction. Press the STOP key to stop the motor.

(4) Check that:
  1) the motor runs in the selected direction (see Figure 3-4-3),
  2) it revolves without any problem (motor roars and excessive vibration), and
  3) it smoothly accelerates or decelerates.

If no abnormal condition is observed, raise the operating speed and check again.

Table 3-4-1 General Operating Methods

| Operating method | Speed controls | Operation commands |
|---|---|---|
| From KEYPAD panel | KEYPAD panel keys<br>∧ ∨ | FWD , REV<br>STOP |
| Through external signal input | ∧ ∨<br>Variable resistor (POT) or analog voltages | Contact inputs (switches)<br>Terminals: FWD - CM<br>Terminals: REV - CM |

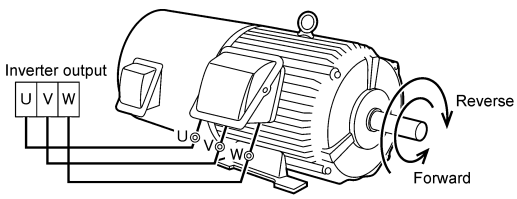



Figure 3-4-3 Motor Rotating Directions

# 3. Preparatory Operations and Test Run

If the inverter is found to normally function in the test run, start regular operation.

| ⚠CAUTION |
| --- |
| • If any abnarmal condition is observed with the inverter or motor, immediately stop and locate the cause (see 'Troubleshooting').<br>• Even after the inverter stops outputting, touching any of the inverter output terminals, U, V, and W may lead to electric shock if a voltage is continuously applied to the main circuit power terminals, L1/R, L2/S, and L3/T, and auxiliary control power terminals, R0 and T0. The smoothing capacitor remains live after the power switch is turned off and requires some time until completely discharged.<br>When touching an electric circuit after the shut-down, check that the charge lamp is off or check with a multimeter that the voltage has been reduced to a safe level (24V or less). |

| ⚠WARNING |
| --- |
| • Setting a function code in a wrong manner or without fully understanding this manual may cause the motor to revolve at an unacceptable torque or speed, possibly resulting in accident or injury.<br>**Accident on injury may result.** |

THE INVERTER

# IV. Control and Operation

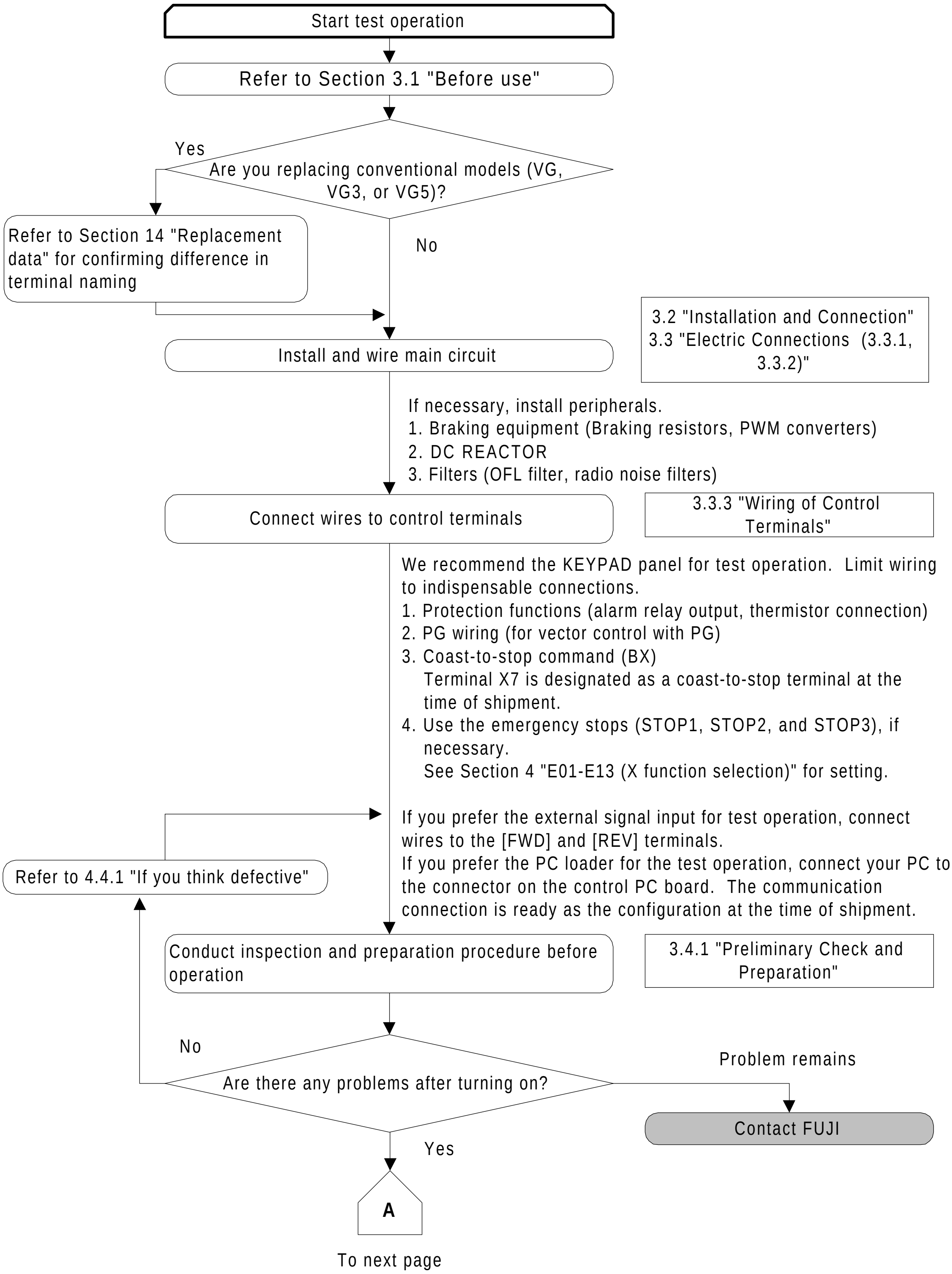
# 4. Control and Operation

## 4.1 Read this Section First

This section describes how to start the VG7 after your purchase. The description here assumes that you have already finished the selection of capacities of your inverter, its braking resistor, and peripheral equipment by consulting Chapter 2 "Specifications", Chapter 9 "Selecting Peripheral equipment", Chapter 10 "Selecting Inverter Capacity", Chapter 11 "About Motors", Chapter 14 "Replacement Data", and Chapter 15 "Appendix" before your purchase.

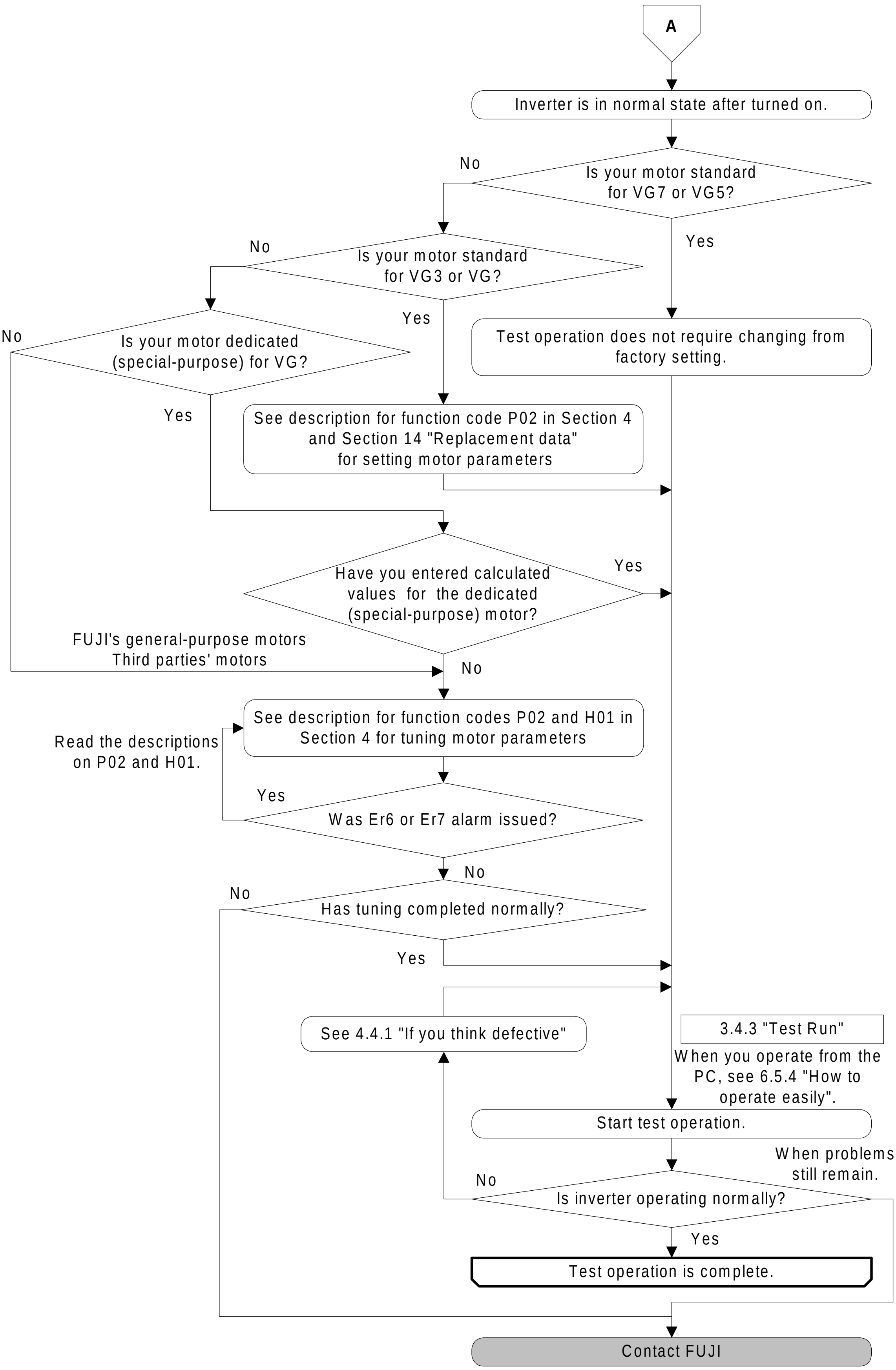
### 4.1.1 Turning ON the Power

The following chart presents the preparation procedure from wiring to applying power for test operation.



## 4.1.2 Starting Test Operation

Start test operation after the inverter is turned on normally.



## 4.1.3 Introduction to Setting in Detail

FRENIC5000VG7 inverters contain various functions to meet all customer needs. You can extend these functions by employing their options. This section gives you a brief description on these functions.

**Changes made to previous models**

| | |
|---|---|
| You can assign any functions to any control terminals. The standard nine terminals are [X1] to [X9] | The dedicated terminals, [RST]: Alarm reset and [THR]: Trip command terminals are discontinued. They are included for general assignment. [X8] terminal= [RST], [X9] terminal= [THR] are factory assignment. |
| Trip command [THR] is set to "NO: Normally Open" | External alarm input is set to "NO" at shipment. Refer to "External alarm" in "E01 to E13" in 4.3 "Function code description" for instruction on switching to "NC terminal" |
| Service power supplies (± 15 V, 24 V) are discontinued. | Obtain commercial power supplies for your needs. |
| The KEYPAD panel is firmly installed. | Since the KEYPAD panel is firmly inserted into the face cover, remove the KEYPAD panel after you open the cover. |

**Overview of the integrated functions**

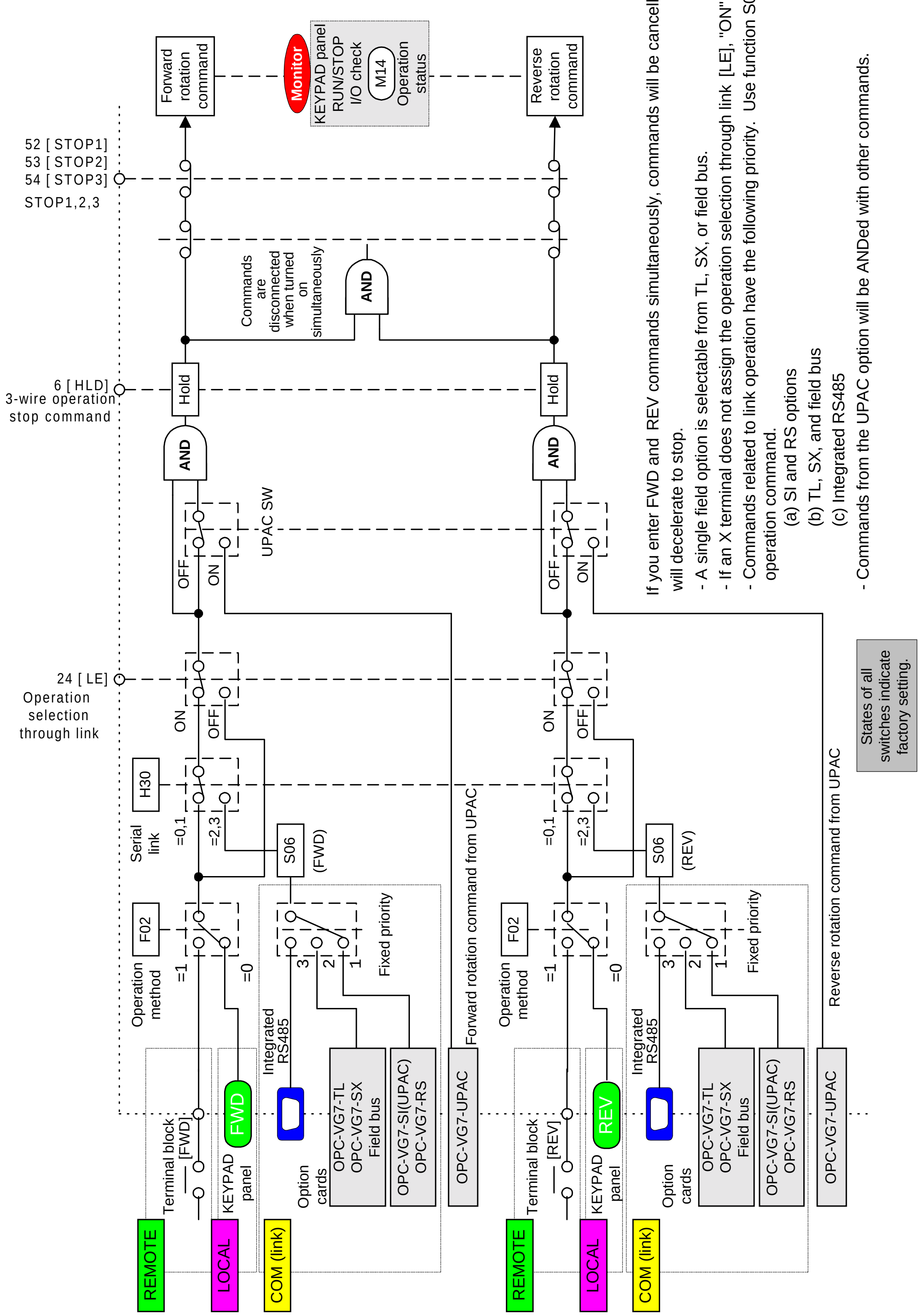
| | |
|---|---|
| PWM converter connection is provided as standard. | See Section 3.3.2 "Wiring of Main Circuit and Grounding Terminals". |
| Triple standards (CT, VT, and HT) are selectable. | See "F80" in Section 4.3" Function Code Description". |
| Various control types (such as vector control) are available. | See "P01" and "A01" in Section 4.3 "Function code description". |
| "NO" or "NC" is selectable for control terminals, [X1] to [X9], [Y1] to [Y5A], and alarm output [30X]. | See "F36", "E14", and "E28" in Section 4.3 "Function Code Description". |
| Electronic thermal relay protection is available for motors. | See "F10" to "F12" in Section 4.3 "Function Code Description". |
| Servo-lock is available. | See zero speed locking control (LOCK) in "E01" to "E13" in Section 4.3 "Function Code Description". |
| You can store motor parameters for three motors. | See "F79", P codes, and A codes in Section 4.3 "Function Code Description". |
| Four patterns are available for acceleration/ deceleration and ASR setting. | See "E01" to "E13" and "RT1" and "RT2" for ASR, ACC/DEC time selection in Section 4.3 "Function Code Description". |
| r/min and % are available for 15-step speed selection. | See "C21" in Section 4.3 "Function Code Description". |
| Speed control is available during torque (current) control command operation. | See "F76" to "F78" in Section 4.3 "Function Code Description". |
| You can restrict the speed control reference according to load. | See "H60" to "H66" in Section 4.3 "Function Code Description". |
| Dedicated S-curve acceleration and deceleration setting is available for vertical transer applications. | See L codes in Section 4.3 "Function Code Description". |
| Seven languages are available in the KEYPAD indication. | See "F58" in Section 4.3 "Function Code Description". |
| PID function is integrated. | See 4.2 "Control block diagrams" and "H20" to "H27" in Section 4.3 "Function Code Description". |
| PG pulse can be divided for output. | See "E29" in Section 4.3 "Function Code Description". |
| UP/DOWN function is available. | See UP/DOWN functions in "E01" to "E13" in Section 4.3 "Function Code Description". |
| Motor parameter tuning is available during motor stopping state. | See "H01" in Section 4.3 "Function Code Description". |
| Speed observer (vibration, disturbance) is available. | See "H46" in Section 4.3 "Function Code Description". |
| Line speed control is available. | See "H53" in Section 4.3 "Function Code Description". |

| Introduction to optional functions | |
|---|---|
| You can control and monitor the inverter using your PC. | See section 6.5 "How to use PC Loader ". |
| Various PLC's are available for connection. | See T-Link, SX, and field bus in Section 7 "Optional control devices". |
| Users can modify control programs freely. | See UPAC in Section 7 "Optional control devices". |
| Synchronized operation and pulse train operation are available. | See synchronization command in "E01" to "E13" in 4.3 "Function code description". |
| You can drive multiwinding motors. | See multi-winding motor control canceling [MT-CCL] in "E01" to "E13" in 4.3 "Function code description". |
| 16-bit digital input is available. | See DI in Section 7 "Optional control devices". |

Control and Operation

## 4.2 Control Block Diagrams

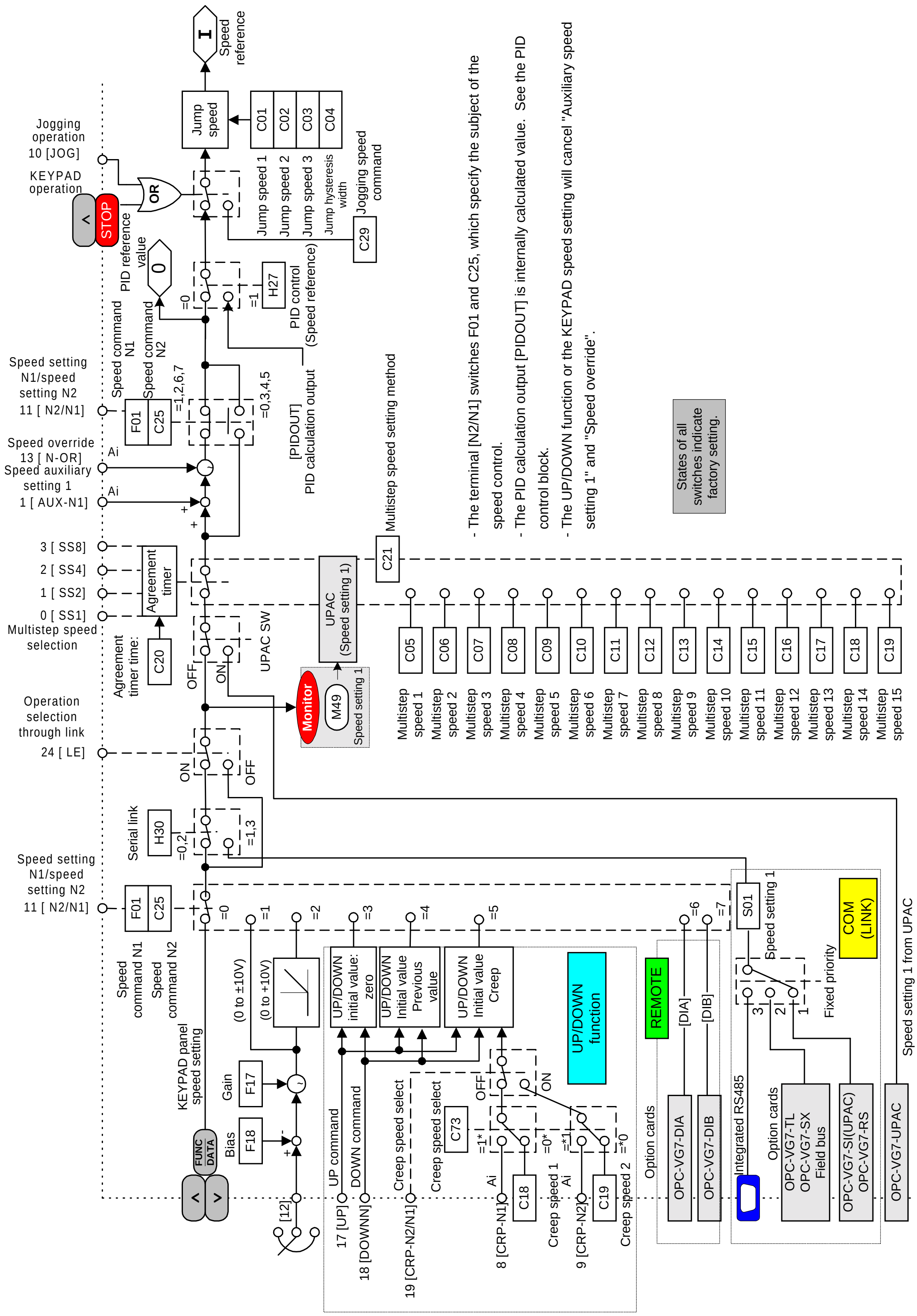
### 4.2.1 Operation Command



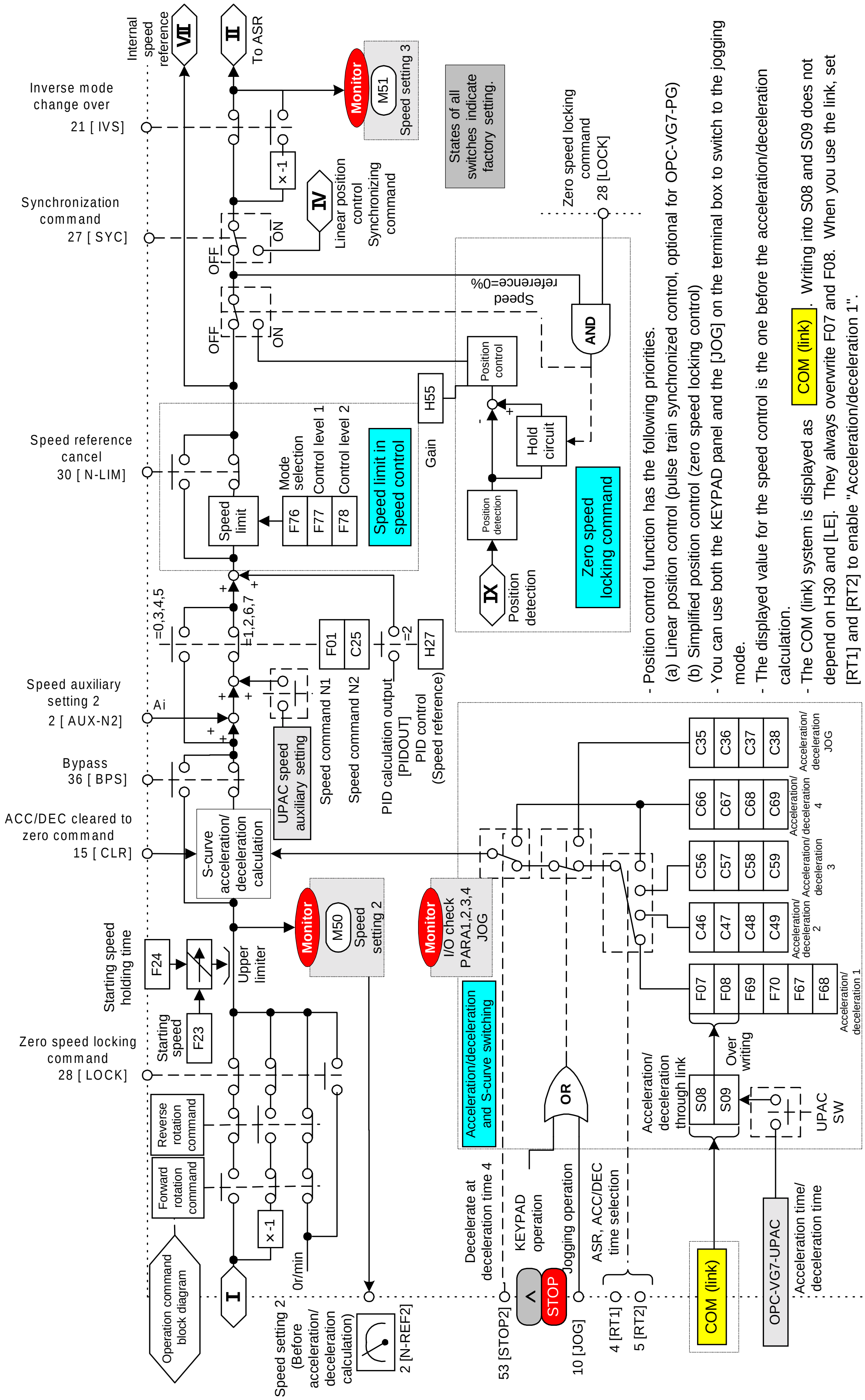

If you enter FWD and REV commands simultaneously, commands will be cancelled and the motor will decelerate to stop.

- A single field option is selectable from TL, SX, or field bus.
- If an X terminal does not assign the operation selection through link [LE], "ON" is assumed to it.
- Commands related to link operation have the following priority. Use function S06 for an operation command.
  (a) SI and RS options
  (b) TL, SX, and field bus
  (c) Integrated RS485
- Commands from the UPAC option will be ANDed with other commands.

# 4.2.2 Speed Command Selection Section

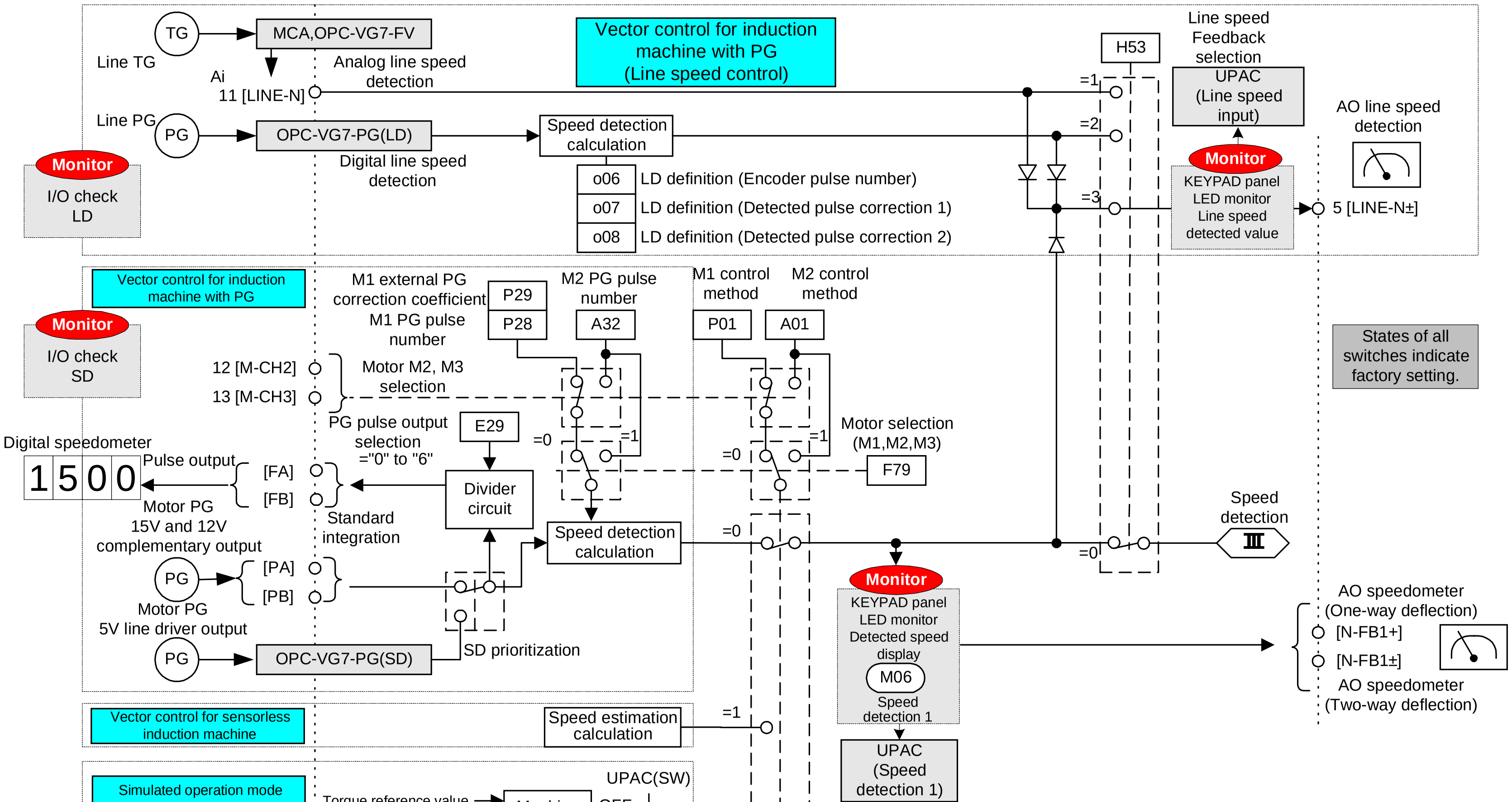


## 4.2.3 Acceleration/deceleration Calculation, Speed Limiting, and Position Control Input Section



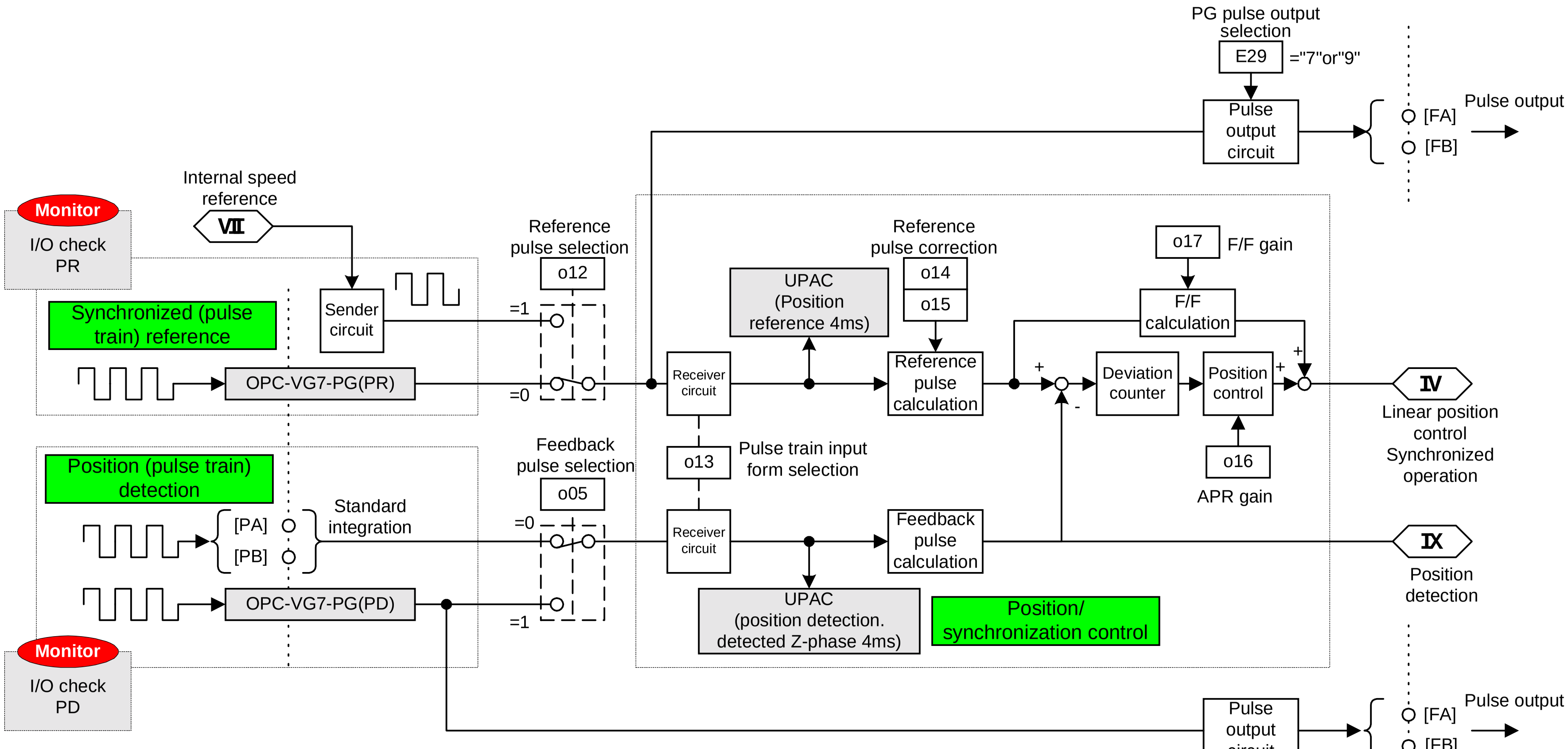

- Position control function has the following priorities.
  (a) Linear position control (pulse train synchronized control, optional for OPC-VG7-PG)
  (b) Simplified position control (zero speed locking control)
- You can use both the KEYPAD panel and the [JOG] on the terminal box to switch to the jogging mode.
- The displayed value for the speed control is the one before the acceleration/deceleration calculation.
- The COM (link) system is displayed as COM (link). Writing into S08 and S09 does not depend on H30 and [LE]. They always overwrite F07 and F08. When you use the link, set [RT1] and [RT2] to enable "Acceleration/deceleration 1".

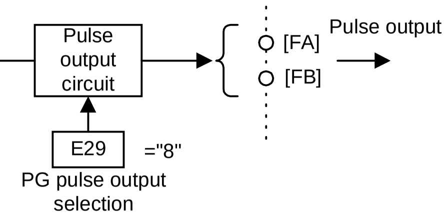
# 4.2.4 Motor Speed/line Speed Detection




- You can select a switch on the OPC-VG7-PG card to switch between motor speed detection and line speed detection.
  (a) PG (SD): Controls speed by detecting pulse train to calculate speed.
  (b) PG (LD): Controls line speed by detecting digital line speed.
- The speed detection and speed estimation are invalid for V/f control. If you select the M3 motor, the inverter switches to V/f control.
- When you apply an analog frequency such as TG output as line speed, use FUJI's FV converter board to convert it into voltage for Ai [LINE-N] input.
- The pulse output (divider circuit) is equal magnification output.

## 4.2.5 Pulse Train Reference Input Section and Position Detection Section

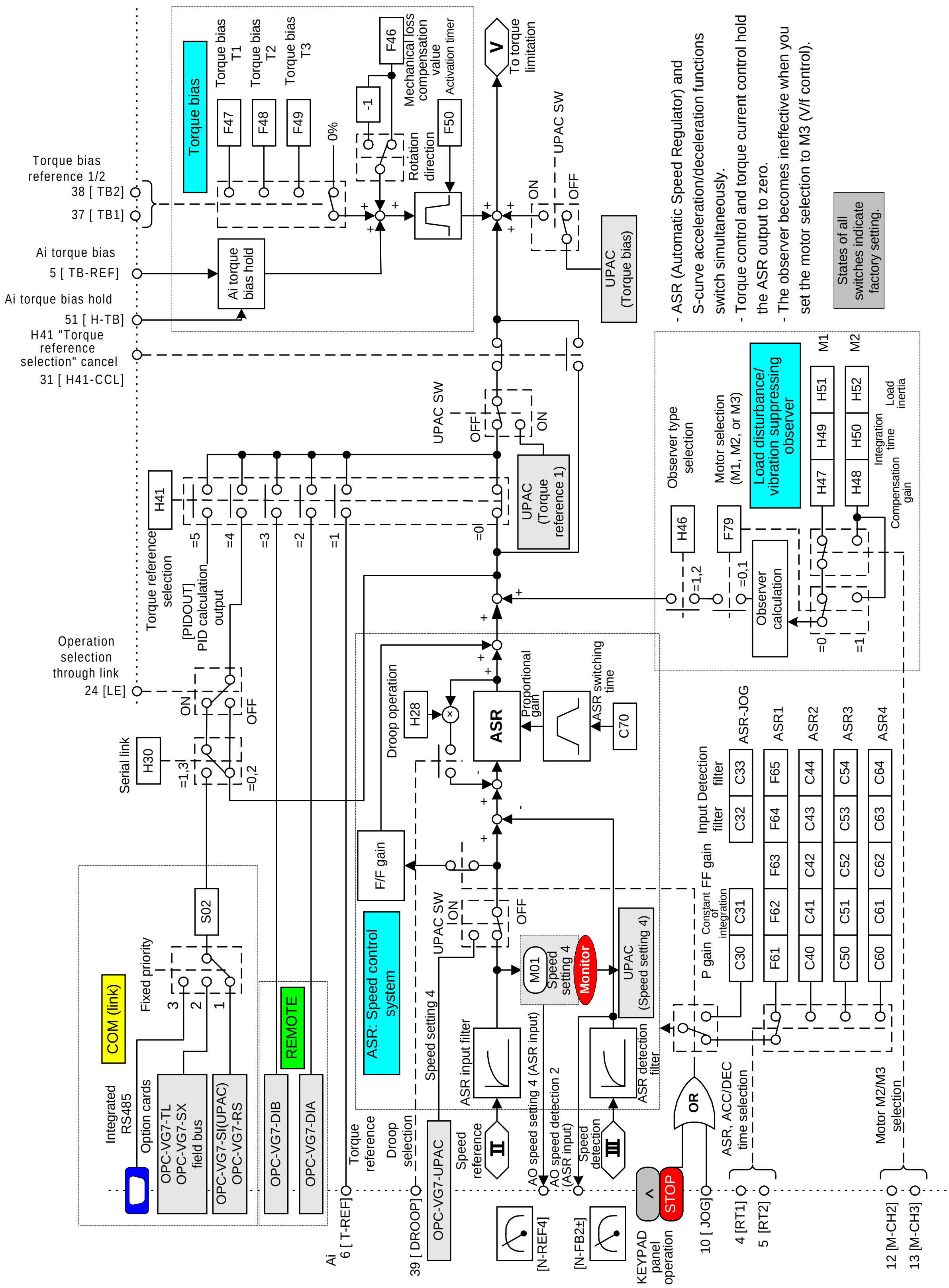



States of all switches indicate factory setting.

- You can select a switch on the OPC-VG7-PG card to switch between two types of pulse reference/pulse detection.
  (a) PG (PR): Controls position and synchronization by receiving a reference pulse train for pulse calculation.
  (b) PG (PD): Controls position by detecting pulse train for pulse calculation.
- You can output either of the pulse reference value, the converted pulse output for the internal speed reference, or the detected pulse value through the integrated [FA] and [FB] in the pulse output circuit.
- The inverter sends reference or detected pulse data magnified by four and accumulated in every 4ms to the UPAC. The UPAC must run 4ms-cycle task.

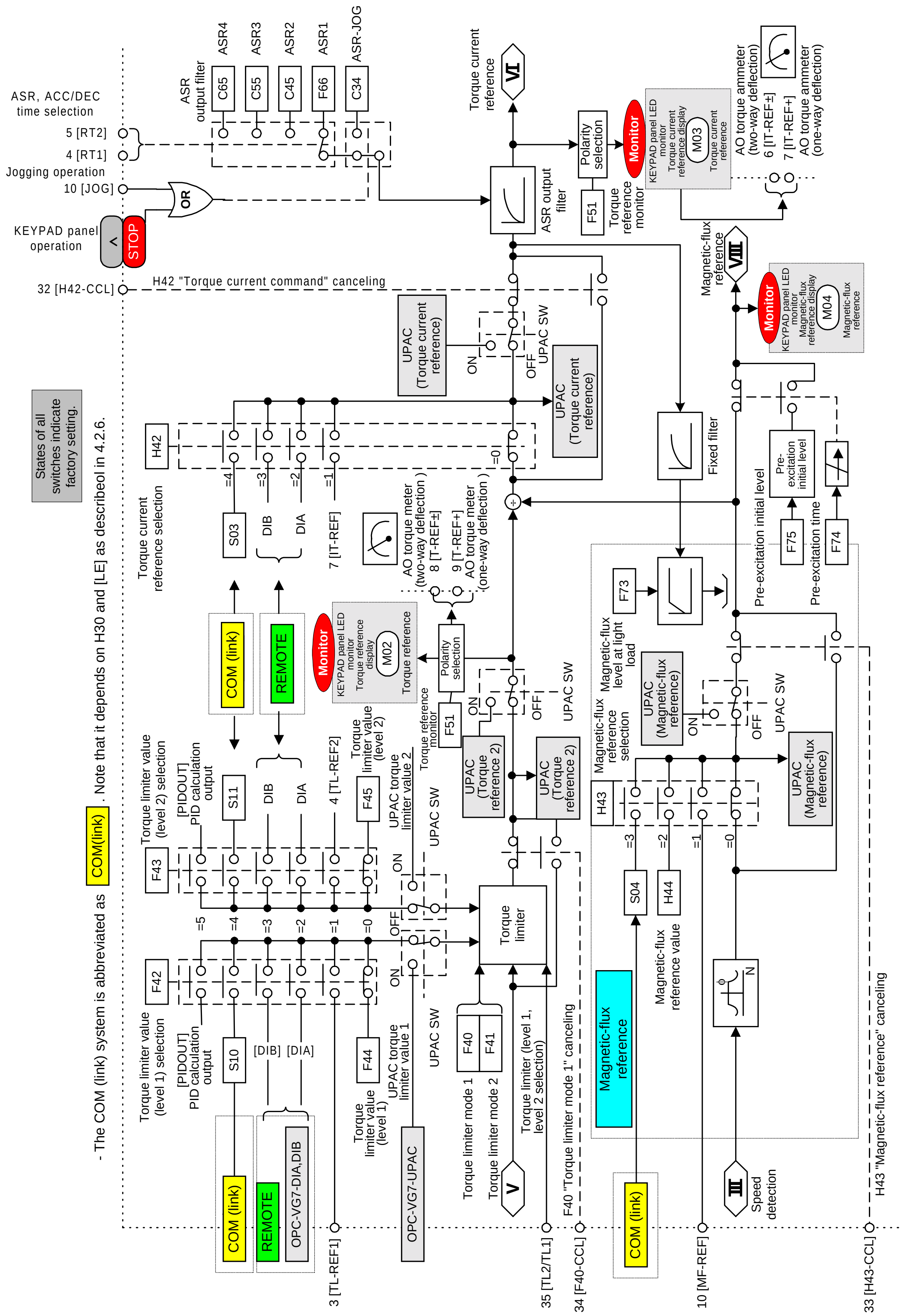
# 4.2.6 Speed Control and Torque Reference Section



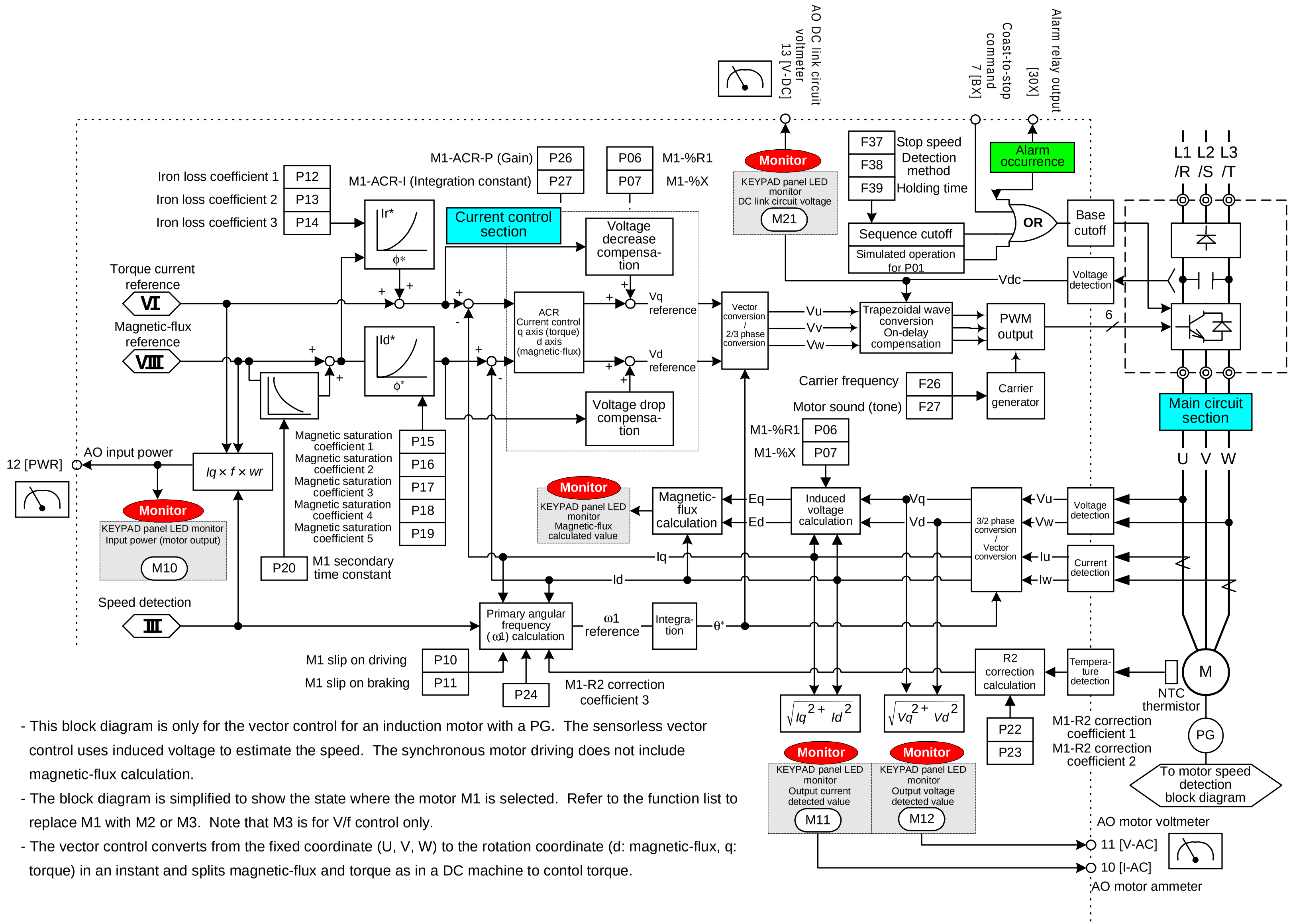

Control and Operation

## 4.2.7 Torque Limit, Torque Current Reference, and Magnetic-flux Reference Section

- The COM (link) system is abbreviated as COM(link). Note that it depends on H30 and [LE] as described in 4.2.6.

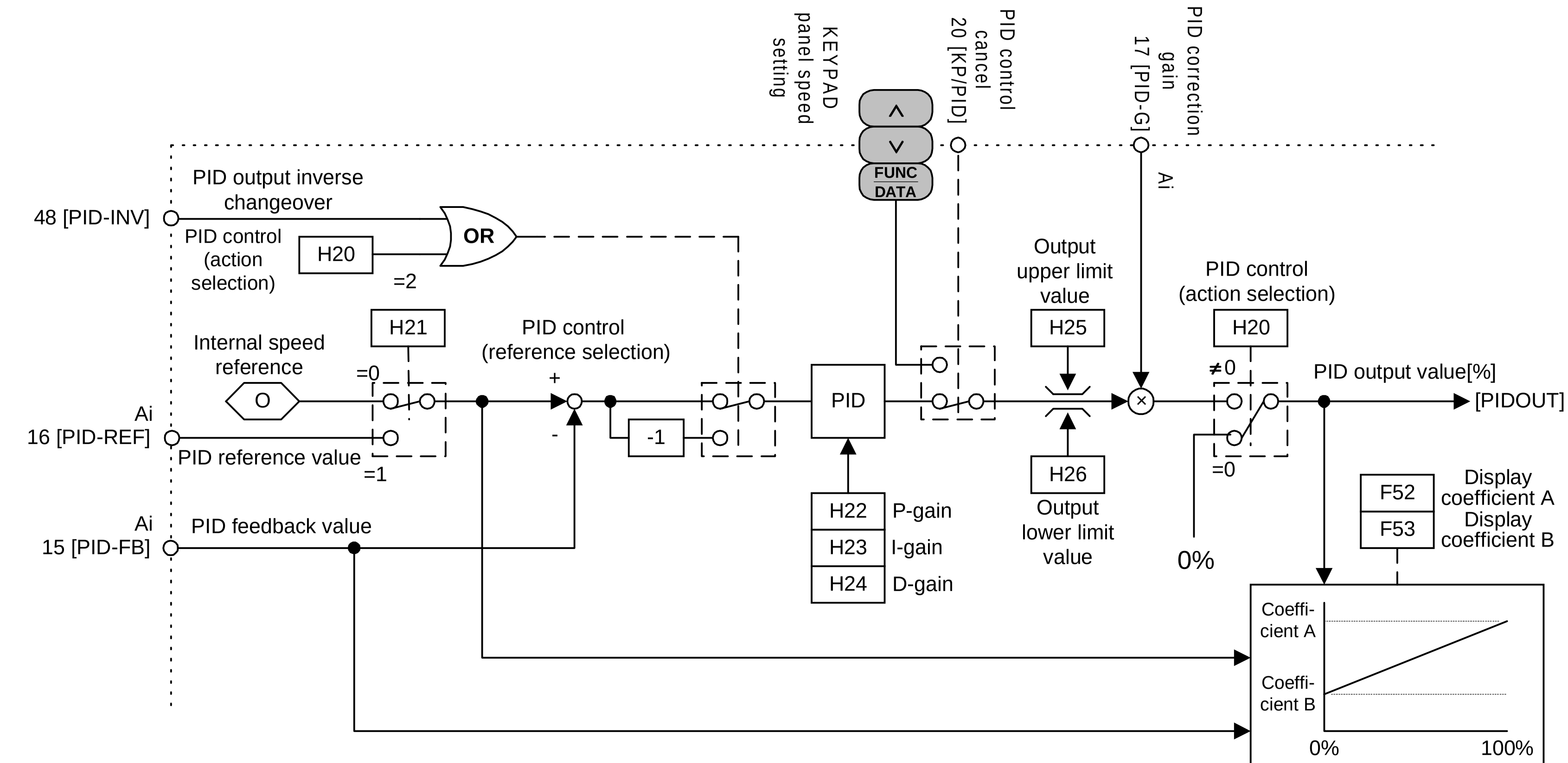


## 4.2.8 Current Control and Vector Control Section




- This block diagram is only for the vector control for an induction motor with a PG. The sensorless vector control uses induced voltage to estimate the speed. The synchronous motor driving does not include magnetic-flux calculation.
- The block diagram is simplified to show the state where the motor M1 is selected. Refer to the function list to replace M1 with M2 or M3. Note that M3 is for V/f control only.
- The vector control converts from the fixed coordinate (U, V, W) to the rotation coordinate (d: magnetic-flux, q: torque) in an instant and splits magnetic-flux and torque as in a DC machine to contol torque.

## 4.2.9 PID Calculation Section




Monitor

KEYPAD panel LED monitor
PID reference value[%]
PID feedback value[%]
PID output value[%]

States of all switches indicate factory setting.

- Setting H20 (PID control, action selection) to zero holds the PID calculation to zero.
- The UP/DOWN setting mode disables PID fuctions.
- [PIDOUT] of PID output is used for individual controls. See corresponding block diagrams for details.

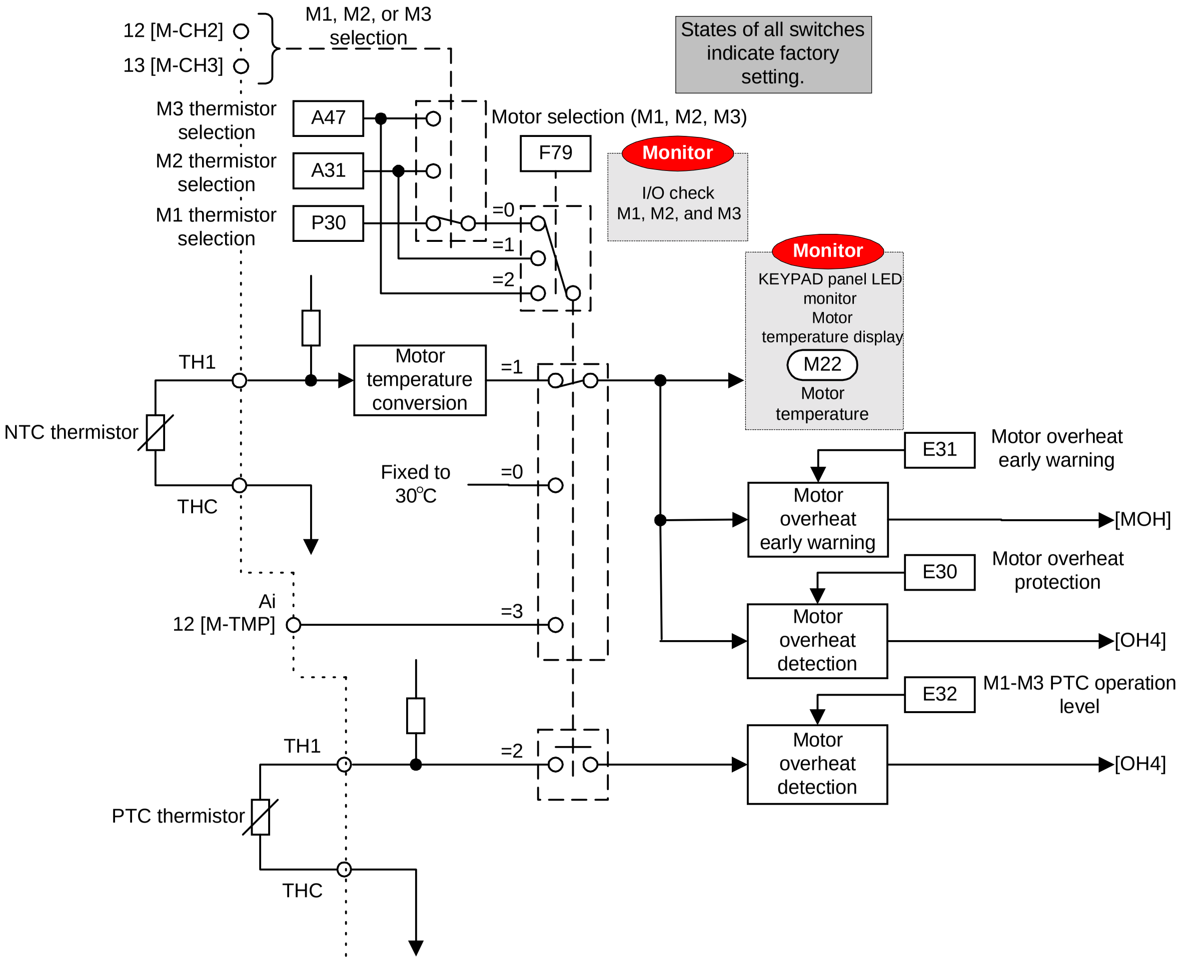
  Speed reference when H27 "PID control (speed reference selection)" is set to 1.

  Auxiliary speed reference when H27 "PID control (speed reference selection)" is set to 2.

  Torque reference when H41 "Torque reference selection" is set to 5.

  Torque limiting when F42 or F43 "Torque limiter value (level 1) or (level 2) selection" is set to 5.

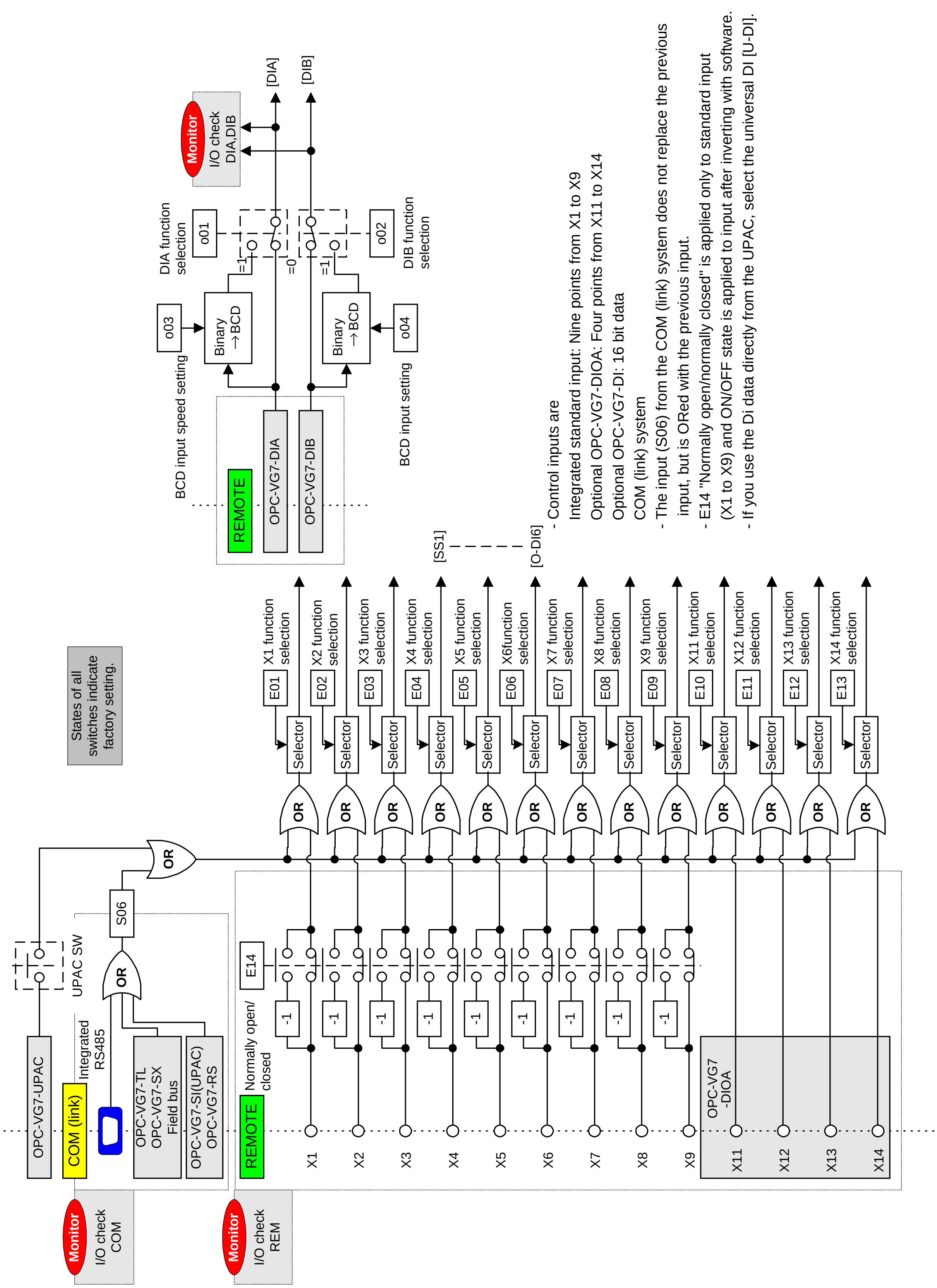
# 4.2.10 Motor Temperature Detection Section




- For thermistor, you can select NTC, PTC thermistor or analog input.
  NTC (Negative Temperature Characteristic) thermistor: a thermistor having a negative relation between temperature and its resistance.
  PTC (Positive Temperature Characteristic) thermistor: a thermistor having a positive relation between temperature and its resistance.
- The motor temperature monitor displays only when an NTC thermistor is connected.  Otherwise it displays "---".
- Though thermistor is used for motor overheat protection, you can use an NTC thermistor for the secondary resistor compensation (R2 compensation) in primary angular frequency calculation to realize accurate torque control without being influenced by the motor temperature as described Section 4.2.8 "Current control and vector control section".

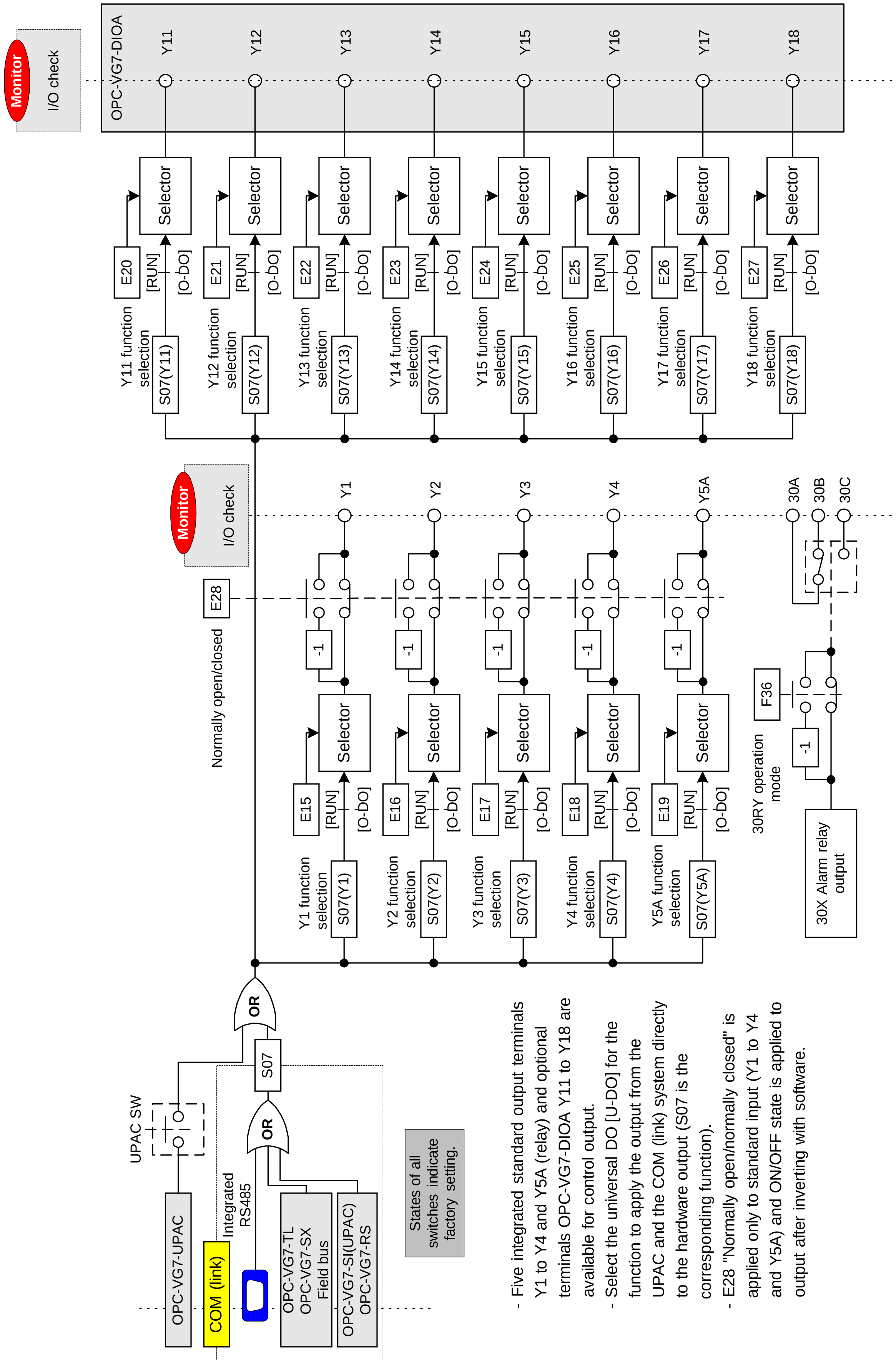
# 4. Control and Operation

## 4.2.11 Function Selection Digital Input



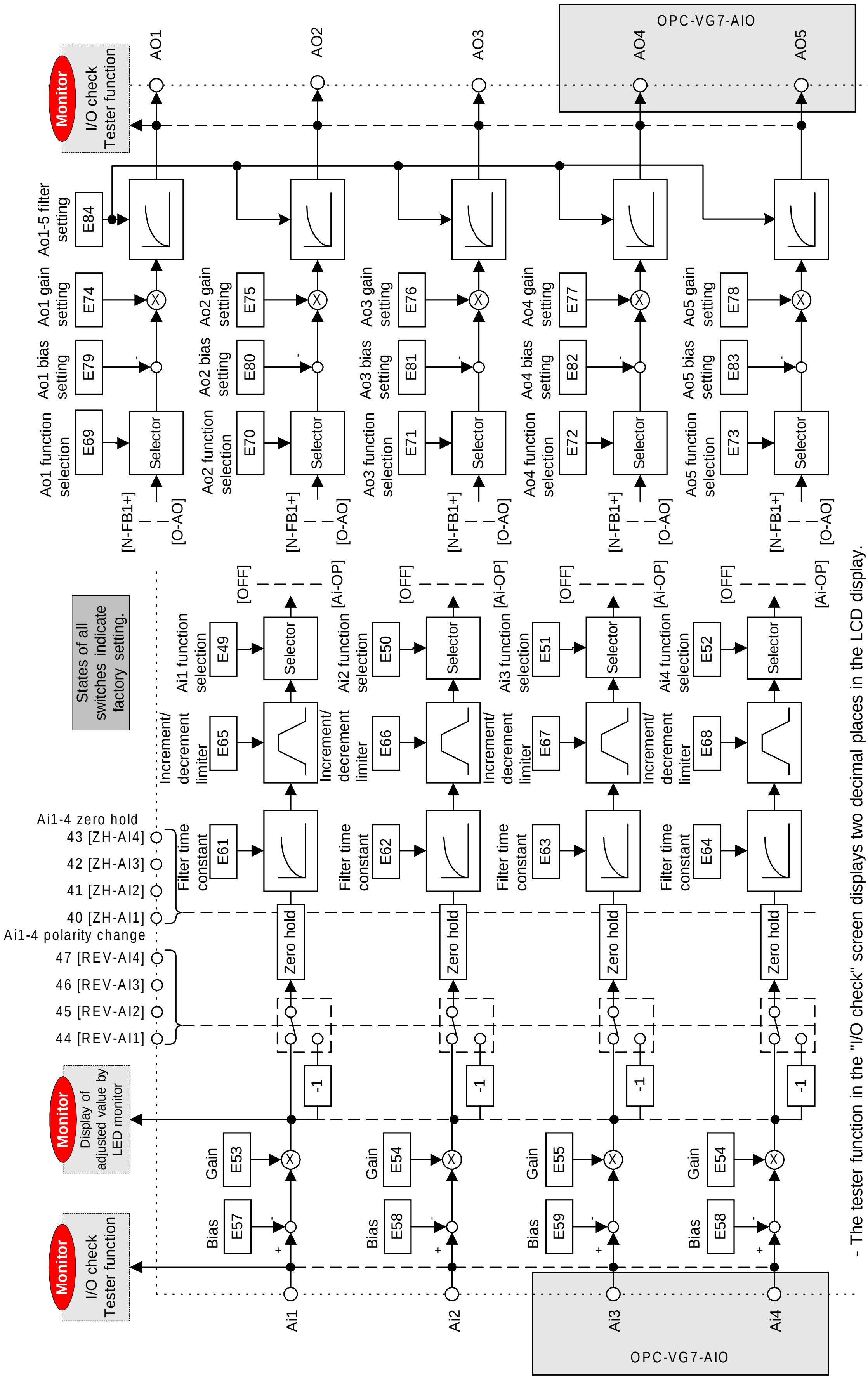

- Control inputs are
  Integrated standard input: Nine points from X1 to X9
  Optional OPC-VG7-DIOA: Four points from X11 to X14
  Optional OPC-VG7-DI: 16 bit data
  COM (link) system
- The input (S06) from the COM (link) system does not replace the previous input, but is ORed with the previous input.
- E14 "Normally open/normally closed" is applied only to standard input (X1 to X9) and ON/OFF state is applied to input after inverting with software.
- If you use the Di data directly from the UPAC, select the universal DI [U-DI].

## 4.2.12 Function Selection Digital Output/Fault Output



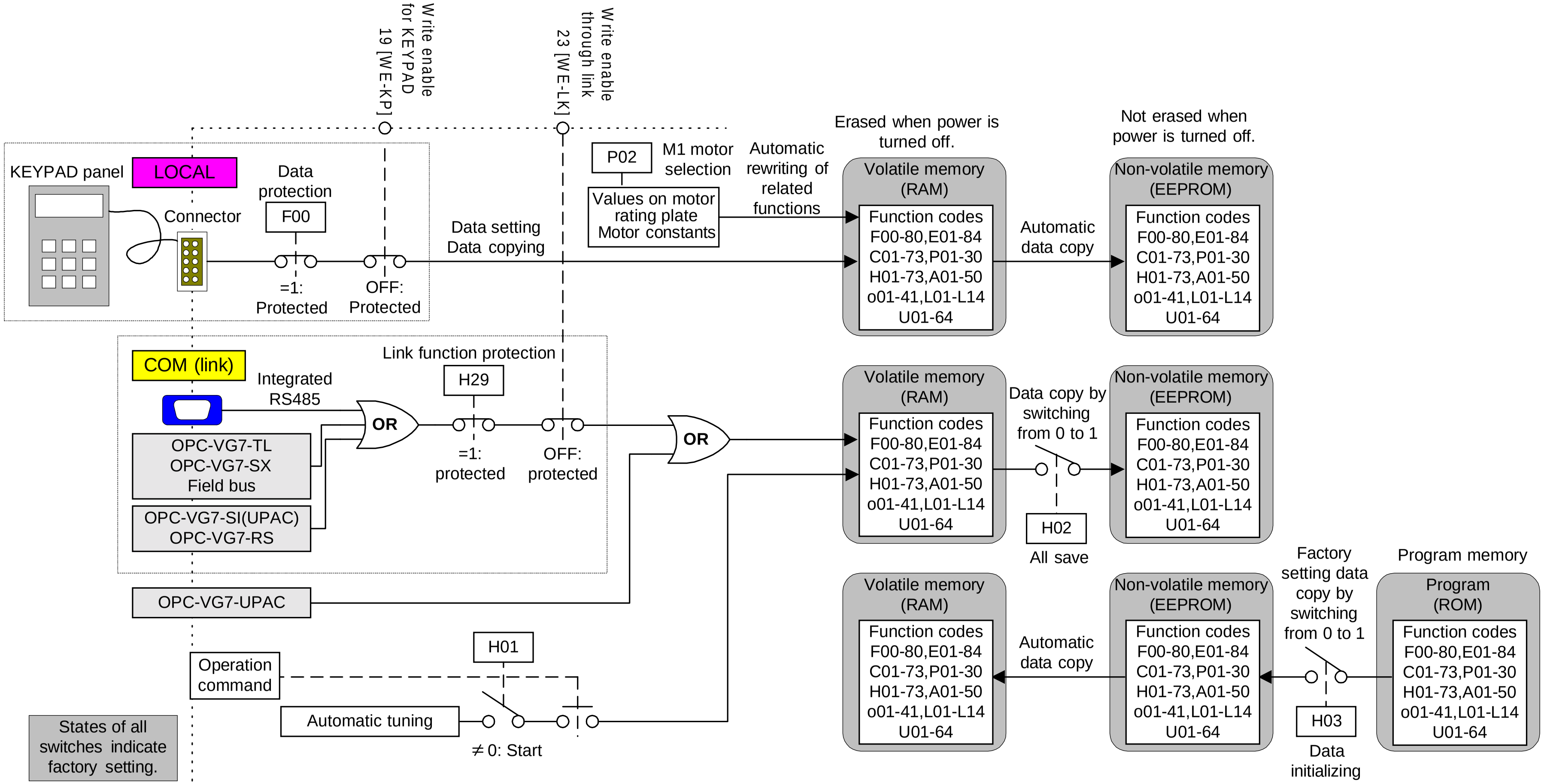

- Five integrated standard output terminals Y1 to Y4 and Y5A (relay) and optional terminals OPC-VG7-DIOA Y11 to Y18 are available for control output.
- Select the universal DO [U-DO] for the function to apply the output from the COM (link) system directly to the hardware output (S07 is the corresponding function).
- E28 "Normally open/normally closed" is applied only to standard input (Y1 to Y4 and Y5A) and ON/OFF state is applied to output after inverting with software.

## 4.2.13 Function Selection Analog Input/Output




- The tester function in the "I/O check" screen displays two decimal places in the LCD display.
- Select the Universal Ai [U-AI] to use the Ai data from the UPAC directly and select the Universal AO [U-AO] to operate the AO.

## 4.2.14 Enabling to Write to/recording Function Codes




- Later writing has always priority. Data written last is maintained and previous data is deleted on writing.
- The all save and initialization procedures take about 2s. You cannot change data in this period.
- When you have not assigned the [WE-KP] or the [WE-LK] to X functions, they are assumed as "ON".
- You cannot enable or disable to write data from the UPAC.
- Data from the COM (link) or the UPAC are written to the RAM and are deleted when you turn off the power.
  If you want to keep them, execute the all save procedure.
- The H30 and [LE] define the access from the COM (link) to the function S area separately.
  See the block diagrams for operation commands and speed reference.
- You cannot use the COM (link) to change the function code P02.

## 4.3 Function Code Description (Arranged by Code)

### 4.3.1 F Code (Fundamental Functions)

**F00** **Data protection**

◆Protection for setting values is available to disable changes through the KEYPAD panel. The KEYPAD panel displays "DATA PRTC" during the data protection.

◆This protection is effective for writing through the KEYPAD, and is not applied to the writing through the link (such as RS485 and field bus). You can use H29 "Protection from write through link" to define the write protection through the link.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 0 | D | A | T | A | | P | R | T | C | |

Set value: 0: You can change data. <0:CHGOK>
1: Data are protected. <1:PROTECT>

[Setting procedure]

0→1: Press STOP and ∧ keys simultaneously to change the value from 0 to 1, then press FUNC/DATA key to confirm the change.

1→0: Press STOP and ∨ keys simultaneously to change the value from 1 to 0, then press FUNC/DATA key to confirm the change.

**F01** **Speed setting N1**

◆Defines the speed reference setting.

◆You can use the digital input signal [N2/N1] to switch the destination of F01 and C25. See the function description of E01 to E13 for switching detail.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 1 | S | P | D | | C | M | D | | 1 | |

Set value: 0: Set by the KEYPAD panel ( ∧ and ∨ keys) <0: KEYPAD>
1: Set by the voltage input (Terminal [12]: 0 to ±10 V) <1:12INPUT>
2: Set by the voltage input (Terminal [12]: 0 to +10 V) <2:12(ABS)>
3: Set by the UP/DOWN (Initial value=0) <3:U/D(0)>
4: Set by the UP/DOWN (Initial value=previous value) <4:U/D(BEF)>
5: Set by UP/DOWN (Initial value=CRP1, CRP2)
(Set by the [UP] and [DOWN] terminals. Related functions: E01 to E13 "X function selection") <5:U/D(CRP)>
6: DIA card input <6: DIA CARD>
7: DIB card input <7: DIB CARD>

◆Use the "Operation monitor" of the KEYPAD panel to confirm the speed reference.
The right figure shows "Operation monitor" screen when you set the speed reference command to 1200r/min and the operation command to ON.

**1200**

N*=1200.0r/m
N =1200.0r/m
f* = 0.0Hz
TRQ= 0%

## F02 Operation method

◆Sets operation method.

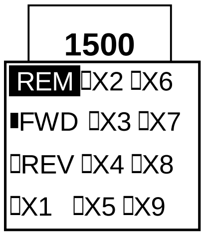
| F | 0 | 2 | O | P | R |  | M | E | T | H | O | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Key operation (KEYPAD panel: FWD, REV, and STOP keys)
(LOCAL mode) <0:KEYPAD>
1: External input (terminal [FWD] and [REV]) (REMOTE mode) <1:FWD, REV>

You can also use RST + STOP keys on the KEYPAD panel to switch between REMOTE and LOCAL (This KEYPAD panel operation rewrites the set value for F02).
When the function code H30 "Serial link" is set to 2 or 3, operation through the link will be effective regardless of F02 setting.

◆Operation command through the key operation on the KEYPAD panel turns on the green RUN LED.
When you have selected an operation through the external inputs (FWD and REV), display the I/O check REM on the KEYPAD panel to make sure that corresponding inputs for ☐FWD and ☐REV are indicated with ■).

The right figure shows the I/O screen when the FWD signal is turned on externally.
Note that the I/O screen for the COMM shows commands through the link and does not reflect the terminal block commands.




## F03 M1 max. speed

◆Sets the maximum speed for the motor 1. If you set the value greater than the rating of a driven device, you may damage the motor or the machine. Be sure to set according to a machine to drive.

| F | 0 | 3 | M | 1 | - | N | m | a | x |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 50 to 24,000 [r/min]

## F04 M1 rated speed

◆Sets the rated speed in the constant torque range of the motor M1. Set according to the rating (displayed on a rating plate) of a motor to be used. When you use a standard motor for the VG5 or the VG7, the data is set automatically and you cannot change it. When P02 is set to "P-OTR", you cannot change the value.

| F | 0 | 4 | M | 1 | - | N | r |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 50 to 24,000 [r/min]

## F05 M1 rated voltage

◆Sets the rated voltage supplied to the motor 1. Set according to the rating (displayed on a rating plate) of a motor to be used. When you use a standard motor for the VG5 or the VG7, the data is set automatically and you cannot change it. When P02 is set to "P-OTR", you cannot change the value.

| F | 0 | 5 | M | 1 | - | V | r |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 80 to 999 [V]

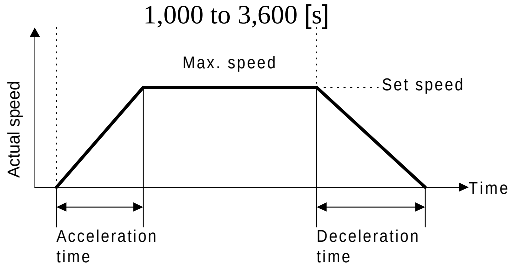
## F07 Acceleration time 1
## F08 Deceleration time 1

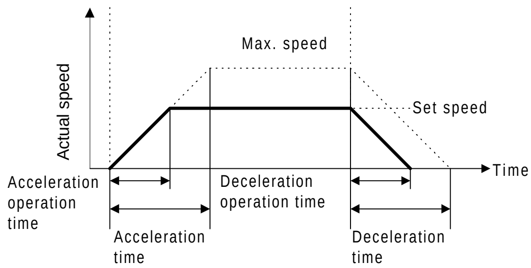
◆Set the acceleration time from zero to the maximum speed and the deceleration time from the maximum speed to zero. The acceleration time and deceleration time are set based on the maximum speed.
◆The following equation denotes the relationship between the set speed and the acceleration/deceleration times. The acceleration/deceleration times become longer when you specify the S-curve acceleration and deceleration. See F67 function description for more details.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 7 | A | C | C | | T | I | M | E | 1 | | |
| F | 0 | 8 | D | E | C | | T | I | M | E | 1 | | |

$$\text{Time required for acceleration/deceleration} = \text{Set value (F07, F08)} \times \frac{\text{Set speed}}{\text{Maximum speed}}$$

Setting range: 0.00 to 99.99 [s]
100.0 to 999.9 [s]
1,000 to 3,600 [s]




◆Specified values through the link (RS485, T-Link, SX, and field bus) are copied to F07 and F08 to use.

## F10 M1 electronic thermal overload relay (Select)
## F11 M1 electronic thermal overload relay (Level)
## F12 M1 electronic thermal overload relay (Thermal time constant)

◆The electronic thermal overload relay manages the motor rotation, the output current and the operation time and protects the motor from overload. This function protects the motor M1. When you use a dedicated motor for the VG5 or the VG7, disable this function (setting is not required).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 1 | 0 | M | 1 | - | E | O | L | - | S | E | L |

- Operation selection

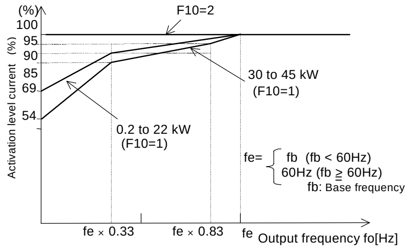
When you use a dedicated motor for the VG5 or the VG7, the motor overheat protection by an NTC thermistor becomes in operation and you do not hove to use an electronic thermal overload relay. Disable this function.
When a motor overheat protection by an NTC thermistor is not available, enable the electronic thermal overload relay and select a motor (self-cooling fan or separate cooling fan).
The protection function (motor overload: oL1) is activated when 150% of the current specified by F11 flows for the time specified by F12.

Set value: 0: Inactive (For a dedicated motor for the VG5 or the VG7. Protected by an NTC thermistor)
1: Active (Self-cooling fan, general-purpose motor)
2: Active (Separate cooling fan, FUJI's inverter motor)

### F11 M1-EOL-LVL

- Operation level

Set the activation level in current value for the electronic thermal overload relay.
Enter a value in the range from 1.0 to 1.1 times of the rated current of a motor.
Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]



Activation level current and output frequency

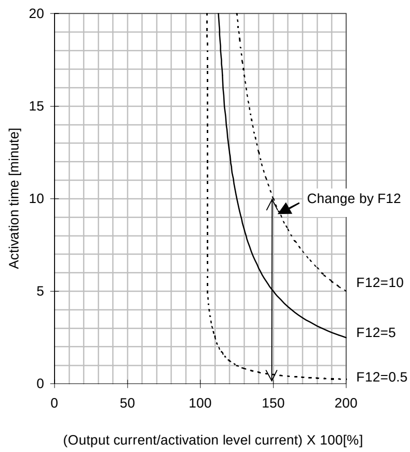
### F12 M1-EOL-TC

- Thermal time constant

Set the time for 150% or more of the current at operation level (specified by F11) flows continuously before the electronic thermal overload relay is activated.
Setting range: 0.5 to 75.0 [min]

(Example) If you set F12=5 [min],
As indicated in the right graph, if 150% current flows for five minutes, the protection function of the motor 1 overload (alarm: oL1) is activated. If the current is 120%, then the protection function will be activated in 13 minutes. Since the current flowing through a motor is not usually constant, the average current in a certain period activates the timer for the electronic thermal overload relay.

Example of current-activation time characteristics




Note: Very frequent operation will fluctuate the load current and the current will reach the short-time rating (100% or more) frequently.
In this case, refer to Section 9.1.3.4 "Actual equivalent loading estimation" to calculate the equivalent effective current and to limit this value under the rated current of a motor (for separate cooling fan).

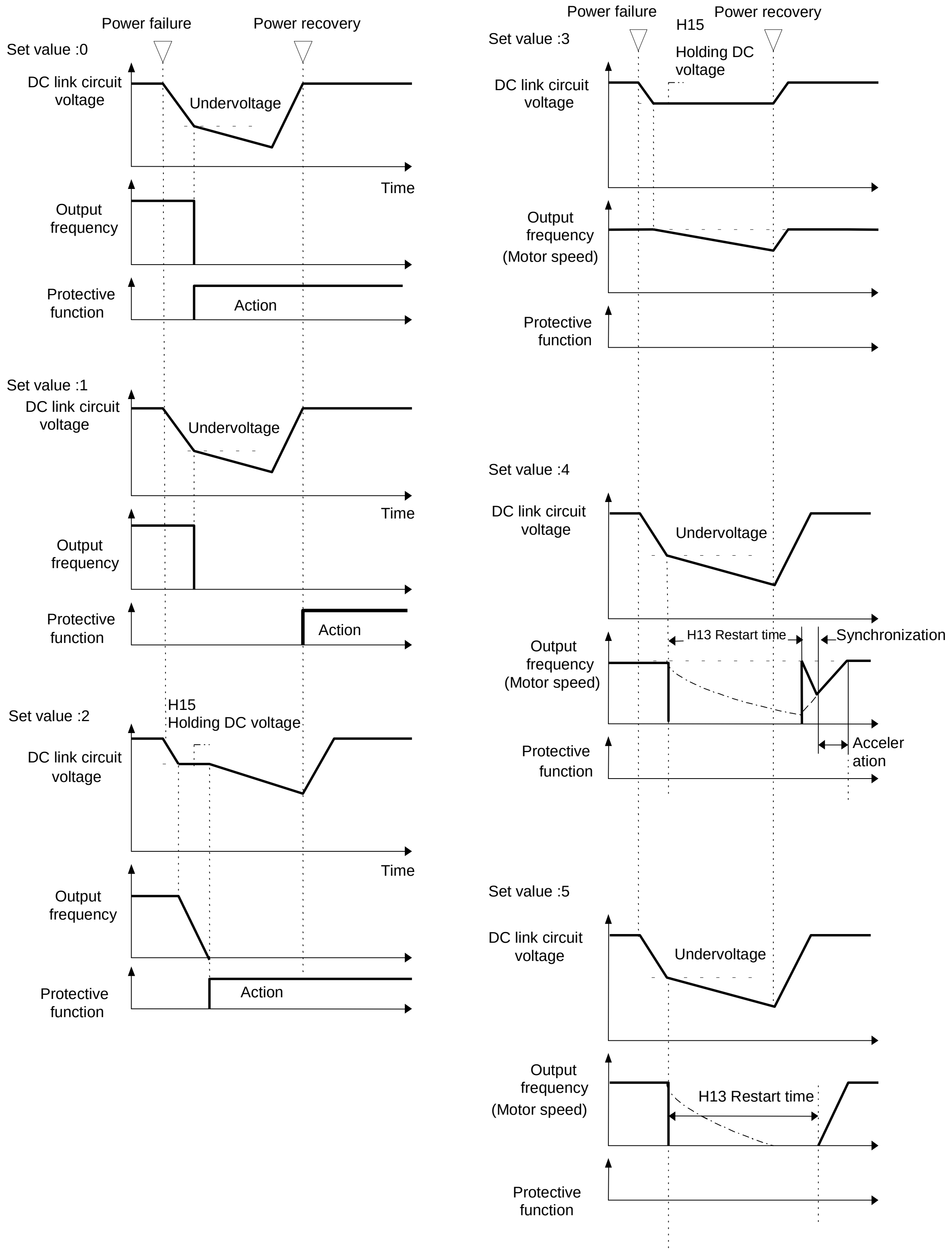
## F14 Restart mode after momentary power failure (Select)

◆This function selects an action after a momentary power failure. You can select a function for detecting power failure and activating protective operation (alarm output, alarm display, inverter output cutoff) for undervoltage or an automatic restart function without stopping a coasting motor after the supply voltage recovery.

◆See the following table for more information on this function.
The function codes H14 to H17 "Auto-restart" are provided for a restart after a momentary power failure. You should be familiar with these functions too.

F14 RESTART

<table>
<tr><th>Set value</th><th>Function name</th><th>Operation on power failure</th><th colspan="2">Operation on power recovery</th></tr>
<tr><td>0</td><td>Inactive (immediate inverter trip)</td><td>If undervoltage is detected, the protective function is activated and output is turned off.</td><td>The inverter does not restart.</td><td rowspan="3">Enter commands for resetting the protective function and starting operation.</td></tr>
<tr><td>1</td><td>Inactive (inverter trip on recovery)</td><td>If undervoltage is detected, the protective function is not activated and output will be turned off.</td><td>The protective function is activated, but the operation does not restart,</td></tr>
<tr><td>2</td><td>Inactive (inverter trip after deceleration to a stop on power failure)</td><td>When the holding DC level (H15) "Restart after momentary power failure" is reached, the inverter decelerates a motor to stop. The DC voltage of the main circuit sharpens the deceleration slope so that the undervoltage protective function is not activated. The inverter collects the inertia energy of the load and controls the motor until it stops, then the undervoltage protective function is activated.<br>If the amount of inertia energy from the load is small, and the undervoltage level is achieved during deceleration, the undervoltage protective function is then activated.</td><td>The protective function is activated, but the operation does not restart,</td></tr>
<tr><td>3</td><td>Active (continuous operation)</td><td>When the holding DC level is reached, energy is collected from the inertia amount of the load to extend the operation continuation time.<br>If undervoltage is detected, the protective function is not activated, but the output is turned off.</td><td colspan="2">Operation restarts automatically. For a power recovery during a continued operation, the inverter accelerates to the original speed. If the inverter detected an undervoltage, operation automatically restarts at the speed when the undervoltage is detected.</td></tr>
<tr><td>4</td><td>Active (restart at the speed on power failure)</td><td>If undervoltage is detected, the protective function is not activated and the output is turned off.</td><td colspan="2">Operating restarts automatically at the speed on a power failure.</td></tr>
<tr><td>5</td><td>Active (restart at the starting speed)</td><td>If undervoltage is detected, the protective function is not activated and the output is turned off.</td><td colspan="2">Operation restarts automatically at the speed set to F23 "Starting speed".</td></tr>
</table>

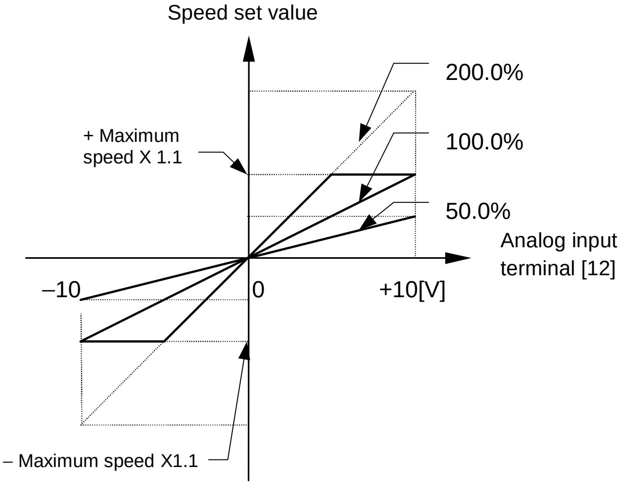

Power failure
Power recovery
Set value :0
DC link circuit voltage
Undervoltage
Time
Output frequency
Protective function
Action
Set value :1
DC link circuit voltage
Undervoltage
Time
Output frequency
Protective function
Action
Set value :2
H15
Holding DC voltage
DC link circuit voltage
Time
Output frequency
Protective function
Action
Power failure
Power recovery
Set value :3
H15
Holding DC voltage
DC link circuit voltage
Output frequency (Motor speed)
Protective function
Set value :4
DC link circuit voltage
Undervoltage
H13 Restart time
Synchronization
Output frequency (Motor speed)
Protective function
Acceler ation
Set value :5
DC link circuit voltage
Undervoltage
Output frequency (Motor speed)
H13 Restart time
Protective function

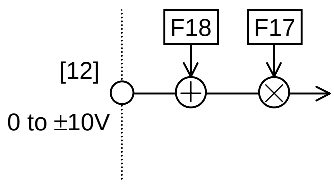
**F17** **Gain (for speed setting signal 12)**

◆Sets the proportion to the speed setting value (analog input) from the control terminal [12]. Setting is limited to 110% (1.1 times) of ±max. speeds.

| F | 1 | 7 | G | A | I | N | ( | 1 | 2 | ) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting rage: 0.0 to 200.0 [%]



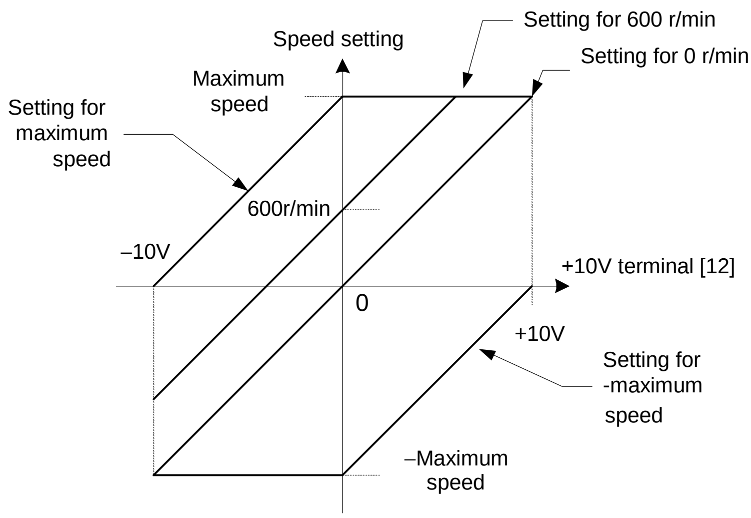




**F18** **Bias (for speed setting signal 12)**

◆You can add a bias speed to the speed setting value (analog input) from the control terminal [12]. Setting is limited to ±max. speeds.

| F | 1 | 8 | B | I | A | S | ( | 1 | 2 | ) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting rage: –24,000 to 24,000 [r/min]



| F20 | DC brake (Starting speed) |
|---|---|
| F21 | DC brake (Braking level) |
| F22 | DC brake (Braking time) |

◆If you apply a DC voltage to an operating motor (set the output frequency to zero), the motor generates a braking torque to decelerate to stop. This is referred as DC brake and these functions specify the setting. If a motor does not stop within a DC braking time, the motor will coast. You can assign a digital signal input [DCBRK] to start the DC brake.

| F | 2 | 0 | D | C | | B | R | K | | N | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Starting speed
  Set the starting speed of the DC brake during decelerating.
  Setting range: 0 to 3,600 [r/min]

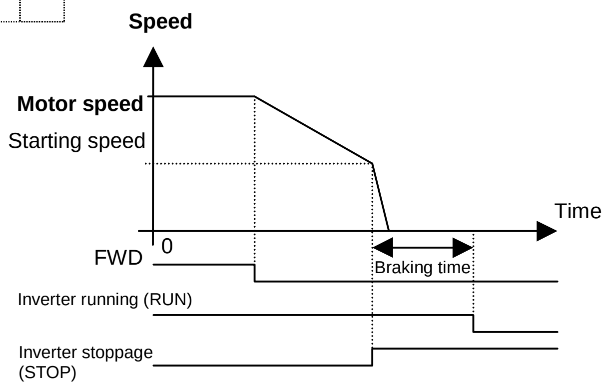
| F | 2 | 1 | D | C | | B | R | K | | L | V | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Braking level
  Sets the output current level of the DC braking.
  You can specify as a percentage of the inverter rated output (100%) with a minimum unit of 1%.
  Setting range: 0 to 100 [%]

| F | 2 | 2 | D | C | | B | R | K | | t | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Braking time
  Sets the operation time for the DC braking
  Setting range: 0.0: Inactive
  0.1 to 30.0 [s]

◆DC brake operation
The DC brake is applied for a specified time after the speed reaches the starting speed level on deceleration of a motor. The inverter running (RUN) signal maintains ON during the DC braking and the inverter stoppage (STOP) signal turns on when the DC brake is activated.



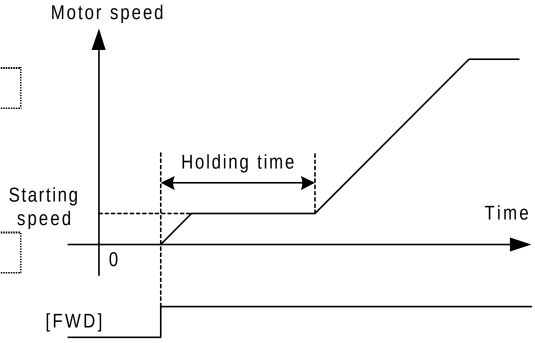

| ⚠ CAUTION |
|---|
| • The brake function of the inverter does not provide a mechanical hold. **You may be injured.** |

| F23 | Starting speed |
|---|---|
| F24 | Starting speed (Holding time) |

◆You can set a starting speed to assure a starting torque.
Vector control operation:
This function acts to release a mechanical brake. If you enter the operation command after setting the starting speed to 0r/min, the brake will be released after the magnetic-flux and the torque reach a certain level. See E15 to E27 "Y function selection" for brake release signal.

V/f control operation:

You can accelerate a motor after operating the motor at a starting speed for a certain period to establish the magnetic-flux on start.




| F | 2 | 3 | S | T | A | R | T | | N | | |
|---|---|---|---|---|---|---|---|---|---|---|---|

- Starting speed
  Sets the rotation at start.
  Setting range: 0.0 to 150.0 [r/min]

| F | 2 | 4 | H | L | D | | S | T | A | R | T | t |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Holding time
  Sets the period for maintaining the starting time.
  Setting range: 0.0 to 10.0 [s]

Note: The holding time is not activated when you switch between forward and reverse rotation. The acceleration time does not include the holding time.

## F26 Motor sound (Carrier freq.)

◆Adjusts the carrier frequency. You can adjust the carrier frequency to reduce the motor sound and the inverter noise, to avoid resonance with the mechanical systems, and to reduce the leakage current from the output circuit wiring.

| F | 2 | 6 | M | T | R | | S | O | U | N | D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.75 to 15 [kHz]

| | |
|---|---|
| Carrier frequency | 0.75 to 15kHz |
| Motor sound | High to low |
| Output current waveform | Bad to good |
| Leakage current | Low to high |
| Generated noise | Low to high |

Note 1: Reducing the setting adversely affects the output current waveform (i.e., high harmonics), increases the motor loss, and raises the motor temperature. For example, setting 0.75 kHz reduces the motor torque by about 15%. Increasing the setting increases inverter loss and raises the inverter temperature.

Note 2: The recommended carrier frequency is 2 to 15kHz for vector control. If you select the range from 0.75 to 1kHz, you cannot control current properly. Insufficient current control will activate the protective function for overcurrent (OC).

## F27 Motor sound (Sound tone)

◆You can adjust the motor sound tone when the carrier frequency is lower than 7kHz. Use this function, if needed.

| F | 2 | 7 | S | O | U | N | D | | T | O | N | E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set values: 0: Level 0
1: Level 1
2: Level 2
3: Level 3

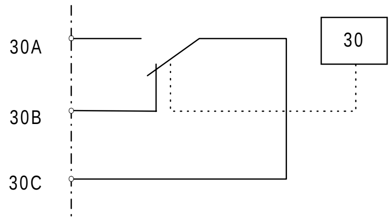
This function changes (modulates) the carrier frequency in the range of set frequency ±α[%] periodically. This does not cause adverse effects such as losses (motor or inverter).

## F36 — 30RY operation mode

◆Selects whether to activate (excite) the alarm output relay (30RY) in a normal state or in an abnormal state.

| F | 3 | 6 | R | Y | | M | O | D | E | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting value: 0:Normal state: 30A-30C: OFF, 30B-30C: ON
Abnormal state: 30A-30C: ON, 30B-30C: OFF
1:Normal state: 30A-30C: ON, 30B-30C: OFF
Abnormal state: 30A-30C: OFF, 30B-30C: ON




When the setting value is 1, the contacts between 30A and 30C are connected after the inverter control voltage is established (about one second after turning on). Since the relay is excited in a normal state, the relay can detect a disconnection in the alarm output line.

## F37 — Stop speed
## F38 — Stop speed (Detection method)
## F39 — Stop speed (Zero speed holding time)

| F | 3 | 7 | S | T | O | P | | N | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Stop speed
  Sets the stop speed.
  Setting range: 0.0 to 150.0 [r/min]
  If starting speed < stop speed, or the speed setting value is lower than the stop speed, a motor does not start.

| F | 3 | 8 | D | E | T | | S | I | G | N | A | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

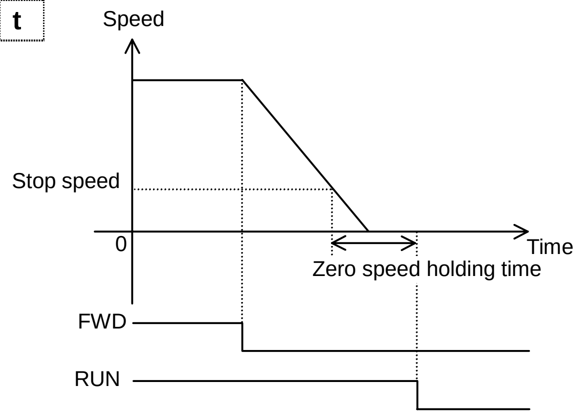
- Detection method
  Sets the stop speed detection method whether to the speed reference value (Speed setting 4 (ASR input)) or the detected speed value (Detected speed 1)
  Setting value: 0: Speed reference value
  1: Detected speed value
  Note that only the speed reference value is valid in the V/f control mode. Estimated speed value is used when you select the detected speed value in the sensorless control.

| F | 3 | 9 | H | L | D | | S | T | O | P | | t |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Zero speed holding time
  Setting range: 0.00 to 10.00 [s]

The Inverter running (RUN) signal will turns off at the end of the Zero speed holding time for continuing operation after the motor speed reaches the stop speed level.

◆You can use this function to adjust the timing to apply a mechanical brake.



## F40 Torque limiter mode 1
## F41 Torque limiter mode 2

◆Torque limiter mode 1: Selects whether to enable or disable limiters (torque, power, or torque current). Turning on with applying "F40 cancel" [F40-CCL] has the same effect as setting "0" which disabling limiters.

| F | 4 | 0 | T | L | I | M | | M | O | D | E | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Limiters disabled
1: Torque limiter enabled
2: Power limiter enabled
3: Torque current limiter enabled

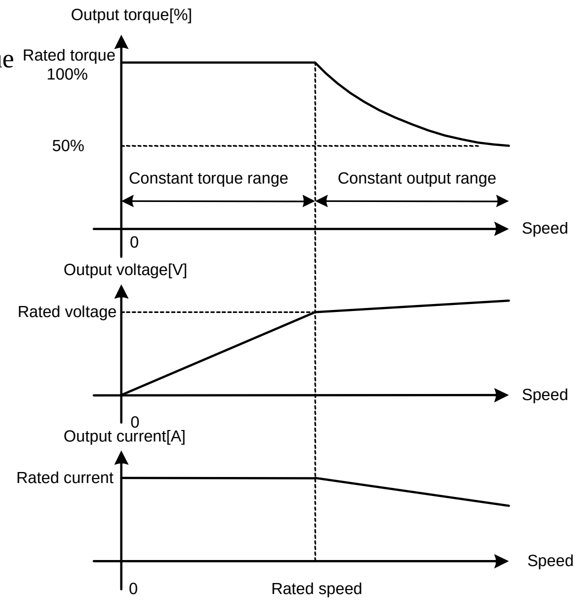
Background information

The right graph shows a continuous permissible torque (not short-time rating) for forward rotation driving in the speed control range (0-rated speed-200%). The control generally reduces magnetic-flux above the rated speed to extend the speed control range. The reduced output current in the right graph shows that the control reduces the current corresponding to the amount of the reduced magnetic-flux. This reduces the increase of the induced motor voltage to restrain the increase of the voltage output proportional to the speed.

Under the rated speed, the rated torque is effective. Since the torque is proportional to the product of the exciting current ant the torque current, the current is limited in practice.

Over the rated speed, since the inverter capacity (output: power) resticts the torque, the output torque decreases in inversely proportional to the speed.

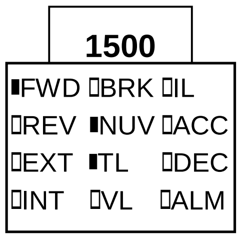
The torque limiter condition switches at the rated speed.



Output characteristic
(first quadrant, forward rotation driving)

◆You can use the "Operation monitor" of the "I/O check" of the KEYPAD panel to review the state of the torque limiter, the power limiter and torque current limiter status

■TL in the right figure shows the torque limiter is active. When the torque limiter is not applied, the display turns to □TL. You can also read the function code M14 "Operation status" through the link to confirm the state.




◆Torque limiter mode 2: Selects a type of torque limiter.

| F | 4 | 1 | T | L | I | M | | M | O | D | E | 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value1: 0: Level 1 for four quadrants simultaneously
1: Driving (Level 1), braking (Level 2)
2: Upper limit (Level 1), lower limit (Level 2)
3: Switching between the Level 1 and the Level 2 for all four quadrants.

The next section describes the actual limitations determined by the values set at F40 and F41. For level 1 and level 2 of each limitation, see the explanation of the function codes F42 and F43.

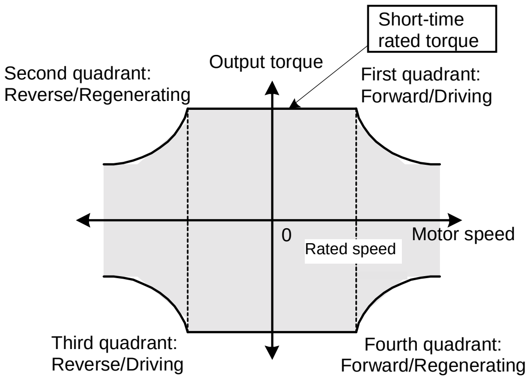
Description and application of the limiter mode 1

| Limiter type | Limiter description | Application |
|---|---|---|
| Torque limiter disabled<br>(set value: 0)<br>[F40-CCL]= ON | Limits the torque by the maximum output current (One-minute, ten-second ratings) in the entire speed limiting range.<br><br>$\tau(\text{Torque\%}) = \frac{\sqrt{\text{Im}ax^2 - \text{Im}^2}}{It} \times 100[\%]$<br>Maximum driving torque for 30kW, 200V, CT use, and VG7 dedicated motor is 153.1%<br><br>Imax(Short-time rated current)=174(A)<br>Im(Exciting current:P08)=53.42(A)<br>It(Torque current:P09)=108.18(A)<br><br>$\tau(\text{Torque\%}) = \frac{\sqrt{174^2 - 53.42^2}}{108.18} \times 100[\%]$<br>$= 153.1[\%]$ | Use for the shortest acceleration/deceleration with the inverter.<br><br>Note:<br>For driving, check the operation sequence to avoid activating the protective function due to the inverter over load or the motor overload.<br>For braking, check if disabled limiters do not cause any problems when you select braking resistor capacity for the operation sequence if you use power regenerative devices (RHR or RHC series) or connect braking resistors. |
| Torque limiter enabled<br>(set value: 1) | Limits the output of the speed control unit (ASR).<br>Restrain the torque[N·m] in terms of the percentage of the rated torque of a motor assumed as 100%.<br>The maximum output current of the inverter (one-minute, ten-second rating) may limit the torque in the constant output range depending on the set value for the limiter. | Use for constant torque control involving speed control and torque limiting such as winding or tension control. |
| Power limiter enabled<br>(set value: 2) | Limits the torque by the power in the entire speed control range. Restrain the output capacity (power: kW) in terms of the percentage of the rated capacity of an inverter assumed as 100%.<br>The maximum output current of the inverter (one-minute, ten-second rating) may limit the torque in the constant torque range depending on the set value for the limiter. | Use for limiting braking torque such as stopping by braking capacity (power).<br>Use for braking that uses the capacity of a braking resistor.<br>Also use for stopping that uses only the inverter loss[kW] when you do not use an external braking resistor (DB). |
| Torque current limiter enabled<br>(set value: 3) | Limits the torque in the constant torque range and limits the power in the constant output range.<br>Restricts the torque current reference in terms of the percentage of the rated torque current assumed as 100%. Since this control limits the torque current to a constant level, the control reduces the magnetic-flux in the constant output range, resulting in reducing torque accordingly. | Enables a limiter restricting below the short-time rated torque.<br>Use when you limit the output torque for the motor temporarily. |

See the following pages for detailed application examples.

(1) Torque limiter disabled

| Code | Set value | Description |
|---|---|---|
| F40 | 0 | Limiter disabled |
| F41 | 0, 1, 2, 3 | Not effective |

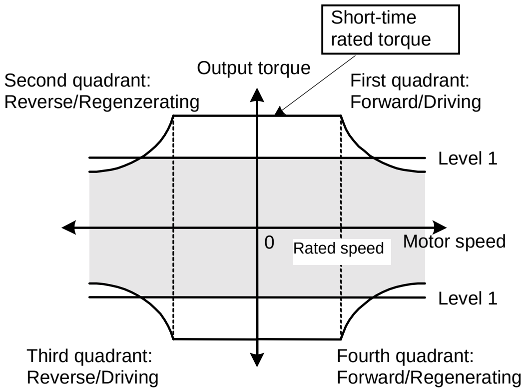



- Limits the torque by the maximum output current (one-minute, ten-second ratings) in the entire speed limiting range. Use for the shortest acceleration/deceleration with the inverter.
- For driving, check the operation sequence to avoid activating the protective function due to the inverter overload or the motor overload.
- For braking, check if disabled limiters do not cause any problems when you select braking resistor capacity for the operation sequence if you use power regenerative devices (RHR or RHC series) or connect braking resistors.

(2) Torque limiter enabled

(2)-1.Level 1 for all four quadrants

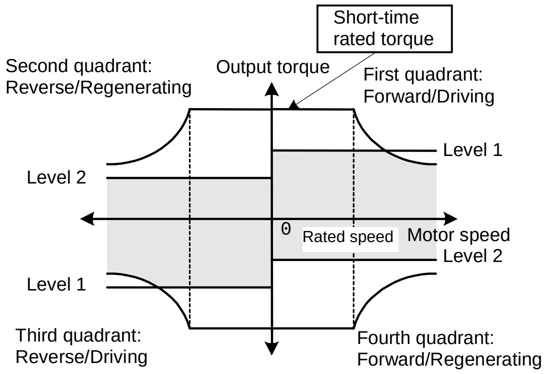
| Code | Set value | Description |
|---|---|---|
| F40 | 1 | Torque limiter enabled |
| F41 | 0 | Level 1 for all four quadrants simultaneously |




- The short-time rated torque limits the torque where the Level 1 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.

(2)-2.Driving (Level 1), braking (Level 2)

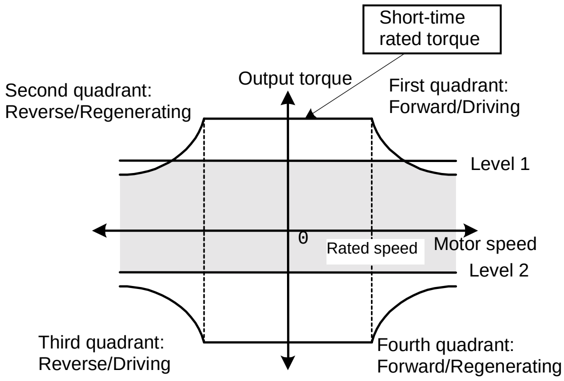
| Code | Set value | Description |
|---|---|---|
| F40 | 1 | Torque limiter enabled |
| F41 | 1 | Driving (Level 1), Braking (Level 2) |



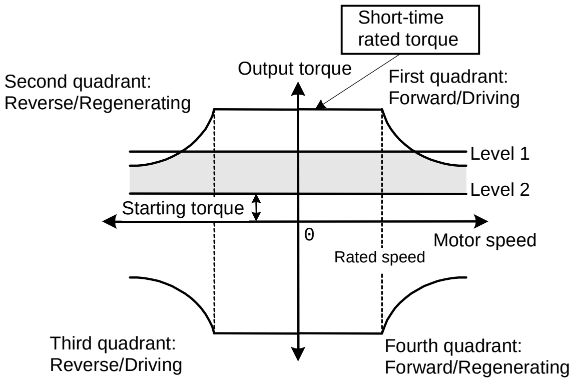

- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.
- You can use this specification to set the Level 1 as the short-time rated torque for driving and to set the Level 2 as the braking torque limiter due to the brake capacity for braking.
- You cannot use the digital input [TL2/TL1] to switch between the Level 1 and the Level 2.

(2)-3.Upper limit (Level 1), lower limit (Level 2)

| Code | Set value | Description |
|---|---|---|
| F40 | 1 | Torque limiter enabled |
| F41 | 2 | Upper limit (Level 1), Lower limit (Level 2) |




- Plus and minus values specifiy the Level 1 and the Level 2. Make sure the setting polarity is correct. Usually the **Level 1 is set to plus ant the Level 2 is set to minus**.
- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- You cannot use the digital input [TL2/TL1] to switch between the Level 1 and the Level 2.



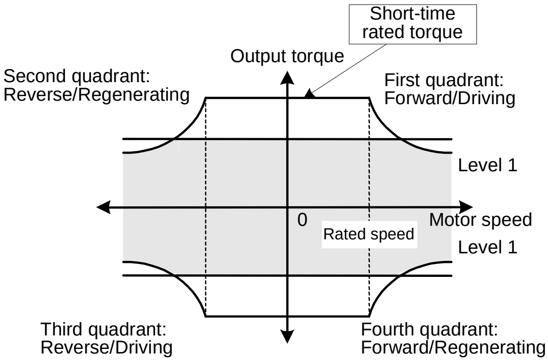

- When you assign plus values both to the Level 1 and the Level 2, the entire valid torque range stays in plus (Level 1 > Level 2).
- When you assign minus values both to the Level 1 and the Level 2, the entire valid torque range stays in minus (|Level 1| < |Level 2|. e.g. Level 1=–10 and Level 2=–100).
- Use for applications such as winding control where starting torque is required (right figure).
- In this setting, a torque more than the starting torque is generated. The motor **may accelerate up to the hazard protective level (overspeed: OS, 120% of the maximum speed)** when the load is light. To avoid this situation, use the **Speed limiter** (function code: F76) as well.

| ⚠ CAUTION |
|---|
| • If you set the Level 2 larger than Level 1, the output torque will be fixed to the Level 1. Unless you want this operation, never use this setting. A motor may become out of control and dangerous. **Accidents or physical injuries may occur.** |

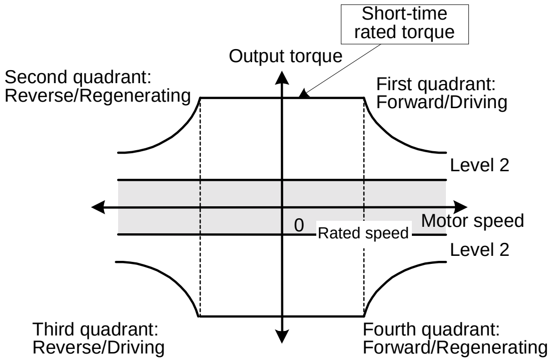
(2)-4.Switching between Level 1 and Level 2 for all four quadrants simultaneously

| Code | Set value | Description |
|---|---|---|
| F40 | 1 | Torque limiter enabled |
| F41 | 3 | Switching between Level 1 and Level 2 for all four quadrants simultaneously |

- When you turn on with assigning the torque limiter (Level 1, Level 2 selection) [TL2/TL1] signal to a digital input signal, you can switch between the Level 1 and the Level 2.




[ TL2/TL1 ] = OFF




[ TL2/TL1 ] = ON

- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.

(3) Power limiter enabled

(3)-1.Level 1 for all four quadrants

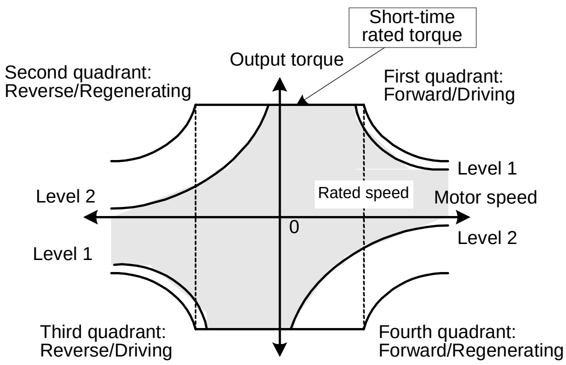
| Code | Set value | Description |
|---|---|---|
| F40 | 2 | Power limiter enabled |
| F41 | 0 | Level 1 for all four quadrants simultaneously |

- Though this setting is possible, there is no such an application.

(3)-2.Driving (Level 1), braking (Level 2)

| Code | Set value | Description |
|---|---|---|
| F40 | 2 | Power limiter enabled |
| F41 | 1 | Driving (Level 1), Braking (Level 2) |

- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.
- If you set the Level 1 as the short-time rated torque for driving and set a capacity corresponding to the inverter loss for braking, you can use the inverter loss to enable the shortest stop without an external braking resistor.
- Use this setting for an application such as applying brake with the capacity of a braking resistor.



### (3)-3.Upper limit (Level 1), lower limit (Level 2)

| Code | Set value | Description |
|---|---|---|
| F40 | 2 | Power limiter enabled |
| F41 | 2 | Upper limit (Level 1),<br>Lower limit (Level 2) |

- Though this setting is possible, there is no such an application.

### (3)-4.Switching between Level 1 and Level 2 for all four quadrants simultaneously

| Code | Set value | Description |
|---|---|---|
| F40 | 2 | Power limiter enabled |
| F41 | 3 | Switching between Level 1 and Level 2 for all four quadrants simultaneously |

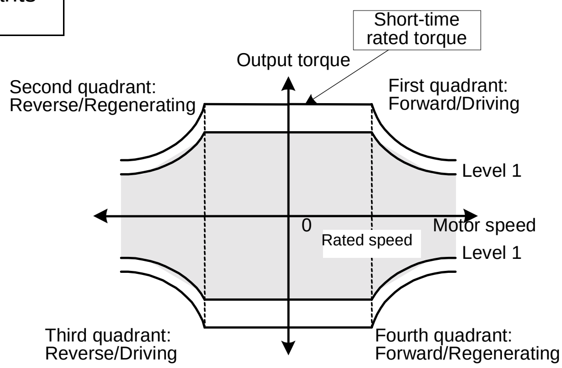
- Though this setting is possible, there is no such an application.

## (4) Torque current limiter enabled

### (4)-1.Level 1 for all four quadrants

| Code | Set value | Description |
|---|---|---|
| F40 | 3 | Torque current limiter enabled |
| F41 | 0 | Level 1 for all four quadrants simultaneously |

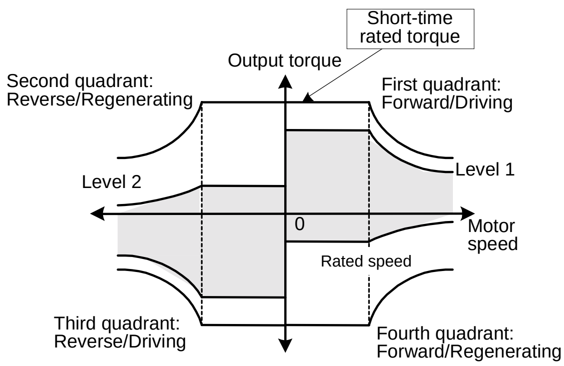
- Unless you set the Level 1 over the short-time rated torque, the short-time rated torque does not limit the torque.
- When protective actions (inverter overload or motor overload) occur frequently, you can lower the setting level to avoid this phenomenon.
- Though you can specify the Level 1 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.




### (4)-2.Driving (Level 1), braking (Level 2)

| Code | Set value | Description |
|---|---|---|
| F40 | 3 | Torque current limiter enabled |
| F41 | 1 | Driving (Level 1),<br>Braking (Level 2) |

- Unless you set the Level 1 and Level 2 over the short-time rated torque, the short-time rated torque does not limit the torque.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.
- You can use this specification to set the Level 1 as the short-time rated torque for driving and to set the Level 2 as the braking torque limiter due to the brake capacity for braking.
- You cannot use the digital input [TL2/TL1] to switch between the Level 1 and the Level 2.



(4)-3.Upper limit (Level 1), lower limit (Level 2)

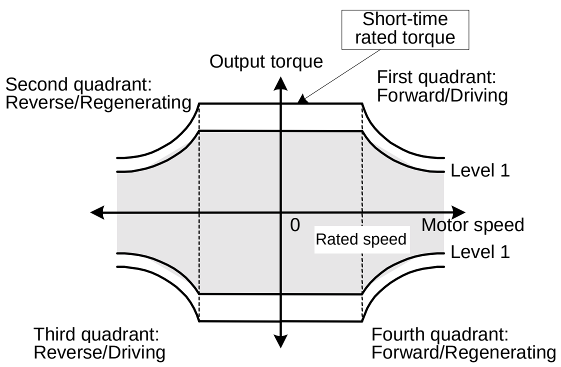
| Code | Set value | Description |
|---|---|---|
| F40 | 3 | Torque current limiter enabled |
| F41 | 2 | Upper limit (Level 1),<br>Lower limit (Level 2) |

- Though this setting is possible, there is no such an application.

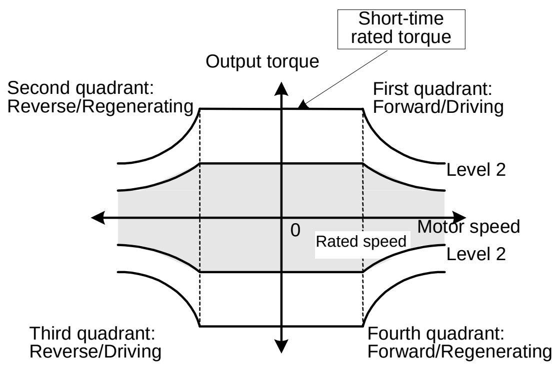
(4)-4.Switching between Level 1 and Level 2 for all four quadrants simultaneously

| Code | Set value | Description |
|---|---|---|
| F40 | 3 | Torque current limiter enabled |
| F41 | 3 | Switching between Level 1 and Level 2 for all four quadrants simultaneously |

- When you turn on with assigning the torque limiter (Level 1, Level 2 selection) [TL2/TL1] to a digital input signal, you can switch between the Level 1 and the Level 2.




[ TL2/TL1 ] = OFF




[ TL2/TL1 ] = ON

- Unless you set the Level 1 and Level 2 over the short-time rated torque, the short-time rated torque does not limit the torque.
- When protective actions (inverter overload or motor overload) occur frequently, you can lower the setting level to avoid this phenomenon. Though you can specify the Level 1 and Level 2 with both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.

## F42 Torque limiter value selection (Level 1)

## F43 Torque limiter value selection (Level 2)

◆Selects a mean that sets the torque limiter. These means are the function code, the analog input, the digital input card (DIA, DIB), the link (RS485, T-Link, SX, field bus) and the PID output (PIDOUT)

◆When this function is activated (the torque limiter takes effect), the acceleration and the deceleration become longer than the set values.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 4 | 2 | T | - | L | I | M | - | L | V | L | 1 |
| F | 4 | 3 | T | - | L | I | M | - | L | V | L | 2 |

- Level 1

  Selects a mean that sets the Level 1

  Set value: 0: Function code F44
  1: Ai [TL-REF1]
  2: DIA card
  3: DIB card
  4: Link enabled
  5: PID output

- Level 2

  Selects a mean that sets the Level 2

  Set value: 0: Function code F45
  1: Ai [TL-REF2]
  2: DIA card
  3: DIB card
  4: Link enabled
  5: PID output

<Setting example>

(1) Preparation

- Set 1, 2, or 3 to the function code F40 to enable the limiter.
- Use the function code F41 to set how to use the limiter Level 1 and Level 2.
- Use the function code F42 and F43 to assign inputs to the Level 1 and Level 2. If you want to set only the Level 1, use F42 only. Go to one of the steps from the following (2) to (6) according to the setting thus far.

(2) When you use the function code

- Set 0 to both of the function code F42 and F43.
- Set a data for the Level 1 to F44 and that for the Level 2 to F45.

(3) When you use the analog input

- Set 1 to both of the function code F42 and F43.
- Use E49 to E52 to select which analog input terminals among Ai1 to 4 (Ai3 and Ai4 are optional AIO) are used. Here we assume that Ai1 and Ai2 are assigned to the Level 1 and the Level 2 respectively.
- Connect the wires to the Ai1 and Ai2. An input of 10V corresponds to 150% (torque, power and torque current).
- See the "I/O check" screen of the KEYPAD panel to check if the inverter correctly recognizes the input while you are varying the voltage input from 0 to ±10V.
- See the description of the function codes E53 to E68 for voltage input setting (gain, bias, filter, and increment/decrement limiter).

(4) When you use the DIA or the DIB card

- Set the hardware switch on the digital input card either to DIA or DIB.
- Set the function code F42 and F43 to 2 or 3 to use the DIA or the DIB respectively.
- You can assign the DIA (F42=2) to the Level 1 and the DIB (F43=3) to the Level 2 when you use two digital input cards and set one to DIA and the other to DIB.
- Connect the wires for the DIA and DIB cards. See the DI option section or the instruction manual supplied with the product for more details.
- See the "I/O check" screen of the KEYPAD panel to check if the inverter correctly recognizes the digital input.

(5) When you use the link
- Set the function codes F42 and F42 to 4.
- Determine which link to be used. Refer the individual sections of the function description to study the detail of the links (RS485, T-Link, SX, field bus).
- Set 1 or 3 to the function code H30 to enable the reference data through the link. Note that setting 3 disables the operation through the terminal block and the KEYPAD panel.
- Write data from a master device (such as PC or PLC) to S10 (Limiter level 1) and S11 (Limiter level 2). The writing is complete when the normal response is sent back. You cannot confirm the writing on the inverter side. Since writing to S area (reference data) is performed on the RAM (volatile memory) and written data disappear when your turn the inverter off, you should write necessary data every time when you turns on the inverter.

(6) When you use the PID output
- Set 5 to the function code F42. Also set 5 to F43 to assign the PID output. Usually set the PID output to the upper limit and use the function code to set the lower limit.
- See the PID control block diagram (4.2.9) or the PID description section to wire the system.
- You can display the PID output on the LED monitor of the KEYPAD panel.

## F44 Torque limiter value (Level 1)
## F45 Torque limiter value (Level 2)

◆Sets the torque limiter values (Level 1 and Level 2)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 4 | 4 | T | - | L | I | M | - | S | E | T | 1 |
| F | 4 | 5 | T | - | L | I | M | - | S | E | T | 2 |

Setting range: –300 to 300 [%]

## F46 Mechanical loss compensation value

◆Use to compensate the amount of the mechanical loss of a load.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 4 | 6 | T | - | M | E | C | - | L | O | S | |

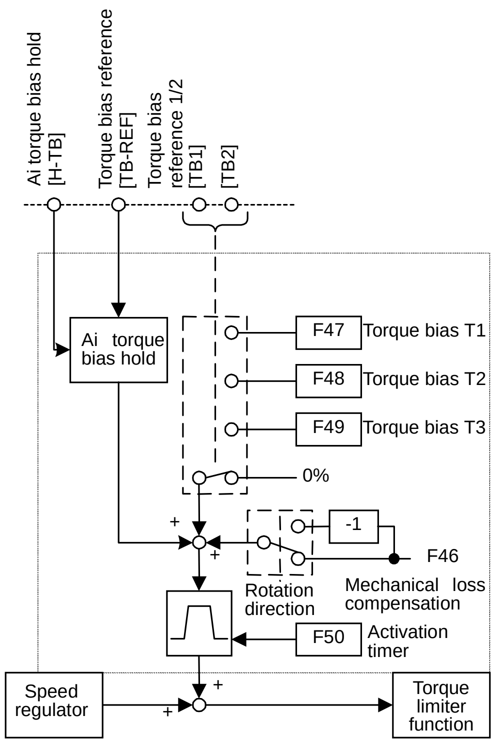
Setting range: –300.00 to 300.00 [%]

## F47 Torque bias 1
## F48 Torque bias 2
## F49 Torque bias 3

◆You can add these setting values to the torque reference values. The addition is conducted on a stage before the torque limiter. You can use the function selection Di, the torque bias reference 1 [TB1] and the torque bias reference 2 [TB2] to switch among three torque biases (T1, T2, T3).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 4 | 7 | T | - | B | I | A | S | 1 | | | |
| F | 4 | 8 | T | - | B | I | A | S | 2 | | | |
| F | 4 | 9 | T | - | B | I | A | S | 3 | | | |

Setting range: –300.00 to 300.00 [%]



**F50** | **Torque bias activation time**

◆Sets the time to increase the torque by 300%.

| F | 5 | 0 | T | - | B | I | A | S | - | T | I | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.00 to 1.00 [s]

**F51** | **Torque reference monitor (Polarity selection)**

◆Sets the polarity for data display related to torque. (AO monitor, KEYPAD panel LED monitor, KEYPAD panel LCD monitor)

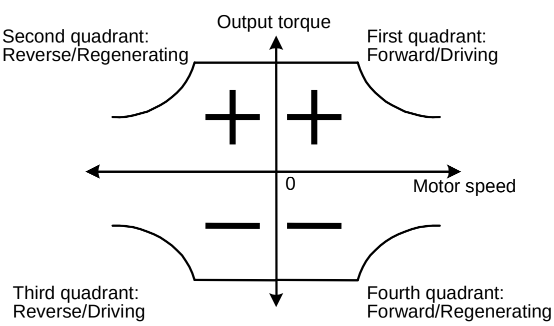
| F | 5 | 1 | T | - | R | E | F | - | M | N | T | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Torque polarity

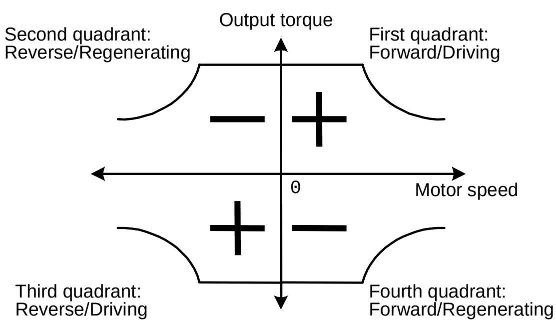
1: + for driving, – for braking

◆The following table shows data related with torque. These values are displayed or transmitted with sign. Judge the meaning of signs from the F51 set value.

| Display and output | Setting | Related data |
|---|---|---|
| KEYPAD panel LED monitor | 3 | Torque current reference value |
| | 4 | Torque reference value |
| | 5 | Calculated torque value |
| KEYPAD panel LCD monitor | Operation status monitor | Torque reference value |
| | Alarm information | Torque reference value on alarm |
| Analog output (AO1, 2, 3) | 6 | Torque current reference value (torque ammeter, two-way deflection) |
| | 8 | Torque reference value (torque meter, two-way deflection) |
| Function code M (monitor codes) | M02 | Torque reference value |
| | M03 | Torque current reference value |
| | M07 | Calculated torque value |
| | M08 | Calculated torque current value |
| | M28 | Torque reference value on alarm |
| | M29 | Torque current reference value on alarm |
| | M33 | Calculated torque value on alarm |
| | M34 | Calculated torque current value on alarm |




F51=0: Torque polarity




F51=1: + for driving, – for braking

## F52 Display coefficient A

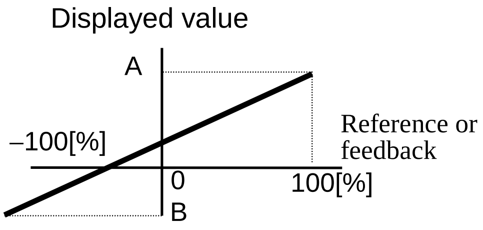
## F53 Display coefficient B

◆Use these coefficients as conversion coefficient to determine the display values (process amount) of the load speed/line speed, the reference/feedback of the PID regulator on the KEYPAD panel LED.
Setting range: Display coefficient A: –999.00 to +999.00
Display coefficient B: –999.00 to +999.00

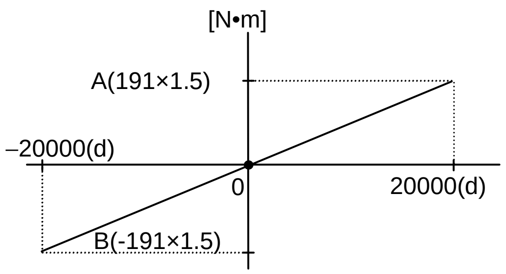
◆Load speed, line speed
Use the Display coefficient A of F52
Displayed value=Motor speed × (0.01 to 200.00)
The effective display range is 0.01 to 200.00 while the setting range is ±999.00. The minimum value 0.01 or the maximum value 200.00 replaces a value out of the display range.
Foe example, you should specify as F52=0.02 when the motor speed is 1500[r/min] and the line speed is 30[m/min].

◆Reference and feedback values for the PID regulator
Use F52 Display coefficient A to set the maximum value for display data and use F53 Display coefficient B to set the minimum value for display data.
Displayed value=(Reference or feedback value)
× (Display coefficient A–B)+B

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 5 | 2 | C | O | E | F | | A | | | | |
| F | 5 | 3 | C | O | E | F | | B | | | | |




<Display example>
When you want to display the output of the PID calculation (reference value) in [N·m] for a unit with 30 kW and rated torque of 191[N·m], the PID output is 150% torque output at 20,000 [d].
Thus you should set the coefficients as follows to obtain the right graphs.
Coefficient A: F52=286.5 [N·m]
Coefficient B: F53=–286.5 [N·m]




## F54 Display filter

◆You do not have to display an instant value for some continuously changing data on the LED monitor of the KEYPAD panel. You can apply a filter for those data to prevent the flicker due to the change of the value.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 5 | 4 | D | I | S | P | L | A | Y | | F | L |

Setting range: 0.0 to 5.0 [s]

## F55 LED monitor (Display selection)

◆The LED monitor of the KEYPAD panel displays different data at operation, stopping, speed setting and PID setting.

| F | 5 | 5 | L | E | D | | M | N | T | R | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| Set value | Function | Unit | Description |
|---|---|---|---|
| 0 | Detected speed value 1 | [r/min] | Change display with F56 when motor is stopping |
| 1 | Speed reference value 4 | [r/min] | Speed reference 4 of ASR input |
| 2 | Output frequency | [Hz] | Slip included |
| 3 | Torque current reference value | [%] | |
| 4 | Torque reference value | [%] | |
| 5 | Torque calculation value | [%] | |
| 6 | Input power | [kW, HP] | Use F60 to change unit |
| 7 | Output current | [A] | |
| 8 | Output voltage | [V] | |
| 9 | DC link circuit voltage | [V] | |
| 10 | Magnetic-flux reference value | [%] | |
| 11 | Magnetic-flux calculation value | [%] | |
| 12 | Motor temperature | [°C] | Displays --- when NTC thermistor is not isntalled |
| 13 | Load shaft speed | [r/min] | Use F56 to change display when motor is stopping |
| 14 | Line speed | [m/min] | |
| 15 | Ai adjusted value (12) | [%] | |
| 16 | Ai adjusted value (Ai1) | [%] | |
| 17 | Ai adjusted value (Ai2) | [%] | |
| 18 | Ai adjusted value (Ai3) | [%] | |
| 19 | Ai adjusted value (Ai4) | [%] | |
| 20 | PID reference value | [%] | Displayed in the PID mode |
| 21 | PID feedback value | [%] | |
| 22 | PID output value | [%] | |
| 23 | Option monitor 1 | [HEX] | Displayed with option |
| 24 | Option monitor 2 | [HEX] | |
| 25 | Option monitor 3 | [DEC] | Displayed with option. Positive data. |
| 26 | Option monitor 4 | [DEC] | |
| 27 | Option monitor 5 | [DEC] | Displayed with option. Positive and negative data. |
| 28 | Option monitor 6 | [DEC] | |

- Set values 20 to 22 are displayed when you set H20 "PID control setting" (action selection) to 1 (forward operation) or 2 (reverse operation).
- Set value 23 to 28 are displayed when you install control options. See the option section for more details.

## F56 LED monitor (Display at stopping state)

◆You can switch the detected data display for F55 to the reference value display when a motor stops (no output from the inverter, STOP state).

| F | 5 | 6 | L | E | D | | M | N | T | R | 2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Reference value display

1: Actual value display (detected value)

◆Corresponding data are F55=0 (Detected speed value), 13 (Load shaft speed), and 14 (Line speed).

## F57 LCD monitor (Display selection)

◆Selects the contents of the KEYPAD panel LCD monitor in the operation mode.

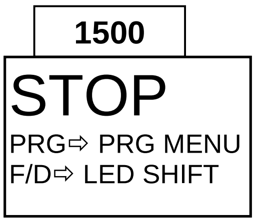
**F57 LCD MNTR**

Set value: 0: Operation state, rotation direction, operation guide
1: Bar graphs for motor speed, output current, torque reference values.

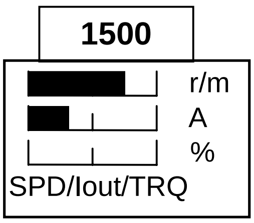
Set value: 0

In operation


In stopping




Set value: 1




Full scale values for bar graphs

| Display item | Full scale value |
|---|---|
| Motor speed | Maximum speed (Code F03, A06, and A40) |
| Output current | Inverter rating × 200% |
| Torque reference value | Rated torque × 200% |

Note: The scale is not adjustable.

## F58 LCD monitor (Language selection)

◆Selects a language displayed on the KEYPAD LCD monitor.

**F58 LANGUAGE**

| Set value | Displayed language | Set value | Displayed language |
|---|---|---|---|
| 0 | Japanese | 4 | Spanish |
| 1 | English | 5 | Italian |
| 2 | German | 6 | Chinese |
| 3 | French | | |

Note 1: The language used in this manual is English.

Note 2: L codes are displayed in Japanese, English and Chinese, and U codes are displayed only in English.

## F59 LCD monitor (Contrast adjusting)

◆Adjusts the contrast of the KEYPAD LCD monitor. Increase the set value to adjust the contrast to high and to decrease the set value to adjust the contrast to low.

**F59 CONTRAST**

| Set value | 0, 1, 2, ... 7, 9, 10 |
|---|---|
| Display | Low High |

| F60 | Output unit (HP/kW) selection |
|---|---|

◆Switches the display unit of the inverter output (input power) and the selection list (kW-HP) of P02 "Motor selection (M1, 2, 3)".

| F | 6 | 0 | k | W | / | H | P | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Display in kW
1: Display in HP

| F61 | ASR1-P (Gain) |
|---|---|
| F62 | ASR1-I (Constant of integration) |

◆Sets the P and I constants of the ASR1.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 6 | 1 | A | S | R | 1 | - | P | | | | |
| F | 6 | 2 | A | S | R | 1 | - | I | | | | |

Setting range: F61: 0.1 to 200.0 [times]
F62: 0.010 to 1.000 [s]

- P gain

Adjust accoding to the mechanical inertia (inertia and mechanical constant) connected to the motor shaft. The factory set value of 10.0 corresponds to the inertia of a single VG standard motor. The following table provides a guideline for setting. If you drive a machine whose inertia is larger than that of the VG standard motor when converted into a motor shaft inertia, set a value larger than 10.0. See Chapter 2 "Specifications" for the inertia data of the standard motors.

| Intertia | Single VG standard motor to Medium to Large |
|---|---|
| P gain | 10.0 to Medium to Large |

P gain=1.0 is defined such that the torque reference is 100% (corresponding to the maximum speed setting) when the speed deviation (speed reference–observed speed) is 100%.

**⚠ CAUTION**

- If you set a too large value to gain compared with the inertia, though you can get faster control response, the motor may present an overshoot or a hunting. Also the motor or the machine may generate oscillation due to mechanical resonance or over-amplified noise.
- If you set a too small value to gain compared with the inertia, the control response slows down and it may take time to settle down the speed fluctuation at low speed.

- Constant of integration

Sets the constant of integration of the Automatic Speed Regulator (ASR). You can specify a value in the range from 0.010 to 0.999s to set the speed deviation (speed reference-observed speed) at steady state to zero. Setting 1.000s disables the integration (P control only).
The integration means to sum the deviation at a specified interval. A smaller interval means a smaller summation interval that presents faster response. On the other hand, larger interval extends summation interval to reduce the effect on the ASR.
Set a small value to reach the speed reference faster while allowing overshoots.

**⚠ CAUTION**

- Integrating action is a delay element. The constant of integration corresponds to the gain of a delay element. If you increase the response of the integration action, the delay element becomes larger to destabilize the control system including motors and machines. The instability presents overshoots and oscillations. Thus, one measure to restrain the mechanical resonance such as abnormal mechanical noises from motors and gears is to increase the constant of integration.
- However, if you do not want a slower response, the machine side may need measures such as reviewing machines presenting mechanical resonance. You can also use F66 "ASR output filter".

## F63 ASR1-FF (Gain)

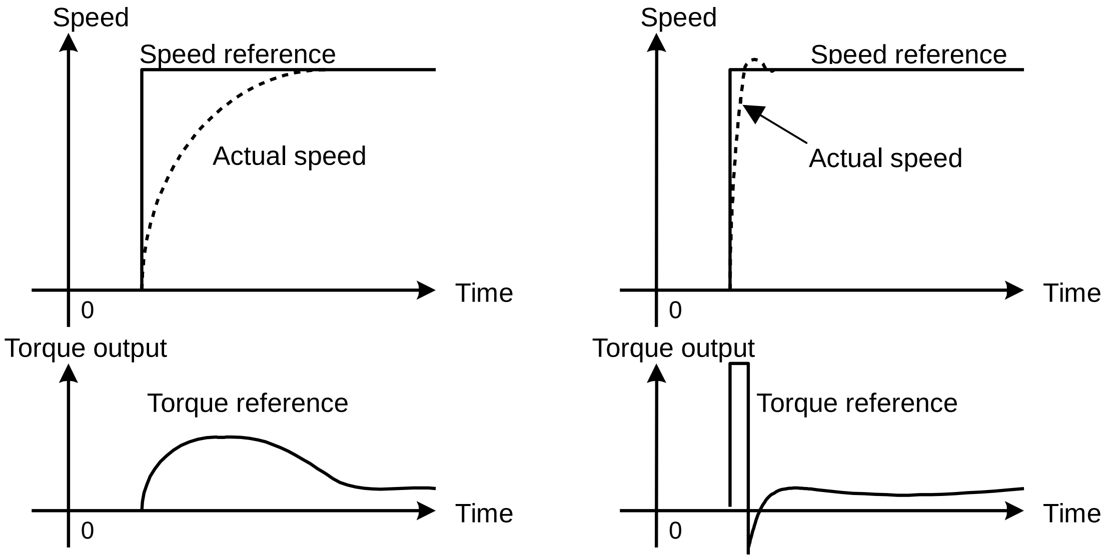
◆Conducts a feedforward control by adding torque determined by the change in the speed reference to the torque reference directly.

◆The PI control by the ASR is a feedback control adjusting the speed against the reference according to its control result (Actual speed). This control can adjust deviations due to what are not measurable such as unexpected disturbances and uncertain characteristics of control subjects. However, known changes in reference value are followed after they appear in the deviation (speed reference-Actual speed). Since you can obtain a control value (torque reference) for a known factor, you can expect a faster control by adding it to the torque reference directly. This function is provided for this purpose.

| F | 6 | 3 | A | S | R | 1 | - | F | F | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.000 to 9.999 [s]

◆It is effective when the inertia is known. The differences in follow-up speed against the reference value between the feedforward and non-feedforward controls are conspicuous as shown in the figures below. Note that it is necessary to balance the PI constants of the feedback control and this setting to obtain the maximum effect.




FF control disabled
(PI feedback control only)

FF control enabled
(PI feedback control enabled)

Though increasing the P gain of the ASR realizes the effect described above, increased gain also increases response resulting in negative effects (such as mechanical resonance or vibration).

## F64 ASR1 input filter

◆Sets the time constant for the first-order lag filter applied to a speed reference. Usually you should not change this value.

◆Use this filter when you cannot stabilize the analog speed setting voltage at control terminal [12] after you failed to eliminate the causes. If noise is the case, first try measures in hardware such as separating control wiring, grounding, or connecting a capacitor to the terminal [12] and [11] in parallel before you use F64 as a software measure.

| F | 6 | 4 | A | S | R | 1 | - | I | N | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.000 to 5.000 [s]

## F65 ASR1 detection filter

◆Sets the time constant for the first-order lag filter applied to the detected speed. Usually you should not change this value. You do not have to change when you use a pulse generator (PG) for the speed detection. Use an oscilloscoepe to check the waveform if the output of the PG is unstable.

◆Use this filter when you use the line speed detection [LINE-N] signal for speed detection and the ripple presents on the signal. Note that a large setting will reduce the response of the speed control loop. A too large setting may destabilize the control.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 6 | 5 | A | S | R | 1 | - | D | E | T | | |

Setting range: 0.000 to 0.100 [s]

## F66 ASR1 output filter

◆Sets the time constant for the first-order lag filter applied to the torque reference. Use this filter for a mechanical resonance after you failed to adjust the ASR gain or the constant of integration to eliminate it.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 6 | 6 | A | S | R | 1 | - | O | U | T | | |

Setting range: 0.000 to 0.100 [s]

◆Check the cause and the oscillation frequency of a mechanical resonance such as a vibration by gear backrush or a rope vibration in a vertical transfer. You should take measures in the inverter side after you failed to investigate and fix machine devices to eliminate the resonance.

(1) Measures to eliminate mechanical resonance

1)Reduce response speed

- Reduce the ASR P gain to reduce the amplitude of the resonance.
- Increase the ASR I constant to shift the resonance point to lower frequency to restrain the high frequency resonance.

2)Use ASR output filter

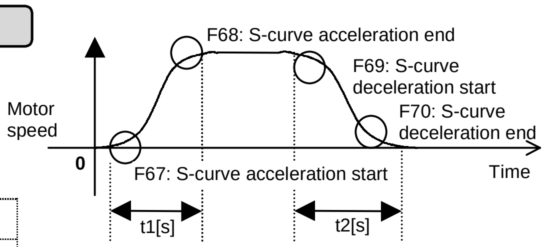
- Though you can reduce the resonance amplitude, excessive filter elements may cause instability.

3)Use oscillation suppressing observer

- See H46 "Observer type selection" for more details.

## F67 S-curve acceleration start side 1
## F68 S-curve acceleration end side 1
## F69 S-curve deceleration start side 1
## F70 S-curve deceleration end side 1

◆Arranges the speed reference value to form a curve at the start and the end of acceleration and deceleration. You can realize smooth acceleration and deceleration actions without shocks.




| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 6 | 7 | S | - | A | C | C | - | S | T | 1 | |
| F | 6 | 8 | S | - | A | C | C | - | A | R | 1 | |
| F | 6 | 9 | S | - | D | E | C | - | S | T | 1 | |
| F | 7 | 0 | S | - | D | E | C | - | A | R | 1 | |

Setting range: 0 to 50 [%]

◆Setting the S-curve will extend F07 "Acceleration time 1" and F08 "Deceleration time 1" as described below.

$$t1(s) = \text{Acceleration time}[s]\times\left(1+\frac{\text{S - curve acceleration start side}[\%]}{100[\%]}+\frac{\text{S - curve acceleration end side}[\%]}{100[\%]}\right)[s]$$

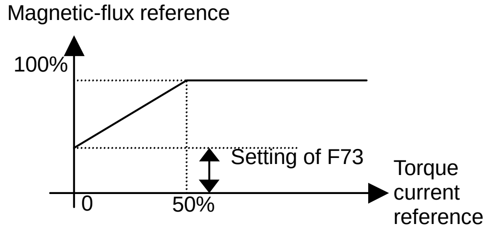
$$t2(s) = \text{Deceleration time}[s]\times\left(1+\frac{\text{S - curve deceleration start side}[\%]}{100[\%]}+\frac{\text{S - curve deceleration end side}[\%]}{100[\%]}\right)[s]$$

## F73 Magnetic-flux level at light load

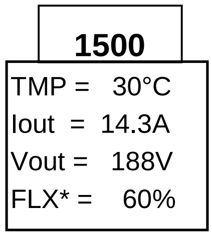
◆You can specify a small value to reduce the electromagnetic noise of a motor at light load. The magnetic-flux reference decreases according to the torque current reference to reduce the electromagnetic noise.

| F | 7 | 3 | M | I | N | - | F | L | U | X | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 10 to 100 [%]
Note: This setting is effective only for PG vector control.




◆You can view the level [%] of the magnetic-flux reference on the "Operation monitor" of the KEYPAD panel.
See "FLX*" (magnetic-flux reference) on the operation monitor screen "Operation monitor".
The value is usually 100% and decreased in the low output range.
This function reduces the magnetic-flux according to the setting as shown in the graph. The graph shows that the magnetic-flux decreases to 60%.

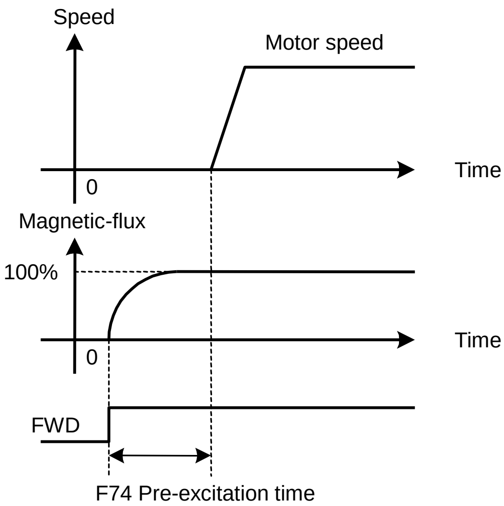



## F74 Pre-excitation time

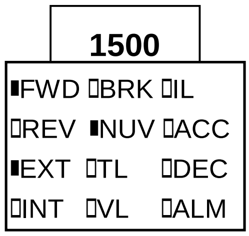
◆When you set ON to the operation command (FWD, REV), the inverter conducts pre-exciting automatically for the time specified by this function code. This function applies only the exciting current to a motor to increase the response of the motor start.

| F | 7 | 4 | P | R | E | | E | X | | t | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.0 to 10.0 [s]
◆Set the pre-excitation time to start a motor after the magnetic-flux is established 100% as shown in the graph.




◆You can use the "Operation status" of the "I/O check" screen of the KEYPAD panel to confirm whether a motor is in normal operation or in pre-exciting.
■EXT indicates pre-exciting and □EXT indicates normal operation.
You can also read out the function code M14 "Operation status" through the link to confirm the status.

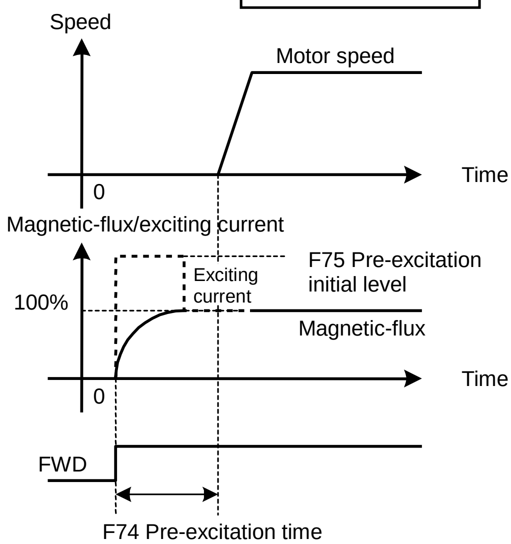



## F75 Pre-excitation initial level

◆Sets the initial level of the pre-excitation.

| F | 7 | 5 | F | L | U | X | | F | O | R | C | E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 100 to 400 [%]
◆When you want to reduce the pre-excitation time (function code F74) to establish the magnetic-flux quickly, set the exciting current high.
◆The transient response to the exciting current reference until the magnetic-flux is established 100% depends on the secondary time constant of a motor (exciting inductance/resistor). This function applies more than 100% of the exciting current to establish the magnetic-flux faster. The initial level ends when the magnetic-flux is established 100%, and the exciting current returns 100%.



| F76 | Speed limiter (method selection) |
|---|---|
| F77 | Speed limiter level 1 |
| F78 | Speed limiter level 2 |

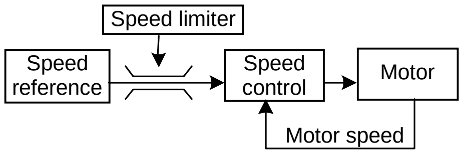
◆The speed control and the torque control (torque control, torque current contol) differs in the usage of these function codes.

Usage for speed control

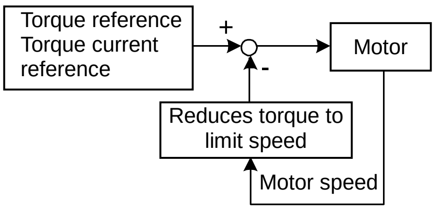
Since the inverter usually (factory setting) controls speed (internal ASR enabled, motor controlled by speed reference), and the speed limitter is applied to the speed reference (See "(1) Speed control")

You can use the function code H41 "Torque reference selection" and H42 "Torque current reference selection" to select a specification other than the "internal ASR enabled" to operate the inverter to control the torque. This is the case, the speed control is applied to the motor speed (speed detection/speed estimation). Since the inverter does not control the speed, the control adds negative torque bias to the torque reference when the motor accelerates beyond the limiter value. You can use the [I2] input as a bias for the speed limiter instead of the speed reference (see "(2) Torque control").

(1) For speed control




(2) For torque control




◆You can set ON to the digital input signal [N-LIM] to disable (cancel) the speed limiter function.

1) Speed control

You can set the speed limit to the speed reference.

| F | 7 | 6 | N | - | L | I | M | - | M | O | D | E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

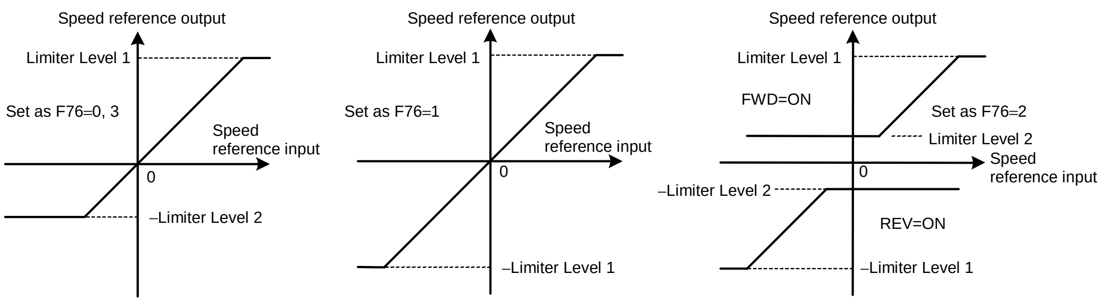
- Method selection

Set value: 0: Forward (Level 1) and reverse (Level 2) are limited individually.
1: Level 1 limits forward and reverse.
2: Upper limit by the Level 1 and the lower limit by the Level 2.
3: Disabled (If set, replaced by 0).

| F | 7 | 7 | N | - | L | I | M | - | L | V | L | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 7 | 8 | N | - | L | I | M | - | L | V | L | 2 |

- Level 1, 2

Setting range: –110.0 to 110.0 [%]



# 4. Control and Operation

| ⚠CAUTION |
|---|
| • Specify such that the imiter Level 1 > the limiter Level 2 for F76=2 (Upper limit by the Level 1 and the lower limit by the Level 2). If you specify as the limiter Level 1 < the limiter Level 2, the speed reference is fixed to the limiter Level 2. In this state, turning off the operation does reduce the speed reference and the operation continues.<br>**You may be injured.** |

<Example of a setting inhibiting reverse rotation>
When you want to inhibit reverse rotation (forward rotation directed by reverse rotation command) while forward rotation command is directed, specify as F76=2 (upper and lower limiter), the limiter level 1=100.0% and the limiter level 2=0,0%.

2) Torque control (torque reference, torque current reference)

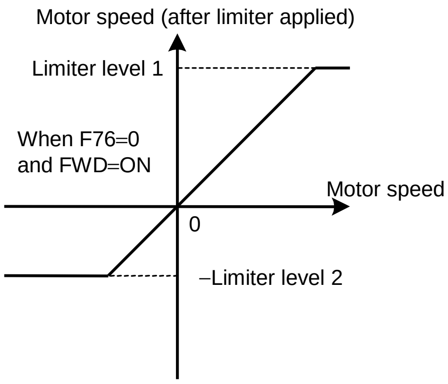
**F76** N-LIM-MODE

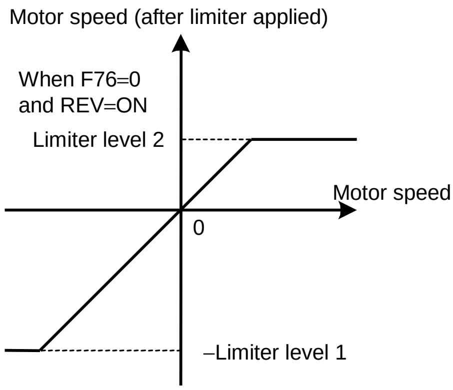
- Method selection
  Set value: 0: Forward and reverse are limited individually. FWD and REV switch the levels.
  1: Level 1 limits forward and reverse.
  2: Upper limit by the Level 1 and the lower limit by the Level 2.
  3: Individual limiters for forward and reverse rotation. [12] input is added as a variable part of limiters.

**F77** N-LIM-LVL1
**F78** N-LIM-LVL2

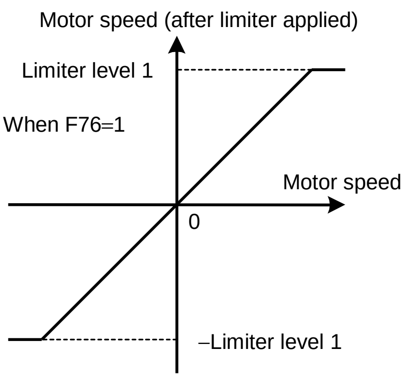
- Level 1, 2
  Setting range: −110.0 to 110.0 [%]

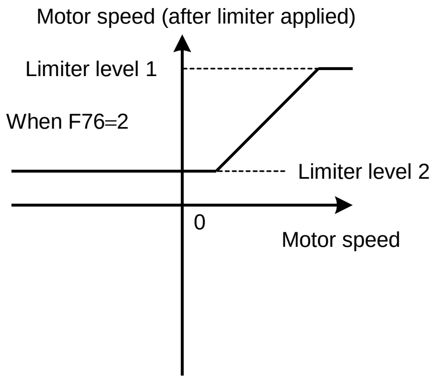
• When F76=0 is specified, the upper and lower limit levels for forward operation and those for reverse operation switch between the Level 1 and the Level 2.



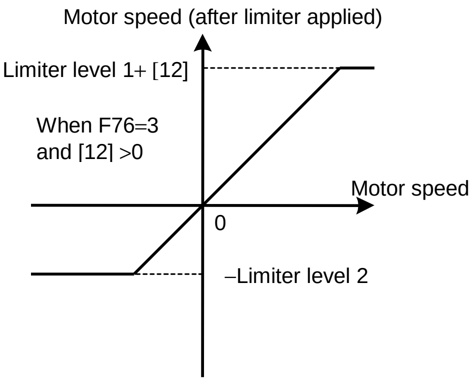



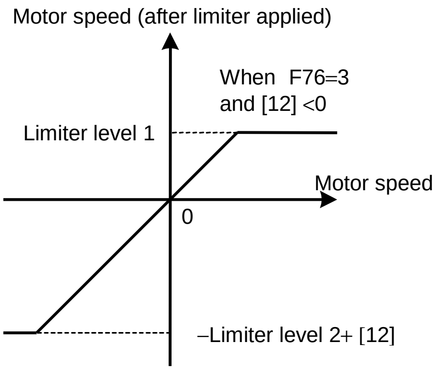

• See the following figures when F76=1 or F76=2 is specified.



• When F76=3 is specified, [12] input acts as a bias as in the following graphs




Input voltage for [12] is ± 10V at maximum motor speed ( ± 100% ).

**F79** **Motor selection**

◆Select a motor to be used from M1, M2, and M3. You should combine this function code and the terminal input to select.

**F79 M1-3SELECT**

Set value: 0: M1 selection. Terminal input has higher priority.
M1 selection, ( [MCH2] , [MCH3] )=(OFF, OFF), or MCH2 and MCH3 have no assigned states.
M2 selection, ( [MCH2] , [MCH3] )=(ON, OFF) (ON, ON)
M3 selection, ( [MCH2] , [MCH3] )=(OFF, ON)
2: M2 selection.
3: M3 selection.

◆Merits and restrictions for selecting M1, M2, or M3

| | M1 selection (first motor) | M2 selection (second motor) | M3 selection (second motor) |
|---|---|---|---|
| Control type | <u>Set by code P01</u><br>PG vector control<br>Sensorless vector control<br>Synchronous motor control<br>Simulated operation | <u>Set by code A01</u><br>PG vector control<br>Sensorless vector control | V/f control only |
| Restrictions specific to control type | None | None | V/f control restricts many functions.<br>See function code list for more details. |
| Motor parameters | Code F03 to F05, F10 to F12, P.<br>When a VG7 dedicated motor is selected (P02), data are set to F04, F05, and P03 to P27 automatically. | Code A02 to A34<br>Manual setting | Code A35 to A50<br>Manual setting |
| Protective functions specific to motor parameters | Code P01 specifies a dedicated motor, P-OTHER specifies write protection. | None | None |

◆You can use the "Effective sets of motors/parameters" on the "I/O check" screen of the KEYPAD panel to check the currently selected motor set (M1, M2, M3).
If the motor set 2 is selected, ■M2 is indicated.

**1500**

□PARA 1 □M1
□PARA 2 ■M2
■PARA 3 □M3
□PARA 4 □JOG

◆Answer back signals are put on the DO output [SW-M2] and [SW-M3] to indicate whether the motor switch among motor set (M1, M2, M3) is completed in the inverter.
See E15 to E27 for more information. We recommend to prepare a sequence to check the DO for the answer back when you use the terminal input signals [MCH2] and [MCH3] to switch motors.

## F80 Current rating switching

◆Switches the triple ratings (CT, VT, and HT) of the inveter.

| F | 8 | 0 | I | r | | S | E | L | E | C | T | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

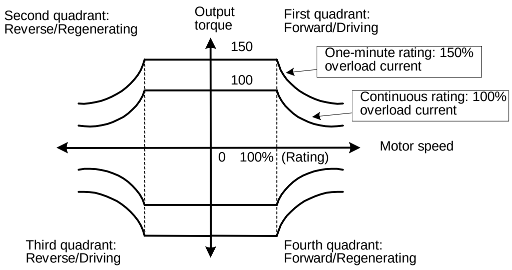
Set value: 0: CT (Constant Torque, overload current 150%)
1: VT (Variable Torque, overload current 110%)
2: HT (High Torque, overload torque 200%/170%)

◆Overload current means to apply overload limiter by torque current (corresponding armature current of a DC motor), and the torque decreases in proportion to the decrease of the magnetic-flux above the rated speed (100%). Overload torque for the HT use means to apply overload limiter by torque.

- Torque characteristics for CT use

Application

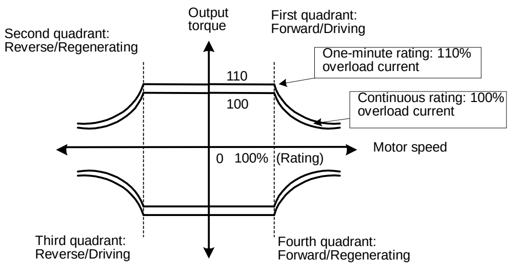
Use for general constant torque applications including speed control with torque limit for winding machines, wire drawing machines, and test machines and control by direct torque reference.




- Torque characteristics for VT use

Application

Use for applications that do not require overload capability for a short period such as extruding machines and centrifugal separators. Also suitable for applications where the operation cycle is short and torque is limited to 100% or less since the root-mean-square current exceeds the rated current of an inverter (Large press machines).
You can choose an inverter by one class smaller grade compared with CT and HT uses.
Suitable for general variable torque lead application.
Note that the maximum carrier frequency is smaller than the CT and HT uses. See Section 2.1 "Standard Specifications" for more details.



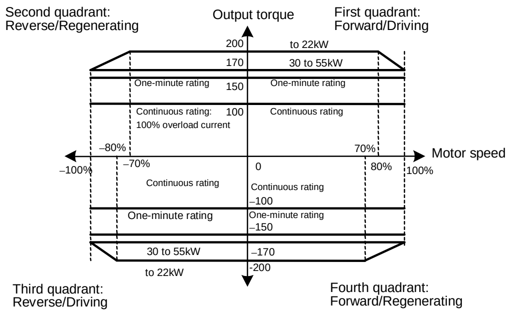

- HT use

Application

Use for vertical transfer applications (elevators, multi-storied parking facilities) that require about 200%/170% of torque for a short period (ten seconds or less).

Restrictions

10s rating is 200% up to 80% of the rated speed and is reduced to 170% over 80% of the rated speed for 22kW or less.
10s rating is 170% for 30 to 50kW (200/400V).




Motor operation exceeding the rated speed.

The motor torque reduces in inverse proportion to the motor speed as in the case of CT or VT use. Though HT use is suitably applied to the motor operation in the constant torque range, it is also applicable in the operation in the constant output range.

## 4.3.2 E Codes (Extension Terminal Functions)

**E01-E13** **X function selection**

◆You can assign arbitrary functions to individual digital input terminals [X1-X14] ( [X11-X14] are effective only when optional OPC-VG7-DIOA is installed).
◆Use after you review the 4.2 "Control Block Diagrams" to check the selection of control terminals.

| E | 0 | 1 | X | 1 | | F | U | N | C | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

to

| E | 1 | 3 | X | 1 | 4 | | F | U | N | C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 63

| Set value | Function | Symbol | Set value | Function | Symbol |
|---|---|---|---|---|---|
| 0, 1, 2, 3 | Multistep speed selection | [SS1, 2, 4,8] | 31 | H41 [torque reference] cancel | [H41-CCL] |
| 4, 5 | ASR, ACC/DEC time selection (4 steps) | [RT1, RT2] | 32 | H42 [torque current reference] cancel | [H42-CCL] |
| 6 | 3-wire operation stop command | [HLD] | 33 | H43 [magnetic-flux reference selection] cancel | [H43-CCL] |
| 7 | Coast-to-stop command | [BX] | 34 | F40 [torque limiter mode 1] cancel | [F40-CCL] |
| 8 | Alarm reset | [RST] | 35 | Torque limiter (level1, level2 selection) | [TL2/TL1] |
| 9 | Trip command | [THR] | 36 | Bypass | [BPS] |
| 10 | Jogging operation | [JOG] | 37, 38 | Torque bias reference 1/2 | [TB1, TB2] |
| 11 | Speed setting N2/speed setting N1 | [N2/N1] | 39 | Droop selection | [DROOP] |
| 12 | Motor M2 selection | [M-CH2] | 40 | Ai1 zero hold | [ZH-AI1] |
| 13 | Motor M3 selection | [M-CH3] | 41 | Ai2 zero hold | [ZH-AI2] |
| 14 | DC brake command | [DCBRK] | 42 | Ai3 zero hold (AIO optional function) | [ZH-AI3] |
| 15 | ACC/DEC cleared to zero | [CLR] | 43 | Ai4 zero hold (AIO optional function) | [ZH-AI4] |
| 16 | Creep speed switching in UP/DOWN setting | [CRP-N2/N1] | 44 | Ai1 polarity change | [REV-AI1] |
| 17 | UP command in UP/DOWN setting | [UP] | 45 | Ai2 polarity change | [REV-AI2] |
| 18 | DOWN command in UP/DOWN setting | [DOWN] | 46 | Ai3 polarity change (AIO optional function) | [REV-AI3] |
| 19 | Write enable for KEYPAD (data can be altered) | [WE-KP] | 47 | Ai4 polarity change (AIO optional function) | [REV-AI4] |
| 20 | PID control cancel | [N/PID] | 48 | PID output inverse changeover | [PID-INV] |
| 21 | Inverse mode changeover | [IVS] | 49 | PG alarm cancel | [PG-CCL] |
| 22 | Interlock signal for 52-2 | [IL] | 50 | Undervoltage cancel | [LU-CCL] |
| 23 | Write enable through link | [WE-LK] | 51 | Ai torque bias hold | [H-TB] |
| 24 | Operation selection through link | [LE] | 52 | STOP1 (The motor stops with normal deceleration time) | [STOP1] |
| 25 | Universal DI | [U-DI] | 53 | STOP2 (The motor decelerates and stops with deceleration time 4) | [STOP2] |
| 26 | Pick up start mode | [STM] | 54 | STOP3 (The motor stops with torque limiter) | [STOP3] |
| 27 | Synchronization command (PG (PR) optional function) | [SYC] | 55 | DIA data latch (DIA optional function) | [DIA] |
| 28 | Zero speed locking command | [LOCK] | 56 | DIB data latch (DIB optional function) | [DIB] |
| 29 | Pre-exciting command | [EXITE] | 57 | Multiwinding motor control cancel (SI (MWS) optional function) | [MT-CCL] |
| 30 | Speed reference limiter cancel | [N-LIM] | 58-63 | Option Di 1/2/3/4/5/6 | [O-DI1 to 6] |

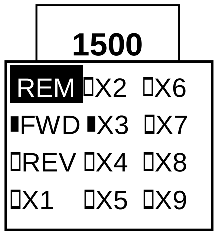
<Using terminal input>

There are 64 types of terminal input functions available. You cannot use all of them simultaneously. You can use total of thirteen terminals, which are nine terminals from X1 to X9 as standard and four terminals from X11 to X14 using option of DIOA. You can also access these thirteen terminals through the link function (RS485, T-Link, SX, and field bus).

Note that the alarm reset [RST] and trip command [THR] are included into general X function assignment, though they used to have dedicated terminals.

Setting procedure

- Select a function you want to use. We select the "Coast-to-stop" command as an example.
- Assign the "Coast-to-stop" command to one of the available terminals (X1 to X9, X11 to X14). If you want to assign it to X3, write a data, "7:BX", to the function code E03 "X3 function selection".
- When you turn on the X3 terminal externally (turn on [BX] ), the coast-to-stop function is activated. When you turn it off, the function is disabled.
- See the "I/O check" screen of the KEYPAD panel to confirm the ON/OFF status of the X3. If you switch the X3 from OFF to ON, □X3 changes to ■X3 on the screen.
- When you access through the link function, you should see another I/O screen COM.




<You can specify as "NO terminal" or "NC terminal">

You can use the function code E14 to specify the state of individual terminals (standard 9 terminals only) as normally open ("NO terminal") or normally closed ("NC terminal"). See the function description of E14 or the description of the trip command [THR] for more information.

Multistep speed selection

You can use external digital input signals to switch predetermined speeds specified by function codes from C05 to C19 "Multistep speed". Assign data 00 to 03 to digital terminals to select a speed by combining those terminal inputs.

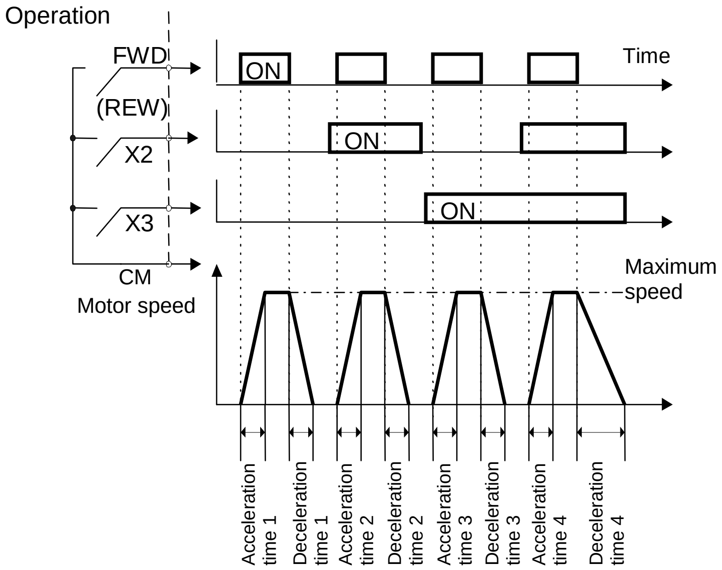
| Input signal combination to select specified data | | | | Speed to be selected | |
|---|---|---|---|---|---|
| 3 [SS8] | 2 [SS4] | 1 [SS2] | 0 [SS1] | | |
| OFF | OFF | OFF | ON | C05 Multistep speed 1 | Related function codes C05 to C19<br><br>Setting range 0 to 24000r/min or 0.00 to 100.00% |
| OFF | OFF | ON | OFF | C06 Multistep speed 2 | |
| OFF | OFF | ON | ON | C07 Multistep speed 3 | |
| OFF | ON | OFF | OFF | C08 Multistep speed 4 | |
| OFF | ON | OFF | ON | C09 Multistep speed 5 | |
| OFF | ON | ON | OFF | C10 Multistep speed 6 | |
| OFF | ON | ON | ON | C11 Multistep speed 7 | |
| ON | OFF | OFF | OFF | C12 Multistep speed 8 | |
| ON | OFF | OFF | ON | C13 Multistep speed 9 | |
| ON | OFF | ON | OFF | C14 Multistep speed 10 | |
| ON | OFF | ON | ON | C15 Multistep speed 11 | |
| ON | ON | OFF | OFF | C16 Multistep speed 12 | |
| ON | ON | OFF | ON | C17 Multistep speed 13 | |
| ON | ON | ON | OFF | C18 Multistep speed 14/Creep speed 1 | |
| ON | ON | ON | ON | C19 Multistep speed 15/Creep speed 2 | |

## ASR, acceleration/deceleration time selection

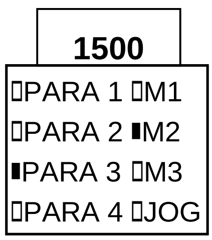
You can switch predetermined acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations specified by function codes through external digital input signals. Assign data 04 to 05 to digital terminals to select acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations.

| Input signal combination to select specified data | | Acceleration/deceleration times to be selected | |
|---|---|---|---|
| 05<br>[RT2] | 04<br>[RT1] | | |
| OFF | OFF | F07 Acceleration time 1<br>F08 Deceleration time 1<br>F61 to F66 ASR1 constants<br>F67 S-curve (Acc start side)<br>F68 S-curve (Acc end side)<br>F69 S-curve (Dec start side)<br>F70 S-curve (Dec end side) | Related function codes<br>F07, F08,<br>F61 to F70<br>C40 to C69 |
| OFF | ON | C40 to C45 ASR 2 constants<br>C46 Acceleration time 2<br>C47 Deceleration time 2<br>C48 S-curve 2 (Start side)<br>C49 S-curve 2 (End side) | |
| ON | OFF | C50 to C55 ASR 3 constants<br>C56 Acceleration time 3<br>C57 Deceleration time 3<br>C58 S-curve 3 (Start side)<br>C59 S-curve 3 (End side) | |
| ON | ON | C60 to C65 ASR 4 constants<br>C66 Acceleration time 4<br>C67 Deceleration time 4<br>C68 S-curve 4 (Start side)<br>C69 S-curve 4 (End side) | |

◆Example: Four and five are assigned to the terminals [X2] and [X3].

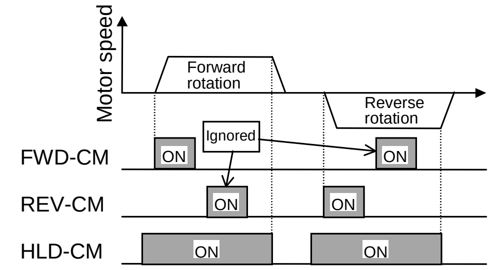



* If you switch the acceleration/deceleration times, the ASR constants and S-curve actions are switched simultaneously. You can see which set is currently selected from (1, 2, 3, 4) on the "I/O check" screen of the KEYPAD panel. When the data set 3 is selected, "■ PARA 3" is indicated on the display.



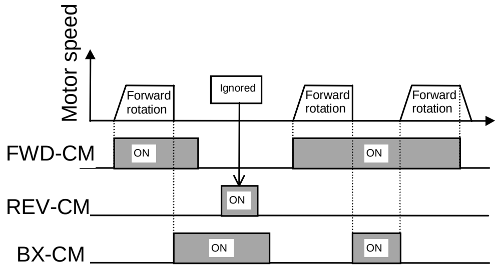
### 3-wire operation stop command [HLD]

Use for 3-wire operation. When [HLD]-[CM] is ON, the FWD or the REV signal is self-held, and is canceled when [HLD]-[CM] is OFF.
When you want use this [HLD] function, you should assign a data 06 to a desired digital input terminal.




### Coast-to-stop command [BX]

The inverter output is turned off and the motor enters into the coast-to-stop state, when [BX]-[CM] is ON.
The signal does not cause an alarm output. Also, this signal is not self-held.
When you want use this [BX] function, you should assign data a 07 to a desired digital input terminal.




### Alarm reset [RST]

Switching the [RST]-[CM] from OFF to ON cancels the alarm relay output and the alarm display and restart operation while the protective function is active.
When you want use this [RST] function, you should assign a data 08 to a desired digital input terminal.

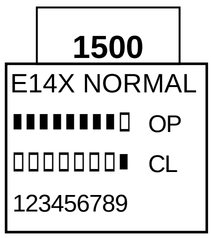
### Trip command [THR]

The factory setting for the trip command is an "NO terminal" (normally open).

When you use the trip command as an "NC terminal" (normally closed), follow the procedure described below.
When [THR]-[CM] is ON, the operation is assumed as normal. When [THR]-[CM] is turned OFF, the inverter output is turned off (motor is in the coast-to-stop state) and the alarm "OH2" is issued. You can use the trip command for the overheat protection of an external resistor.

<Application and notes>

- The [THR] function is assigned to the X9 terminal in the factory setting (function code E09=9, THR). Use the X9 as an external alarm as it is.
- Use the function code E14 "X function normally open/normally closed" to set the X9 terminal to an "NC terminal".
  To set as an "NC terminal", move the 9th ■ (X9 terminal) from the OP side to the CL side and use the FUNC/DATA key to write.
- When you turn on the inverter while X9 [THR]-[CM] is open, the "OH2" alarm is issued. This is a normal state.
- Connect a braking resister between the X9 [THR] and the [CM]. Now the procedure is complete.
- If you do not connect a braking resistor, short-circuit the [THR]-[CM] or move the 9th ■ (X9 terminal) from the CL side to the OP side again and use the FUNC/DATA key to write.



# 4. Control and Operation

### Jogging operation [JOG]

Use this function for an inching action such as work adjustment. You can operate at the jogging speed specified by the function C29 "Jogging speed" by turning on the signal between [JOG] and [CM] while the operation command (FWD-CM or REV-CM) is ON. You can also use the KEYPAD panel to switch to the jogging mode.
When you want to use this [JOG] function, you should assign a data 10 to a desired digital input terminal.
The function codes related to the jogging operation are C29 to C38. A dedicated speed control setting (such as gain) is available.
The indicator stays at the JOG position on the LCD monitor of the KEYPAD panel during the jogging operation.

### Speed setting N2/speed setting N1 [N2/N1]

You can switch the predetermined speed setting method specified by F01 "Speed setting N1" and C25 "Speed setting N2".
If you do not specify, F01 is selected.

| Input signal to select specified data | Speed setting method to be selected |
|---|---|
| 11 | |
| OFF | F01 Speed setting N1 |
| ON | C25 Speed setting N2 |

### Motor selection 1,2 [MCH2, CH3]

You can use the external digital input signals to switch the predetermined motor parameters.
You can use the terminal to switch only when F79 "Motor selection (M1, 2, 3)" is set to 0.
If F79=1, the selection is fixed to the M2. If F79=2, the selection is fixed to the M3.
The switching result becomes effective when the operation command to the inverter is ON and the motor is in the stop state.

| Input signal combination to select specified data | | Motor to be selected | Related codes |
|---|---|---|---|
| 13 [MCH3] | 12 [MCH2] | | |
| OFF | OFF | First motor | F03 to 05, F10 to 12, P01 to P30 |
| OFF | ON | Second motor | A01 to A34 |
| ON | OFF | Third motor (dedicated for V/f control) | A35 to A50 |
| ON | ON | First motor | F03 to 05, F10 to 12, P01 to P30 |

Note: Both [MCH2] and [MCH3] are ON, the first motor is selected.
See also the description of the function code F79.

## DC brake command [DCBRK]

When the external digital input signal is ON and the operation command is turned OFF (when you press the STOP key during the KEYPAD panel operation, or the both [FWD] and [REV] terminals are OFF during the external signal operation), the DC braking starts after the motor speed decreases to the predetermined rotation specified by the function code F20 "DC brake (Starting speed)", and the braking continues while the input signal is ON.
The longer period between F22 "DC brake (Braking time)" or the ON duration of the input signal [DCBRK] is selected.
Note that turning on the operation command will resume the operation.
See also the description of the function codes F20 to 22.

| Input signal to select specified data | Action to be selected |
|---|---|
| 14 | |
| OFF | DC braking active |
| ON | DC braking inactive |

## ACC/DEC cleared to zero [CLR]

The external digital input signal clears the calculated speed of the acceleration/deceleration calculation unit.
During the UP/DOWN operation in particular, this input signal clears the acceleration/deceleration and operates the inverter at 0r/min, the previous speed, or the creep speed specified by the C18 and 19 "Multistep speed".

## Creep speed switching in UP/DOWN setting [CRP-N2/N1]

The external digital input signal switches the creep speed at the UP/DOWN selector unit.

| Input signal to select specified data | Specified speed to be selected |
|---|---|
| 16 | |
| OFF | C18 N – 15 / CREP 1 |
| ON | C19 N – 16 / CREP 2 |

## UP command in UP/DOWN setting [UP]

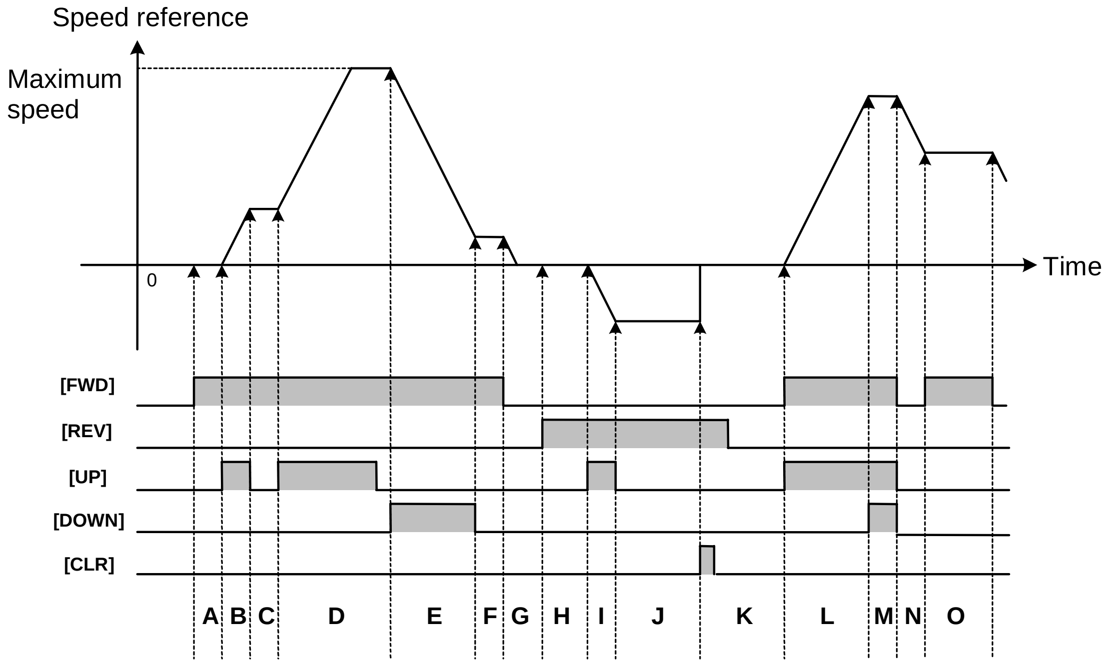
The external digital input signal increase the speed during the signal is ON. The maximum speed restricts the speed. The acceleration follows the specified acceleration time and S-curve acceleration.

## DOWN command in UP/DOWN setting [DOWN]

The external digital input signal decrease the speed during the signal is ON.
The deceleration follows the specified deceleration time and S-curve deceleration.
The current speed is maintained when the [UP] and the [DOWN] are pressed at the same time (no acceleration/deceleration).
There are three types of the UP/DOWN operations depending on the initial values. You can use the speed setting function (function code F01 or C25) to select them.

(1) UP/DOWN (initial value: 0r/min)

The following graph shows an operation with this function (The S-curve specification is not active in this example).

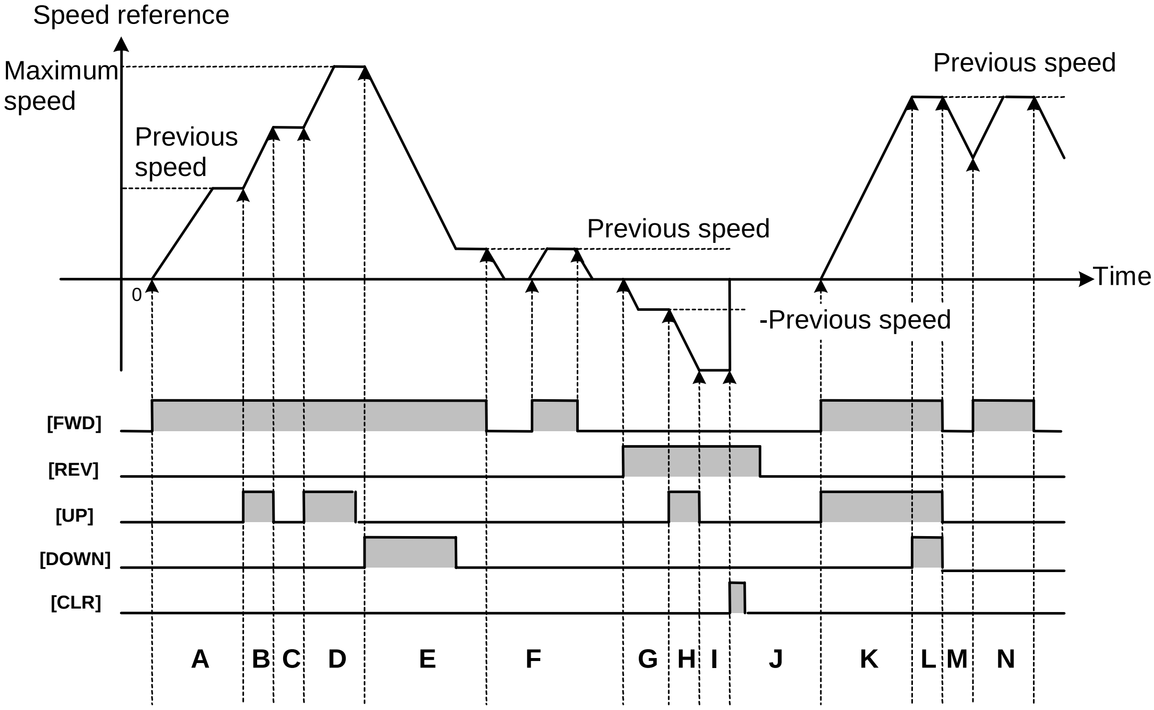



**A** : Operates at 0r/min speed reference
**B** : Accelerates in forward direction
**C** : Fixed to the speed reference when **[UP]** is set to OFF
**D** : Restricted by the maximum speed after acceleration in forward direction
**E** : Decelerates in forward direction
**F** : Fixed to the speed reference when **[DOWN]** is set to OFF
**G** : Decelerates to stop
**H** : Operates at 0r/min speed reference
**I** : Accelerates in reverse direction
**J** : Fixed to the speed reference when **[UP]** is set to OFF
**K** : Resets to 0r/min when **[CLR]** is set to ON
**L** : Accelerates in forward direction
**M** : Simultaneous **[UP]** and **[DOWN]** are treated as OFF. Fixed to the speed reference when both **[UP]** and **[DOWN]** are turned ON
**N** : Decelerates to stop
**O** : Continues operation at the speed just after **[FWD]** is set to ON.

(2) UP/DOWN (initial value: previous value)

The following graph shows an operation with this function (The S-curve specification is not active in this example).

- The previous value is defined as the speed reference value adopted when the previous operation command (FWD, REV) is turned OFF. The previous value is stored in the non-volatile memory (memory that retains data even when the power has been switched OFF), and becomes effective when the power is supplied again.

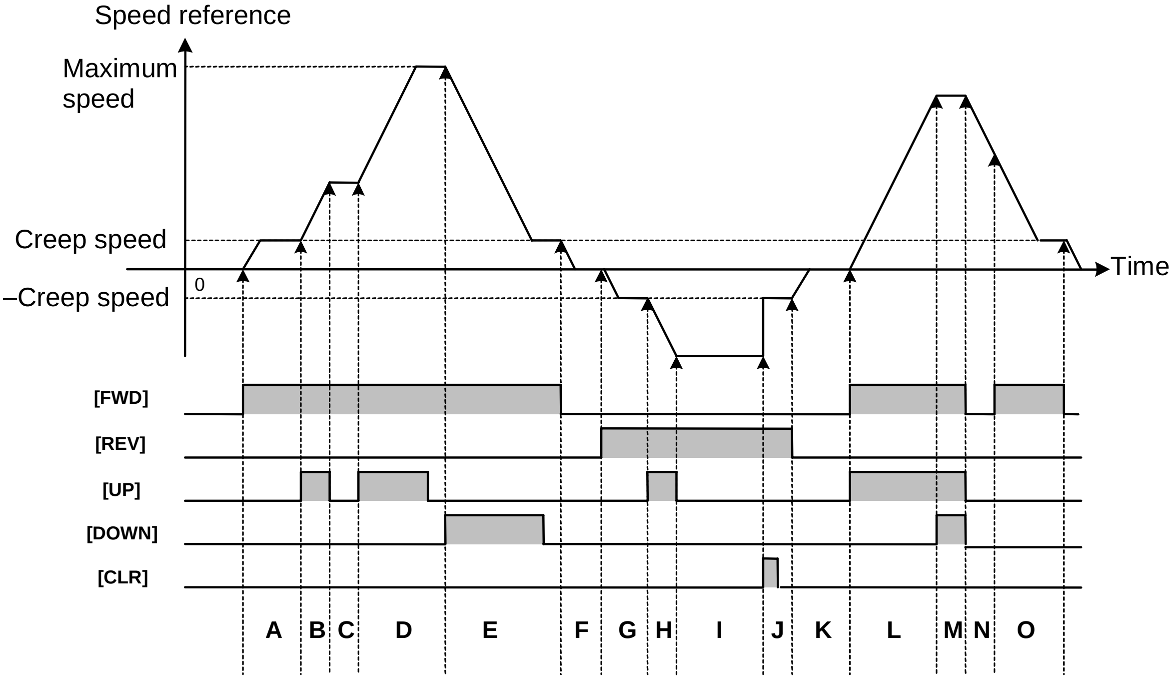



**A** : Accelerates in forward direction up to "+previous speed reference (speed reference just before the operation command is set to OFF)"
**B** : Accelerates in forward direction
**C** : Fixed to the speed reference when **[UP]** is set to OFF
**D** : Restricted by the maximum speed after acceleration in forward direction
**E** : Decelerates to stop. Fixed to the speed reference when **[DOWN]** is set to OFF
**F** : Stores the speed as a previous value when the **[FWD]** is set to OFF. Accelerates in forward direction to the previous value when the **[FWD]** is set to ON. Decelerates to stop when the **[FWD]** is set to OFF.
**G** : Accelerates in reverse direction up to "−previous speed reference"
**H** : Accelerates in reverse direction
**I** : Fixed to the speed reference when **[UP]** is turned OFF
**J** : Resets to 0r/min when **[CLR]** is turned ON
**K** : Accelerates in forward direction
**L** : Simultaneous **[UP]** and **[DOWN]** are treated as OFF. Fixed to the speed reference when both **[UP]** and **[DOWN]** are turned ON
**M** : Decelerates to stop. Stores the speed as a previous value when the **[FWD]** is set to OFF.
**N** : Accelerates in forward direction up to "+previous speed reference"

(3) UP/DOWN (initial value: creep speed 1, 2)

The following graph shows an operation with this function (The S-curve specification is not active in this example).

- You can use the terminal inputs [CRP-N2/N1] to select the creep speed 1 or the creep speed 2.
- You should specify the function code C73 "Creep speed switching (on UP/DOWN control)" to choose the function codes C18 and C19 or the analog input signals ([CRP-N1] and [CRP-N2]). See the description of the C73 for more details.




**A** : Accelerates in forward direction up to "+creep speed"
**B** : Acceleration in forward direction
**C** : Fixed to the speed reference when **[UP]** is turned OFF
**D** : Restricted by the maximum speed after acceleration in forward direction
**E** : Decelerates in forward direction down to "+creep speed"
**F** : Deceleration to stop
**G** : Accelerates in reverse direction to "–creep speed"
**H** : Acceleration in reverse direction
**I** : Fixed to the speed reference when **[UP]** is turned OFF
**J** : Resets to creep speed when **[CLR]** is set to ON
**K** : Deceleration to stop
**L** : Acceleration in forward direction
**M** : Simultaneous **[UP]** and **[DOWN]** are treated as OFF. Fixed to the speed reference when both **[UP]** and **[DOWN]** are turned ON
**N** : Deceleration to stop
**O** : Resets to creep speed since **[FWD]** is set to OFF once

### Write enable for KEYPAD [WE-KP]

This function enables changes to the function codes through the KEYPAD panel only when the digital input signal [WE-KP] is applied to prevent unauthorized changes. You can make changes when 19 is not assigned to a terminal. This function enables/disables changes through the KEYPAD panel. Use "Write enable through link" to enable/disable changes through the link.

| Input signal to select specified data | Function to be selected |
|---|---|
| 19 | |
| OFF | Changes to data disabled |
| ON | Changes to data enabled |

Note: You cannot change the function codes if you set this data to a terminal by mistake. If this is a case, set ON to the terminal, and then set a correct data.

### PID control cancel [N/PID]

The external digital input signal disables the PID control.

| Input signal to select specified data | Function to be selected |
|---|---|
| 20 | |
| OFF | PID control enabled |
| ON | PID control disabled |

### Inverse mode changeover [IVS]

The external digital input signal switches the direction of the motor rotation.

| Input signal to select specified data | Rotation direction to be selected | | Normal/inverse |
|---|---|---|---|
| 21 | FWD command | REV command | |
| OFF | Forward rotation | Reverse rotation | Normal operation |
| ON | Reverse rotation | Forward rotation | Inverse operation |

Note: Forward rotation is defined as CCW (counter clockwise facing to motor shaft) for regular motors in Japan. Forward rotation is defined as CW for some motors from abroad

### Interlock signal [IL]

When a magnetic contactor is provided to the output of the inverter, this magnetic contactor (52-2) opens to slow down the voltage drop in the DC circuit at a momentary power failure. As a result, the inverter may not detect the power failure to recover from the momentary power failure smoothly.
In such a case, use an external device to give a digital signal for informing the inverter of the momentary power failure.
The motor will restart smoothly after the power failure.

| Input signal to select specified data | Function to be selected |
|---|---|
| 22 | |
| OFF | Momentary power failure detection through digital input disabled |
| ON | Momentary power failure detection through digital input enabled |

### Write enable through link [WE-LK]

This function enables changes to the function codes through RS485, T-Link, SX, or field bus only when the digital input signal is applied to prevent unauthorized changes. You can make changes when 23 is not assigned to a terminal. Use aforementioned "Write enable for KEYPAD" to enable/disable changes through the KEYPAD.

| Input signal to select specified data<br>23 | Function to be selected | Applicable communication system |
|---|---|---|
| OFF | Changes to data disabled | Integrated RS 485<br>T-Link, SX<br>Field bus |
| ON | Changes to data enabled | |

Note: This function does not restrict the writing to the function code S (such as operation command, speed reference) areas dedicated to the communication system. The next function "Operation selection through link" enables/disables writing to the S area.

### Operation selection through link [LE]

The external digital input enables/disables the speed reference and the operation command through the link (communication system). Assign a data 24 to a desired digital input terminal and the input signal applied to it switches between the enabled state and the disabled state.

When the operation selection is enabled or this function is not assigned, you can specify the sources of commands.

| Input signal to select specified data<br>24 | Function to be selected |
|---|---|
| OFF | Link commands disabled<br>(link disabled regardless of setting by H30) |
| ON | Link commands enabled (setting by H30 enabled) |

When the link is enabled, the following priority applies if speed references and operation commands come from multiple communication systems.

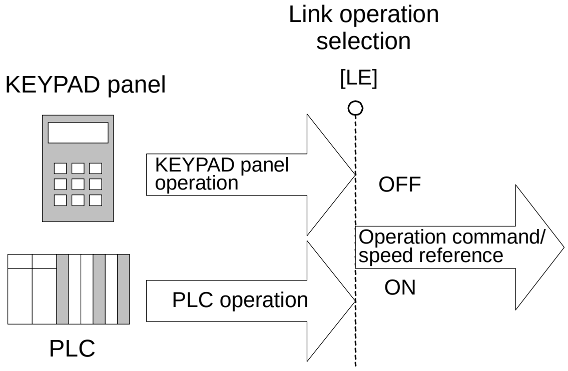
| Priority | Operation command (FWD, REV), speed reference | Description of source of commands |
|---|---|---|
| 1 | Field options | One option selected from T-Link, SX, and field bus can be installed at a time. |
| 2 | Integrated RS485 | Disabled when the option above is installed. |

### <Application example 1>

When you specify the operation command and the speed reference from the KEYPAD panel and use the terminal function [LE] to switch to the operation command and the speed reference from the PLC, the KEYPAD panel will be enabled if the terminal [LE] is OFF, and the PLC will be enabled if the terminal [LE] is ON.

The description "Not assigned (*)" in the following table on the next page indicates that a function 24 [LE] is not assigned to an X function terminal. If this is a case, the setting by the function code H30 becomes effective.

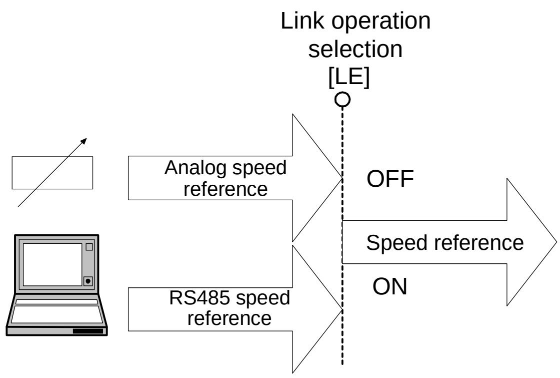
The PLC operation requires option cards (If you use RS485, an integrated function is available). See the descriptions of the option or RS485 for more details.



| | Set value | Description | Terminal [LE] | | |
|---|---|---|---|---|---|
| | | | OFF | ON | Not assigned (*) |
| Function code specification | F01="0" | Operation command from KEYPAD panel | Enabled | Disabled | |
| | F02="0" | Speed reference from KEYPAD panel | | | |
| | H30="3" | Initial setting enabling both speed reference and operation command through link (PLC) | Disabled | Enabled | |

<Application example 2>

When you select the operation command from the external signal ([FWD], [REV]) and the speed reference from the analog terminal [12] input (0±10V) or the RS485 communication (from master device such as a personal computer) using [LE] function, the analog terminal [12] will be enabled if the terminal [LE] is OFF, and the RS485 will be enabled if the terminal [LE] is ON.
If you use RS485, an integrated function is available. See the descriptions of RS485 for more details.




| | Set value | Description | Terminal [LE] | | |
|---|---|---|---|---|---|
| | | | OFF | ON | Not assigned (*) |
| Function code specification | F01="1" | Operation command from [FWD] and [REV] | Enabled (External signal is always selected) | | |
| | F02="1" | Speed reference from analog input at terminal [12] | Enabled | Disabled | |
| | H30="1" | Initial setting enabling only speed reference from link (RS485) | Disabled | Enabled | |

Universal DI [U-DI]

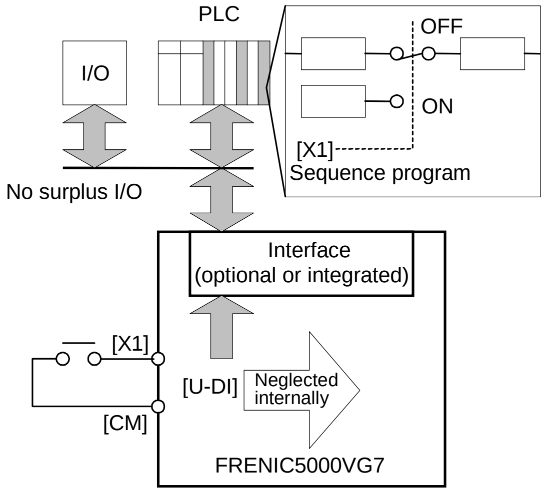
You can assign a data 25 to a digital terminal to designate it as a universal DI terminal. This function is provided to check the existence of an input signal through communication and does not affect the inverter operation.
There are following applications for this signal.

1) Check the ON/OFF state of the input signal through RS485, T-Link, SX, or field bus.
2) Use for an input to software created with the UPAC option without affecting the inverter operation.

<Application example>

You do not have enough numbers of I/O and want to use inverter control terminals to switch the control of a PLC program.
If you choose [X1] as a control terminal:

1) Set the function code E01 "X1 function selection" to 25. This specification makes this input neglected by the inverter.
2) Use the PLC to read out (polling) the function code M13 "Operation method (final command)" through communication.
3) Since the data type of M13 is 32 (type), refer to the bit assignment under that data type to check the corresponding bit of X1 input.




Note that you can read out input information of an input terminal using the code M13 without assigning the [U-DI] to the terminal. The significance of the assignment is to avoid activating an assigned function to the terminal unless you do not assign the [U-DI].

Pick up start mode [STM]

The external digital input signal enables/disables the function H09 "Start mode (Rotating motor pick up)"
Assign a data 26 to a desired digital input terminal and the input signal applied to it switches between the enabled state and the disabled state.

| Input signal to select specified data 26 | Function to be selected |
|---|---|
| OFF | Pick up mode function disabled |
| ON | Pick up mode function enabled |

Synchronization command [SYC]

This function switches between the speed reference converted from a pulse train received as a position reference via the position control and other speed reference. You can use this function for a synchronized operation. You need an optional PG (PR).

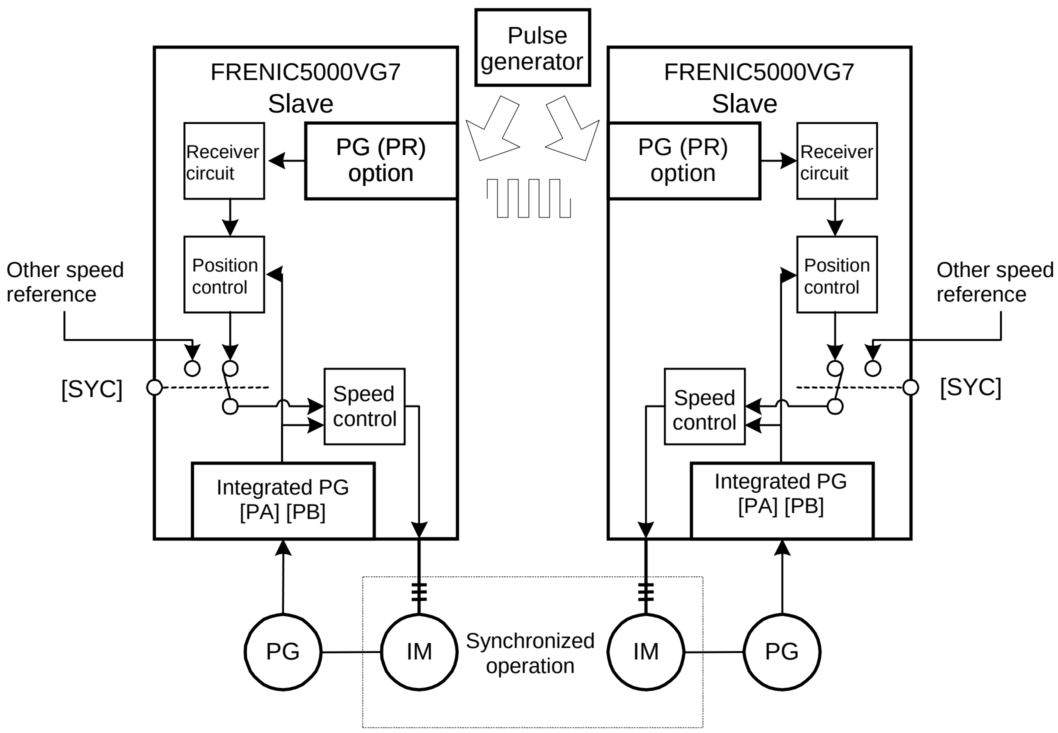
Assign a data 27 to a desired digital input terminal and the state of the input signal applied to it selects the function.

| Input signal to select specified data | Function to be selected |
|---|---|
| 27 | |
| OFF | Synchronized speed disabled (Other speed reference enabled) |
| ON | Synchronized speed enabled |

Also see E29 "PG pulse output selection", o12 to 19 "PG (PR) options", and the description on the PG (PR) options.
Note that the Zero speed locking command [LOCK] is disabled during the pulse train position control with [SYC].

<Application example 1> Synchronized operation by receiving pulse

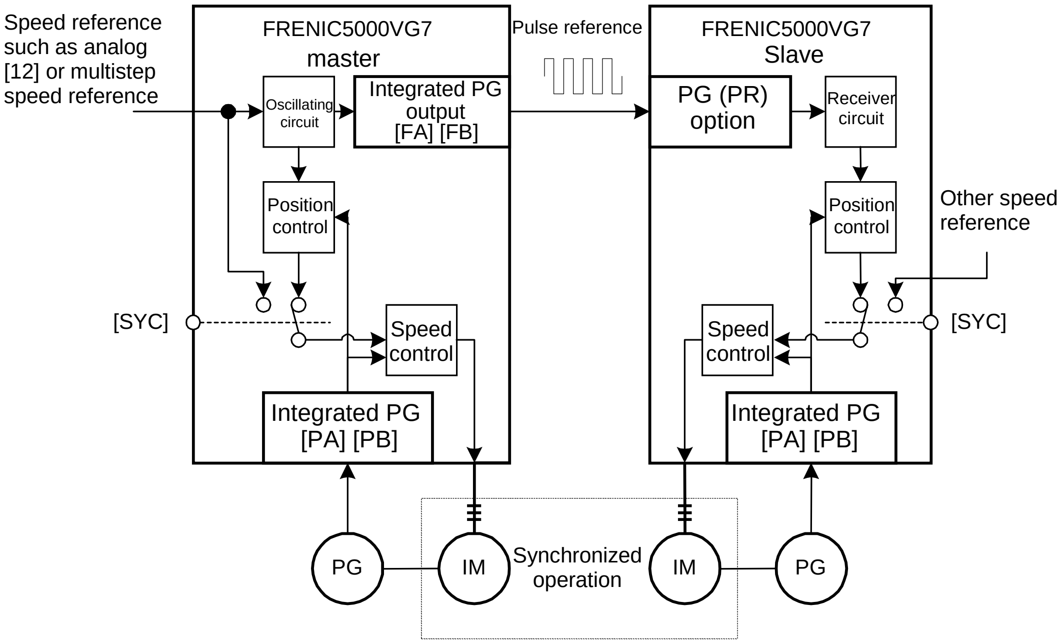
Apply a pulse train signal from the external pulse generator to the PG (PR) options of multiple inverters to be synchronized. The position reference received by the option is converted into a synchronized speed reference and the [SYC] enables the speed reference.



### <Application example 2> Synchronized operation by pulse generation

Pulse signal converted (oscillated) from an internal speed reference (such as [12] input or multistep speed reference) is also converted into a speed reference through the position control and the [SYC] enables the resulting speed reference. You can put the converted pulse signal to the output and apply it to the other inverters to synchronize the inverter with other inverters.

The motor speed of the master and the PG pulse number determines the pulse frequency. When you use a PG with 1024P/R at 1500r/min, the frequency is 1500×1024/60=25.6kHz. The pulse compensation is available on the slave side. See the function codes o14 and o15 or the PG (PR) option for more details.



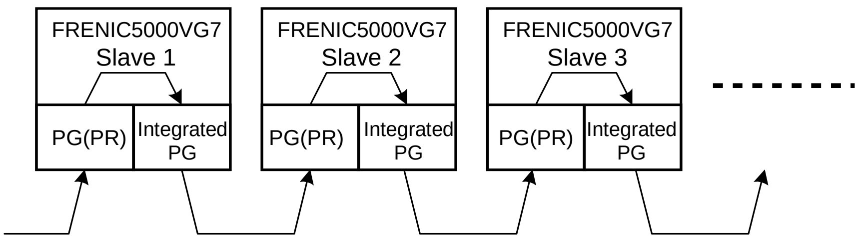

The complete synchronization (± 2 pulses or less) is possible both in the application example 1 and 2 during both transient and steady states.

About differences in methods

| Method | Merits | Demerits |
|---|---|---|
| <Application example 1> Synchronized operation by receiving pulse | No position deviation | One PG (PR) option necessary<br>Pulse generator necessary |
| <Application example 2> Synchronized operation by pulse generation | No position deviation<br>One PG (PR) option can be omitted<br>No pulse generator | None |
| Master-slave operation (Master directly applies its PG signal to slaves) | None | Position deviation |

### <Application example> Synchronized operation for three or more inverters

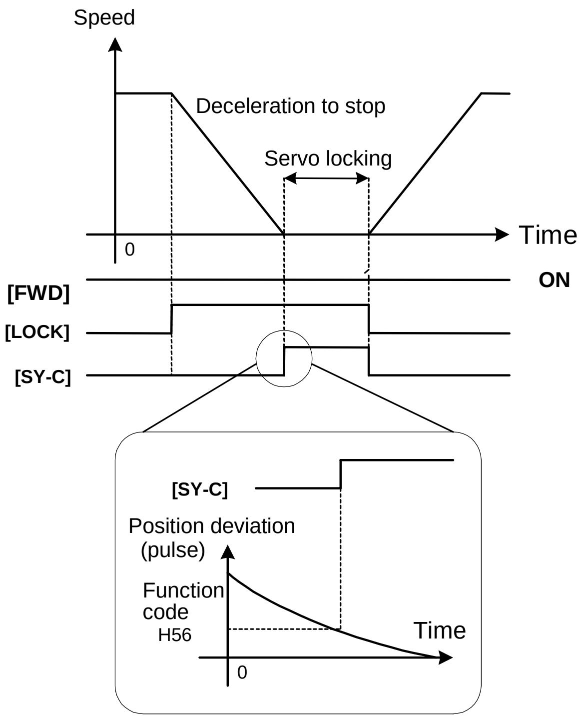
Set E29 "PG pulse output selection" to 9 to directly supply the position reference applied to the PG (PR) option to the [FA] and the [FB] of the integrated PG.



Zero speed locking command [LOCK]

The external digital input signal conducts servo lock. Assign data 28 [LOCK] to a terminal and set the input signal ON.

| Input signal to select specified data 28 | Function to be selected |
|---|---|
| OFF | Normal state |
| ON | Zero speed locking state |



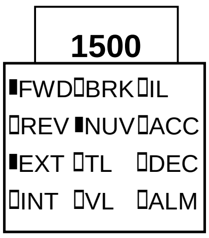

1) The inverter decelerates to stop (following an effective deceleration time setting) from the speed just after the [LOCK] is set to ON.
2) Position control (servo locking state) is applied with respect to the motor position (angle) when the speed reference of the acceleration/deceleration calculation unit reaches to zero.
   The acceleration/deceleration calculation unit declines a step speed reference directed by the user in a specified acceleration/deceleration time.
3) You can supply a resistive torque up to the short-time rating. The function code H55 "Zero speed control (Gain)" and the speed control system (ASR gain) control the magnitude of the torque in relation to the position deviation (position error).
4) Balance the speed control (ASR) gain (function codes F and C) and the position control gain (H55) to adjust the gain. The system may become unstable to present low frequency hunting when you increase the setting of the H55 while leaving ASR gain small.
5) A signal indicating completed servo locking appears on the DO as "Synchronization completion signal" when the position deviation converges into the setting range of the H56 "Zero speed control (completion range)".
   When PG (PR) option is used for synchronization control by pulse train, the zero speed locking command becomes invalid.

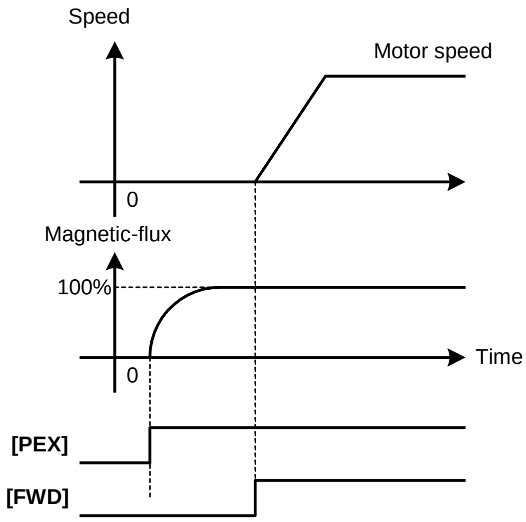
### Pre-exciting command [PEX]

The external digital input signal switches the inverter in pre-exciting state. Assign a data 29 to a desired digital input terminal and the state of the input signal applied to it selects the function. When the operation command (FWD, REV) is set to ON, the state changes from pre-exciting to normal.

| Input signal to select specified data 29 | Function to be selected |
|---|---|
| OFF | Normal state |
| ON | Pre-exciting state |

You can also use the function codes F74 and F75 to start the pre-exciting. See also the description of these functions.
You can use the "Operation status " of the "I/O check" screen of the KEYPAD panel to see whether the inverter is in the pre-exciting state or in the normal state. The ■EXT indicates the pre-exciting state and the □EXT indicates the normal operation.
You can also read out the function code M14 "Operation status" through the link.




### Speed reference limiter cancel [N-LIM]

The external digital input signal disables the speed reference limiter. Assign a data 30 to a desired digital input terminal and the state of the input signal applied to it selects the function. See the description of the function code F76 for more information on the speed reference limiter function.

| Input signal to select specified data 30 | Function to be selected |
|---|---|
| OFF | Speed limiter enabled |
| ON | Speed limiter disabled |

### H41 (torque reference) cancel [H41-CCL]

The external digital input signal cancels the setting specified by the H41 "Torque reference selection" (0: internal ASR enabled). Assign a data 31 to a desired digital input terminal and the state of the input signal applied to it selects the function.

| Input signal to select specified data 31 | Function to be selected |
|---|---|
| OFF | H41 setting enabled |
| ON | H41 setting disabled (internal ASR enabled) |

Application

Use for applications that switch between speed control (internal ASR) and torque reference control.

### H42 (torque current reference) cancel [H42-CCL]

The external digital input signal cancels the setting specified by the H42 "Torque current reference" (0: internal ASR enabled). Assign a data 32 to a desired digital input terminal and the state of the input signal applied to it selects the function.

| Input signal to select specified data<br>32 | Function to be selected |
|---|---|
| OFF | H42 setting enabled |
| ON | H42 setting disabled (internal ASR enabled) |

Application

Use for applications that switch between speed control (internal ASR) and torque current reference control.

### H43 (magnetic-flux reference selection) cancel [H43-CCL]

The external digital input signal cancels the setting specified by the H43 "Magnetic-flux reference selection" (0: internal calculation enabled). Assign a data 33 to a desired digital input terminal and the state of the input signal applied to it selects the function.

| Input signal to select specified data<br>33 | Function to be selected |
|---|---|
| OFF | H43 setting enabled |
| ON | H43 setting disabled (internal calculation enabled) |

### F40 (torque limiter mode 1) cancel [F40-CCL]

The external digital input signal cancels the setting specified by F40 "Torque limiter mode 1" (0: limiter disabled). Assign a data 34 to a desired digital input terminal and the state of the input signal applied to it switches between the enabled state and the disabled state.

| Input signal to select specified data<br>34 | Function to be selected |
|---|---|
| OFF | F40 setting enabled |
| ON | F40 setting disabled (limiter disabled) |

### Torque limiter (level 1, level 2 selection) [TL2/TL1]

The external digital input signal switches the torque limiter value (level 1 or 2). Assign a data 35 to a desired digital input terminal and the state of the input signal applied to it switches between the level 1 and the level 2. This function is effective only when F41 "Torque limiter mode 2"=3.

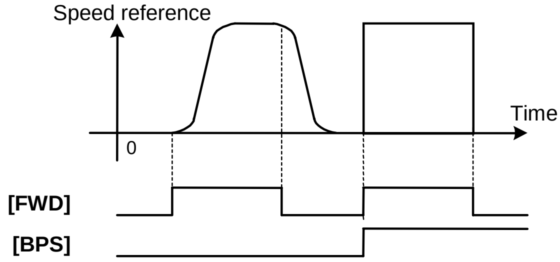
| Input signal to select specified data<br>35 | Function to be selected |
|---|---|
| OFF | F42: Torque limiter value (level 1) selection |
| ON | F43: Torque limiter value (level 2) selection |

### Bypass [BPS]

The external digital input signal bypasses the acceleration/deceleration calculation unit to disable the acceleration/deceleration time and the S-curve specifications. Assign a data 36 to a desired digital input terminal and the state of the input signal applied to it switches between the enabled state and the disabled state.
(The resultant setting is the same as the acceleration/deceleration time: 0.00s and the S-curve acceleration/deceleration: 0%)

| Input signal to select specified data 36 | Function to be selected |
|---|---|
| OFF | Acceleration/deceleration calculation unit enabled |
| ON | Acceleration/deceleration calculation unit disabled |

The speed reference from the acceleration/deceleration calculation unit follows the acceleration/deceleration and S-curve settings as shown in the figure. Setting the [BPS] to ON cancels these functions to control the motor speed following a step-form speed reference.
Use the dedicated jogging operation function codes (C30 to C38), not the [BPS], for jogging operation.




#### Restrictions

- When you use the [BPS], control functions such as the UP/DOWN control and the active drive (when V/f control is setected) are also disabled.
- The [BPS] does not affect the auxiliary speed setting 2 and the PID calculation output (speed reference). For details, refer to the control block diagrams.

| ⚠ **CAUTION** |
|---|
| • Setting the [BPS] ON accelerates/decelerates the motor rapidly and the motor may accelerate at its maximum permissible torque and decelerate down to the zero speed. Use the [BPS] after you confirm that these are permissible actions of the mechanical system and the braking devices you use. **You may be injured.** |

### Torque bias reference 1/2 [TB1, TB2]

The external input digital signals can be used to switch among three types of torque biases predetermined by F47 to 49 "Torque bias T1, T2, and T3".
See the function code F47 to 49 for more details.

| Input signal combination to select specified data | | Torque bias to be selected |
|---|---|---|
| 38 [TB2] | 37 [TB1] | |
| OFF | OFF | Torque bias disabled |
| OFF | ON | F47 torque bias T1 enabled |
| ON | OFF | F48 torque bias T2 enabled |
| ON | ON | F49 torque bias T3 enabled |

### Droop selection [DROOP]

The external digital input signal switches between the droop control enabled state and the droop control disabled state. Assign a data 39 to a desired digital input terminal and the state of the input signal applied to it selects the function. See the function code H28 "Droop control" for more details.

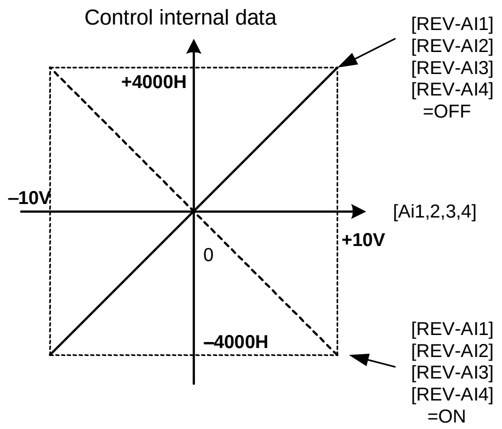
| Input signal to select specified data 39 | Function to be selected |
|---|---|
| OFF | Droop control disabled |
| ON | Droop control enabled |

Ai1 zero hold [ZH-AI1]
Ai2 zero hold [ZH-AI2]
Ai3 zero hold [ZH-AI3]
Ai4 zero hold [ZH-AI4]

The external digital input signals fix the individual analog signals Ai1 to 4 to "0: input voltage invalid". Assign a data to a desired digital input terminal and the state of the input signal applied to it selects the function.
You need optional OPC-VG7-AIO for Ai3 and Ai4.

| Input signal to select specified data | Function to be selected |
|---|---|
| 40 to 43 | |
| OFF | Ai input enabled |
| ON | Ai input held to zero |

Ai1 polarity change [REV-AI1]
Ai2 polarity change [REV-AI2]
Ai3 polarity change [REV-AI3]
Ai4 polarity change [REV-AI4]



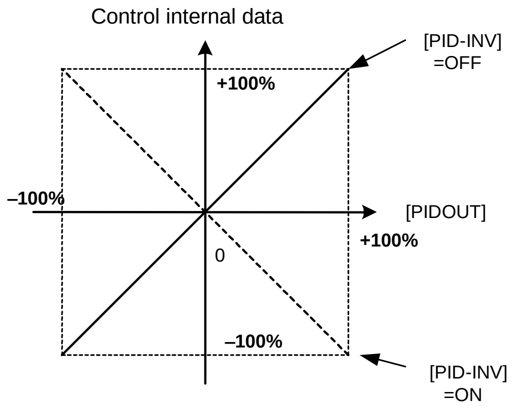

The external digital input signals invert the polarity of the input data from Ai1 to 4. Assign a data to a desired digital input terminal and the state of the input signal applied to it selects the function.
You need optional OPC-VG7-AIO for Ai3 and Ai4.

| Input signal to select specified data | Function to be selected |
|---|---|
| 44 to 47 | |
| OFF | Normal operation |
| ON | Inverted polarity |

PID output inverse changeover [PID-INV]

The external digital input signal switches the PID output [PIDOUT] between the normal operation and the inverse operation. Assign a data 48 to a desired digital input terminal and the state of the input signal applied to it selects the function.

| Input signal to select specified data | Function to be selected |
|---|---|
| 48 | |
| OFF | Normal PID output operation |
| ON | Inverse PID output operation |



### PG alarm cancel [PG-CCL]

The external digital input signal cancels the PG alarm. This function is available when you select "vector control" for the function code P01 or A01.

The inverter does not issue the alarm even when the PG wiring is disconnected during the input signal is ON. Assign a data 49 to a desired digital input terminal and the existence of the input signal cancels the PG alarm.

| Input signal to select specified data | Function to be selected |
|---|---|
| 49 | |
| OFF | Normal operation |
| ON | PG alarm canceled |

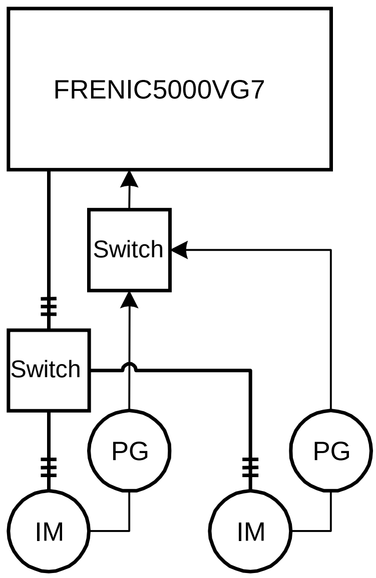
### Actions on detecting PG disconnection

| Alarm operation | [PG-CCL] = OFF | [PG-CCL] = ON |
|---|---|---|
| | Normal operation | PG alarm canceled |
| KEYPAD panel | Alarm mode | Operation mode |
| Alarm history | Recorded | Not recorded |
| Alarm DO output | PG disconnection output | No output |
| 30X relay output | Alarm output | No output |
| Inverter output | Shut down | Normal operation |

### Application

Since this is a special function, limit your application to the following cases. When you use the function code E14 "X function normally open/normally closed", you can set to "normally closed (ON)" without actually short-circuiting terminals.

1) Use to apply the power to a system and test the system without connecting the PG signal.
2) When you use two motors by switching them with one unit, a momentary disconnection will present and the PG alarm is issued if the PGs are switched externally. Chancel the PG alarm at the sequence timing when the PGs are switched. Note that when you use FUJI's option (OPC-VG7-CPG) for PG switching, you do not need this canceling function.
3) Monitoring the current on the signal line detects the PG disconnection. The false detection may occur when the PG wiring has high impedance causing low current. Usually 0.6mA or less is considered as a disconnection. If this is the case, you can operate with canceling the PG alarm as an emergency mean.



### Operation with PG disconnected

A motor rotates at a slip frequency regardless of the speed reference when the PG is disconnected (either PGP, PGM, PA, or PB is disconnected) and the PG alarm is canceled ( [PG-CCL] = ON). Since the calculation of the speed control system (ASR) will saturate and increase the torque reference and the torque current reference to the maximum, either the inverter overload (OLU) or the motor overloads (OL1, 2, 3) when you use an electronic thermal overload relay will enter the alarm mode (Note that if you invert the A phase and the B phase of the PG signal, it will present the same phenomenon).

If you are sure that the PG wiring is disconnected, do not operate with canceling the PG alarm.

### <Control mechanism>

The vector control of the VG7 is a slip frequency type vector control. The inverter obtains the motor speed ($\omega r$) from the PG signal and the slip frequency ($\omega s$) from the current detection to determine the output frequency to the motor ($\omega 1=\omega r+\omega s$). In case of a PG disconnection, the motor speed is 0 ($\omega r=0$) and the output frequency to the motor becomes the slip frequency $\omega s$.

In the speed control system (ASR), since the motor speed ($\omega r$) does not follow the speed reference ($\omega r^*$), the speed control system (ASR) conducts an integral operation (I constant of ASR) to increase the speed deviation ($\omega r^* - \omega r$) and the saturation is reached in a short period. The output of the ASR is the torque reference and this torque reference is fixed to the maximum value resulting in the overload protection.

### Undervoltage cancel [LU-CCL]

The external digital input signal cancels the undervoltage alarm. When the input signal is ON, the alarm is canceled.
Assign a data 50 to a desired digital input terminal and the existence of the input signal cancels the undervoltage alarm.

| Input signal to select specified data | Function to be selected |
|---|---|
| 50 | |
| OFF | Normal operation |
| ON | Undervoltage alarm canceled |

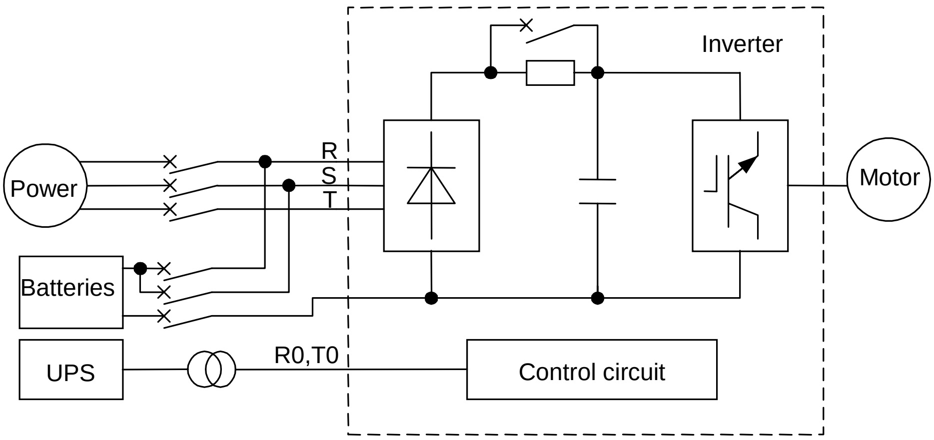
### Actions on detecting undervoltage inside the inverter

| Alarm operation | [LU-CCL] = OFF | [LU-CCL] = ON |
|---|---|---|
| | Normal operation | Undervoltage alarm canceled |
| KEYPAD panel | Alarm mode | Operation mode |
| Alarm history | Recorded | Not recorded |
| Alarm DO output | PG disconnection output | No output |
| DO output for Stopping on undervoltage [LU] | Output | No output |
| 30X relay output | Alarm output | No output |
| Inverter output | Shut down | Normal operation |

### Application

Since this is a special function, limit your application to the following cases. When you use the function code E14 "X function normally open/normally closed", you can set to "normally closed (ON)" without actually short-circuiting terminals.

1) When you supply control power via [R0] and [T0]separately, if you turn of the main circuit power supply, the inverter enters the alarm mode due to the detected undervoltage. Use this function to avoid the alarm.
2) Use for elevators during power failure. Since you can operate at a slow speed even under the undervoltage level (200V systems: 186V, 400V systems: 371V), employ a UPS, a battery and a stand-by power generator to build your system as follows.



Ai torque bias hold [H-TB]

The external digital input signal directs to preserve the torque bias data supplied via an analog input. Assign a data 51 to a desired digital input terminal and the existence of the input signal preserves the analog data.

| Input signal to select specified data<br>51 | Function to be selected |
|---|---|
| OFF | Torque bias hold disabled |
| ON | Torque bias hold enabled |

STOP1 [STOP1]

The external digital input signal directs to decelerate to stop with the currently specified/effective deceleration time and S-curve decelerations on start/end sides.
Assign a data 52 to a desired digital input terminal and the existence of the input signal activates the operation.

| Input signal to select specified data<br>52 | Function to be selected |
|---|---|
| OFF | Normal operation |
| ON | Deceleration to stop (effective deceleration time) |

STOP2 [STOP2]

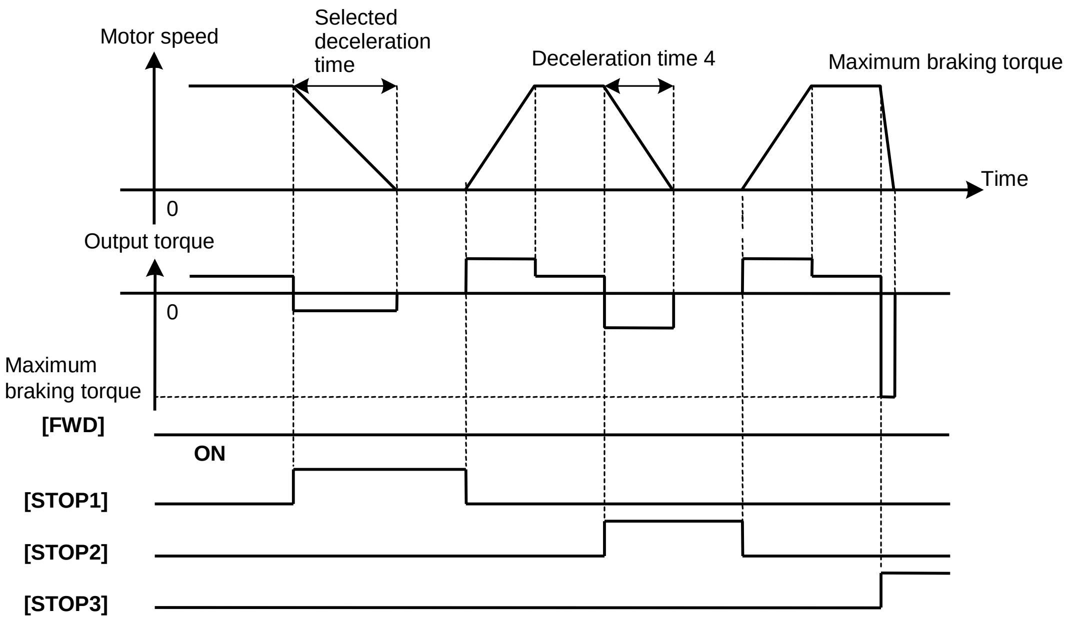
The external digital input signal directs to decelerate to stop with the C67 "Deceleration time 4" and C68 and C69 "S-curve start/end side 4".
Assign a data 53 to a desired digital input terminal and the existence of the input signal activates the operation.

| Input signal to select specified data<br>53 | Function to be selected |
|---|---|
| OFF | Normal operation |
| ON | Deceleration to stop (Deceleration time 4) |

STOP3 [STOP3]

The external digital input signal directs to decelerate to stop with the maximum braking torque regardless of the specified deceleration time.
Assign a data 54 to a desired digital input terminal and the existence of the input signal activates the operation.

| Input signal to select specified data<br>54 | Function to be selected |
|---|---|
| OFF | Normal operation |
| ON | Deceleration to stop (Maximum braking torque) |



### DIA data latch [DIA]
### DIB data latch [DIB]

The external digital input signal enables to read in a data through the DI option (OPC-VG7-DIA, DIB).
The data is read when the input signal [DIA] or [DIB] is ON and the data is held when the input signal [DIA] or [DIB]is OFF.  See the DI option section for more details.

| Input signal to select specified data 55 | Function to be selected |
|---|---|
| OFF | Hold DIA data |
| ON | Read DIA data |

| Input signal to select specified data 56 | Function to be selected |
|---|---|
| OFF | Hold DIB data |
| ON | Read DIB data |

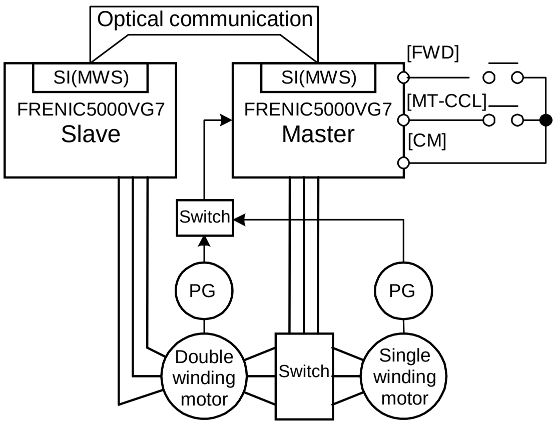
### Option Di1 to 6 [O-DI1 to 6]

Not used

### Multiwinding motor control cancel [MT-CCL]

The external digital input signal cancels the multiwinding drive with SI (MWS) option (OPC-VG7-SI(MWS)) and switches to the standard single wining motor drive.
The function code to switch to the multiwinding drive is o33 "Multiwinding system".

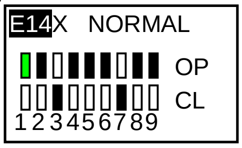
The right figure shows easy connection for changing drives between 2-winding motor and single-winding motor. In this circuit, the slave unit does not need operation command or feedback of PG, NTC signals. With change of motors, PG and NTC signals must be changed as well as the 2nd power circuit. To change PG and NTC signals, use the DI option (OPC-VG7-CPG).
For details of the multiwinding system, refer to the description of Options.




| Input signal to select specified data 57 | Function to be selected when o33 "Multiwinding system"=1 |
|---|---|
| OFF | Multiwinding motor drive |
| ON | Single winding motor drive (Multiwinding cancelled) |

| E14 | X function normally open/normally closed |
|---|---|

◆Sets [X1] to [X9] to be open or closed by software when their terminals do not have connections.
Use for "NC terminal" connection for functions such as THR (Trip command).




E14 X NORMAL

Setting range: 0000 to 01FF
0: Normally open
1: Normally closed

| E15-E27 | Y function selection |
|---|---|

◆Part of control signals and monitor signals can be selected and output to the terminals [Y1] to [Y18] and [Y5A].
The transistor signals are output to the terminals [Y1] to [Y18] and the relay contact signal to [Y5A].
Use of terminal functions from [Y11] to [Y18] requires the optional OPC-VG7-DIOA.

E15 Y1 FUNC
E16 Y2 FUNC
E17 Y3 FUNC
E18 Y4 FUNC
E19 Y5 FUNC
E20 Y11 FUNC
E21 Y12 FUNC
E22 Y13 FUNC
E23 Y14 FUNC
E24 Y15 FUNC
E25 Y16 FUNC
E26 Y17 FUNC
E27 Y18 FUNC

Setting range: 0 to 47

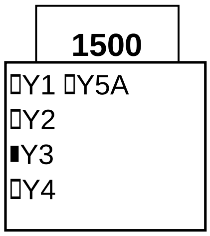
| Set value | Function | Symbol | Set value | Function | Symbol |
|---|---|---|---|---|---|
| 0 | Inverter running | [RUN] | 21 | Alarm indication 4 | [AL4] |
| 1 | Speed existence | [N-EX] | 22 | Alarm indication 8 | [AL8] |
| 2 | Speed agreement | [N-AG] | 23 | Fan operation signal | [FAN] |
| 3 | Speed equivalent | [N-AR] | 24 | Auto-resetting | [TRY] |
| 4 | Detected speed 1 | [N-DT1] | 25 | Universal DO | [U-DO] |
| 5 | Detected speed 2 | [N-DT2] | 26 | Heat sink overheat early warning | [INV-OH] |
| 6 | Detected speed 3 | [N-DT3] | 27 | Synchronization completion signal | [SY-C] |
| 7 | Stopping on undervoltage | [LU] | 28 | Lifetime alarm | [LIFE] |
| 8 | Detected torque polarity (braking/driving) | [B/D] | 29 | Under accelerating | [U-ACC] |
| 9 | Torque limiting | [TL] | 30 | Under decelerating | [U-DEC] |
| 10 | Detected torque 1 | [T-DT1] | 31 | Inverter overload early warning | [INV-OL] |
| 11 | Detected torque 2 | [T-DT2] | 32 | Motor temperature early warning | [M-OH] |
| 12 | KEYPAD operation mode | [KP] | 33 | Motor overload early warning | [M-OL] |
| 13 | Inverter stopping | [STOP] | 34 | DB overload early warning | [DB-OL] |
| 14 | Operation ready output | [RDY] | 35 | Link transmission error | [LK-ERR] |
| 15 | Magnetic-flux detection signal | [MF-DT] | 36 | Load adaptive control under limiting | [ANL] |
| 16 | Motor M2 selection status | [SW-M2] | 37 | Load adaptive control under calculation | [ANC] |
| 17 | Motor M3 selection status | [SW-M3] | 38 | Analog torque bias hold | [TBH] |
| 18 | Brake release signal | [BRK] | 39-47 | Optional Do 1 to 9 | [O-DO1 to 9] |
| 19 | Alarm indication 1 | [AL1] | | | |
| 20 | Alarm indication 2 | [AL2] | | | |

<Using terminal output>

There are 48 types of terminal output functions available. You cannot use all of these functions at the same time. You can use total of thirteen terminals, which are five terminals from Y1 to Y4 and Y5A as standard and eight terminals from Y11 to Y18 using option of DIOA. You can also use thirteen types of data on the terminals through the link function (RS485, T-Link, SX, and field bus).
You can use the function code M52, 53 and 54 (control output 1, 2, and 3) to read all information (48 bits in total) that are available for the DO outputs through the link (RS485, T-Link, SX, and field bus) and UPAC.
See M52 to M54 on the function code list for more details.

### Setting procedure

- Select a function you want to use. We select the "Operation ready output" command as an example.
- Assign the "Operation ready output" command to one of the available terminals (Y1 to Y4, Y5A, Y11 to Y18). If you want to assign it to Y3, write a data, "14:RDY", to the function code E17 "Y3 function selection".
- Y3 terminal is set to ON after you turn on and the operation becomes ready.
- See the "I/O check" screen of the KEYPAD panel to confirm the ON/OFF status of the Y3. If you switch the Y3 from OFF to ON, □ Y3 changes to ■Y3 on the screen shown on the right.




### <You can specify as "NO terminal" or "NC terminal">

You can use the function code E28 to specify the state of individual terminals (standard 5 terminals only) as normally open ("NO terminal") or normally closed ("NC terminal"). See the function description of E28 for more information.

### Inverter running [RUN]

"Running" is defined as a state when the inverter supplies output. This signal is ON when the inverter is running and OFF when the inverter is stopping.
The inverter does not stop when it is decelerating after you turn OFF the FWD or the REV signal.
The inverter shuts down the output and stops when the speed becomes less than the speed specified by F37 "Stop speed" and the zero speed continues for the time specified by F39 "Zero speed holding time".
The status is running during DC braking, pre-exciting, and servo locking (synchronized control completed).

### Speed existence [N-EX]

Turns ON when the absolute value of the speed reference or the actual speed is more than the value specified by the function code F37 "Stop speed", and OFF when the value is less than the "Stop speed".
You can use the function code F38 "Stop speed (Detection method)" to select either the speed reference or the actual speed.

### Speed agreement [N-AG]

Turns ON when the actual speed value falls in the detection range specified by the speed reference value (Speed reference 4: ASR input).
See the function description of E44 "Speed agreement (Off delay timer)"and E45 "Enable/disable alarm for speed disagreement".

### Speed equivalent [N-AR]

Turns ON when the actual speed value reaches the speed reference value (Speed reference 1: acceleration/deceleration calculation unit input). See the function description of E43.

### Detected speed 1, 2, 3 [N-DT1, 2, 3]

Turns ON when the observed speed reaches the Speed detection level 1 (E39), level 2 (E40), or level 3 (E41). See the function description of E39, 40, and 41.

### Stopping on undervoltage [LU]

Turns ON when the undervoltage protective function is active, or the DC link circuit voltage of the main circuit decreases down below the undervoltage detection level. This function is not active when the "undervoltage alarm cancel" signal is ON.
This signal turns OFF when the voltage recovers to exceed the undervoltage detection level.
Undervoltage detection level 200V series: 186V,400V series: 371V

### Detected torque polarity (braking/driving) [B/D]

Provides a signal indicating whether the torque is for driving or for braking by detecting the polarity of the calculated torque inside the inverter.
Turns OFF for the driving torque and turns ON for the braking torque.

### Torque limiting [TL]

Turns on when the torque reference is limited by the torque limiter 1 or 2.

### Detected torque 1, 2 [T-DT1, 2]

Turns on when the torque reference increases over the Torque detection level 1 or 2 (E46 or E47).

### KEYPAD operation mode [KP]

Turns ON when the operation command keys (FWD, REV, STOP keys) directing running/stopping are effective (F02 "Operation method"=0).

### Inverter stopping [STOP]

Supplies an inverted signal of the [RUN] signal indicating zero speed.
Provides the ON signal during DC braking, pre-exciting, and servo locking (synchronized control completed).

### Operation ready output [RDY]

Turns ON when the inverter is ready for the operation, for example, the power supply to the main and the control circuits are established or the inverter protective function is not active. Under a normal condition, the inverter becomes ready in about one second after you turn on. Note that the inverter becomes ready in two to three seconds when the UPAC option is installed.

### Magnetic-flux detection signal [MF-DT]

Turns ON when the magnetic-flux reference values increases over the Magnetic-flux detection level (E48).

Motor M2, M3 selection status [SW-M2, M3]

Provides the motor switching signal to the magnetic contactor for a motor according to the selected motor M1, M2, or M3 selected by the function code F79 or X control terminal.

| Combination of the output signals | | Motor to be selected |
|---|---|---|
| [SW-M3] | [SW- M2] | |
| OFF | OFF | Motor 1 |
| OFF | ON | Motor 2 |
| ON | OFF | Motor 3 |
| ON | ON | - |

Brake release signal [BRK]

◆Provides the mechanical brake apply/release signal.

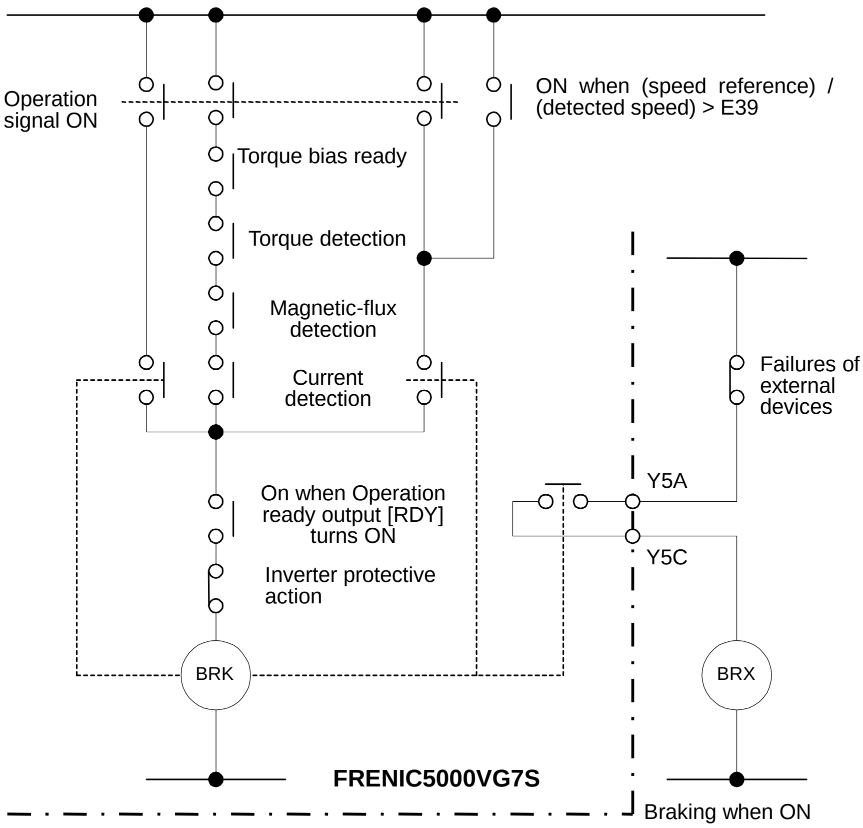
There are the Torque bias, the Torque detection level 1, and the Magnetic-flux detection level as parameters (user defined) for releasing (opening) brake.

There is the speed detection level 1 as parameter for applying brake.

Usually you should assign the brake releasing signal to the relay output (Y5A and Y5C) of the VG7S standard DO. This signal is connected to the external mechanical brake (BRX relay). The action of the mechanical brake is "NC contact".

Y5A-Y5C: Brake is released on ON (closed)

Y5A-Y5C: Brake is applied on OFF (open)




Servo locking function (braking not by a mechanical brake but by the inverter output torque) is also available. See the zero speed locking command in E01 to E13 "X function selection" for more details.

<Setting>

Brake release sequence

The following procedure turns ON the Brake release signal [BRK] and releases the mechanical brake.

1) Operation ready output [RDY] turns ON to release the mechanical brake after the power supply to the main is turned on, the control circuit voltage is established, and the initialization is completed.
2) The inverter protective function (alarm) is not active.
3) The operation command (FWD or REV) is ON.
4) Current detection: The presence of overcurrent level/64 is considered as "detected".
5) Magnetic-flux detection: Specified by the function code E48 "Magnetic-flux detection level"
6) Torque detection: Specified by the function code E46 "Torque detection level 1". There are two torque detection levels, Torque detection level 1 (E46) and Torque detection level 2 (E47). Use E46 for the Forward command (FWD) and E47 for the Reverse command (REV).
7) Torque bias ready: You can use the activation timer (function code F50) to set the rise time for the bias when you add a torque bias (function code F46 to F49). This time duration is defined as "torque bias ready".

Brake applying sequence

The following procedure turns OFF the Brake release signal [BRK] and applies the mechanical brake.

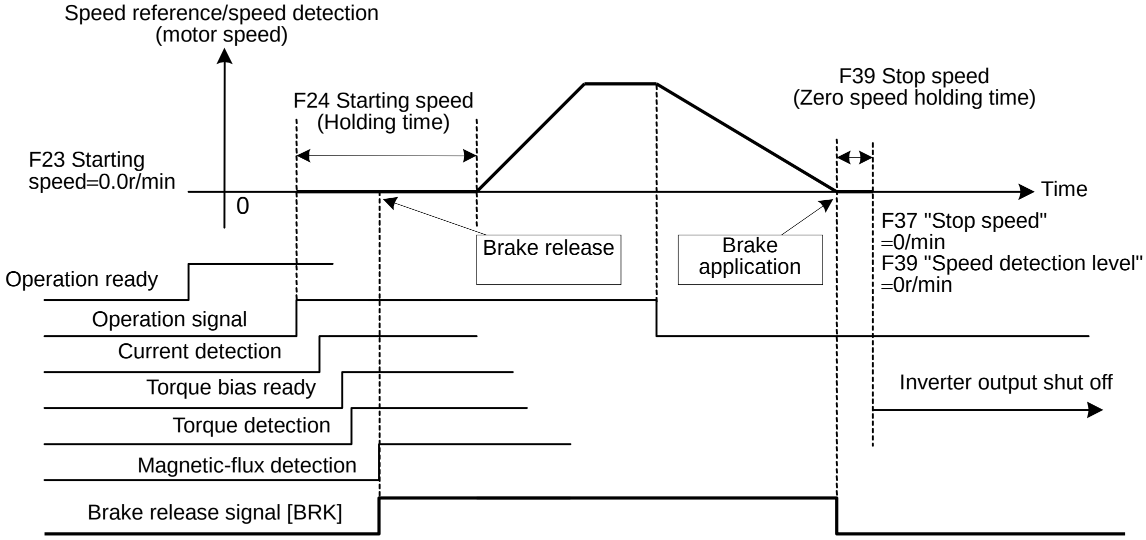
1) The operation command (FWD or REV) is OFF.
2) (Speed reference value/Detected speed value) < Speed detection level 1
   Select the speed reference for sensorless control.
   Use the third digit (0: Speed detection, 1: Speed reference) of the function code E38 "Speed detection method" to select the detection method (reference, detection) and use the function code E39 "Speed detection level 1" to set the Detection level 1.

Starting speed/Stop speed

You should also set the Staring speed (function code F23 and F24) and the Stop speed (function code F37 to F39) for the brake sequence.

Starting speed: Set to the zero speed control (F23=0.0r/min) to release the brake in less than zero speed holding time (F24).

Stop speed: When you set to the zero speed control (F37=0.0r/min), the Brake release signal is set to OFF when a motor (machine) stops completely.



### Alarm indication [AL1, 2, 4, 8]

Provides the operation status of the inverter protection function.

| Alarm description (Inverter protective function) | Output terminal | | | |
|---|---|---|---|---|
| | [AL1] | [AL2] | [AL4] | [AL8] |
| No alarm | OFF | OFF | OFF | OFF |
| Overcurrent (EF, OC) | ON | OFF | OFF | OFF |
| Overvoltage (OU) | OFF | ON | OFF | OFF |
| Undervoltage (LU) | ON | ON | OFF | OFF |
| Main circuit error (dcF, PbF) | OFF | OFF | ON | OFF |
| CPU system error (Er1, Er3, Er8, ErA) | ON | OFF | ON | OFF |
| Overheat (dBH, OH1, OH3, OH4) | OFF | ON | ON | OFF |
| Overload (OL1, OL2, OL3, OLU) | ON | ON | ON | OFF |
| Speed error (dO, Er9, OS) | OFF | OFF | OFF | ON |
| Input phase loss (Lin) | ON | OFF | OFF | ON |
| Inverter output circuit error (Er7) | OFF | ON | OFF | ON |
| Communication error (Er2, Er4, Er5, Erb) | ON | ON | OFF | ON |
| Signal disconnection (nrb, PG) | OFF | OFF | ON | ON |
| Operation procedure error (Er6) | ON | OFF | ON | ON |
| External fault (OH2) | OFF | ON | ON | ON |
| Others (Ar1 to ArF) | ON | ON | ON | ON |

### Fan operation signal [FAN]

This signal is associated with H06 "Fan stop operation" and is present when the cooling fan is operating.

### Auto-resetting [TRY]

This signal is issued when the protective function is conducting the retry operation if you set one or more to H04 "Auto reset (Times)".

Universal DO [U-DO]

You assign a data 25 to a digital output terminal to use it as a universal DO terminal. You can turn on/off through RS485, field bus, and UPAC. This function simply set ON and OFF to the transistor and relay outputs without affecting the inverter functions.

The applications of this signal are:

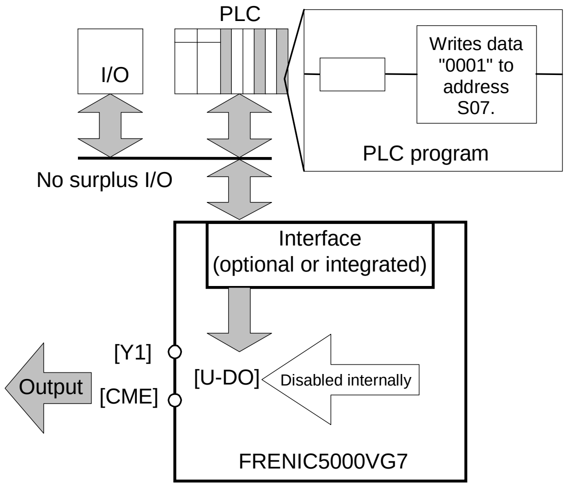
1) To set ON/OFF to the control terminal directly through RS485 or field bus.
2) To put the output which are assigned by the software created by the UPAC option on a DO of the control terminals.

<Application>

You do not have enough numbers of I/O and want to use an inverter control terminal for a control output of a PLC program.

If you use the control terminal [Y1]:

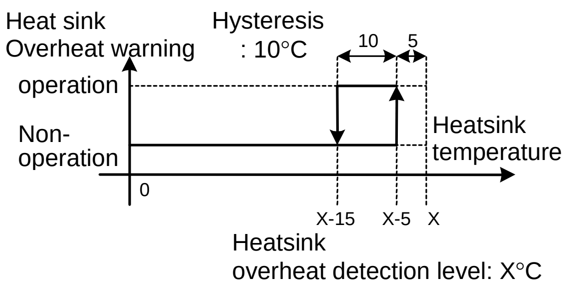
1) Set 25 [U-DO] to the function code E15 "Y1 function selection". Now the inverter does not use the Y1 terminal internally and you can use the terminal for the output of the communication.
2) Use the PLC to write "1" to the corresponding bit (data type: 33) of the function code S07 "Universal DO". You will write "0001 [h] " for [Y1].




Heat sink overheat early warning [INV-OH]

The heat sink overheat early warning will be issued when the temperature of the heat sink reaches the temperature five degrees less than the detection level of "Heat sink overheat alarm" (OH1). This is an early warning for the "Heat sink overheat alarm" which is present when the ambient temperature of the heatsink that cools the rectifier diode and the IGBT (PWM switching device) due to the failure of the cooling fan.

The heat sink overheat level (X°C) is set within the range of about 80 to 110°C based on the inverter capacity and short-time rating (CT, VT, and HT), and user cannot change it.



### Synchronization completion signal [SY-C]

Turns ON when the synchronization completes within the pulse width specified by the function o19 "Deviation zero range" during the synchronizing operation with an option OPC-VG7-PG (PR). See the option section for more details.
It also turns ON when the lock completes within the pulse width specified by the function H56 "Zero speed control (completion range)". See the function description of the zero speed locking command (function code E01 to E13).

### Lifetime alarm [LIFE]

Turns ON when the accumulated operation time of main circuit smoothing capacitor, the electrolytic capacitor on the control print circuit board, or the cooling fan.
The lifetime is determined by the following criteria and the lifetime is considered to be expired if either of them is reached. You can see them in the maintenance information of the KEYPAD panel.

| Part | Life time determination level |
|---|---|
| Main circuit capacitor | 85.0% or less of the initial value.<br>Life time expires when CAP=85.0%. |
| Electrolytic capacitor on control print circuit board | Accumulated time: 61,000 hours |
| Cooling fan | 40,000 hours (3.7kW or less)<br>25,000 hours (5.5kW or more)<br>Estimated life time in 45°C of inverter ambient temperature |

### Under accelerating [U-ACC]
### Under decelerating [U-DEC]

Turns ON during acceleration or deceleration.
Acceleration or deceleration is determined by comparing the input to the acceleration/deceleration calculation unit (Speed reference 1) and the detected speed value. The Under-acceleration/ deceleration signal turns OFF when the speed reaches to a level specified by the function code E42 "Speed equivalent (Detection range)".

### Inverter overload early warning [INV-OL]

Provides the overload early warning signal at a level specified by the Inverter overload early warning (E33). See the E33 "Inverter overload early warning" for more details.

### Motor temperature early warning [M-OH]

Provides the overheat early warning signal at a level specified by the Motor overheat early warning (E31). See the E31 "Motor overheat early warning" for more details.

### Motor overload early warning [M-OL]

Provides the overload early warning signal at a level specified by the Inverter overload early warning (E34). See the E34 "Inverter overload early warning" for more details.

### DB overload early warning [DB-OL]

Provides the overload early warning signal at a level specified by the DB overload early warning (E36). See the E36 "DB overload early warning" for more details.

### Link transmission error [LK-ERR]

Turns ON when a communication error occurs in the transmission through the link (RS485, T-Link, SX, field bus). Turns OFF when the communication returns to normal.

Load adaptive control under limiting [ANL]
Load adaptive control under calculation [ANC]

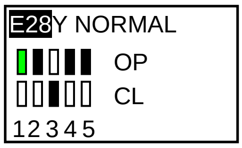
Analog torque bias hold [TBH]
Turns on when the analog bias hold command is present.

## E28 Y function normally open/normally closed

◆Sets Y1 to Y4 and RY to be open or closed by software.

**E28** Y NORMAL

Setting range: 0000 to 01FF
0: Normally open
1: Normally closed




## E29 PG pulse output selection

◆Use this function to provide different applications with the PG pulse signal.

**E29** PG-PLS-OUT

1) You can divide the pulse signal to supply.
Set value 0: 1/1, 1: 1/2, 2: 1/4, 3: 1/8, 4: 1/16, 5: 1/32, 6: 1/64
The input signal to the integrated PG is divided for output as presented above. You can use the divided signal for digital speedometer.

2) You can convert the internal speed reference (digital and analog) into pulse to supply. See the <Application example 2> of Synchronization command [SYC] of the function codes E01 to E13 for more details.
Set value 7: Pulse generation mode (A, B: Signals with 90° phase difference)

3) You can put the optional PG input on the pulse output.
Set value : 8: OPC-VG7-PG (PD), pulse train detection input is directly supplied to the pulse output.
9: OPC-VG7-PG (PR), pulse train reference input is directly supplied to the pulse output.
See the <Application example 3> of Synchronization command [SYC] of the function codes E01 to E13 for more details.

## E30 Motor overheat protection (Temperature)

◆Sets the temperature at which the Motor overheat alarm is issued. Select the protection level according to the types of motors.

**E30** M-PRTC-T

Note: This function is available for the motor temperature input from the NTC thermistor or the Ai.
Setting range: 100 to 200 [°C]

## E31 Motor overheat early warning (Temperature)

◆Sets the temperature at which the Motor overheat early warning is issued before the overheat protection becomes active. The early warning signal is put on the DO to which [M-OH] is assigned.

| E | 3 | 1 | M | - | W | A | R | N | - | T | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Note: This function is available for the motor temperature input from the NTC thermistor or the Ai.
Setting range: 50 to 200 [°C]

## E32 M1-M3 PTC operation level

◆Activated when the input voltage from a PTC becomes higher than the specified voltage (activation level) if you select to use a thermistor.

| E | 3 | 2 | M | - | P | R | T | C | - | L | V | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.00 to 5.00 [V]
The warning temperature depends on a PTC thermistor and the resistor of the PTC thermistor changes drastically at the warning temperature. The activation (voltage) level is specified by this change of the resistor.

## E33 Inverter overload early warning

◆Sets the level at which the overload early warning is issued before the Inverter overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection. The early warning signal is put on the DO to which [INV-OL] is assigned.

| E | 3 | 3 | I | N | V | - | O | L | W | A | R | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 25 to 100 [%]

## E34 Motor overload early warning

◆Sets the level at which the overload early warning is issued before the Motor overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection. The early warning signal is put on the DO to which [M-OL] is assigned.

| E | 3 | 4 | M | - | O | L | - | W | A | R | N | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 25 to 100 [%]

## E35 DB overload protection

◆Sets in %ED with respect to the inverter capacity. When you use a braking resistor with 10%ED, set as 10%. When the set value is zero, the overload protection (dBH) becomes disabled.

| E | 3 | 5 | D | B | - | O | L | - | P | R | T | C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 100 [%]

## E36 DB overload early warning

◆Sets the level at which the overload early warning is issued before the DB overload protection becomes active. When you set 100%, the early warning is simultaneously issued with the overload protection. The early warning signal is put on the DO to which [DB-OL] is assigned.

| E | 3 | 6 | D | B | - | O | L | - | W | A | R | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 100 [%]

| E37 | DB thermal time constant |
|---|---|

◆Sets the thermal time constant of a DB resistor to be used.

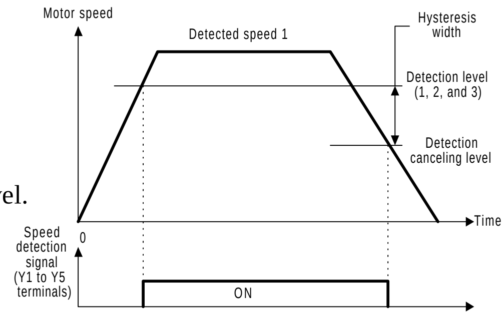
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 3 | 7 | D | B | - | T | H | - | T | C | | |

Setting range: 0 to 1,000 [s]

| E38 | Speed detection method |
|---|---|
| E39 | Speed detection level 1 |
| E40 | Speed detection level 2 |
| E41 | Speed detection level 3 |

◆Provide signals when the Detected speed 1 [N-FB1±] /Speed reference 4 [N-REF4] exceeds the detection level (1, 2, and 3). The detected signals are present on the DO's to which [N-DT1], [N-DT2], and [N-DT3] are assigned. You can set the detection method (detection, reference) individually.

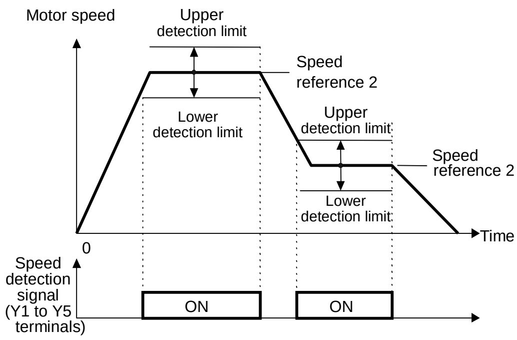
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 3 | 8 | N | D | T | | M | E | T | H | O | D |
| E | 3 | 9 | N | D | T | 1 | - | L | V | L | | |
| E | 4 | 0 | N | D | T | 2 | - | L | V | L | | |
| E | 4 | 1 | N | D | T | 3 | - | L | V | L | | |




- Detection level
  You can specify three types of speed detection level.
  (Level 1)
  Setting range: 0 to 24,000 [r/min]
  Note: The absolute value of the speed is used.
  (Level 2 and 3)
  Setting range: –24,000 to 24,000 [r/min]
  Note: When the reference value exceeds the maximum speed, the reference value is interpreted as the maximum speed. The hysteresis width is 1% of the maximum speed.
- Detection method
  You can specify the detection method of the speed detection functions individually.
  Setting range: 000 to 111
    First digit=Detection method of E39: 0=Detected speed (estimation), 1=Reference speed
    Second digit=Detection method of E40: 0=Detected speed (estimation), 1=Reference speed
    Third digit=Detection method of E41: 0=Detected speed (estimation), 1=Reference speed
  Detected speed 1 [N-FB1±] is used as the detected speed.
  Speed reference 4 (ASR input) [N-REF4] is used as the speed reference.

| E42 | Speed equivalence (Detection range) |
|---|---|

◆Specifies the level (detection range) to determine whether the Detected speed 2 (ASR input) [N-FB2±] reaches the Speed reference 2 (before the acceleration/deceleration calculation) [N-REF2]. The inverter provides the detection signal when the detected speed is between the Speed reference 2 plus the hysteresis and the Speed reference 2 minus the hysteresis. The 100% means the maximum speed. The detection signal appears on the DO to which the [N-AR] is assigned.




| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 2 | N | A | R | - | H | Y | S | T | R | |

Setting range: 1.0 to 20.0 [%]

| E43 | Speed agreement (Detection range) |
|---|---|
| E44 | Speed agreement (Off delay timer) |

◆Set the agreement levels (agreement ranges) of the Speed reference 4 (ASR input) [N-REF4] and the Detected speed 2 [N-FB2±]. The inverter provides the detection signal when the Detected speed 2 is between the Speed reference 4 plus the Detection range and the Speed reference 4 minus the Detection range.

◆The 100% means the maximum speed. The detection signal appears on the DO to which the [N-AR] is assigned. You can also set the off delay timer for the detection signal. If the Detected speed 2 goes out and returns to the detection range in a period specified by the off delay time, the detection signal will not be set to OFF.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 3 | N | A | G | | H | Y | S | T | R | |
| E | 4 | 4 | N | A | G | | D | E | L | A | Y | |

Setting range: E43 = 1.0 to 20.0 [%]
E44 = 0.000 to 1.000 [s]

| E45 | Enable/disable alarm for speed disagreement |
|---|---|

◆Specifies whether the Speed disagreement alarm (Er9) is issued or not when the deviation between the Speed reference 4 (ASR input) and the Detected speed 2 remains for a certain period.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 5 | N | - | U | E | - | A | L | M | | |

Setting 0: Disabled
1: Enabled

| E46 | Torque detection level 1 |
|---|---|
| E47 | Torque detection level 2 |

◆Provides a detection signal when the torque reference exceeds a specified value. You can specify two levels of detection level, level 1 and level 2. 100% means a torque reference of the continuous rating. The detection signals appear on the DO's to which the [T-DT1] and [T-DT2] are assigned.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 6 | T | D | T | 1 | - | L | V | L | | |
| E | 4 | 7 | T | D | T | 2 | - | L | V | L | | |

Setting range: 0 to 300.0 [%]
Note: The calculated torque value is used for determination in V/f control.

| E48 | Magnetic-flux detection level |
|---|---|

◆Provides a detection signal when the calculated magnetic-flux value exceeds a specified value. The detection signal appears on the DO to which the [M-DT] is assigned.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 8 | M | F | D | T | - | L | V | L | | |

Setting range: 10 to 100 [%]

**E49-E52** **Ai function selection**

◆You can select functions for the analog input Ai1 to Ai4 from the following.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 4 | 9 | A | i | 1 | | F | U | N | C | | |
| E | 5 | 0 | A | i | 2 | | F | U | N | C | | |
| E | 5 | 1 | A | i | 3 | | F | U | N | C | | |
| E | 5 | 2 | A | i | 4 | | F | U | N | C | | |

Set value: 0 to 18

| Set value | Function | Symbol | Scale |
|---|---|---|---|
| 0 | Input signal off | [OFF] | – |
| 1 | Auxiliary speed setting 1 | [AUX-N1] | ±10V/±Nmax |
| 2 | Auxiliary speed setting 2 | [AUX-N2] | ±10V/±Nmax |
| 3 | Torque limiter (level 1) | [TL-REF1] | ±10V/±150 % |
| 4 | Torque limiter (level 2) | [TL-REF2] | ±10V/±150 % |
| 5 | Torque bias reference | [TB-REF] | ±10V/±150 % |
| 6 | Torque reference | [T-REF] | ±10V/±150 % |
| 7 | Torque current reference | [IT-REF] | ±10V/±150 % |
| 8 | Creep speed 1 in UP/DOWN setting | [CRP-N1] | ±10V/±Nmax |
| 9 | Creep speed 2 in UP/DOWN setting | [CRP-N2] | ±10V/±Nmax |
| 10 | Magnetic-flux reference | [MF-REF] | +10V/+100 % |
| 11 | Detected line speed | [LINE-N] | ±10V/±Nmax |
| 12 | Motor temperature | [M-TMP] | +10V/200 °C |
| 13 | Speed override | [N-OR] | ±10V/±50 % |
| 14 | Universal Ai | [U-AI] | ±10V/±4,000 [h] |
| 15 | PID feedback value | [PID-FB] | ±10V/±20,000 [d] |
| 16 | PID reference value | [PID-REF] | ±10V/±20,000 [d] |
| 17 | PID correction gain | [PID-G] | ±10V/±4,000 [h] |
| 18 | Option Ai | [O-AI] | ±10V/±7,FFF [h] |

<Using analog input>

There are 19 types of analog input functions from 0 to 18 available.  You cannot use all of these functions at the same time.  You can use total of four terminals, which are two terminals, [Ai1] and [Ai2], as standard and two terminals, [Ai3] and [Ai4], using optional AIO.  The maximum number you can use is four unless you switch externally.

When you assign the same function to [Ai1] and [Ai2], the input to [Ai2] will become effective.  When you install the AIO option and assign the same function to [Ai1], [Ai2], [Ai3], and [Ai4], the input to [Ai4] will become effective.  Note that you should assign [U-AI] to all the analog input terminals at the same time.

### Setting procedure

- Select a function you want to use. We select the "Torque bias" as an example.
- Assign the "Torque bias" function to one of the available terminals ([Ai1] to [Ai4]). If you want to assign it to [Ai2], write a data, "5:TB-REF", to the function code E50 "Ai2 function selection".
- Apply a voltage of ±10V/±150% to the analog terminal [Ai2] considering the scale conversion of the torque bias in mind. If you need the torque bias of 15%, you should apply +1.0V.
- See the "I/O check" screen of the KEYPAD panel to confirm that +1.0V is applied to [Ai2]. The right figure shows the screen you must view.

**1500**

12 = 0.0 V
Ai1 = 0.2 V
Ai2 = 1.0 V

- You can specify the bias, the gain, the filter and the increment/decrement limiter applied to the analog input.

| Function | Application |
|---|---|
| Bias | Sets the offset. |
| Gain | Use to enlarge a small voltage range or to reduce a large voltage range.<br>Use a minus value to invert the polarity. |
| Filter | Use to eliminate high frequency ripple and noise on the input voltage.<br>Since you apply a low-pass filter, excessive setting may slow down the response. |
| Increment/decrement limiter | Slants a step input voltage. The specified values work as rising and falling times. |

See the description of the individual function codes for more details.

- You can use the DI terminal input to hold the analog input to zero or to invert the polarity of the analog input. See Ai zero hold and Ai polarity change of E01 to E13 "X function selection" for more details.

See also the control block diagram to work with this function effectively.

### Input signal off [OFF]

Select when you want assign no function to an analog input terminal.
Use when you do not use the analog input terminals.

### Auxiliary speed setting 1, 2 [AUX-N1, 2]

Assign a data 1 [AUX-N1] and a data 2 [AUX-N2], to desired analog input terminals to designate them as Auxiliary speed setting 1 and Auxiliary speed setting 2 terminals. See the table below and the control diagram for the points where the control inputs are applied. This function adds a speed (±10V corresponds ±maximum speed) to main speed reference values ( [12] input and the multistep speed reference). Two points are available to add a speed.

| Auxiliary speed setting | Point of application | Restrictions |
|---|---|---|
| 1 [AUX-N1] | After multistep speed command | Disabled when you use "0: KEYPAD panel" and "3, 4, 5: UP/DOWN functions" of the function codes F01 and C25. |
| 2 [AUX-N2] | After acceleration/deceleration calculation (acceleration/deceleration calculation applied to input is disabled) | |

### Torque limiter (level 1, 2) [TL-REF1, 2]

Assign a data 3 [TL-REF1] and a data 2 [TL-REF2] to desired analog input terminals to designate them as Torque limiter (level 1) and Torque limiter (level 2) terminals. See the function codes F40 to 43 for torque limiter.

### Torque bias reference [TB-REF]

Assign a data 5 [TB-REF] to a desired analog input terminal to designate it as Torque bias reference terminal. See the function code F47 to 49 for more details.

### Torque reference [T-REF]

Assign a data 6 [T-REF] to a desired analog input terminal to designate it as Torque reference terminal. See the control block diagram and the function code H41 "Torque reference selection" for more details.

### Torque current reference [IT-REF]

Assign a data 7 [IT-REF] to a desired analog input terminal to designate it as Torque current reference terminal. See the control block diagram and the function code H42 "Torque current reference selection" for more details.

### Creep speed 1 and 2 in UP/DOWN setting [CRP-N1, 2]

Assign a data 8 [CRP-N1] and a data 9 [CRP-N2] to desired analog input terminals to designate them as Creep speed 1 and Creep speed 2 terminals. See the UP/DOWN functions of the function codes E01 to 13 for more details.

### Magnetic-flux reference [MF-REF]

Assign a data 10 [MF-REF] to a desired analog input terminal to designate it as Magnetic-flux reference terminal. See the control block diagram and the function code H44 "Magnetic-flux reference value" for more details.

### Detected line speed [LINE-N]

Assign a data 11 [LINE-N] to a desired analog input terminal to designate it as Detected line speed terminal. See the control block diagram and the function code H53 "Line speed feedback selection" for more details.

### Motor temperature [M-TMP]

Assign a data 12 [M-TMP] to a desired analog input terminal to designate it as Motor temperature terminal. When you use a VG dedicated motor (VG3, VG5, VG7), you can use the NTC thermistor supplied with a motor to detect the motor temperature and to protect the motor from overheat. When you use a motor with a PTC thermistor, you can use it for overheat protection. You can also use an electronic thermal relay for protection against motor overload.

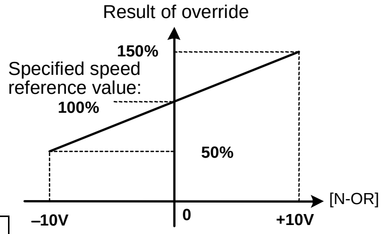
You can use this function to build your own motor overheat protection system detecting the motor temperature directly without using method mentioned above.

You can use the function code E30 "Motor overheat protection" and E31 "Motor overheat early warning" to specify the detection levels.

Speed override [N-OR]

Assign a data 13 [N-OR] to a desired analog input terminal to designate it as Speed override terminal.

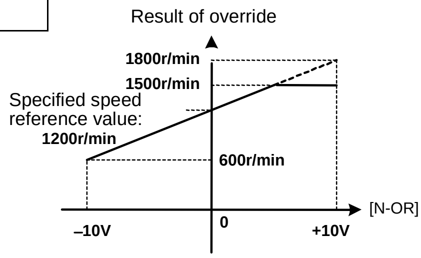
You can supply +10V to override the speed reference with 150% of the reference and supply –10V to override with 50% of the reference. See the control diagram for a point of the control input.




| Speed override | Point of application | Restrictions |
|---|---|---|
| 13 [N-OR] | Just after Auxiliary speed setting 1 | Disabled when you use "0: KEYPAD panel" and "3, 4, 5: UP/DOWN functions" of the function codes F01 and C25.<br>Used for acceleration/deceleration calculation.<br>Restricted by the maximum speed. |

<Application example>

You can specify the coarse/fine adjustment of the speed.
Specified maximum speed value: 1,500r/min
Specified speed reference value: 1,200rmin (100%)
Input voltage applied to the terminal [N-OR]: ±10V

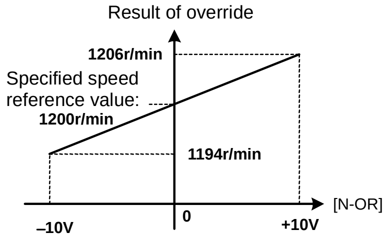



Coarse adjustment

As shown in the right graph, the overridden value is 600r/min for –10V input and is restricted by the maximum speed for +10V input.
Applying voltage enables coarse speed adjustment around the speed reference (1,200r/min).

Fine adjustment

Set the gain of used [Ai] to 0,01 (function code E53 to 56).
As shown in the right graph, the overridden value is 1194r/min for –10V input and is 1206r/min for +10V input.
Applying voltage enables fine speed adjustment around the speed reference (1,200r/min).
Either the reference value of the maximum speed or the precision of the analog input determines the resolution.
In this example, the resolution is determined by the former one: 0.08r/min.



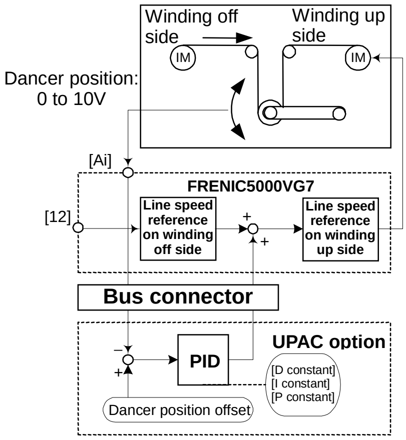

The larger value between the following values determines the resolution.
Reference value of the maximum speed: 1,500r/min÷internal data 20,000=0.075r/min≈0.08r/min
Precision of the analog input: Unipolar scale (6r/min) is divided into 15 bit. Thus, 6r/min÷32767 (15bit)×100 (scaling)=0.018r/min

Universal Ai [U-AI]

Assign a data 14 [U-AI] to a desired analog input terminal to designate it as Universal Ai terminal. You can use this function to check the existence of the input signal through communication and this function does not affect the inverter operation.

You can use this signal to the following applications.

1) You can read out input signal as an analog data through RS485 or optional field bus.
2) You can use Ai for an input to a software you create with the UPAC option or the PLC without affecting the inverter operation.




<Application example>

The right figure shows a diagram of a winding control utilizing dancer control.

The UPAC option uses PID control for dancer position control. The line speed reference generated by adding the PID output to the line speed reference for the winding off side received from [12] is supplied to the winding up side.

You can use an [Ai] terminal to read the dancer position detected by a potentiometer.

If you assign Universal Ai [U-AI] to the AI input, the output of the potentiometer is directly available to the UPAC. See the description of the UPAC for more details on the UPAC.

You can also use [U-AI] to control in the same manner if you replace the UPAC option and the bus connector with the PLC and the communication line.

PID feedback value [PID-FB]

PID reference value [PID-REF]

PID correction value [PID-G]

Assign a data 15 [PID-FB], a data 16 [PID-REF] and a data 17 [PID-G] to desired analog input terminals to designate them as PID feedback value , PID reference value, and PID correction value terminals, respectively.

These terminals can be used as input terminals for feedback signals, reference signals and correction signals in the process under PID control.

See the function codes H19 to H26 for more details on the PID functions.

Option Ai [O-AI]

Reserved for options and special applications

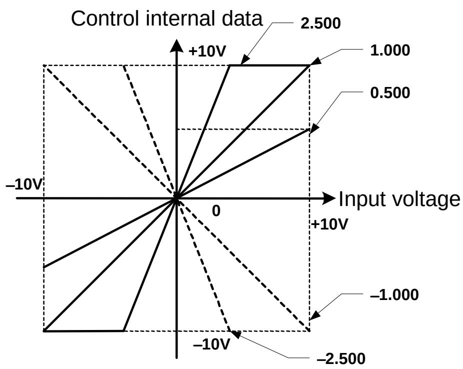
## E53-E56 Ai gain setting

◆You can specify a times applied to the analog input (Ai1 to 4 terminals)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 5 | 3 | G | A | I | N | | A | i | 1 | | |
| E | 5 | 4 | G | A | I | N | | A | i | 2 | | |
| E | 5 | 5 | G | A | I | N | | A | i | 3 | | |
| E | 5 | 6 | G | A | I | N | | A | i | 4 | | |

Setting range: –10.000 to 10.000 [times]

Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.



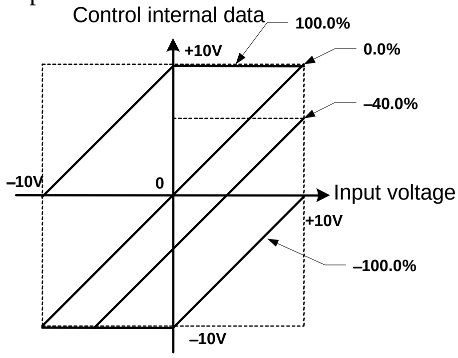
## E57-E60 Ai bias setting

◆Sets a bias to the analog input [Ai1-4]. A value of 100% corresponds to a doubled offset value.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 5 | 7 | B | I | A | S | | A | i | 1 | | |
| E | 5 | 8 | B | I | A | S | | A | i | 2 | | |
| E | 5 | 9 | B | I | A | S | | A | i | 3 | | |
| E | 6 | 0 | B | I | A | S | | A | i | 4 | | |

Setting range: –100.0 to 100.0 [%]

Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.




## E61-E64 Ai filter setting

◆You can specify whether to apply a filter to the analog input [Ai1 to 4] terminals, and you can also specify a time constant of the filter individually. The filter used here is a low-pass filter. The time constant means the time until the filter output data reaches 63% of the input data.

Since a large filter time constant decreases the response, consider the response of a mechanical system to determine the time constant. If the input voltage fluctuates due to noise, first try hardware measures, and then use this filter after you failed.

Use the function code (E65 to E68) to increase or decrease a reference value gradually.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 6 | 1 | F | I | L | T | E | R | | A | i | 1 |
| E | 6 | 2 | F | I | L | T | E | R | | A | i | 2 |
| E | 6 | 3 | F | I | L | T | E | R | | A | i | 3 |
| E | 6 | 4 | F | I | L | T | E | R | | A | i | 4 |

Setting range: 0.000 to 0.500 [s]

Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.

## E65-E68 Increment/decrement limiter (Ai)

◆Specifies a time to increase a data inside the inverter from 0V to 10V when you change the input from 0 to 10V applied to the analog input [Ai1 to 4] terminals.

<Application example>

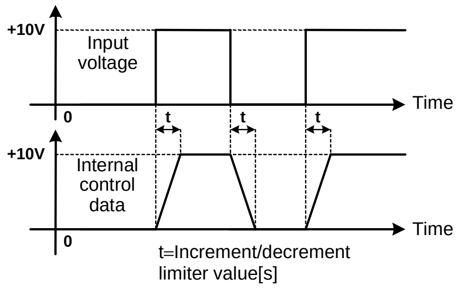
When you use the analog torque reference or the analog torque bias, you may not use a reference that changes stepwise. A step-wise torque reference may tear a paper in a paper rolling machine or present an elastic vibration (damping) when a subject matter has a large elastic modulus.

To avoid this phenomenon, though you should change the reference with an external volume, you can use this Increment/decrement limiter to specify the automatic increase and decrease of an analog reference value.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 6 | 5 | A | / | D | - | L | - | A | i | 1 | |
| E | 6 | 6 | A | / | D | - | L | - | A | i | 2 | |
| E | 6 | 7 | A | / | D | - | L | - | A | i | 3 | |
| E | 6 | 8 | A | / | D | - | L | - | A | i | 4 | |

Setting range: 0.00 to 60.00 [s]

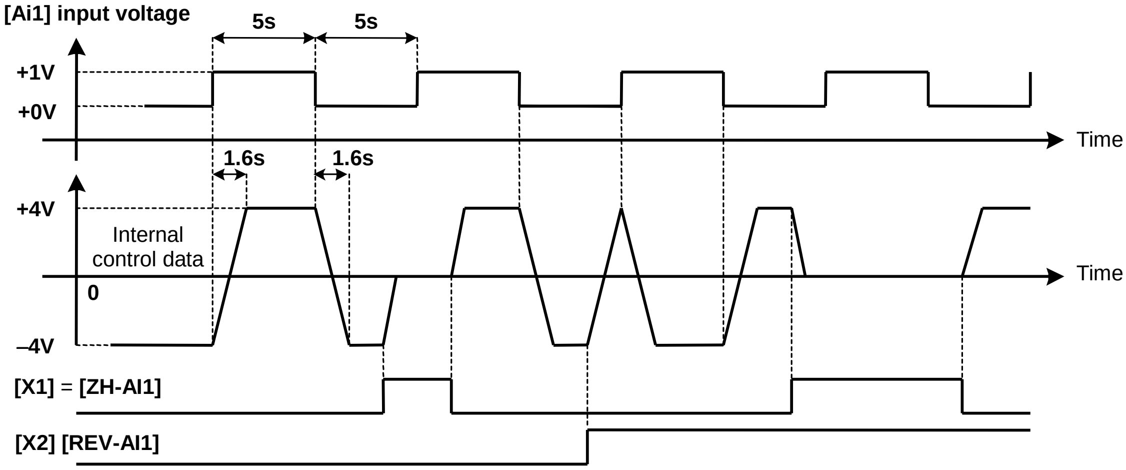
Note: [Ai3, 4] are available only when you install OPC-VG7-AIO.



Appendix

This section shows an example specifying the bias, the gain, and the increment/decrement limiter of [Ai1] and assigning "Ai1 zero hold" to [X1] function and "Ai1 polarity change" to [X2] function. See also the control block diagram for better understanding. The filter function is not included in this example, since you can use this function to eliminate noise, but should not use actively.

| Function code | Set value |
|---|---|
| E01: X1 function selection | 40: Ai1 zero hold [ZH-AI1] |
| E02: X2 function selection | 44: Ai1 polarity change [REV-AI1] |
| E53: Ai1 gain setting | 8.000 [magnification] |
| E57: Ai1 bias setting | –50.0 [%] |
| E65: Increment/decrement limiter (Ai1) | 2.00s |




- The increment/decrement limiter set the time for the change of an internal control data by 8V (–4V↔4V) to 2.0s×8/10=1.6s. Note that the increment/decrement limiter is applied not to the change of the input voltage from 0 to 1V, but to the change of the internal data scaled by the gain.
- The change of the internal control data to 0V follows the increment/decrement limiter when the zero hold signal [ZH-AI1]is applied.
- The change of the polarity of the internal control data follows the increment/decrement limiter when the polarity change signal [REV-AI1] is applied.

## E69-E73 AO function selection

◆You can select signals applied to the analog output and signals for adjusting AO.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 6 | 9 | A | O | 1 | | F | U | N | C | | |
| E | 7 | 0 | A | O | 2 | | F | U | N | C | | |
| E | 7 | 1 | A | O | 3 | | F | U | N | C | | |
| E | 7 | 2 | A | O | 4 | | F | U | N | C | | |
| E | 7 | 3 | A | O | 5 | | F | U | N | C | | |

Setting range: 0 to 15, 30, 31
16 to 29 are reserved. Do not use them.

| Set value | Function | Symbol | Scale |
|---|---|---|---|
| 0 | Detected speed 1<br>(Speedometer, one-way deflection) | [N-FB1+] | +Nmax/10V |
| 1 | Detected Speed 1<br>(Speedometer, two-way deflection) | [N-FB1±] | ±Nmax/±10V |
| 2 | Speed setting 2<br>(Before acceleration/deceleration calculation) | [N-REF2] | ±Nmax/±10V |
| 3 | Speed setting 4 (ASR input) | [N-REF4] | ±Nmax/±10V |
| 4 | Detected speed 2 (ASR input) | [N-FB2±] | ±Nmax/±10V |
| 5 | Detected line speed | [LINE-N±] | ±Nmax/±10V |
| 6 | Torque current reference<br>(Torque ammeter, two-way deflection) | [IT-REF±] | ±150%/±10V |
| 7 | Torque current reference<br>(Torque ammeter, one-way deflection) | [IT-REF+] | +150%/10V |
| 8 | Torque reference<br>(Torque meter, two-way deflection) | [T-REF±] | ±150%/±10V |
| 9 | Torque reference<br>(Torque meter, one-way deflection) | [T-REF+] | +150%/10V |
| 10 | Motor current rms value | [I-AC] | 200%/10V |
| 11 | Motor voltage rms value | [V-AC] | 200%/10V |
| 12 | Input power | [PWR] | 200%/10V |
| 13 | DC link circuit voltage | [V-DC] | 800V/10V |
| 14 | +10V output test | [P10] | Output equivalent to +10V |
| 15 | –10V output test | [N10] | Output equivalent to –10V |
| 30 | Universal AO | [U-AO] | ±4000H/±10V |
| 31 | Option AO | [O-AO] | ±4000H/±10V |

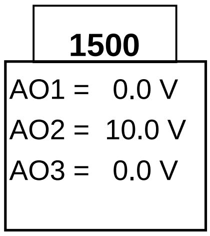
Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

<Using analog output>

There are 16 types of analog output functions from 0 to 15 available. You cannot use all of these functions at the same time. You can use total of five terminals, which are three terminals, [AO1], [AO2] and [AO3], as standard and two terminals, [AO4] and [AO5] using optional AIO.

Setting procedure

- Check a device such as a meter including wires. Set data to 14 to check 10V output.
- Select a function you want to use. We select the "Detected Speed 1 (Speedometer, two-way deflection)" as an example.
- Assign the "Detected Speed 1 (Speedometer, two-way deflection)" function to one of the available terminals ([AO1] to [AO5]). If you want to assign it to [AO2], write a data, "1:N-FB1±", to the function code E70 "AO2 function selection".
- See the "I/O check" screen of the KEYPAD panel to confirm that [AO2] supplies +10.0V during operating a motor. The right figure shows the screen you must view.
- Connect a speedometer to the analog terminal [AO2].



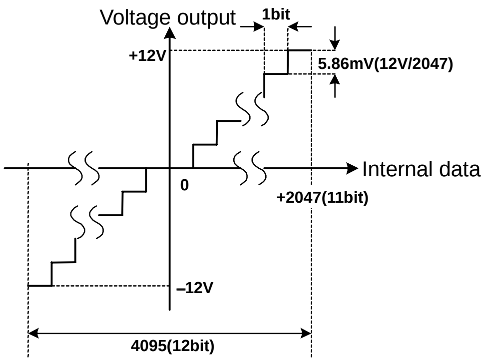

- You can specify the bias, the gain, and the filter applied to the analog output.

| Function | Application |
|---|---|
| Bias | Sets the offset. |
| Gain | Use to enlarge a small voltage range or to reduce a large voltage range.<br>Use a minus value to invert the polarity. |
| Filter | You do not need to change the factory set data 0.010s (10ms).<br>This filter does work for the noise affecting a device (such as a meter) and wires between the device and [AO] terminal.<br>Take necessary measures against noise outside of the inverter. |

See the description of the individual function codes for more details.
See also the control block diagram to work with this function effectively.

Output resolution

The AO converts a 12-bit digital data into an analog data for output. 11 bits (2047) are assigned to +12V, thus the output resolution is 5.86mV. Note that a binary data corresponding to 10V is 1705 (2047×10/12).
When you use about +10V to supply a speed reference corresponding to the maximum speed of 1500r/min, the resolution is 1500/1700=0.88r/min.




Output cycle

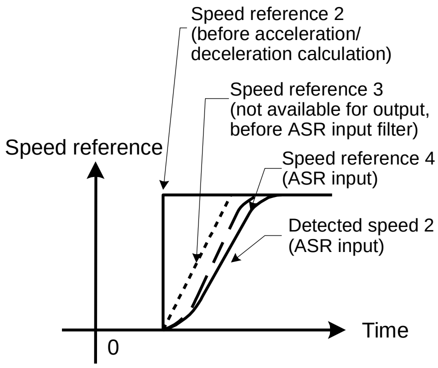
Output is supplied with a sampling cycle of 500µs.

Detected speed 1 (Speedometer, one-way deflection) [N-FB1+]
Detected speed 1 (Speedometer, two-way deflection) [N-FB1±]

Assign a data 0 [N-FB1+] and 1 [N-FB1±] to desired analog output terminals to designate them as speedometer functions.
Use [N-FB1+] for a unipolar meter and use [N-FB1±] for a bipolar meter. This function detects encoded motor speed and supplies a data after the speed detection calculation or the speed estimation calculation.

### Speed setting 2 (Before acceleration/deceleration calculation) [N-REF2]
### Speed setting 4 (ASR input) [N-REF4]
### Detected speed 2 (ASR input) [N-FB2±]

Assign a data 2 [N-REF2], 3 [N-REF4] and 4 [N-FB1+] to desired analog output terminals to output the speed reference and detected speed of each of them. You can use these functions to measure and observe the follow-up and the deviation of the Detected speed 2 (ASR input) against individual speed references externally. Note that the Speed agreement (the comparison between [N-REF2] and [N-FB2±] ) and the Speed equivalent ( [N-REF4] and [N-FB2±] ) of the inverter DO output use these data for output.
The speed reference 3 in the right graph is not available for an AO output.




### Detected line speed [LINE-N±]

Assign a data 5 [LINE-N±] to a desired analog output terminal to designate it as line speed detection. The highest data among the analog line speed [LINE-N], the digital line speed, detected speed by PG (LD) and a data from integrated speed detection/estimation is provided to output.

### Torque current reference (Torque ammeter, two-way deflection) [IT-REF±]
### Torque current reference (Torque ammeter, one-way deflection) [IT-REF+]

Assign a data 6 [IT-REF±] and 7 [IT-REF+] to desired analog output terminals to designate them as torque ammeters.
Use [IT-REF+] for a unipolar meter and use [IT-REF±] for a bipolar meter. You can use the function code F51 "Torque reference monitor (Polarity selection)" to select the output polarity.

### Torque reference (Torque meter, two-way deflection) [T-REF±]
### Torque reference (Torque meter, one-way deflection) [T-REF+]

Assign a data 8 [T-REF±] and 9 [T-REF+] to desired analog output terminals to designate them as torque meters.
Use [T-REF+] for a unipolar meter and use [T-REF±] for a bipolar meter. You can use the function code F51 "Torque reference monitor (Polarity selection)" to select the output polarity.

### Torque meter and torque ammeter

A torque meter and a torque ammeter behave differently in constant output range over the rated speed (100%).
You can use the torque ammeter as a load meter (equivalent to load current).
You can use the torque meter as an output equivalent to actual torque reflecting torque decrement.
Though both of them provide the reference values, you can use them as real torque and torque current since the VG7 controls the current.

### Motor current rms value [I-AC]
### Motor voltage rms value [V-AC]

Provide effective values of the output current and voltage supplied to the motor.

### Input power [PWR]
### DC link circuit voltage [V-DC]

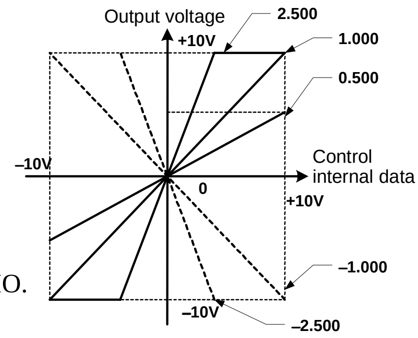
See the control block diagram (4.2.8).

| E74-E78 | AO gain setting |
|---|---|

◆Sets the gain of the analog output A01 to AO5.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 7 | 4 | G | A | I | N | | A | O | 1 | | |
| E | 7 | 5 | G | A | I | N | | A | O | 2 | | |
| E | 7 | 6 | G | A | I | N | | A | O | 3 | | |
| E | 7 | 7 | G | A | I | N | | A | O | 4 | | |
| E | 7 | 8 | G | A | I | N | | A | O | 5 | | |

Setting range: –100.00 to 100.00 [times]
Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

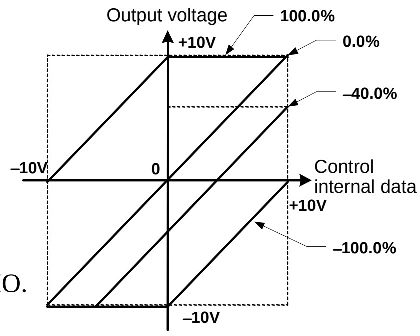



| E79-E83 | AO bias setting |
|---|---|

◆Sets the bias of the analog output A01 to AO6.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E | 7 | 9 | B | I | A | S | | A | O | 1 | | |
| E | 8 | 0 | B | I | A | S | | A | O | 2 | | |
| E | 8 | 1 | B | I | A | S | | A | O | 3 | | |
| E | 8 | 2 | B | I | A | S | | A | O | 4 | | |
| E | 8 | 3 | B | I | A | S | | A | O | 5 | | |

Setting range: –100.00 to 100.00 [%]
Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

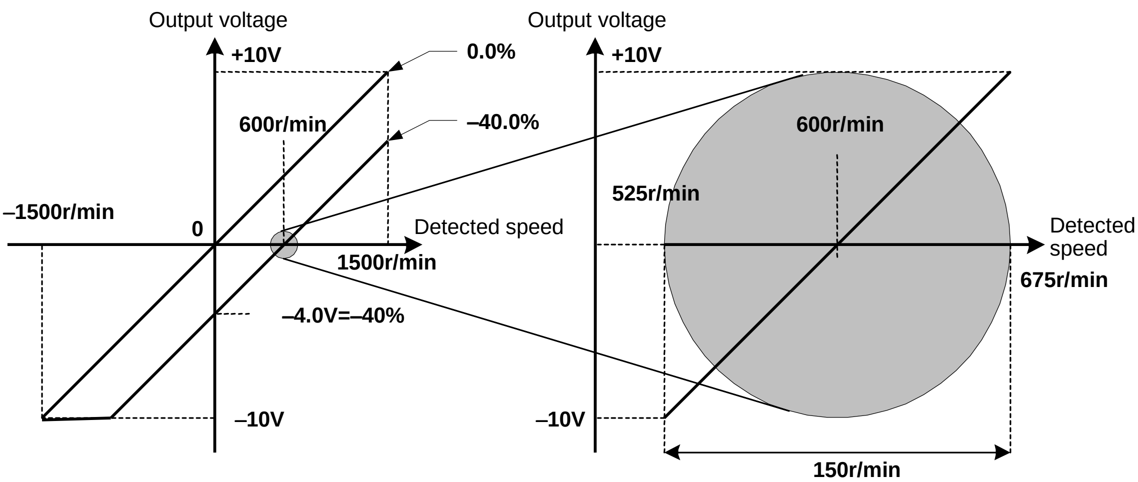



<Application example>

This is an example to use the AO gain and the AO bias functions to magnify the data of the Detected speed 1 around 600r/min to provide full-scale output (in the range from -10 to 0 to 10V). If we use [AO3] as an output analog terminal, the following setting is necessary.

| Function code | Set value |
|---|---|
| E71: AO3 function selection | 1: [N-FB1±] |
| E76: AO3 gain setting | 20.0 [magnification] |
| E81: AO3 bias setting | –40.0 [%] |

When we set the bias to shift 0.0% to –40.0%, 0r/min provides –4.0V (–40.0%) output. Therefore 0V corresponds to 600r/min. Then, when we set the gain to 20.0, 1500r/min/10V becomes 75r/min/10V. As a result, –10V output indicates 600–75r/min and +10V output indicates 600+75r/min.



**E84** **AO1-5 filter setting**

◆Sets the time constant of the output filters for the analog output AO1 to AO5 simultaneously.

| E | 8 | 4 | F | I | L | T | | A | O | 1 | - | 5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.000 to 0.500 [s]

Note: [AO4, 5] are available only when you install OPC-VG7-AIO.

## 4.3.3 C Codes (Control Functions of Frequency)

| | |
|---|---|
| **C01** | **Jump speed 1** |
| **C02** | **Jump speed 2** |
| **C03** | **Jump speed 3** |
| **C04** | **Jump hysteresis** |

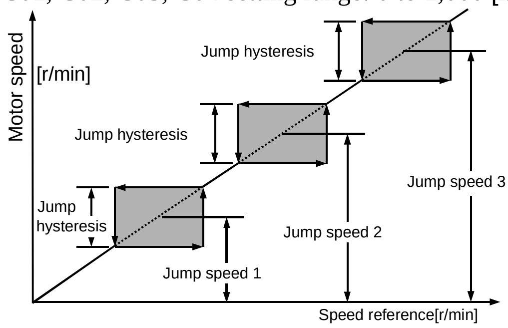
◆Jumps the speed reference to avoid mechanical resonance points of a load.  You can set three jump points.

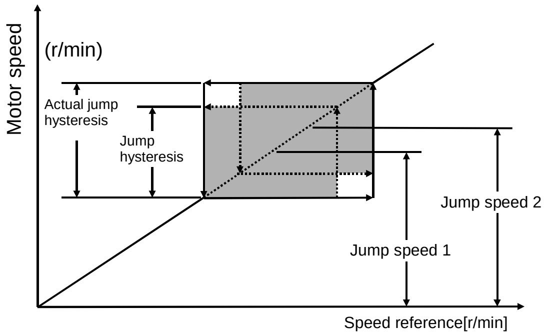
◆When you set the Jump speed 1 to 3 to 0r/min, this function is disabled. The speed reference does not jump during acceleration/deceleration.

◆When specified ranges of jump speed overlap one another, the sum of them is considered as a jump range.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 0 | 1 | J | U | M | P | | N | 1 | | | |
| C | 0 | 2 | J | U | M | P | | N | 2 | | | |
| C | 0 | 3 | J | U | M | P | | N | 3 | | | |
| C | 0 | 4 | J | U | M | P | | H | Y | S | T | R |

C01, C02, C03, C04 setting range: 0 to 1,000 [r/min] setting range: 0 to 24,000 [r/min]

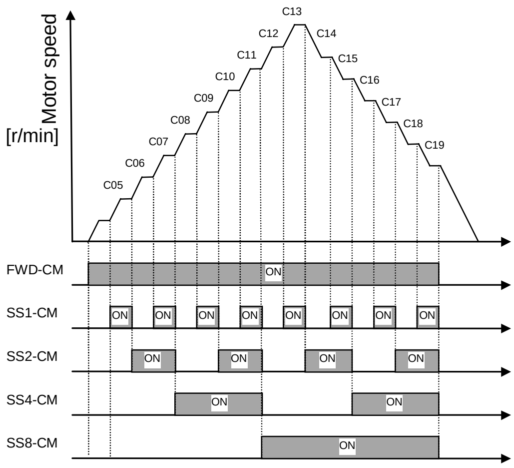



| | |
|---|---|
| **C05-C17** | **Multistep speed 1-13** |

◆You can set ON or OFF to the terminal function [SS1], [SS2], [SS4], and [SS8] to switch among Multistep speed 1 to 15 (refer to E01 to E13 "X function selection" for setting the terminal function).

◆When a terminal among [SS1], [SS2], [SS4], and [SS8] is not defined, the terminal considered to be OFF.  You can select 1r/min or 0.01% for a unit of a setting range according to the setting of C21 "Multistep setting definition".  When you choose 0.01% for a unit, 100% is the maximum speed defined by the function code (F03, A06, or A40).




| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 0 | 5 | M | U | L | T | I | | N | - | 1 | |

to

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1 | 7 | M | U | L | T | I | | N | - | 1 | 3 |

Setting range: 0 to 24,000 [r/min], 0.00 to 100.00 [%] or 0.0 to 999.9 [m/min]

## C18 Multistep speed 14/Creep speed 1

## C19 Multistep speed 15/Creep speed 2

◆C18 and C19 also work as a creep speed function when you use the UP/DOWN function. See E01 to E09 "X function selection" for more details.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1 | 8 | N | - | 1 | 4 | / | C | R | E | P | 1 |
| C | 1 | 9 | N | - | 1 | 5 | / | C | R | E | P | 2 |

Setting range: 0 to 24,000 [r/min], 0.00 to 100.00 [%] or 0.0 to 999.9 [m/min]

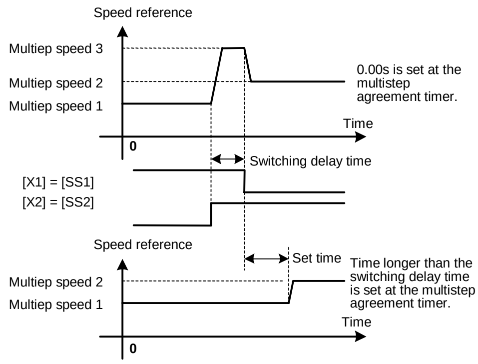
## C20 Multistep speed reference agreement timer

◆When the terminal function [SS1], [SS2], [SS4], and [SS8]do not change simultaneously, a speed reference out of the specification may be specified. When you use the Multistep speed reference agreement timer, the speed reference changes after [SS1], [SS2], [SS4], and [SS8] maintain the same state for a time specified by the Multistep speed reference agreement timer.
Use this timer to use two or more terminals simultaneously among [SS1], [SS2], [SS4], and [SS8] to switch the speed. If you switch only one terminal, leave the setting to 0.000s.

<Application example>

This section shows an example to use terminals [SS1] and [SS2] to switch the multistep speed. When you want to change from the Multistep speed 1 to the Multistep speed 2, you should switch two terminals simultaneously.

- When you set the timer to 0.00s, the difference in switching timing of [SS1] and [SS2] activates the Multistep speed 3 for the delayed period and presents a operation pattern out of the specification as shown in the upper right graph.
- When you set the time of this function code to a period longer than the switching time, the switching to Multistep speed 2 occurs just when a specified time passes after [SS1] is set to OFF. You can avoid the Multistep speed 3 to be selected.




<Point>

The cycle sampling the terminal signals is about 500μs (0.5ms) in the VG7. You do not have to set this function if your switching period is shorter than the sampling cycle.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 2 | 0 | M | L | T | | N | | T | I | M | E |

Setting range: 0.000 to 0.100 [s]

## C21 Multistep setting definition

◆Sets the unit to specify the multistep speed.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 2 | 1 | M | L | T | | U | N | I | T | | |

Set value: 0: 0 to 24,000 [r/min]
1: 0.00 to 100.00 [%]
2: 0.0 to 999.9 [m/min]

Defines setting methods of C05 to C19.
With selection of "1", the setting range applies to the max speeds (F03, A06, A40) of selected motor .
Refer to F79 for motor selection.

## C25 Speed setting N2

◆Sets a method to specify the speed reference. When the X terminal function [N2/N1] is set to ON, the speed specified this function will be effective. See the description of F01 "Speed setting N1" for setting method you can select.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 2 | 5 | S | P | D | | C | M | D | | 2 | |

## C29 Jogging speed

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 2 | 9 | J | O | G | | N | | | | | |

Setting range: 0 to 24,000 [r/min]

◆Sets a speed for inching a motor in addition to the normal operation. You can use this function for positioning a work, for example.

◆You can choose the following two ways for the jogging operation.

- Turn on the X control terminal [JOG] to change to the jogging mode and set the operation command [FWD] or [REV] to ON.
- Set the ∧ and STOP keys on the KEYPAD panel to ON simultaneously to switch to the jogging mode and set the operation command [FWD] or [REV] to ON.

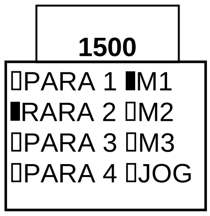
## C30-C69 ASR, S-curve acceleration/ deceleration 2, 3, and 4, and JOG function groups

The function code group C30 to C38 becomes effective in the JOG mode.
The terminal input signal [RT1] and [RT2] set the function code group C39 to C69 to either enabled or disabled
See E01 to E13 "X function selection" and the control block diagram for the details of switching.

Acceleration/deceleration time: See the description of the function code F07 and F08.

S-curve setting : See the description of the function codes F67 to F70. Note that you can set only the two points, the start and end sides, for the S-curve acceleration/deceleration 2,3, and 4 and the JOG.

ASR setting : See the description of the function codes F61 to F65. Note that you cannot set the F/F gain to the ASR-JOG.

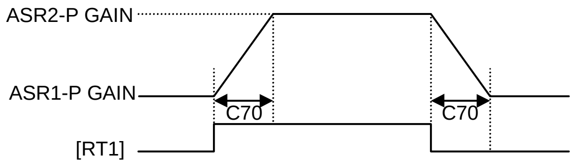



You can view the setting on the "I/O check" screen of the KEYPAD panel.
The right figure shows that the ASR2 and the S-curve deceleration (PARA 2) are selected.

## C70 ASR switching time

◆This function specifies the duration of the switching, when you use the X control terminals [RT1] and [RT2] to switch the ASRs. This function change the P (gain) gradually in a specified time to reduce the mechanical shocks during the switching.

◆The right figure shows an example to set the [RT1] to OFF, ON, then to ON to switch the gain between the ASR1 and ASR2.




| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 7 | 0 | A | S | R | | C | H | | t | | |

Setting range: 0.00 to 2.55 [s]

## C71 Acceleration/ deceleration time switching speed

## C72 ASR switching time

See the description of the L code for more details.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 7 | 1 | A | C | C | / | D | E | C | | C | H |
| C | 7 | 2 | A | S | R | | C | H | | S | P | D |

Setting range: 0.00 to 100.00 [s]

◆100.00% corresponds to the maximum speeds specified by the function codes (F03, A06 and A40).

| C73 | Creep speed switching (on UP/DOWN control) |
|---|---|

◆Specifies whether to use a function or an analog input to set the creep speeds used in the UP/DOWN setting mode.

| C | 7 | 3 | C | R | P | | S | W | I | T | C | H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 00 to 11

Description: □ □

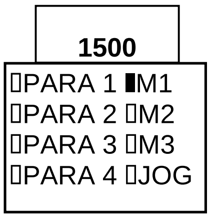
First digit: Creep speed 1 (0: function code C18, 1: analog input [CRP-N1] )

Second digit: Creep speed 2 (0: function code C19, 1: analog input [CRP-N2] )

See the description of the UP/DOWN in the E01 to E13 "X function selection".

## 4.3.4 P Codes (Motor Parameters)

The P codes are motor parameters that become available when you select the M1 (first motor). See the A codes (second and third motors) when you use the M2 or M3.
You can use the function code F79 and the terminal input signal [M-CH2] and [M-CH3] to select the M1, the M2, or the M3.
See the individual descriptions and make sure that the M1 is selected. You can use the "I/O check" screen of the KEYPAD panel as shown in the right figure.
■ indicates a selection. Check if ■M1 is indicated.
F03 to 05 and F10 to 12 are available in addition to the P codes when you select the M1.




**P01** **M1 control method**

◆You can select a control method to drive the motor 1 from vector control for an induction motor with PG, vector control without PG (sensorless control), and vector control for a synchronous motor with PG. See also the description of the function code P02 for the setting.

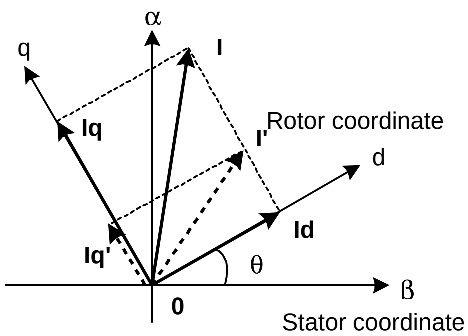
| P | 0 | 1 | M | 1 | - | C | T | L | - | M | T | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Vector control
1: Sensorless vector control
2: Simulated operation mode
3: Vector control (synchronous motors)

◆About vector control

The right figure shows a rotating coordinate (d-q axes) of a rotor on a coordinate (α-β axes) generated by two-phase conversion from a stator coordinate (U, V, W). θ shows the rotation position and indicates the position of the magnetic-flux (d axis=direction of magnetic flux) observed on the fixed coordinate (α-β axes).

The alternating current (I) flowing through the stator generates a rotating magnetic field. The rotor coordinate (d-q axes) rotates at the frequency of this alternating current. If you observe the current (I) from the rotor coordinate (d-q axes), the current (I) seems stationary. Thus, the alternating current (I) can be considered direct current value on the rotor coordinate (d-q axes). You can decompose the current into the d axis element and the q axis element (I→Iq+Id). The d axis current (Id) is defined as magnetic-flux current (exciting current) denoting a current required to generate a magnetic-flux. The q axis current (Iq) is defined as torque current (load current).




When a load changes to require Iq' (indicated by a dotted arrow in the figure) as the torque current, you should control the current by directing I' (indicated by a dotted arrow in the figure) as a current reference while maintaining the magnetic-flux current (Id). The control that maintains the magnetic-flux (Id=constant) and changes the torque current (Iq) according to the load is referred as **vector control**. Since this control is similar to the control for the direct current motor where the magnetic-flux is maintained constant by the magnet and the rotor current is controlled according to the load, you can use the same control for a alternating current motor as for a direct current motor.

◆About sensorless control

This control utilizes vector control (similar to DC motor control) for a motor without a pulse generator. This control enables torque control, which is not available in V/f control. Use this control when you use existing general-purpose motors or motors to which you cannot install a PG.
Note that the control capability (such as speed control range, speed control response, and speed control accuracy) differs from that of control utilizing PG described in Chapter 2 "Specifications" when you select the control. If you need this capability, select vector control with PG for a motor with a PG.
Tune the motor parameter to control properly. Use the function code H01 to conduct tuning (set value 3 and 4).

<Control mechanism>

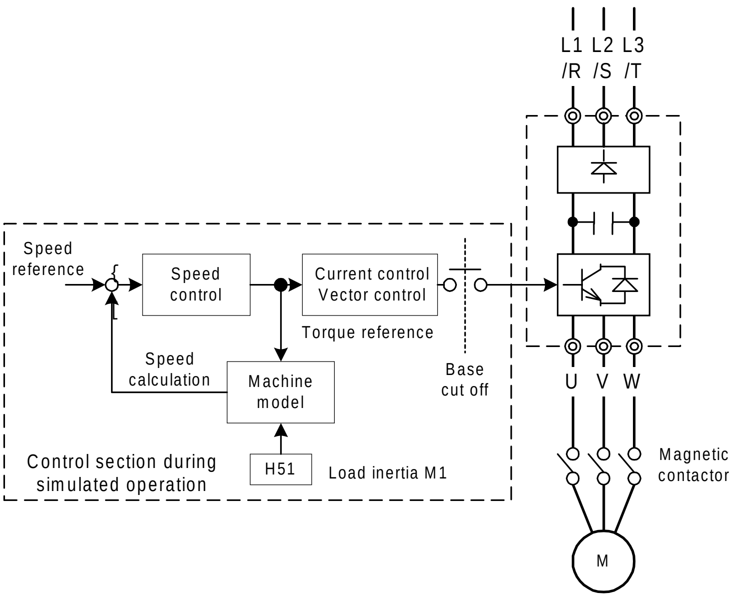
Sensorless control calculates the motor speed and the magnetic pole position. This control detects the output voltage and the output current and uses the motor parameters (R1, Lσ) identified through tuning to calculate the induced voltage. The magnetic flux position is determined since the Ed element obtained by decomposing this induced voltage into the d axis direction is 0. Since the Eq element on the q axis direction corresponds to the induced motor voltage and is proportional to the motor speed, you can obtain the motor speed. This control has the following restrictions compared with vector control with PG.

- Speed control range is limited at low speed due to the inferior accuracy of the induced motor voltage compared with that at high speed.
- Speed control response is low due to the slow convergence of the internal calculation.
- Speed control accuracy is inferior due to the accuracy of the speed calculation based on the induced voltage.

◆About simulated operation

You can select the setting "2" "Simulated operation mode" to operate the inverter internally without connecting a motor in a state similar to the real operation. Use the simulated operation to check your system such as I/O or to test after installation.

When you give a torque reference to a machine model (load inertia: H51), the machine model accelerates to a certain speed. Since speed control is a type of feedback control, the machine model rotates to follow the speed reference in the end. You can use the LED and the LCD monitor on the KEYPAD panel and the monitor code (M code) to monitor this operation. Note that since the inverter does not detect the current and the voltage, the "Detected output current" and the "Detected output voltage" display "0". The individual function codes and the protective function are available as long as they are not restricted. Since the simulated operation cuts off the bases (cuts of the inverter output), the secondary side (U, V, W) does not present voltage. However, disconnect the secondary side or use a magnetic contactor to cut off the secondary side for your safety.



**P02** **M1 motor selection**

◆You need different procedure to use a standard motor for VG7S and VG5 (setting: 0.75-2 to 220-4) (Note 1) or another motor (setting: OTHER)

◆When you use a standard motor for VG7S or VG5, select a combination of "capacity (kW)-voltage (2 or 4)" from the setting list ranging "0.75-2" to "220-4", and optimal values for the standard motor are written into F04, F05, and P03 to P27 automatically.  You do not need to change F04, F05, and P03 to P27 and they are write-protected.

◆Select "OTHER" when you use a motor (FUJI's motor, standard motor for VG3 or VG, or others) other than standard motors for VG7S and VG5.

◆Specifies the function codes in the table below following the items from top to bottom according to the motor to be used.  They are valid only for vector control and sensorless control of an induction motor.  When you use a synchronous motor, contact FUJI.

| P | 0 | 2 | M | 1 | - | S | E | L | E | C | T | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

<table>
<tr><th rowspan="2">Function code for motor 1</th><th colspan="3">FUJI motors</th><th rowspan="2">Other motors</th></tr>
<tr><th>Standard motors for VG7S or VG5</th><th>Standard motors for VG3 and VG</th><th>FUJI motors</th></tr>
<tr><td>P01 M1 control method</td><td colspan="2">0: Vector control</td><td colspan="2">Select depending on with or without PG<br>With PG : 0, vector control<br>Without PG: 1, sensorless control</td></tr>
<tr><td>P02 M1 motor selection</td><td>Select form "0.75-2" to "220-4"</td><td colspan="3">Select "OTHER"</td></tr>
<tr><td>F04 M1 rated speed</td><td rowspan="17">P02 automatically sets:<br>- Motor ratings nameplate values, and<br>- Optimal motor constants.<br><br>These data remain after you turn off.<br><br>You cannot change the data set automatically (write-protected).<br><br>Do not use H01 "Tuning operation selection".</td><td rowspan="17">Set the data described in the Chapter 14 "Replacement data" manually.<br><br>Do not use H01 "Tuning operation selection".</td><td colspan="2" rowspan="5">Set the ratings nameplate data provided on the motor manually.</td></tr>
<tr><td>F05 M1 rated voltage</td></tr>
<tr><td>P03 M1 rated capacity</td></tr>
<tr><td>P04 M1 rated current</td></tr>
<tr><td>P05 M1 pole number</td></tr>
<tr><td>P06 M1-%R1</td><td colspan="2" rowspan="5">Use H01 "Tuning operation selection" to tune motor parameters.<br>See the function description of H01 for more details.</td></tr>
<tr><td>P07 M1-%X</td></tr>
<tr><td>P08 M1 exciting current</td></tr>
<tr><td>P09 M1 torque current</td></tr>
<tr><td>P10,11 M1 slip on driving, braking</td></tr>
<tr><td>P12-14 M1 iron loss coefficient 1-3</td><td colspan="2">Preserve the initial value.  Not available for tuning.</td></tr>
<tr><td>P15-19 M1 magnetic saturation coefficient 1-5</td><td colspan="2" rowspan="5"></td></tr>
<tr><td>P20 M1 secondary time constant</td></tr>
<tr><td>P21 M1 induced voltage coefficient</td></tr>
<tr><td>P22-24 M1-R2 correction coefficient 1-3</td></tr>
<tr><td>P25 M1 exciting current correction coefficient</td></tr>
<tr><td>P26, 27 M1-ACR-P, I (Gain, Constant of integration)</td><td colspan="2">Preserve the initial value.</td></tr>
<tr><td>P28 M1-PG pulse number</td><td colspan="4">Select PG pulse number.<br>Not effective during sensorless control.</td></tr>
<tr><td>P30 M1 thermistor selection</td><td colspan="2">1: NTC thermistor</td><td colspan="2" rowspan="2">See F10 for details on motor protection.</td></tr>
<tr><td>F10 M1 electronic thermal overload relay (Select)</td><td colspan="2">0: Disabled (VG standard motor)</td></tr>
<tr><td>H01 Tuning operation selection</td><td colspan="2">Motor parameters tuning not required.<br>Procedure above sets optimal data automatically.<br>Select "2" for tuning operation when output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.</td><td colspan="2">Motor parameters turning required.<br>Tune while wires are installed.<br>See function description of function code H01.</td></tr>
<tr><td>H02 All save function</td><td colspan="4">Execute "all save" operation after using H01 to tune.  This operation writes tuned data to non-volatile memory.  Not necessary when you did not tune parameters.</td></tr>
<tr><td>P02 M1 motor selection</td><td>-</td><td colspan="3">Setting to "36:P-OTR" protects function code F04, F05, and P03 to P27 from writing.  Set last if necessary.</td></tr>
</table>

Note 1: VG7S standard motors are the same as the VG5 standard motors in shape and electrical constants (motor parameters).

| P03 | M1 rated capacity |
|---|---|

◆Sets the rated capacity value of the motor 1. Enter the value described on the ratings nameplate. Set a capacity corresponding to a single winding for a multiwinding motor.

| P | 0 | 3 | M | 1 | - | C | A | P | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range F60=0: 0.00 to 500.00 [kW]
F60=1: 0.00 to 600.00 [HP]

| P04 | M1 rated current |
|---|---|

◆Sets the rated current value of the motor 1. Enter the value described on the ratings nameplate.

| P | 0 | 4 | M | 1 | - | I | r | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]

| P05 | M1 pole number |
|---|---|

◆Sets the number of poles of the motor 1. Enter the value described on the ratings nameplate.

| P | 0 | 5 | M | 1 | - | P | O | L | E | S | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 2 to 20 [pole]

| P06 | M1-%R1 |
|---|---|

| P | 0 | 6 | M | 1 | - | % | R | 1 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.00 to 30.00 [%]

$$\%R1 = \left( \frac{(R1[\Omega] + \text{Cable resistance}[\Omega]) \times \text{P04 : Motor rated current}[A]}{\text{F05 : Motor rated voltage}[V]/\sqrt{3}} \right) \times 100[\%]$$

Use a value corresponding to the Y connection for one phase to specify R1 [Ω].
Use a value corresponding to one winding of multiwinding motor.

| P07 | M1-%X |
|---|---|

| P | 0 | 7 | M | 1 | - | % | X | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.00 to 30.00 [%]

$$\%X = \left( \frac{(L\sigma[H] + \text{Cable } L[H]) \times \text{P04 : Motor rated current}[A]}{\text{F05 : Motor rated voltage}[V]/\sqrt{3}} \times 2\pi \left( \frac{\text{P05 : Pole numbers} \times \text{P04 : Rated speed}[r/min]}{120} \right) \right) \times 100[\%]$$

Use a value corresponding to the Y connection to specify Lσ[H].
Use a value corresponding to one winding of multiwinding motor.

| P08 | M1 exciting current |
|---|---|

◆Sets the effective current value of the motor 1 during no-load operation.

| P | 0 | 8 | M | 1 | - | I | M | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]

| P09 | M1 torque current |
|---|---|

◆Sets the current contributing torque.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 0 | 9 | M | 1 | - | I | T | | | | | |

Setting range: 0.01 to 99.99 [A]
100.0 to 999.9 [A]
1,000 to 2,000 [A]

$$\text{P09 : Torque current} = \sqrt{(\text{P04 : Rated current})^2 - (\text{P08 : Exciting current})^2}\,[A]$$

| P10 | M1 slip on driving |
|---|---|
| P11 | M1 slip on braking |

◆Sets the slips of the motor at rated speed and under rated load.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 1 | 0 | M | 1 | - | S | L | I | P | d | | |
| P | 1 | 1 | M | 1 | - | S | L | I | P | b | | |

Setting range: 0.001 to 10.000 [Hz]

$$\text{Slip frequency}[\text{Hz}] \times \frac{\text{P05 :Pole numbers} \times \text{(Synchronized speed)[r/min]} - \text{F04 :Rated speed[r/min])}}{120}$$

| P12 | M1 iron loss coefficient 1 |
|---|---|
| P13 | M1 iron loss coefficient 2 |
| P14 | M1 iron loss coefficient 3 |

◆Sets coefficients to compensate an amount corresponding the iron loss (hysteresis loss, eddy current loss) of the motor. If you do not need the iron loss compensation, you may set 0.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 1 | 2 | M | 1 | - | L | O | S | S | 1 | | |
| P | 1 | 3 | M | 1 | - | L | O | S | S | 2 | | |
| P | 1 | 4 | M | 1 | - | L | O | S | S | 3 | | |

Setting range: 0.00 to 10.00 [%]

| P15 | Magnetic saturation coefficient 1 |
|---|---|
| P16 | Magnetic saturation coefficient 2 |
| P17 | Magnetic saturation coefficient 3 |
| P18 | Magnetic saturation coefficient 4 |
| P19 | Magnetic saturation coefficient 5 |

◆The relation between the exciting current (current generating magnetic-flux in a motor) and the magnetic-flux is non-linear. These functions set the coefficients to compensate this relation.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 1 | 5 | M | 1 | - | S | A | T | 1 | | | |
| P | 1 | 6 | M | 1 | - | S | A | T | 2 | | | |
| P | 1 | 7 | M | 1 | - | S | A | T | 3 | | | |
| P | 1 | 8 | M | 1 | - | S | A | T | 4 | | | |
| P | 1 | 9 | M | 1 | - | S | A | T | 5 | | | |

Setting range: 0.0 to 100.0 [%]

| P20 | M1 secondary time constant |
|---|---|

◆The response of the magnetic-flux to the exciting current is a first-order lag. This time constant is defined as secondary time constant and you should set a value determined by the motor parameters as in the following equation. You can compensate the lag to lead.

| P | 2 | 0 | M | 1 | - | N | D | - | T | C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.001 to 9.999 [s]
Set value: Secondary time constant [s]=Lm [H] / R2 [Ω]
Lm: Exciting inductance, R2: Resistance of secondary winding

| P21 | M1 induced voltage coefficient |
|---|---|

◆The rotating magnetic field generated by the stator (primary winding) sections the rotor vertically to induce voltage on the secondary side in an induction machine. You can add voltage larger than this induced voltage to accelerate a motor. This function sets a coefficient to compensate this induced voltage.

| P | 2 | 1 | M | 1 | - | E | M | F | - | C | O | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 999 [V]
Set value: Effective induced voltage substituted by the voltage between the windings at the rated speed.

| | |
|---|---|
| P22 | M1-R2 correction coefficient 1 |
| P23 | M1-R2 correction coefficient 2 |
| P24 | M1-R2 correction coefficient 3 |

◆The resistance of the rotor (secondary resistor) is used to calculate the slip frequency in vector control of slip frequency type. The change in secondary resistance due to the temperature increase caused by the frequent operation or load may degrade the torque control accuracy. The inverter detect the temperature with an NTC thermistor and use R2 correction coefficient 1, 2, and 3 to estimate the rotor temperature to prevent the decrease of the torque control accuracy. Do not change these settings.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 2 | 2 | M | 1 | - | R | 2 | C | O | R | R | 1 |
| P | 2 | 3 | M | 1 | - | R | 2 | C | O | R | R | 2 |
| P | 2 | 4 | M | 1 | - | R | 2 | C | O | R | R | 3 |

P22, P23 setting range: 0.500 to 5.000
P24 setting range: 0.010 to 5.000 (P24)

| P25 | M1 exciting current correction coefficient |
|---|---|

◆Corrects the exciting inductance. Do not change these settings.

| P | 2 | 5 | M | 1 | - | I | M | | C | O | R | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.000 to 5.000

| P26 | M1-ACR-P (Gain) |
|---|---|
| **P27** | **M1-ACR-I (Integration time)** |

◆Vector control feeds back the motor output current to control a motor to follow the current reference. These functions specify the gain and the integration time for the current control (ACR). Usually you do not have to change from the factory setting.

◆When a winding has a large inductance, you should set a large P gain to compensate it in general. When a winding has a small inductance, you should set a small P gain to prevent OC (overcurrent) due to the overshoot of the current.

◆You should specify the integration time to reduce the steady-state deviation between the current reference and the actual current to zero. Do not specify too small value otherwise a current hunting occurs.

| P | 2 | 6 | M | 1 | - | A | C | R | - | P | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 2 | 7 | M | 1 | - | A | C | R | - | I | | |

P26 setting range: 0.1 to 20.0

P27 setting range: 0.5 to 100.0 [ms]

| P28 | M1-PG pulse number |
|---|---|

◆Set according to the pulse number of the PG for detecting the speed of the motor 1. If you set a wrong value, the inverter cannot determine the speed and the magnetic pole to conduct speed and vector controls accurately.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 2 | 8 | M | 1 | - | P | G | - | P | L | U | S |

Setting range: 100 to 60,000

| P29 | M1 external PG correction coefficient |
|---|---|

◆You need a correction coefficient to convert the output of a PG built in a machine system into the motor speed to control the speed. Set the coefficient here. Speed control by PG requires parameter setting at both P28 and P29.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 2 | 9 | P | G | - | C | O | M | P | | | |

Setting range: 0000 to 7FFF

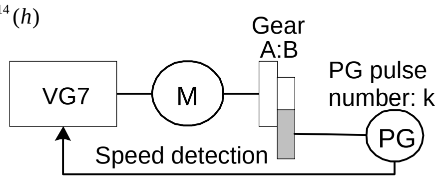
◆When you do not use an external PG, do not change from 4000h. The value of 4000h corresponds to a gear ratio of 1:1, i.e., a PG directly coupled to a motor. When you use a PG directly coupled to a motor, if you set a value other than 4000h, you cannot conduct speed and vector controls accurately.

Setting procedure

Suppose the gear ratio is A:B, specify the function code P28 and P29 as indicated below.

$$\text{Function code P28 (M1 - PG pulse number)} = \text{Integer part of } \left| \text{k(PG pulse number)} \times \frac{B}{A} \right|$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[ \frac{P28}{k \times {}^{B}\!/_{A}} \right] \times 2^{14}(h)$$




<Setting example>

If PG pulse number=1,024 and the gear ratio A:B=13:1, then:

$$\text{Function code P28 (M1 - PG pulse number)} = \text{Integer part of } \left| \text{1024(PG pulse number)} \times \frac{1}{13} \right| = 78$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[ \frac{P28}{k \times {}^{B}\!/_{A}} \right] \times 2^{14}(h) = \left[ \frac{78}{1024 \times {}^{1}\!/_{13}} \right] \times 2^{14}(h) = 16224(d) = 3F60(h)$$

**P30** **M1 thermistor selection**

◆Specifies an analog input (0 to 10V) from a thermistor or a temperature sensor for motor protection. Select NTC thermistor for VG standard motors (VG7S, VG5, and VG3). Select PTC thermistor when a PTC thermistor is installed on a motor for overheat protection.

| P | 3 | 0 | M | 1 | - | T | H | R | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0: No thermistor
1: NTC thermistor (for VG standard motors)
2: PTC thermistor
3: Ai [M-TMP]

Use E30 "Motor overheat protection (Temperature)" to E32 "M1-M3 PTC operation level" to specify the protection level of the motor.

## 4.3.5 H Codes (High Performance Functions)

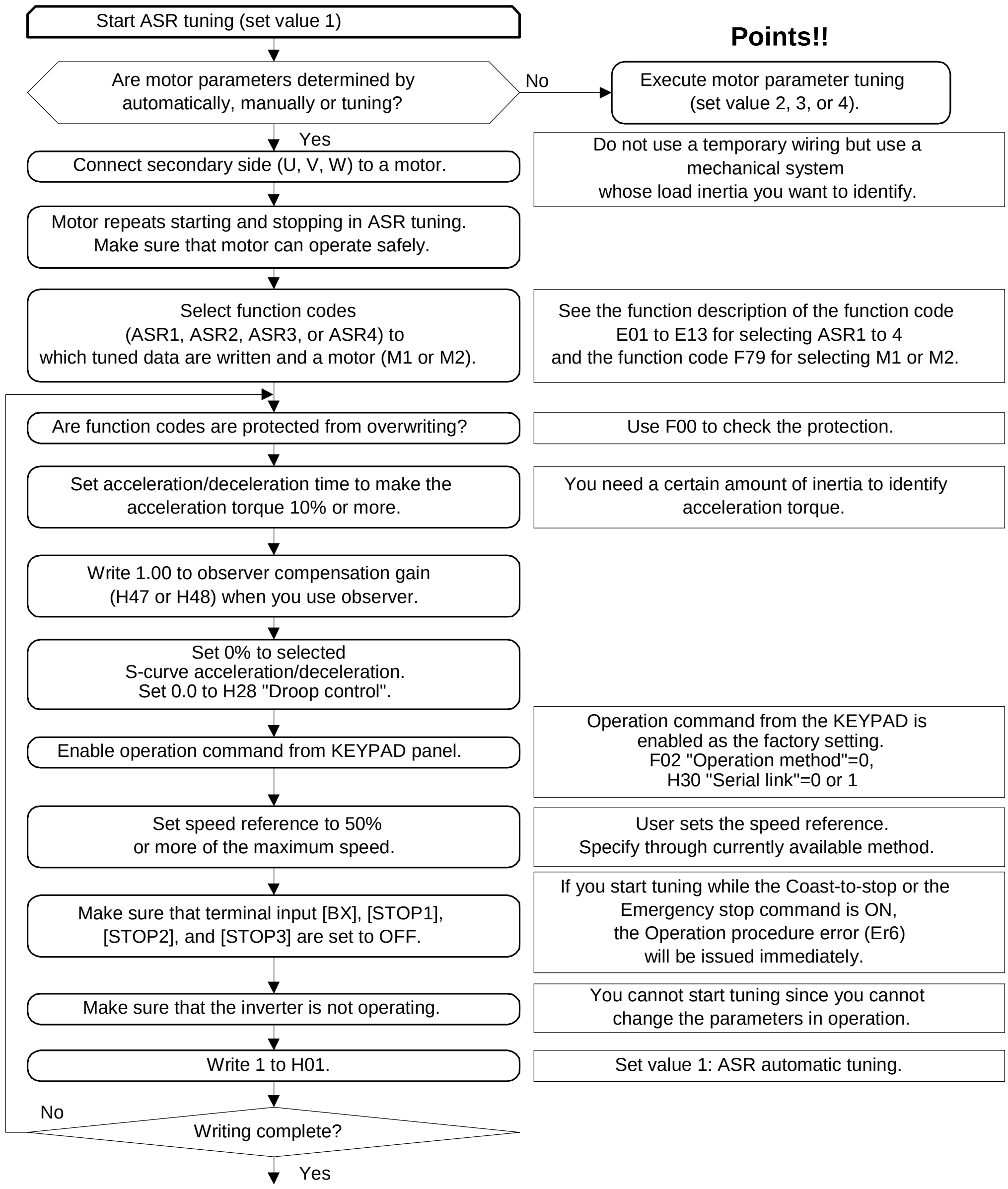
**H01** **Tuning operation selection**

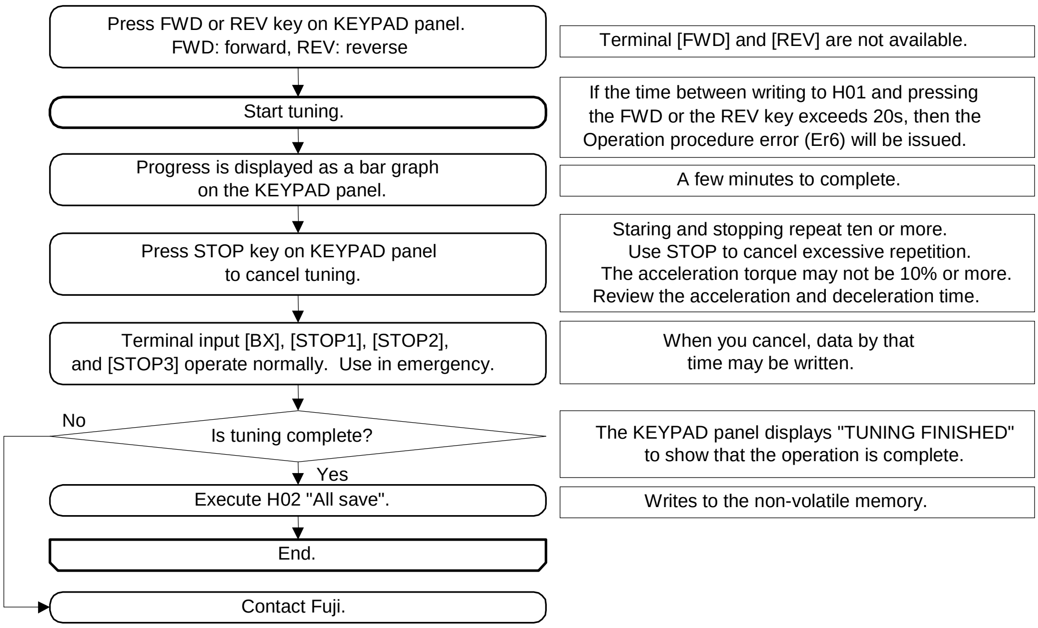
◆Refer to the table below and flowcharts on the following pages to tune correctly.
◆The tuned data are written to the volatile memory (RAM) and are erased when you turn off the power. Make sure to use H02 "All save" to write data into the non-volatile memory after tuning.
◆Execute the ASR automatic tuning specified by the setting "1" after motor parameters are determined (determined by automatically, manually, or tuning).
◆Contact FUJI to tune a synchronous motor.

H01 TUN MODE

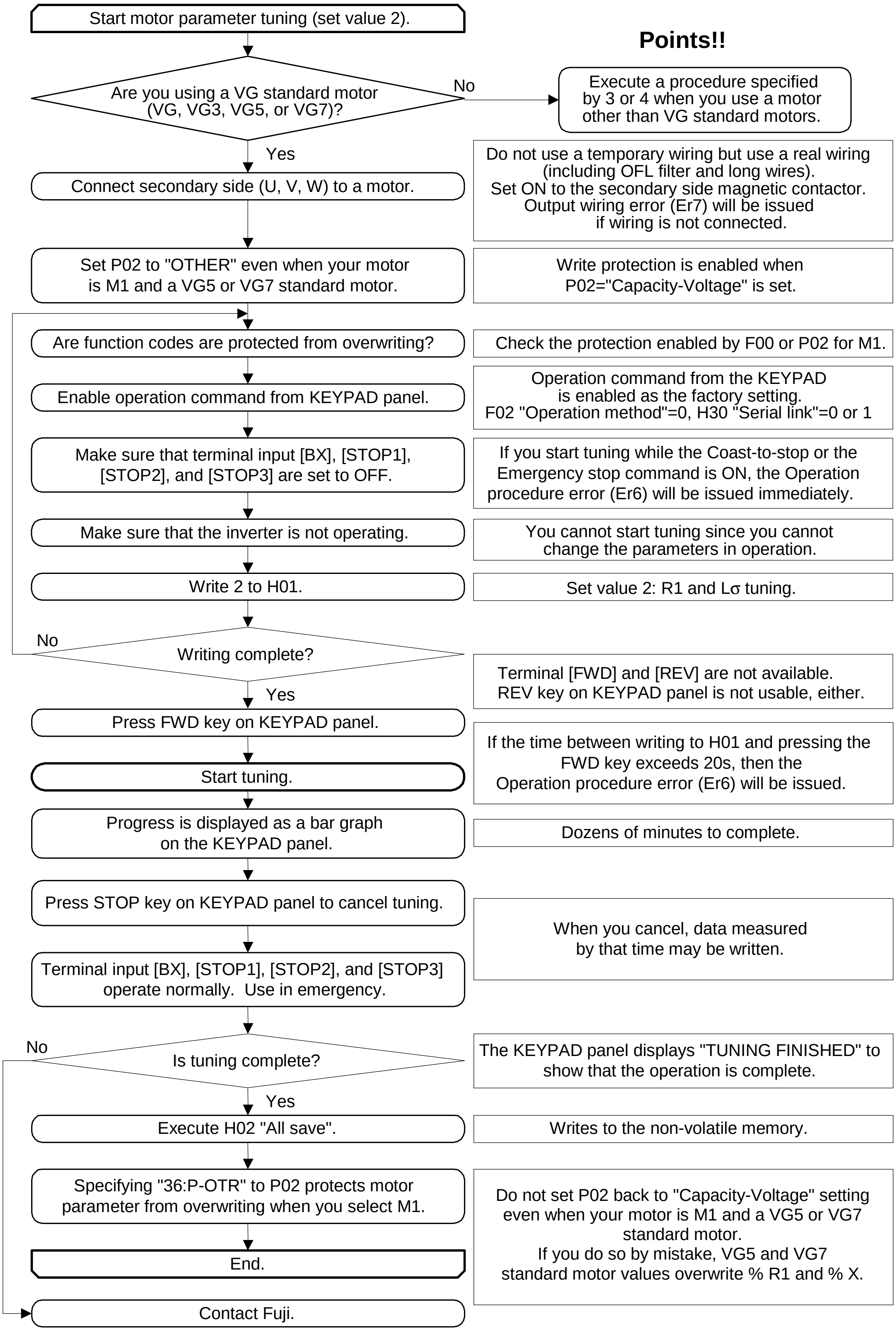
<table>
<tr><th>Setting</th><th colspan="2">Tuning description</th><th>Data to be tuned</th><th>Process description</th><th>Application</th></tr>
<tr><td>1</td><td colspan="2">ASR (Speed control system) tuning<br>(* Execute after motor parameters are fixed)<br>Not available for V/f control</td><td>Following functions to be selected<br>ASR-P (Gain)<br>ASR-I (Constant of integration)<br>H47, 48: Compensation gain<br>H49, 50: Integration time<br>H51, 52: Load inertia</td><td>Measures motor shaft conversion load inertia of a mechanical device (mechanical time constant), calculates optimal gain and constant of integration, and sets them to corresponding function codes</td><td>Execute for a motor integrated into a mechanical system to be tuned for speed control. Execute especially to obtain the motor shaft conversion mechanical inertia to use observer function of H46 "Observer type selection"</td></tr>
<tr><td>2</td><td rowspan="3">Motor parameter tuning</td><td>R1, Lσ</td><td>When M1 is selected: P06, P07<br>When M2 is selected: A08, A09<br>When M3 is selected: A42, A43</td><td>Measures primary resistance (%R1) when the motor is at stopping and leakage reactance (Lσ) when the motor is at rated speed and sets motor parameters (M1, M2, and M3) automatically</td><td>Use when you use a VG standard motor (VG, VG3, VG5, and VG7) and output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.</td></tr>
<tr><td>3</td><td>Motor stopping action</td><td rowspan="2">When M1 is selected: P06 to P25 (P12, P13, and P14 excluded)<br>When M2 is selected: A08 to A27 (A14, A15, and A16 excluded)<br>When M3 is selected: A42 to A45</td><td>Measures %R1 and %X when the motor is at stopping as in set value "2". Then, measures and tune exciting current, slip of rated load, magnetic saturation coefficient, induced voltage, secondary time constant, R2 correction coefficient, and exciting current correction coefficient when the motor is at stopping and writes them into corresponding motor parameters (M1, M2, and M3) automatically.</td><td>Execute in advance to drive a non-standard motor or a special-purpose motor whose motor parameters are not available.<br>Use when a motor you want to drive is integrated into a mechanical system and you cannot disconnect it. Note that the tuning accuracy is a bit inferior to those obtained by the tuning in operation for the set value "4".</td></tr>
<tr><td>4</td><td>Motor rotation action</td><td>Measures %R1 and %X when the motor is at stopping as in set value "2". Then, measures and tune exciting current, slip of rated load, magnetic saturation coefficient, induced voltage, secondary time constant, R2 correction coefficient, and exciting current correction coefficient when the motor is running and writes them into corresponding motor parameters (M1, M2, and M3) automatically.</td><td>Execute in advance to drive a non-standard motor or a special-purpose motor whose motor parameters are not available.<br>Since you tune parameters while motor is running, make sure that you can drive a motor safely when the motor is disconnected from a mechanical system before you start. The motor operates following the specified acceleration/deceleration times.</td></tr>
</table>

ASR tuning procedure (For set value 1)

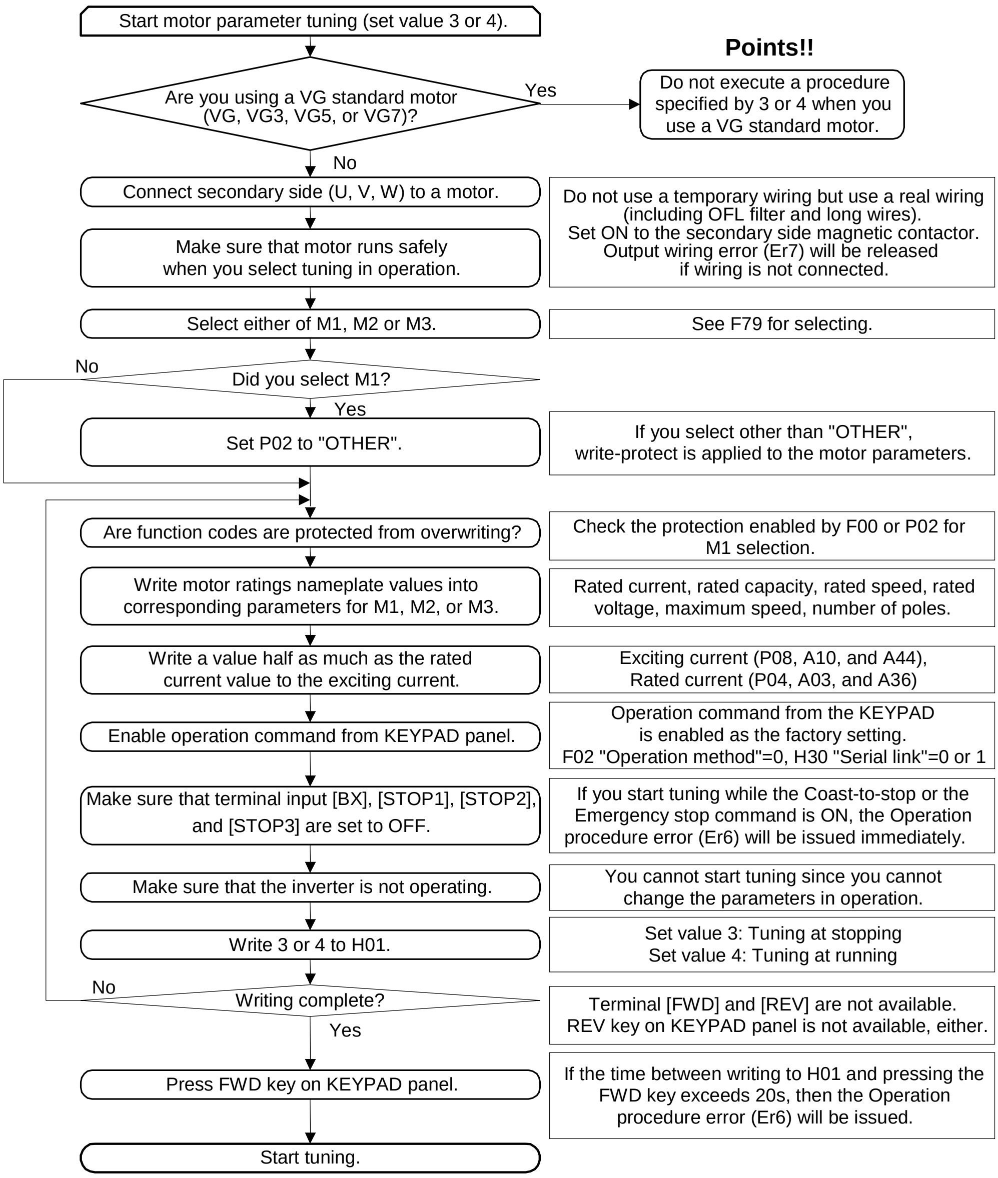


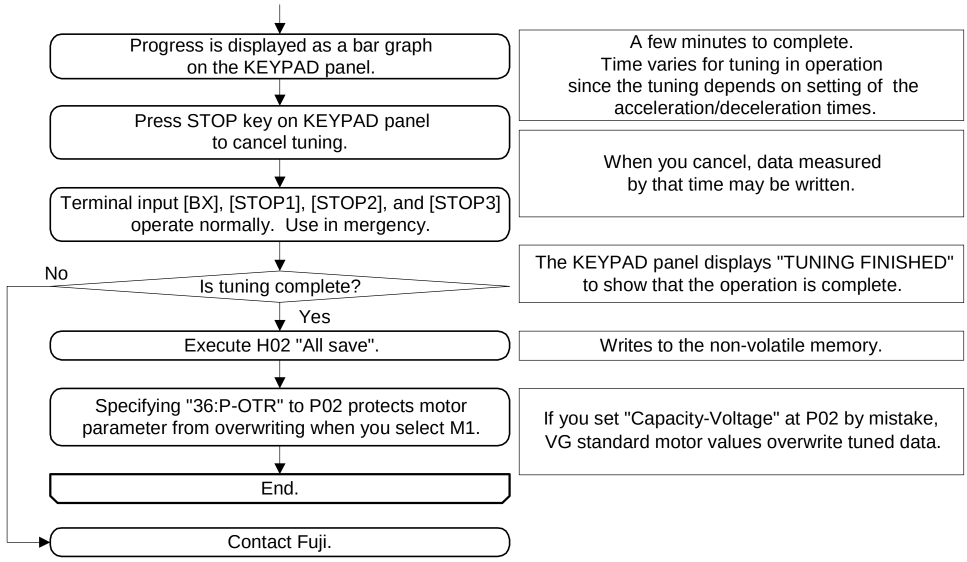

Press FWD or REV key on KEYPAD panel.
FWD: forward, REV: reverse
Terminal [FWD] and [REV] are not available.
Start tuning.
If the time between writing to H01 and pressing the FWD or the REV key exceeds 20s, then the Operation procedure error (Er6) will be issued.
Progress is displayed as a bar graph on the KEYPAD panel.
A few minutes to complete.
Press STOP key on KEYPAD panel to cancel tuning.
Staring and stopping repeat ten or more.
Use STOP to cancel excessive repetition.
The acceleration torque may not be 10% or more.
Review the acceleration and deceleration time.
Terminal input [BX], [STOP1], [STOP2], and [STOP3] operate normally. Use in emergency.
When you cancel, data by that time may be written.
No
Is tuning complete?
The KEYPAD panel displays "TUNING FINISHED" to show that the operation is complete.
Yes
Execute H02 "All save".
Writes to the non-volatile memory.
End.
Contact Fuji.

## Motor parameters tuning procedure (For set value 2)



Motor parameters tuning procedure (For set value 3, or 4)






**⚠ WARNING**

- When you set 1 or 4 to the tuning, a motor will run. Make sure that the motor runs safely.

**You may be injured.**

| H02 | All save function |
|---|---|

◆When you execute H01 "Tuning operation" to rewrite the internal data or you rewrite data through the link (RS485 or field bus), the data are written to the volatile memory (RAM) temporarily and the data are erased when you turn off the power. Execute this function when you want to save these data (to write to the non-volatile memory).

◆Set the value 1 and press **STOP** and **∧** keys at the same time to execute. Progress is displayed as a bar graph on the KEYPAD panel and "100%" is indicated when saving is completed.

◆When you use the All save, you may delete previous data.

| H | 0 | 2 | A | L | L | | S | A | V | E | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| H03 | Data initializing |
|---|---|

◆Set the value 1 and press **STOP** and **∧** keys at the same time to initialize set values to the factory setting. When the initialization is complete, the set values return to zero automatically. Not all functions execute initialization. See the function code list for more details.

| H | 0 | 3 | D | A | T | A | | I | N | I | T | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| H04 | Auto-reset (Number) |
|---|---|
| H05 | Auto-reset (Reset interval) |

◆The Auto-reset function cancels the inverter protective function to restart the inverter automatically without alarm and output shut-off after the inverter protective function is activated. These functions set the number of canceling the protective function and the wait time between the activation and the cancellation of the protective function.

| H | 0 | 4 | A | U | T | O | - | R | E | S | E | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 0 | 5 | R | E | S | E | T | | I | N | T | |

Setting range (number): 0: Auto-reset disabled
1 to 10 [times]
(Wait time) 0.01 to 20.00 [s]

Set H04 "Auto-reset (Number)" to 0 when you do not use the auto-reset function.

◆Inverter protective functions you can reset to restart.

| | |
|---|---|
| OC: Overcurrent | dBH: Braking resistor overheat |
| OV: Overvoltage | OL1, 2, 3: Motor 1,2, and 3 overload |
| OH1: Overheating at heat sink | OLU: Inverter overload |
| OH3: Inverter internal overheat | |

◆When you set 1 to 10 to H04 "Auto-reset (Number)", the auto-reset is activated and inverter start command is automatically directed after a time specified by H05 "Auto-reset (Reset interval)" has passed. If the cause of the alarm does not exist any more, the inverter starts without entering the alarm mode. Otherwise, the protective function is activated again to wait for the time specified by H05 "Auto-reset (Reset interval)". If the cause of the alarm still exists after the inverter restarts specified times by H04 "Auto-reset (Number)", then the inverter enters the alarm mode.

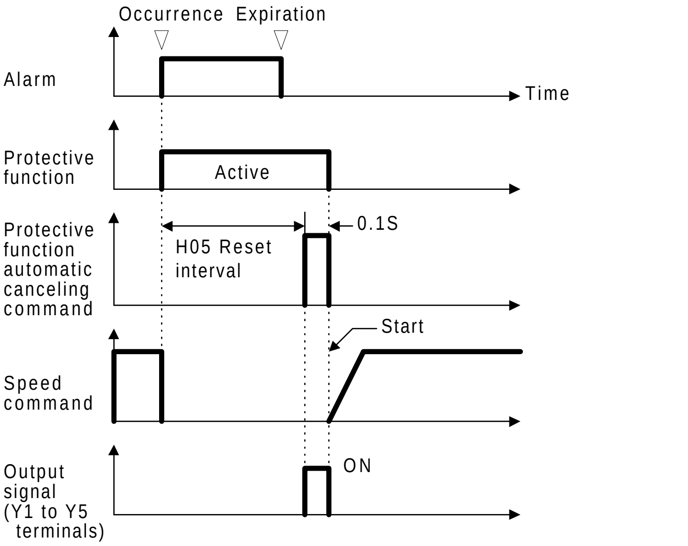
You can use the terminal [Y1] to [Y5] and [Y11] to [Y18] to monitor the retry operation. Note that if you want to use [Y11] to [Y18], you need the option OPC-VG7-DIOA. You can also use the link to poll M15 to read out the terminal information.

**⚠ WARNING**

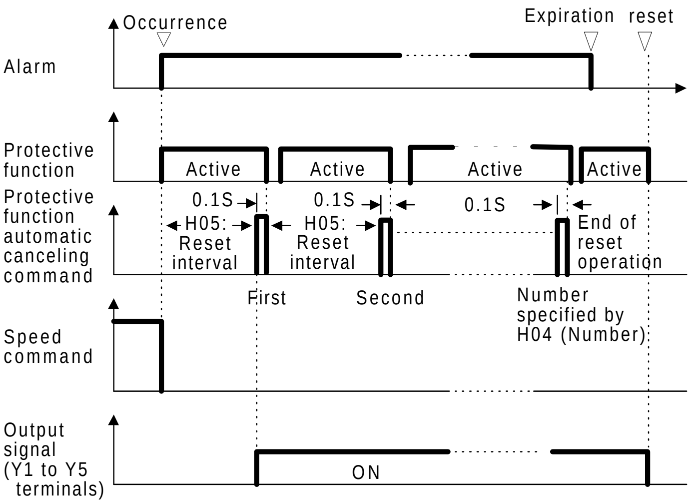
- When you select the restart function, the inverter may restart automatically depending on the cause a trip after the inverter stops due to the trip. You must design your machine such that the machine restarts without causing any danger to persons.

**Otherwise the restart may cause accidents.**

■**Successful case**




■**Failed case**




| **H06** | **Fan stop operation** |
|---|---|

◆You can select whether to enable automatic ON/OFF operation of the cooling fan by detecting the temperature of the heat sink inside the inverter when the power is supplied to the inverter.

Set value: 0: Fan ON/OFF operation disabled

1: Fan ON/OFF operation enabled

◆You can use the terminal [Y1] to [Y5] and [Y11] to [Y18] to monitor the cooling fan operation. Note that if you want to use [Y11] to [Y18] , you need the option OPC-VG7-DIOA.

| H | 0 | 6 | F | A | N | | S | T | O | P | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

## H08 Rev. phase sequence lock

◆You can inhibit the reverse rotation of a mechanical devise that should not do so. This function is not available when you use V/f control.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 0 | 8 | P | R | T | D | - | I | N | V | T | |

Set value: 0: Disabled
1: Enabled

◆Use the function code F76 to F78 "Speed limiter" to inhibit the reverse operation directed by negative [12] input or [REV] input. This function uses torque control to inhibit the reverse operation due to an undershoot in stopping operation.

## H09 Start mode (Rotating motor pick up)

◆Restarts a motor smoothly when the motor starts after a momentary power failure or an external force is coasting the motor.
Detects the speed of a motor and supplies the same speed as that of the motor to start. Thus, the motor starts smoothly without presenting any shocks.

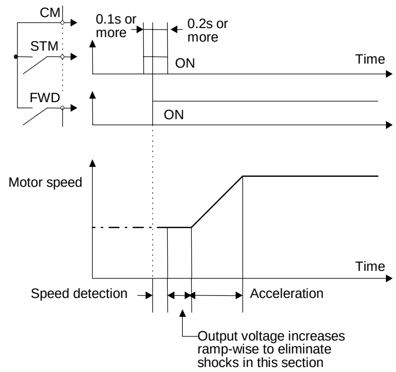
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 0 | 9 | S | T | A | R | T | | C | H | A | R |

◆Setting range: 0, 1, and 2

| Set value | Normal start | Start after momentary power failure |
|---|---|---|
| 0 | Disabled | Disabled |
| 1 | Disabled | Enabled |
| 2 | Enabled | Enabled |

◆Description of the set values
- 1: Enabled when F14 "Restart mode after momentary power failure (Select)" is set to 3, 4, or 5. Also starts the motor at the coasting speed.
- 2: Starts the motor at the detected coasting speed after any start situation including the ON operation command regardless of the occurrence of a momentary power failure.

◆Assign a setting value 26 (Pick up start mode) to either of the terminal from [X1] to [X9] to switch this function externally to apply the function to a normal ON operation command.




## H10 Energy-saving operation

◆To reduces the output voltage automatically during constant speed operation with light load to operate at a state where the product of voltage and current (power) is the smallest. This function is not available for V/f control.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 1 | 0 | A | U | T | O | - | E | N | G | Y | |

Set value: 0: Disabled
1: Enabled

## H11 Automatic operation OFF function

◆Turns off the operation automatically when the motor speed decreases down under the F37 "Stop speed" while the FWD or REV command is present, or coasts the motor instead of decelerating the motor to stop when the input is set to OFF.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 1 | 1 | A | U | T | O | | O | F | F | | |

Set value: 0: The motor decelerates to stop when the FWD-CM and the REV-CM are OFF (normal).
1: The motor operation is set to OFF when the speed is F37 under the "Stop speed" while the FWD-CM and the REV-CM are ON.
2: The motor coasts to stop when the FWD-CM and the REV-CM are OFF.

**H13** **Auto-restart (Restart time)**

◆Waits for a time specified this function after power recovery and restarts.

| H | 1 | 3 | R | E | S | T | A | R | T | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.1 to 5.0 [s]

**H14** **Auto-restart (Speed fall rate)**

◆Sets the speed fall rate, i.e. the speed of matching operation, to match the inverter output speed to the motor speed after a momentary power failure and power recovery.

| H | 1 | 4 | F | A | L | L | | R | A | T | E | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 1 to 3,600 [r/min/s]

**H15** **Auto-restart (Holding DC voltage)**

◆If you select setting 2 (deceleration to a stop on power failure) or 3 (continuous operation) in Restart mode after momentary power failure (F14: Action selection), this function affects them. At both settings, control operation starts when the main circuit DC voltage drops below this setting level.

| H | 1 | 5 | H | O | L | D | | V | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 200V: 200 to 300 [V]
400V: 400 to 600 [V]

**H16** **Auto-restart (Operation command self-hold setting)**

◆Holds the operation command when the control power supply is maintained in the inverter or until the main circuit DC power supply voltage decreases about to zero (recognized as "momentary power failure") when you specifies 1.

◆Holds the operation command for a time specified by the H17 "Auto-restart (Operation command self-hold time)" when you specifies 0.

| H | 1 | 6 | S | L | F | H | L | D | - | S | E | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

**H17** **Auto-restart (Operation command self-hold time)**

◆When the power to the main power supply and the external control circuit (relay sequence) discontinues on power failure, the operation command given to the inverter becomes OFF in general. This function sets the time to hold the operation command. When the period of a power failure exceeds the self-hold time, the inverter recognizes the power failure here cancels the "restart after momentary power failure" mode and restarts normally on power recovery (you can consider this setting as permissible momentary power failure time).

| H | 1 | 7 | S | E | L | F | H | O | L | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.0 to 30.0 [s]

**H19** **Active drive**

◆Restrains the output torque automatically in vector control for a machine system with a large inertia requiring acceleration for more than 60 seconds and avoid a trip due to overload.

◆Triples the acceleration time automatically in V/f control for a similar machine system mentioned above to avoid trip.

| H | 1 | 9 | A | C | T | - | D | R | I | V | E | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

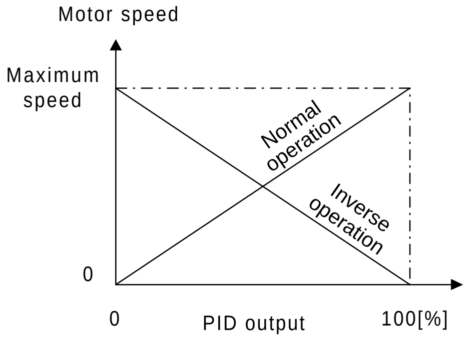
Set value: 0: Disabled
1: Enabled

| H20 | PID control |
|---|---|

◆PID control uses a sensor attached to a subject of control to detect the controlled value (feedback value) and compares it with the reference value (such as speed reference). When there is a deviation between them, the control behaves to decrease the deviation to zero. This is a control to match the feedback value with the reference value.

This control is applied to process control such as dancer control, tension control and extruders.

◆You can select normal or inverse operation for the output of the PID regulator and set increase or decrease to the rotation of a motor receiving the output of the PID regulator.




| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 2 | 0 | P | I | D | | C | O | M | N | D | |

Set value: 0: Disabled
1: Enabled (normal operation)
2: Enabled (inverse operation)

| H21 | Command selection |
|---|---|

◆Select the source of the reference applied to the PID regulator.
Set value: 0: KEYPAD panel or [12] terminal input
1: Analog input Ai [PID-REF]

◆You can assign [PID-FB] to an analog input Ai to specify the feed back value applied to the PID regulator. You cannot specify a feed back value other than this voltage input.

◆You can view the process values of the reference value and the feedback value according to set values of the F52 "Display coefficient A" and F53 "Display coefficient B". See the function description of F52 and F53 for more details.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 2 | 1 | P | I | D | | R | E | F | E | R | |

| H22 | PID control setting (P-gain) |
|---|---|
| H23 | PID control setting (I-gain) |
| H24 | PID control setting (D-gain) |

Set the individual constants of PID control.

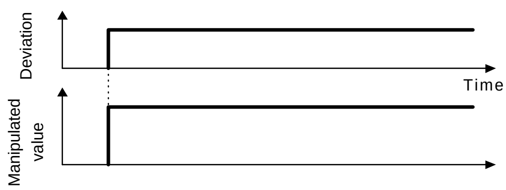
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 2 | 2 | P | - | G | A | I | N | | | | |
| H | 2 | 3 | I | - | G | A | I | N | | | | |
| H | 2 | 4 | D | - | G | A | I | N | | | | |

H22 setting range: 0.000 to 10.000 [times]
H23 setting range: 0.00 to 100.00 [s]
H24 setting range: 0.000 to 10.000 [s]

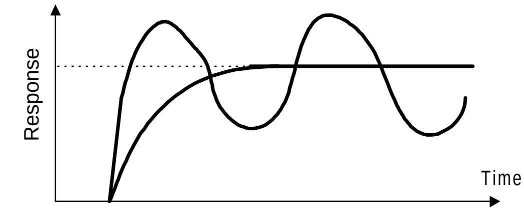
◆You do not use P: Gain, I: Integral time, or D: Differential time individually, but use them by combining them as P control, PI control, PD control, and PID control in general.

◆P control action

This action is referred to as P control action when a manipulated value (Speed reference, Auxiliary speed reference, and Torque limiter) and deviation has a linear relation. Thus P control action provides a manipulated value proportional to the deviation. Note that you cannot use only P control action to decrease the deviation to zero.

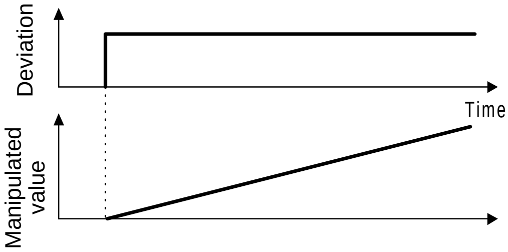


P: gain is a parameter to define a degree of the response to a deviation. When you set a large gain, you will have a quick response. Too large gain presents an oscillation. Too small gain slows down the response.




◆I control action

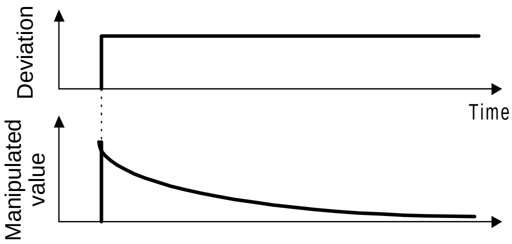
This action is referred to as I control action when a manipulated value (Speed reference, Auxiliary speed reference, and Torque limiter) changes at a speed in proportion to deviation. Thus, I control action provides an integrated deviation as a manipulated value. I control action behaves to conform the controlled value (feedback value) to the reference value (such as speed reference). However I control cannot responds to a deviation changing quickly.




You can use I: integral time as a parameter to determine the effect of I control action. If you set a large integral time, you will have a slow response. A large integral time also decreases the repulsive force. A small integral time quickens response. However, too small integral time will cause an oscillation.

◆D control action

This action is referred to as D control action when a manipulated value (Speed reference, Auxiliary speed reference, and Torque limiter) is proportional to differential of deviation. Thus D control action provides a differential of deviation as a manipulated value to respond a quick change.




You can use D: differential time as a parameter to determine the effect of D control action. A large differential time attenuates an oscillation caused by P control action quickly when a deviation occurs. Too large differential time may induce even a larger oscillation. A small differential time decreases attenuation action applied to a deviation.

◆PI control action

When you use only P control action, the deviation still remains. PI control, P control action combined with I control action, is used in general to eliminate this residual deviation. PI control always behaves to eliminate a deviation due to a change of reference or a continual disturbance. However if you increase I control action, the control cannot respond a fast deviation.

You can use only P control action for a load including an integral element.

◆PD control action

PD control action generates a larger manipulated value than that of D control action to restrain the increase of the deviation. When the deviation decreases, P control action is restrained.

If a subject of control contains an integral element, sole P control action will present an oscillating response due to the integral element. If this is a case, you can use PD control to attenuate the oscillation caused by sole P control action. You apply this control to a process that does not have self-damping action.

◆PID control action

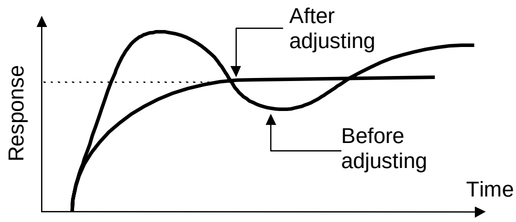
PID control action combines I control action, which acts to reduce deviation and D control action, which acts to restrain oscillation with P control action. You can obtain a stable response with no deviation.

This control is effective when applied to a load which respond slowly.

◆Adjusting PID setting

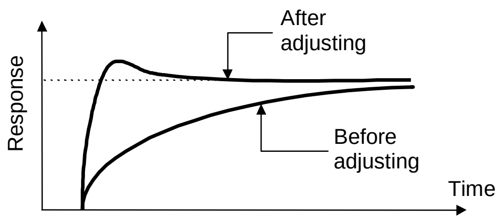
We recommend you to use an oscilloscope to view a response waveform and adjust PID setting.  Adjust following the procedure described below.

- Increase H22 "PID control setting (P control action)" (P gain) as long as it does not present an oscillation.
- Decrease H23 "PID control setting (I control action)" (I integral time) as long as it does not present an oscillation.
- Increase H24 "PID control setting (D control action)" (D differential time) as long as it does not present an oscillation.

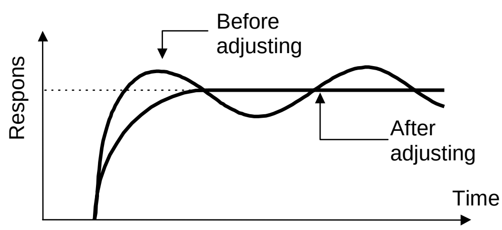



Follow the procedure below to adjust the response waveform.

- To restrict overshoot
  Increase H23 "PID control setting (I control action)" (I integral time).  Decrease H24 "PID control setting (D control action)" (D differential time).

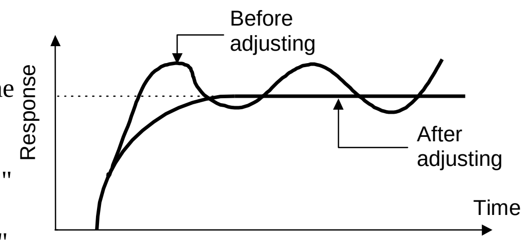



- To stabilize fast (accepting some overshoots.)
  Decrease H23 "PID control setting (I control action)" (I integral time).  Increase H24 "PID control setting (D control action)" (D differential time).




- To restrain an oscillation whose cycle is longer than H23 "PID control setting (I control action)" (I integral time).
  Increase H23 "PID control setting (I control action)" (I integral time).

- To restrain a oscillation whose cycle is about the same as the H24 PID control setting (D control action)" (D differential time)
  Decrease H24 "PID control setting (D control action)" (D differential time).
  Decrease H22 "PID control setting (P control action)" (P gain) if you set 0.0 and the oscillation still exists.




| H25 | PID control setting (Output upper limit value) |
|---|---|
| **H26** | **PID control setting (Output lower limit value)** |

◆Set the upper and lower limiters applied to PID control.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 2 | 5 | P | I | D | | U | P | P | E | R | |
| H | 2 | 6 | P | I | D | | L | O | W | E | R | |

Setting range: –300 to 300 [%]

| H27 | PID control setting (Speed reference selection) |
|---|---|

◆Selects a destination of PID output to be used as a speed reference.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 2 | 7 | P | I | D | | S | P | | R | E | F |

Setting: 0: Disabled
1: PID
2: Auxiliary speed

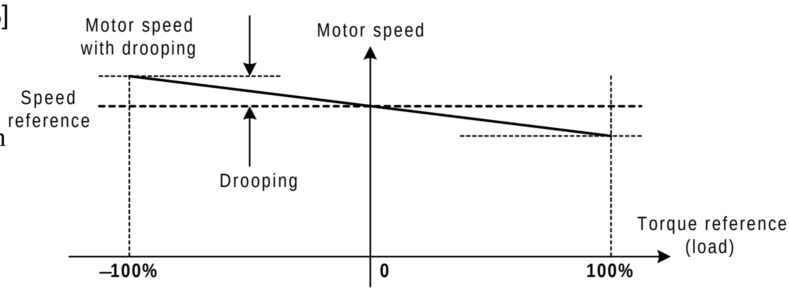
## H28 Droop operation

◆When you use multiple motors to drive a single machine, a motor whose speed is higher has to drive a larger load. Droop operation balances load by adding a drooping characteristic to speed. This function is not available for V/f control.

**H28 DROOP**

Setting range: 0.0 to 25.0 [%]

◆Set a drooping amount at 100% of torque reference. A value set to 100% corresponds to the maximum speed. When the maximum speed is 1,500r/min and the drooping is set to 10%, then the drooping speed is –150.0r/min at 100% of torque reference (load).




## H29 Link function protection

◆Protects code data from false writing through different types of communication systems (such as integrated RS485 and field bus).

Set value: 0: Write enabled
1: Write protected

◆You should use H30 "Serial link" to define the write operation to the S area (function codes including operation commands and speed references) separately.

◆When you assign [WE-LINK] to a digital input, you can protect from writing by short-circuiting between [WE-LINK] and [COM].

**H29 LINK PROCT**

## H30 Serial link

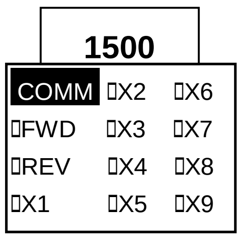
◆Uses different types of communication systems (such as integrated RS485 and field bus) to enable/disable reference data (such as speed reference, position reference, torque reference) and operation commands (FWD and REV). Monitoring (access to M area) is always available. The reference data correspond to S01 to S05 and S08 to S12. The operation commands correspond to the lowest two bits of S06.

◆When you assign [LE] to a digital input, you can connect between [LE] and [CM] to enable the setting by H30 and open to disable operations specified through the link (set to H30=0 regardless of the setting by H30).

**H30 LINK FUNC**

Set value:

| | Monitoring | Reference data | Operation commands (FWD, REV) |
|---|---|---|---|
| 0: | Enabled | Disabled | Disabled |
| 1: | Enabled | Enabled | Disabled |
| 2: | Enabled | Disabled | Enabled |
| 3: | Enabled | Enabled | Enabled |




You can use the KEYPAD panel to check the operation commands from the link and Di inputs.

**H31-H40** **RS485 setting**

◆Sets different types of specifications for RS485 communication. Specify according to your host device. See "Standerd RS485 interface" for the communication protocol.

- Station address
  Sets the station address of RS485
  Setting range: 0 to 255 (Broad cast: (0: RTU), (99: FUJI)/ address: 1 to 255)

- Action on error occurrence
- Timer operation time
  Specify a procedure when an error occurs and an error handling time.
  Set values
  Procedure: 0: Immediate trip on Er5 (forced stop)
  1: Stop after the timer operation time (H33) initiated by an error, then trip on Er5
  2: Stop after a continued transmission error over the timer operation time (H33), then trip on Er5.
  3: Continued operation
  Timer operation time: 0.01 to 20.00 [s]

- Transmission rate
  Specifies transmission rate.
  Set value: 0: 38,400 [bps]
  1: 19,200 [bps]
  2: 9,600 [bps]
  3: 4,800 [bps]
  4: 2,400 [bps]

- Data length
  Specifies data length.
  Set value: 0: 8 [bit]
  1: 7 [bit]
  (fixed to 8 bit for SX protocol)

- Parity bit
  Specifies parity bit.
  Set value: 0: None
  1: Even parity
  2: Odd parity
  (fixed to even parity for SX protocol)

- Stop bit
  Specifies stop bit.
  Set value: 0: 2 [bit]
  1: 1 [bit]
  (fixed to 1bit for SX protocol)

- Continued communication disconnected time
  Specifies a time to wait to provide a trip signal (Er5) after detecting discontinued access due to disconnection during operation through RS485 in a system where the station is always accessed in a certain period.
  Setting range: 0: Detection disabled
  0.1 to 60.0 [s]

- Interval time
  Specifies a time between the completion of receiving a request from a host device (personal computer or PLC) and the start of responding to the request.
  Setting range: 0.00 to 1.00 [s]

- Protocol selection
 Specifies a communication protocol.
 Set value: 0: FUJI general-purpose inverter protocol
 1: SX bus protocol (loader protocol)
 2: Modbus RTU protocol
 Set 1 to connect to VG7S support loader.
 Set 0 to control FUJI general-purpose inverters and VG7S inverters connected through the common RS485 communication.
 Modbus RTU is a communication protocol defined by Modicon company.

**H41** **Torque reference selection**

◆Selects an element with which you provide the torque reference. See the control block diagram for more details.

| H | 4 | 1 | T | - | R | E | F | | S | E | L | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting value: 0: Internal ASR data
1: Ai input [T-REF]
2: DIA card
3: DIB card
4: Link (S02)
5: PID output

◆Use also the speed limiter setting (F76 to F78) when you use the torque reference.

**H42** **Torque current reference selection**

◆Selects an element with which you provide the torque current reference. See the control block diagram for more details.

| H | 4 | 2 | I | T | | R | E | F | | S | E | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting value: 0: Internal ASR data
1: Ai input [IT-REF]
2: DIA card
3: DIB card
4: Link (S03)

◆Use also the speed limiter setting (F76 to F78) when you use the torque current reference.

| ⚠ WARNING |
|---|
| • Make sure to use the speed limiter in cooperation with the torque reference or the torque current reference. You can avoid the motor overrun.<br>**Accidents or physical injuries may occur otherwise.** |

**H43** **Magnetic-flux reference selection**

◆Selects an element with which you provide the magnetic-flux reference.

| H | 4 | 3 | M | | R | E | F | | S | E | L | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting value: 0: Internal calculated value
1: Ai input [MF-REF]
2: Function code H44
3: Link (S04)

**H44** **Magnetic-flux reference value**

◆Specifies magnetic-flux reference value. This function becomes available when you set 2 to H43.

| H | 4 | 4 | M | | R | E | F | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 10 to 100 [%]

| H46 | Observer type selection |
|---|---|

◆Specifies an inertia of a mechanical system or uses the ASR tuning to measure the inertia, operates an internal machine model in the inverter, estimates a load torque that becomes a disturbance element or a oscillation element, adds a value to the torque reference to counteract the load torque to increase the speed response against a load disturbance and to damp an oscillation generated by the mechanical resonance quickly. This function selects load disturbance observer or oscillation suppressing observer.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 4 | 6 | O | B | S | | M | O | D | E | | |

Set value: 0: Disabled
1: Load disturbance observer
2: Oscillation suppressing observer

Note: When a load inertia specified by H51 or H52 has a large error, you cannot obtain an expected performance. Specify an accurate value.

| H47,48 | Observer setting (M1, M2 compensation gain) |
|---|---|
| H49,50 | Observer setting (M1, M2 integral time) |
| H51,52 | Observer setting (M1,M2 load inertia) |

◆Specifies the compensation gain, the integral time, and the load inertia for the observer function.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 4 | 7 | O | B | S | - | P | 1 | | | | |
| H | 4 | 8 | O | B | S | - | P | 2 | | | | |
| H | 4 | 9 | O | B | S | - | I | 1 | | | | |
| H | 5 | 0 | O | B | S | - | I | 2 | | | | |
| H | 5 | 1 | M | 1 | - | I | N | E | R | T | I | A |
| H | 5 | 2 | M | 2 | - | I | N | E | R | T | I | A |

H47, H48 setting range: 0.00 to 1.00 [times]
H49, H50 setting range: 0.005 to 1.000 [s]
H51, H52 setting range: 0.001 to 50.000 [$kg \cdot m^2$]

◆Specify a load inertia of motor shaft conversion in $kg \cdot m^2$. You can also use ASR tuning by H01 "Tuning operation selection" to measure the inertia.

| H53 | Line speed feedback selection |
|---|---|

◆You can select an element for the speed feedback.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 5 | 3 | N | - | F | B | | S | E | L | | |

Set value: 0: Line speed disabled (integrated PG enabled)
1: Analog line speed detection [LINE-N]
2: Digital line speed detection (optional OPC-VG7-PG (LD))
3: High selector (select the higher speed between the motor speed or line speed)

◆About High selector

When you conduct a line speed control, and a line PG fails and presents a speed feedback of 0r/min, the inverter provides a reference corresponding the maximum torque (torque limiter value if you use it) to accelerate the motor to the maximum speed to follow up the speed reference. To change the feedback input from the line PG to a motor PG to prevent overrun when the line PG is disconnected is referred as "High selector". Make sure to use this High selector when you do not have a protective mean to detect the PG disconnection for line speed control.

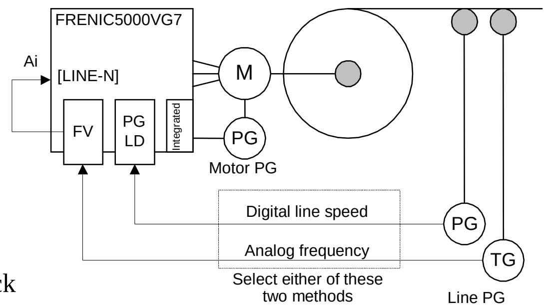
Note: When you use a motor PG and the optional OPC-VG7-PG (LD), a protective function of "PG disconnection alarm" becomes available.

<Application example of line speed control>

The right figure illustrates an example of line speed control with PG.

When the line PG output is analog frequency, then use the FUJI FV card (MCA, OPC-VG7-FV) to convert the analog frequency into voltage to supply the voltage output to Ai [LINE-N]. Also specifies H53 as High selector.

When the line PG output is digital pulse, then use FUJI PG card (OPC-VG7-PG(LD)). See also the description of o06, o07, and o08 and the control block diagram.




## H55 Zero speed control (Gain)

## H56 Zero speed control (Completion range)

◆Specifies the gain of the servo locking command and the range of completion to provide the servo locking completion signal. See the section of [LOCK] of the function code E01 to E13 "X function selection".

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 5 | 5 | Z | E | R | O | - | G | A | I | N | |
| H | 5 | 6 | Z | E | R | O | - | H | I | S | S | |

H55 setting range: 0 to 100 [times]
H56 setting range: 0 to 100 [pulse]

## H57 Overvoltage suppressing function

◆When the DC link circuit voltage exceeds the overvoltage protection level during braking operation, the overvoltage (OV) trip occurs. This function limits the braking torque to zero before the overvoltage trip during the braking operation. The link circuit voltage decreases after 0 limiting, and the brake torque recovers automatically. This operation repeats to restrain the overvoltage trip.

◆You can use only inverter loss energy to apply brake without braking devices (braking resistor and PWM converter). When you want to use this function, see also "Power limiter" of the function code F40 to F45 "Torque limiter".

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 5 | 7 | O | U | | P | R | E | V | E | N | T |

Set value 0: Disabled
1: Enabled

## H58 Overcurrent suppressing function

◆The overcurrent trip occurs when the motor current changes suddenly to become more than the protection level. The overcurrent suppressing function restrains the inverter from supplying a current more than the protection level when the load changes.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 5 | 8 | O | C | | P | R | E | V | E | N | T |

Set value 0: Disabled
1: Enabled

Note: The output torque may decrease under the overcurrent suppressing condition.

## H60-H66 Load adaptive control function

◆When you use a crane to wind up a heavy baggage, if the acceleration torque lacks compared with the speed reference, the speed of the baggage cannot follow the reference. The deviation between the reference and the actual values may become excessive to activate the speed disagreement alarm (Er9). If you do not limit the torque, the inverter continues to provide the maximum torque and the inverter overload and the motor overload protections may be activated when the overload is frequent. Though you should specify longer acceleration and deceleration times to avoid activating these protective functions, the longer acceleration and deceleration times are inefficient for lighter loads.
◆This function limits the speed reference automatically based on the load of a baggage, acceleration/deceleration torque, and the mechanical loss. You can operate the motor at the speed reference when the load is light and at the limited speed when the load is heavy.
◆Contact FUJI for the details of this function.

## H68 Trip data delete

◆Deletes the alarm history and the alarm information maintained in the inverter completely. The corresponding functions are the KEYPAD panel alarm information, the alarm history and the source of alarms.
◆Specify 1 and press the **STOP** and the **∧** keys simultaneously to execute the function. The data returns to 0 automatically.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 6 | 8 | T | R | I | P | | D | A | T | A | |

Setting range: 0 to 1

## H70 Reserved 1

◆Selects function codes to be displayed on the KEYPAD panel.
Set value: 0: Standard
1: Elevators
2-9999: Reserved
◆When you select 1: Elevators, you will view the functions required for vertical transfer.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 7 | 0 | M | A | K | E | R | 1 | | | | |

## H71 Reserved 2

## H72 Reserved 3

## H73 Reserved 4

◆These functions are reserved for makers to adjust the inverter.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| H | 7 | 1 | M | A | K | E | R | 2 | | | | |
| H | 7 | 2 | M | A | K | E | R | 3 | | | | |
| H | 7 | 3 | M | A | K | E | R | 4 | | | | |

## 4.3.6 A Codes (Alternative Motor Parameters)

The A codes are motor parameters that become available when you select the motor M2 or M3 (second or third motor). See the P codes when you use the M1.

### A01 - A34 Codes for the second motor

You can use the function code F79 and the terminal input signal [M-CH2] and [M-CH3] to select the M2.
See the individual descriptions and make sure that the M2 is selected. You can use the "I/O check" screen of the KEYPAD panel as shown in the right figure.
■ indicates "selected". Check if ■ M2 is indicated.

| 1500 |
|---|
| □PARA 1 □M1 |
| □PARA 2 ■M2 |
| □PARA 3 □M3 |
| □PARA 4 □JOG |

◆The function description is omitted since the A codes are the same as the P codes in terms of function.
◆Specifies the function codes in the table below following the items from top to bottom according to the motor to be used.

| Function code for motor 2 | FUJI motors | | Other motors |
|---|---|---|---|
| | Standard motors for VG7S, VG5, VG3 and VG | FUJI motors | |
| A01 M2 control method | 0: Vector control | Select depending on with or without PG.<br>With encoder: 0, vector control<br>Without encoder: 1, sensorless control | |
| A02 M2 rated capacity | Set the data described in the Chapter 14 "Replacement data" manually.<br><br>Do not use H01 "Tuning operation selection". | Set the ratings nameplate data provided on the motor manually. | |
| A03 M2 rated current | | | |
| A04 M2 rated voltage | | | |
| A05 M2 rated speed | | | |
| A06 M2 maximum speed | | | |
| A07 M2 pole number | | Use H01 "Tuning operation selection" to tune motor parameters.<br>See the function description of H01 for more details. | |
| A08 M2-%R1 | | | |
| A09 M2-%X | | | |
| A10 M2 exciting current | | | |
| A11 M2 torque current | | | |
| A12,13 M2 slip on driving, braking | | | |
| A14-16 M2 iron loss coefficient 1-3 | | Preserve the initial value. Not available for tuning. | |
| A17-21 M2 magnetic saturation coefficient 1-5 | | | |
| A22 M2 secondary time constant | | | |
| A23 M2 induced voltage coefficient | | | |
| A24-26 M2-R2 correction coefficient 1-3 | | | |
| A27 M2 exciting current correction coefficient | | | |
| A28, 29 M2-ACR-P, I (Gain, Constant of integration) | | Preserve the initial value. | |
| A30 M2-PG pulse number | Select pulse number of PG to be used.<br>Not effective during sensorless control. | | |
| A31 M2 thermistor selection | 1: NTC thermistor | See F10 for details on motor protection. | |
| A32 M2 electronic thermal overload relay (Select) | 0: Disabled (VG standard motor) | | |
| H01 Tuning operation selection | Motor parameter tuning not required.<br>Procedure above sets optimal data automatically.<br>Select 2 for tuning operation when output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected. | Motor parameter turning required.<br>Tune while wires are installed.<br>See function description of function code H01. | |
| H02 All save function | Execute "all save" operation after using H01 to tune. This operation writes tuned data to non-volatile memory.<br>Not necessary when you did not tune parameters. | | |

Note 1: VG7S standard motors are the same as the VG5 standard motors in shape and electrical constants (motor parameters).

| A35-A50 | Codes for the third motor (for V/f control) |
|---|---|

◆Motor parameters dedicated for the V/f control.
◆These parameters become available when you use the function F79 "Motor selection" and X functions to select the motor 3.
◆Specifies the function codes in the table below following the items from top to bottom according to the motor to be used.

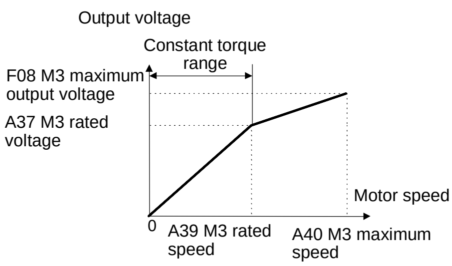
<table>
<tr><th rowspan="2">Function code for motor 3</th><th colspan="2">FUJI motors</th><th rowspan="2">Other motors</th></tr>
<tr><th>Standard motors for VG7S, VG5, VG3 and VG</th><th>FUJI motors</th></tr>
<tr><td>A35 M3 rated capacity</td><td rowspan="11">Set the data described in the Chapter 14 "Replacement data" manually.<br><br>Do not use H01 "Tuning operation selection".</td><td colspan="2" rowspan="6">Set the ratings nameplate plate data provided on the motor manually.</td></tr>
<tr><td>A36 M3 rated current</td></tr>
<tr><td>A37 M3 rated voltage</td></tr>
<tr><td>A38 M3 maximum output voltage</td></tr>
<tr><td>A39 M3 rated speed</td></tr>
<tr><td>A40 M3 maximum speed</td></tr>
<tr><td>A41 M3 pole number</td><td colspan="2" rowspan="5">Use H01 "Tuning operation selection" to tune motor parameters.<br>See the function description of H01 for more details.</td></tr>
<tr><td>A42 M3-%R1</td></tr>
<tr><td>A43 M3-%X</td></tr>
<tr><td>A44 M3 exciting current</td></tr>
<tr><td>A45 M3 slip compensation value</td></tr>
<tr><td>A47 M3 thermistor selection</td><td>1: NTC thermistor</td><td colspan="2" rowspan="2">See F10 for details on motor protection.</td></tr>
<tr><td>A48 M3 electronic thermal overload relay (Select)</td><td>0: Disabled (VG standard motor)</td></tr>
<tr><td>H01 Tuning operation selection</td><td>Motor parameter tuning not required.<br>Procedure above sets optimal data automatically.<br>Select 2 for tuning operation when output impedance is not negligible due to long (100m or more) wires between inverter and motor or OFL filter connected.</td><td colspan="2">Motor parameter tuning required.<br>Tune while wires are installed.<br>See function description of function code H01.</td></tr>
<tr><td>H02 All save function</td><td colspan="3">Execute "all save" operation after using H01 to tune. This operation writes tuned data to non-volatile memory.<br>Not necessary when you did not tune parameters.</td></tr>
</table>

Note 1: VG7S standard motors are the same as the VG5 standard motors in shape and electrical constants (motor parameters).

| A37 | M3 rated voltage |
|---|---|
| A38 | M3 maximum output voltage |
| A39 | M3 rated speed |
| A40 | M3 maximum speed |

◆Specifies the maximum speed of the motor 3 that the inverter provides. The maximum output frequency for V/f control is 400Hz. Set the maximum speed determined by the pole number of the motor.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 3 | 7 | M | 3 | - | V | r | | | | | |
| A | 3 | 8 | M | 3 | - | V | m | a | x | | | |
| A | 3 | 9 | M | 3 | - | N | r | | | | | |
| A | 4 | 0 | M | 3 | - | N | m | a | x | | | |




A37, A38 setting range: 80 to 999 [V]
A39, A40 setting range: 50 to 24,000 [r/min]

You may damage a motor or machines when you set a value higher than the rating of the driven devices. Set according to the devices.

**A45** | **M3 slip compensation value**

◆A change in the load torque will change the motor slip, resulting in the motor speed change. The slip compensation control adds a frequency proportional to the motor torque to the inverter output frequency and reduces the fluctuation of the motor speed due to torque change.

| A | 4 | 5 | M | 3 | - | S | L | I | P | d | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: –20.000 to 5.000 [Hz]

◆You can use the following equation to obtain the slip compensation value.

$$\text{Slip compensation value} = \text{Base frequency} \times \frac{\text{Slip[r/min]}}{\text{Synchronous speed[r/min]}} \text{ [Hz]}$$

Slip = Synchronous speed - Rated speed

**A46** | **M3 torque boost**

◆This function is dedicated to V/f control of the motor 3. The following selections are available.

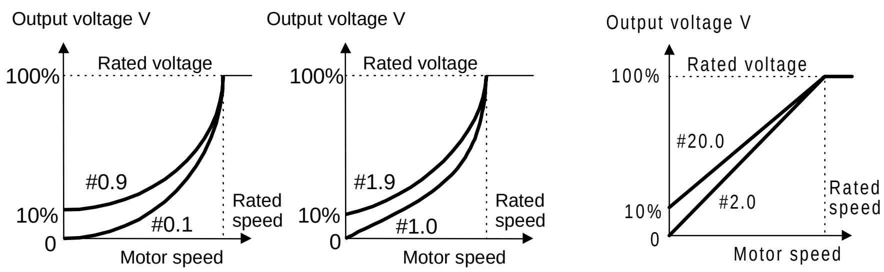
| A | 4 | 6 | M | 3 | - | B | O | O | S | T | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

- Selection of load characteristic from automatic torque boost, variable torque load, proportional torque load, and constant torque load.
- Compensating insufficient magnetic-flex of a motor due to the voltage decrease in low frequency range and boosting torque at low speed operation (boosting V/f characteristic).

| Setting range | Description |
|---|---|
| 0.0 | Automatic torque boost characteristic to adjust torque boost value automatically for constant torque load changing linearly |
| 0.1 to 0.9 | Variable torque characteristic for fan/pump load |
| 1.0 to 1.9 | Linear torque characteristic for a load that has a middle characteristic between variable torque and constant torque characteristics |
| 2.0 to 20.0 | Constant torque characteristic changing linearly |

◆Torque characteristic

<Variable torque characteristic> <Proportional torque characteristic> <Constant torque characteristic>




Note: Increasing torque boost value will present over-excited state at low speed in all characteristics. Continued operation may cause motor overheat. Review the characteristic of a motor to be driven.

## 4.3.7 O Codes (Optional Functions)

OPC-VG7-DIA, DIB

Use this option to specify the digital speed reference, torque limiter value, torque reference, and torque current reference. When you install two option cards, you use hardware switches to distinguish them as DIA and DIB. See the control option section for more details.

**o01** **DIA function selection**

**o02** **DIB function selection**

◆Select the data format for the digital speed reference, torque limiter value, torque reference, and torque current reference.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 0 | 1 | D | I | A | | F | U | N | C | | |
| o | 0 | 2 | D | I | B | | F | U | N | C | | |

1) See the function description of the function code F01 "Speed setting N1" to use for the speed reference.
2) See the function description of the function code F42 "Torque limiter value selection" to use for the torque limiter value.
3) See the function description of the function code H41 "Torque reference selection" to use for the torque reference.
4) See the function description of the function code H42 "Torque current reference selection" to use for the torque current reference.

Set value: 0: Binary
1: BCD

**o03** **DIA BCD input setting**

**o04** **DIB BCD input setting**

◆Specify BCD data for setting the maximum speed of DIA and DIB inputs. Use when you want to enter "machine operation speed" directly to specify input data.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 0 | 3 | B | C | D | | C | M | D | | A | |
| o | 0 | 4 | B | C | D | | C | M | D | | B | |

Setting range: 99 to 7,999

OPC-VG7-PG

Use this option for the following applications.

1) Set the switch to PD to use the PG signal of the 5V line driver for pulse calculation to detect position.
2) Set the switch to LD to detect the line speed.
3) Set the switch to PR to use for pulse train synchronized operation and position control (orientation).
4) Set the switch to SD to use the PG signal of the 5V line driver for speed detection of VG7S.

**o05** **Feedback pulse selection**

◆Switches the source of the position detection signal between the integrated PG and the optional PG. Use for synchronized operation and the position control for orientation control.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 0 | 5 | P | L | S | | F | E | D | | S | L |

Set value: 0: Integrated PG (15, 12V complementary output)
1: PG (PD) option (5V line driver output)

| | |
|---|---|
| **o06** | **Digital line speed detection definition (PG pulse number)** |
| **o07** | **Digital line speed detection definition (Detected pulse correction 1)** |
| **o08** | **Digital line speed detection definition (Detected pulse correction 2)** |

◆Specify to use the PG (LD) option for line speed control. A PG disconnection activates a protective function (PG alarm).

◆The pulse correction is for speed detection. Speed=(Correction 1/Correction 2)×Input pulse

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 0 | 6 | L | S | - | P | G | | D | E | F | |
| o | 0 | 7 | L | S | - | P | G | | C | P | 1 | |
| o | 0 | 8 | L | S | - | P | G | | C | P | 2 | |

o06 setting range: 100 to 60,000 [P/R]
o07, o08 setting range: 0 to 9,999

| | |
|---|---|
| **o12** | **Reference pulse selection** |

◆Select a pulse output source from the PG (PR) option and internal speed data.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 1 | 2 | P | L | S | | R | E | F | | S | L |

Set value: 0: PG (PR) option
1: Internal speed reference

◆See the 4.2.5 Block diagram fore more details.

| | |
|---|---|
| **o13** | **Pulse train input form selection** |

◆Select the input form of the signal supplied to the PG (PR) option.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 1 | 3 | P | L | S | | S | T | A | T | E | |

Set value: 0: 90° phase difference between phase A and phase B.
1: Phase A: Reference pulse, Phase B: Reference code (sign)
2: Phase A: Forward pulse, Phase B: Reverse pulse

| | |
|---|---|
| **o14** | **Reference pulse correction 1** |
| **o15** | **Reference pulse correction 2** |

◆Set when you install the PG (PR) option card to conduct synchronized operation. You can change the position reference data entered into the pulse train card to change the speed ratio between the master motor and the slave motor.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 1 | 4 | P | L | S | | C | O | R | R | | 1 |
| o | 1 | 5 | P | L | S | | C | O | R | R | | 2 |

Setting range: 0 to 9,999

◆Internal data=Input pulse× (Pulse correction 1/Pulse correction 2)

| | |
|---|---|
| **o16** | **APR gain** |

◆You can specify a data to improve the position control response in pulse train operation. You can also reduce the steady-state deviation in the steady-state operation. Since too large setting may present a motor hunting, increase gradually from a small value to adjust.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| o | 1 | 6 | A | P | R | - | P | - | G | A | I | N |

Setting range: 0.0 to 999.9 [times]

| o17 | F/F gain |
|---|---|

◆The setting can reduce the steady-state deviation. The setting of 1.0 provides the smallest deviation. You do not have to change from 0.0 in general.

| o | 1 | 7 | F | / | F | | G | A | I | N | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.0 to 1.5 [times]

| o18 | Deviation excess range |
|---|---|

◆When the difference (deviation) between the internal position reference and the amount of the motor rotation exceeds this setting, the inverter issues the "Excessive position deviation alarm".

| o | 1 | 8 | D | E | V | | O | V | E | R | | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 65,535 [pulse]

| o19 | Deviation zero range |
|---|---|

◆When the current position of the motor comes into this range of a reference position, the inverter provides the "zero deviation" signal. You can use the zero deviation signal to detect that the motor locates almost at the target position. The inverter provides the zero deviation signal on the DO to which you can assign a function.

| o | 1 | 9 | D | E | V | | Z | E | R | O | | W |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 1,000 [pulse]

OPC-VG7-PMPG

You can use this option to detect the magnetic pole position and the speed and to drive a synchronous motor.

| o09 | ABS signal input definition |
|---|---|

◆Defines the input signal when you install a PG card to drive a synchronous motor.

| o | 0 | 9 | A | B | S | | D | E | F | I | N | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0 to 16

| o10 | Magnetic pole position offset |
|---|---|

◆Specifies an offset value relative to the magnetic pole position detected by the PG.

| o | 1 | 0 | S | M | - | O | F | F | S | E | T | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0000 to 03FF

| o11 | Salient pole ratio (%Xq/%Xd) |
|---|---|

◆Set the difference in reactance due to the difference in magnetic resistance on the q axis and the d axis in terms of the ratio of the q axis value/d axis value.

| o | 1 | 1 | S | A | L | I | E | N | T | | R | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 1.000 to 3.000

OPC-VG7-TL

You can use this option to conduct operate, to refer to and change the function codes, and monitor operation from the MICREX-F and SX series PLC.  You cannot install other filed bus options (SX, field bus) at the same time.  See the section of the control options for more details.

**o30** **Action on communication error**

◆Specifies an action on error in the T-Link communication.

| o | 3 | 0 | M | O | D | E | | O | N | | E | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Immediate trip on a communication error

1: Stop after a time specified by o31 "Action time on communication error" initiated by a communication error, then trip

2: Stop after a continued communication error for a time specified by o31 "Action time on communication error", then trip.

3: Continued operation even on a communication error
(Removal of the error cause will recover the operation through communication automatically.)

**o31** **Action time on communication error**

◆Specifies a time for a continued T-Link communication error.

| o | 3 | 1 | T | I | M | E | R | | T | L | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0.01 to 20.00 [s]

**o32** **Communication format**

◆Specifies the number of data transmitted over the T-Link.

| o | 3 | 2 | 4 | W | / | 8 | W | | S | E | L | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0: 4 words+4 words

1: 8 words+8 words

OPC-VG7-SI

You can use this option in the following two ways according to the setting of the hardware switch.

1) SI (MWS): Use as multiwinding system

2) SI (UPAC): Use as inter-inverter link option of the UPAC

**o33** **Multiwinding system**

◆Specifies whether to use the SI option as a multiwinding system.  When you set this parameter to disabled, then you can use this option for single motor operation.  See also the canceling multiwinding motor control of E01 to E13 "X function selection".

| o | 3 | 3 | M | W | S | | A | C | T | V | E | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Disabled (single motor operation)

1: Multiwinding system

**o34** **Multiwinding system slave station number**

◆Specifies the number of slave stations for the multiwinding system.

| o | 3 | 4 | M | W | S | | S | L | A | V | E | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 1 to 5

OPC-VG7-UPAC

You can use this option to create a program and to operate the VG7S with the program. See the description of the UPAC of the control options.

**o38** **UPAC start/stop**

◆Specifies to start/stop the UPAC option.

| o | 3 | 8 | U | P | A | C | | A | C | T | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Set value: 0: Stop UPAC
1: Start UPAC
2: Start UPAC (with initialization)

**o39** **UPAC memory mode**

◆Specifies to clear/to reserve the individual memory areas when you switch the UPAC from start to stop.

| o | 3 | 9 | U | P | A | C | | M | E | M | O | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0000 to 001 [F]
bit1: IQ area
bit2: M area
bit3: RM area
bit4: FM area
bit5: SFM area

**o40** **UPAC Address**

◆Set the address of the UPAC when you access the UPAC from a personal computer through RS485 communication.

| o | 4 | 0 | U | P | A | C | | A | D | R | E | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 100 to 255

**o41** **UPAC system slave station number**

◆Set the number of slave inverters when you link multiple inverters with SI or RS option assigning an inverter with the UPAC as a master.

| o | 4 | 1 | U | P | A | C | | S | T | A | T | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 11

## 4.3.8 L Codes

| L01 | Password data 1 |
|---|---|
| L02 | Password data 2 |

**⚠ CAUTION**

- Handle the password with care. If you set the password by mistake, you cannot refer to or change the function code. The person who is responsible for specifying the password must manage the password carefully.

◆You can specify an 8-digit password by combining L01 and L02. You can use the password to restrict the change and the reference to the function codes. When you specify a non-zero value to either L01 or L02, the restriction by password will become effective.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L | 0 | 1 | P | A | S | S | W | O | R | D | 1 | |
| L | 0 | 2 | P | A | S | S | W | O | R | D | 2 | |

Setting range: 0 to 9,999

(1) Setting password

When you set non-zero data to L01 or L02 and open the program menu, you will not view "1. Set data" and "2. Check data", but "3. Operation monitor". and the rest.  See the figure right below.

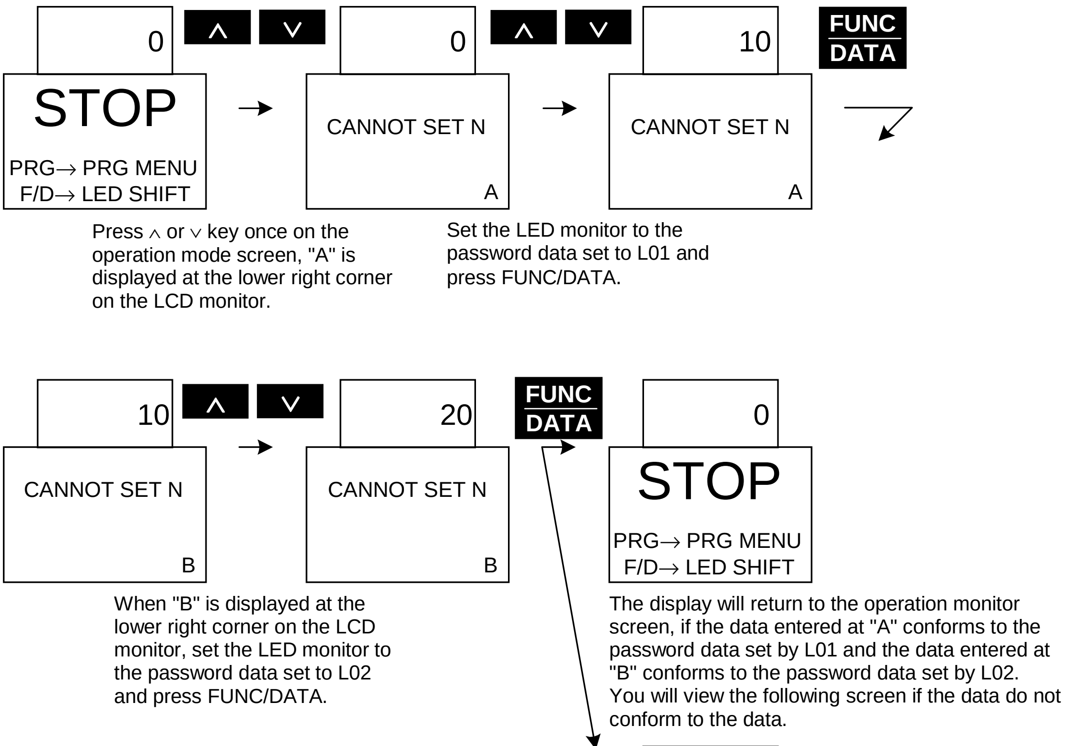
Usual program menu screen
(password is not specified or is disabled)

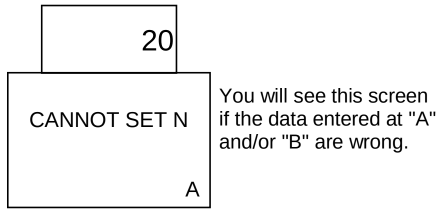
1. Set data
2. Check data
3. Operation monitor
4. I/O check
5. Maintenance info
6. Measure load factor
7. Alarm info
8. Cause

Program menu screen
when password is enabled

3. Operation monitor
4. I/O check
5. Maintenance info
6. Measure load factor
7. Alarm info
8. Cause

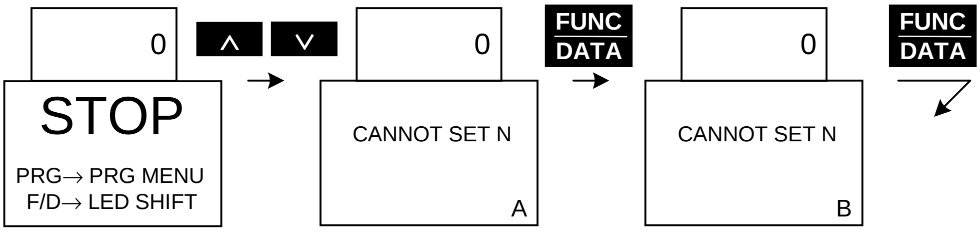
(2) To disable password (ex. password: L01=10, L02=20)




Note: Canceling password described above will become ineffective after you turn off the inverter.

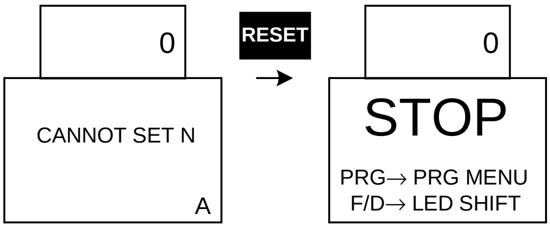
(3) To enable password again after disabled




Press ∧ or ∨ key once on the operation mode screen, "A" is displayed at the lower right corner on the LCD monitor.

Check if "0" appears on the LED monitor and press FUNC/DATA.

Check if "0" appears on the LED monitor and press FUNC/DATA.




Press RESET when "A" is displayed again at the lower right corner on the LCD monitor.

| L03 | Elevator rated speed |
|---|---|

◆This function code is necessary to calculate the estimated travel distance on deceleration.

**L03** LIFT-MAX

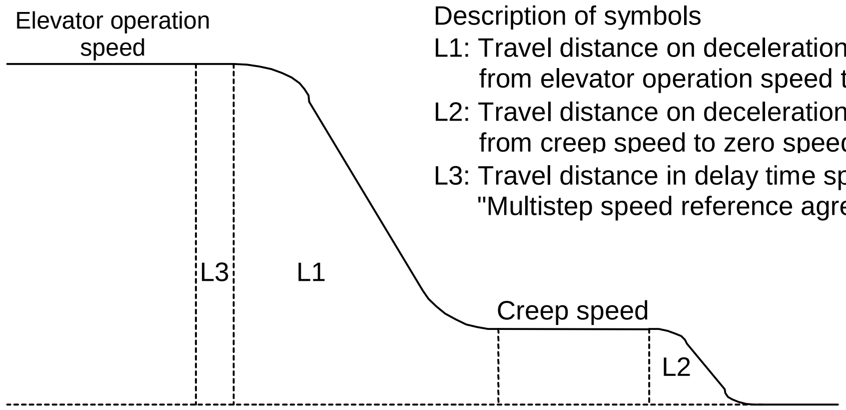
Setting range: 0.0 to 999.9 [m/min]

About the estimated travel distance on deceleration

◆You can display an estimated travel distance from the deceleration start point to the stopping point to check the consistency of the decelerating pattern.

◆The estimated travel distance on deceleration is an addition of travel distance on deceleration from the elevator operation speed to the creep speed and that from the creep speed to the zero speed and does not include the travel distance by the constant operation at the creep speed (L1+L2+L3 in the graph below).

[Operation pattern]




Description of symbols
L1: Travel distance on deceleration from elevator operation speed to creep speed
L2: Travel distance on deceleration from creep speed to zero speed
L3: Travel distance in delay time specified by C20 "Multistep speed reference agreement timer"

◆The estimated travel distance on deceleration appears on the "Option monitor 1, 2" on the LED monitor of the KEYPAD panel.

◆This function is effective when L04=1 or 2.
Option monitor 1: Travel distance from the operation speed 1 after deceleration operation.
Option monitor 2: Travel distance from the operation speed 2 after deceleration operation.

◆Function data codes used for the estimated travel distance on deceleration.

| Description | L04=1 | | L04=2 | |
|---|---|---|---|---|
| | Code | Name | Code | Name |
| Elevator rated speed | L03 | Elevator rated speed | ← | ← |
| Operation speed 1 | C09 | Multistep speed 5 | ← | ← |
| Operation speed 2 | C11 | Multistep speed 7 | C10 | Multistep speed 6 |
| Creep speed | C07 | Multistep speed 3 | ← | ← |
| Deceleration time from operation speed 1 | F08 | Deceleration time 1 | ← | ← |
| Deceleration time from operation speed 2 | C47 | Deceleration time 2 | ← | ← |
| Deceleration time from creep speed | C36 | Deceleration time JOG | ← | ← |
| S-curve setting on decelerating from operation speed 1 | L10 | S-curve 6 | ← | ← |
| S-curve setting on decelerating from operation speed 2 | L12 | S-curve 8 | ← | ← |
| S-curve setting on reaching creep speed | L07 | S-curve 3 | ← | ← |
| S-curve setting on decelerating from creep speed | L08 | S-curve 4 | ← | ← |
| S-curve setting on reaching zero speed | L06 | S-curve 2 | ← | ← |
| Delay time by the speed reference agreement timer | C20 | Multistep speed reference agreement timer | ← | ← |

**L04** **Preset S-curve**

◆Specifies the application of S-curve setting and the multistep speed.

| L | 0 | 4 | S | - | C | U | R | V | E | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 2

Setting: 0: **VG7S standard multistep speed and S-curve mode**
15 steps of multistep speed (C05 to C19)
S-curve applied to four sections (F67 to F70)

Setting: 1: **Elevator application compatible with VG3N and VG5N**
7 steps of multistep speed (C05 to C11)
S-curve applied to eight sections (L05 to L12)

Setting: 2: **VG7 original elevator application mode**
7 steps of multistep speed (C05 to C11)
S-curve applied to ten sections (L05 to L14)

**L05 - L14** **S-curve set 1 to 10**

| L | 0 | 5 | S | - | C | R | V | | S | E | T | 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

to

| L | 1 | 4 | S | - | C | R | V | | S | E | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

Setting range: 0 to 50 [%]

(1) Introduction to an operation example in each mode

1) VG7S standard multistep speed and S-curve mode

Since this operation mode uses the standard multistep speed and the S-curve, see the description of the individual function codes.

2) Elevator application compatible with VG3N and VG5N

Set ON/OFF to the terminal functions [SS1], [SS2], and [SS4] to switch the multistep speed as described in the following table.

| Terminal function | | | Multistep speed setting | | |
|---|---|---|---|---|---|
| SS4 | SS2 | SS1 | Code | Name | Description |
| OFF | OFF | OFF | - | - | External speed setting |
| OFF | OFF | ON | C05 | Multistep speed 1 | Zero speed |
| OFF | ON | OFF | C06 | Multistep speed 2 | Inching speed |
| OFF | ON | ON | C07 | Multistep speed 3 | Creep speed |
| ON | OFF | OFF | C08 | Multistep speed 4 | Maintenance operation speed |
| ON | OFF | ON | C09 | Multistep speed 5 | Operation speed 1 |
| ON | ON | OFF | C10 | Multistep speed 6 | Zero speed |
| ON | ON | ON | C11 | Multistep speed 7 | Operation speed 2 |

The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

| Speed | | | Acceleration | | Deceleration | |
|---|---|---|---|---|---|---|
| Code | Name | Description | Code | Description | Code | Description |
| C06 | Multistep speed 2 | Inching speed | F07 | Acceleration time 1 | F08 | Deceleration time 1 |
| C07 | Multistep speed 3 | Creep speed | C35 | Acceleration time JOG | C36 | Deceleration time JOG |
| C08 | Multistep speed 4 | Maintenance operation speed | F07 | Acceleration time 1 | F08 | Deceleration time 1 |
| C09 | Multistep speed 5 | Operation speed 1 | F07 | Acceleration time 1 | F08 | Deceleration time 1 |
| C11 | Multistep speed 7 | Operation speed 2 | C46 | Acceleration time 2 | C47 | Deceleration time 2 |

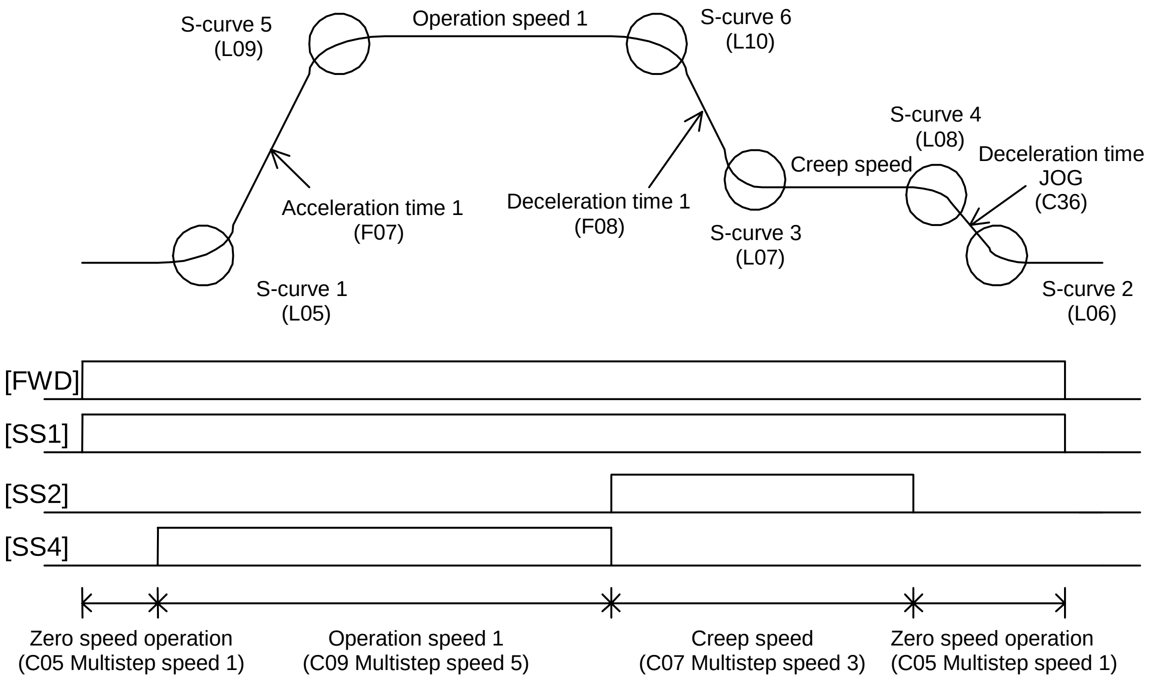
The following table shows how S-curve setting is applied to the multistep speed.

| S curve setting | | Application |
|---|---|---|
| Code | Name | |
| L05 | S-curve 1 | Acceleration start side from Zero speed |
| L06 | S-curve 2 | Deceleration end side to Zero speed |
| L07 | S-curve 3 | Acceleration end side to Creep speed |
| L08 | S-curve 4 | Deceleration start side from Creep speed |
| L09 | S-curve 5 | Acceleration end side to Operation speed 1, Maintenance operation speed, or Inching speed |
| L10 | S-curve 6 | Deceleration start side from Operation speed 1, Maintenance operation speed, or Inching speed |
| L11 | S-curve 7 | Acceleration end side to Operation speed 2 |
| L12 | S-curve 8 | Deceleration start side from Operation speed 2 |

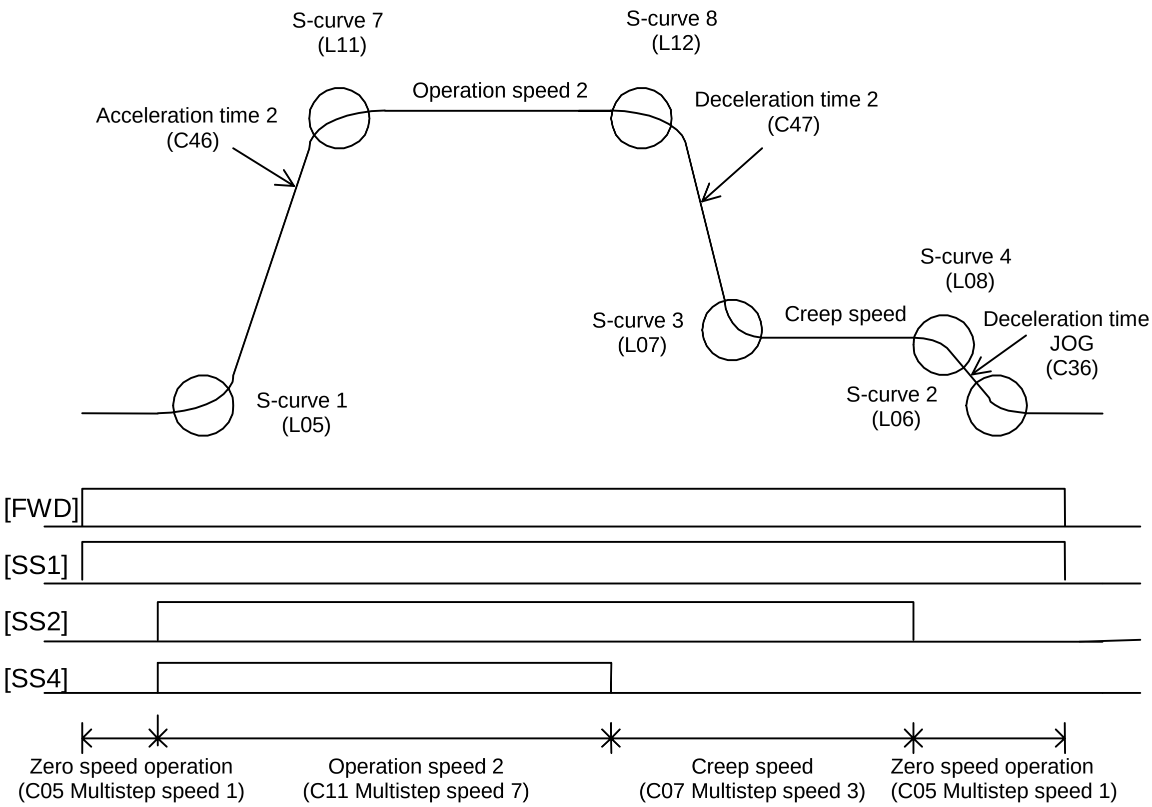
### About emergency stop

When the operation command (FWD, REV) is set to OFF, the inverter decelerates linearly neglecting the S-curve setting. The deceleration time follows the C67 "Deceleration time 4".

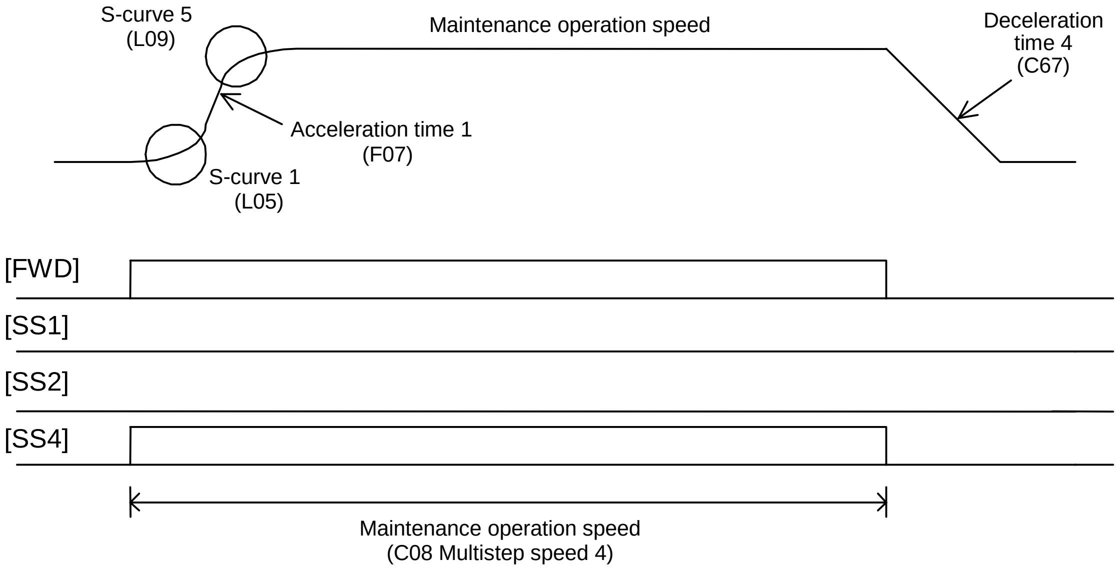
(a) Operation speed 1



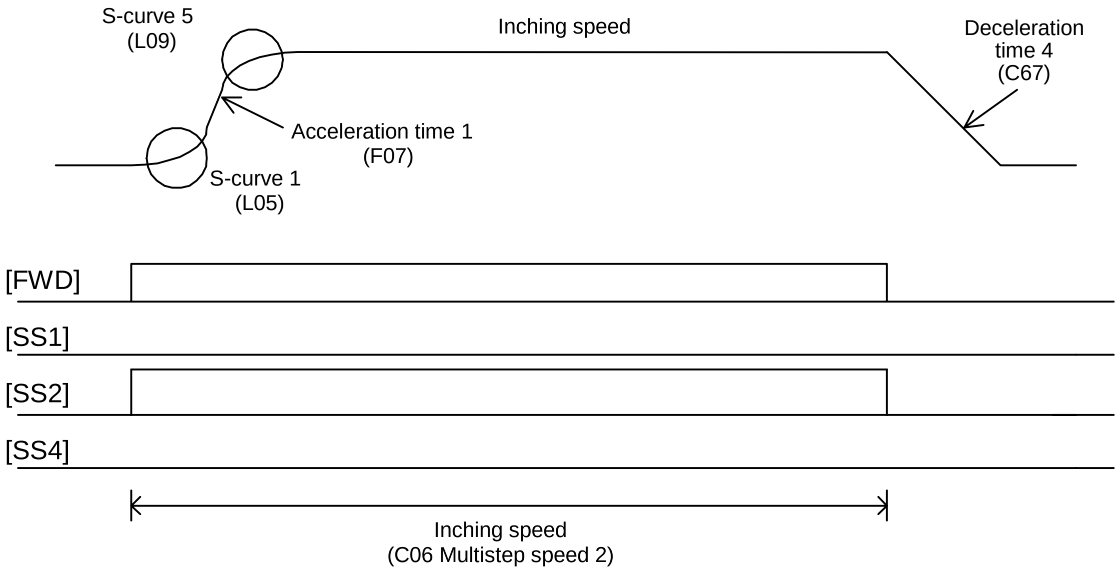

(b) Operation speed 2



(c) Maintenance operation speed




(d) Inching speed



# 4. Control and Operation

3) VG7 original elevator application mode

Set ON/OFF to the terminal functions [SS1], [SS2], and [SS4] to switch the multistep speed as described in the following table.

| Terminal function | | | Multistep speed setting | | |
|---|---|---|---|---|---|
| SS4 | SS2 | SS1 | Code | Name | Description |
| OFF | OFF | OFF | - | - | Zero speed |
| OFF | OFF | ON | C05 | Multistep speed 1 | Emergency elevator speed |
| OFF | ON | OFF | C06 | Multistep speed 2 | Inching speed |
| OFF | ON | ON | C07 | Multistep speed 3 | Creep speed |
| ON | OFF | OFF | C08 | Multistep speed 4 | Maintenance operation speed |
| ON | OFF | ON | C09 | Multistep speed 5 | Operation speed 1 |
| ON | ON | OFF | C10 | Multistep speed 6 | Operation speed 2 |
| ON | ON | ON | C11 | Multistep speed 7 | Operation speed 3 |

The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

| Speed | | | Acceleration | | Deceleration | |
|---|---|---|---|---|---|---|
| Code | Name | Description | Code | Description | Code | Description |
| C05 | Multistep speed 1 | Emergency elevator speed | C56 | Acceleration time 3 | C57 | Deceleration time 3 |
| C06 | Multistep speed 2 | Inching speed | F07 | Acceleration time 1 | F08 | Deceleration time 1 |
| C07 | Multistep speed 3 | Creep speed | C35 | Acceleration time JOG | C36 | Deceleration time JOG |
| C08 | Multistep speed 4 | Maintenance operation speed | F07 | Acceleration time 1 | F08 | Deceleration time 1 |
| C09 | Multistep speed 5 | Operation speed 1 | F07 | Acceleration time 1 | F08 | Deceleration time 1 |
| C10 | Multistep speed 6 | Operation speed 2 | C46 | Acceleration time 2 | C47 | Deceleration time 2 |
| C11 | Multistep speed 7 | Operation speed 3 | C56 | Acceleration time 3 | C57 | Deceleration time 3 |

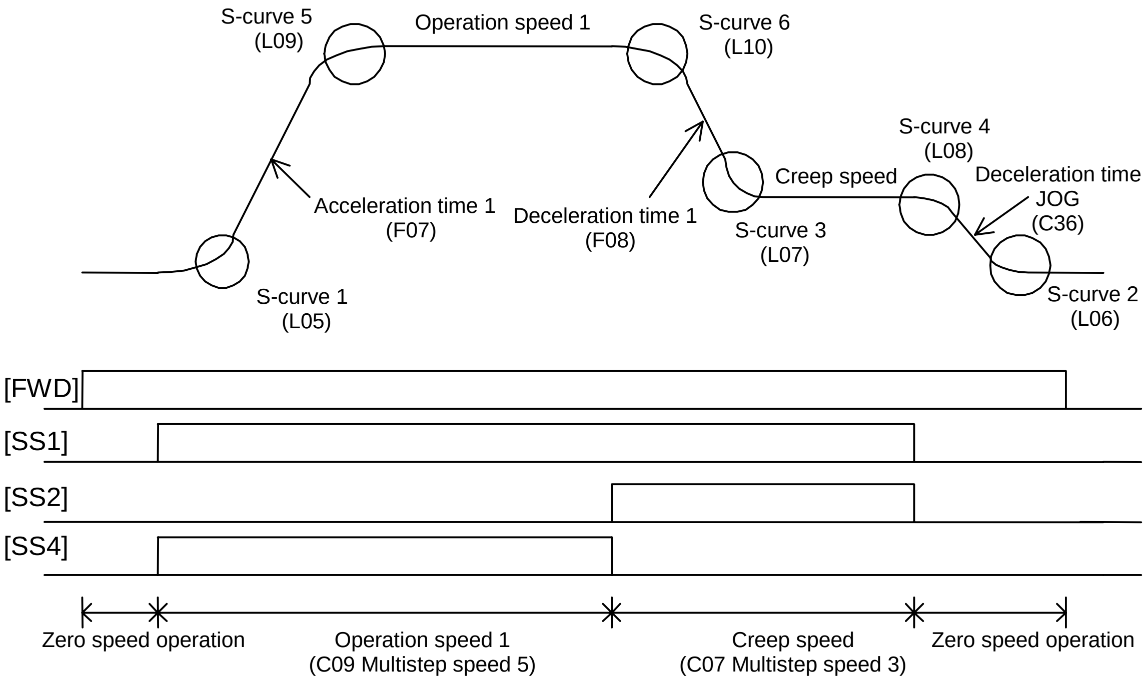
The following table shows how S-curve setting is applied to the multistep speed.

| S curve setting | | Application |
|---|---|---|
| Code | Name | |
| L05 | S-curve 1 | Acceleration start side from Zero speed |
| L06 | S-curve 2 | Deceleration end side to Zero speed |
| L07 | S-curve 3 | Acceleration end side to Creep speed |
| L08 | S-curve 4 | Deceleration start side from Creep speed |
| L09 | S-curve 5 | Acceleration end side to Operation speed 1, Maintenance operation speed, or Inching speed |
| L10 | S-curve 6 | Deceleration start side from Operation speed 1, Maintenance operation speed, or Inching speed |
| L11 | S-curve 7 | Acceleration end side to Operation speed 2 |
| L12 | S-curve 8 | Deceleration start side from Operation speed 2 |
| L13 | S-curve 9 | Acceleration end side to Operation speed 3 or Emergency elevator speed |
| L14 | S-curve 10 | Deceleration start side from Operation speed 3 or Emergency elevator speed |

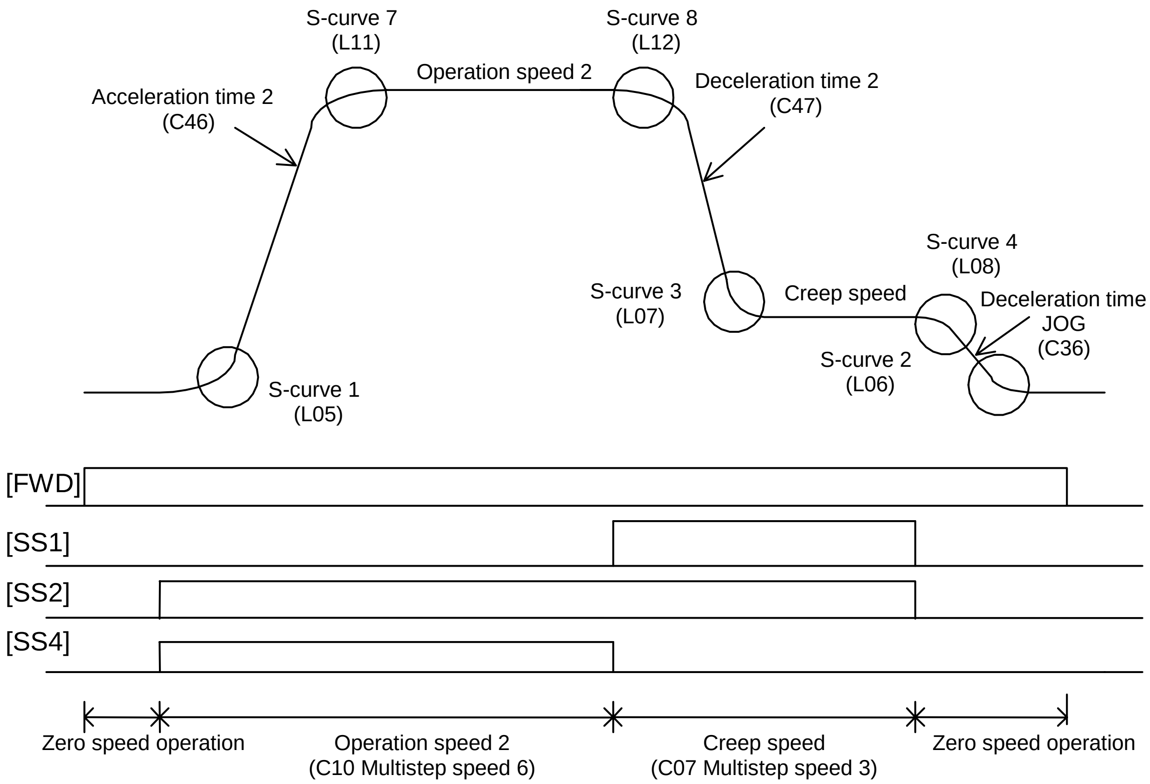
About emergency stop

When the operation command (FWD, REV) is set to OFF, the inverter decelerates linearly neglecting the S-curve setting. The deceleration time follows the C67 "Deceleration time 4".

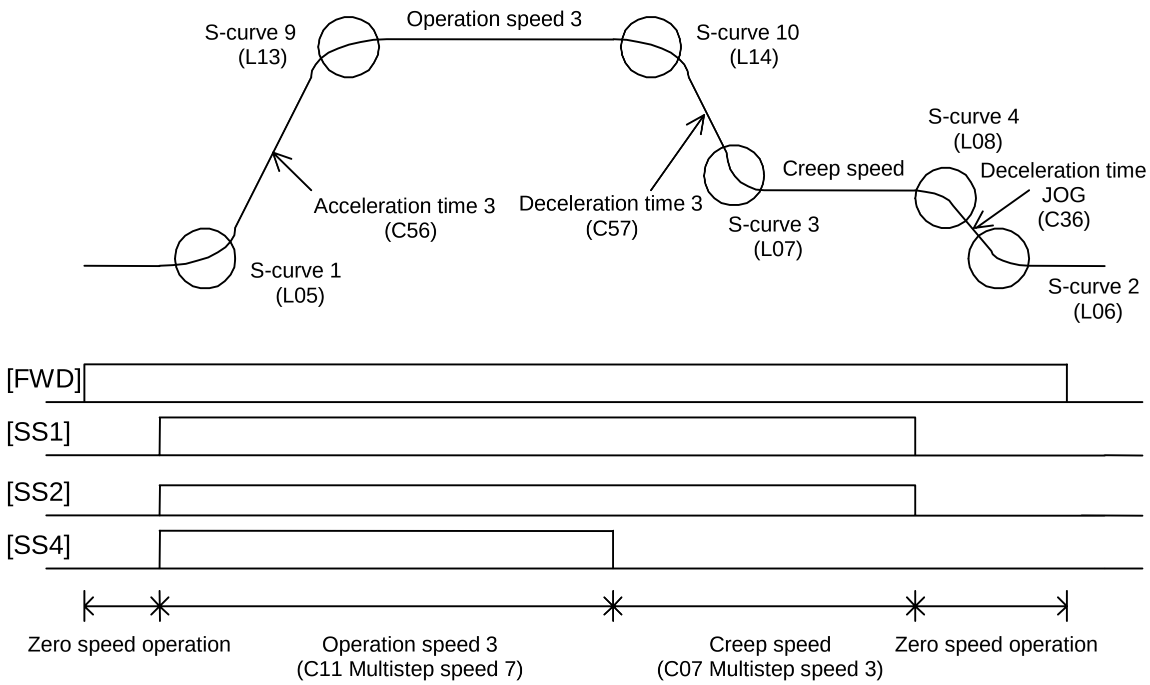
(a) Operation speed 1



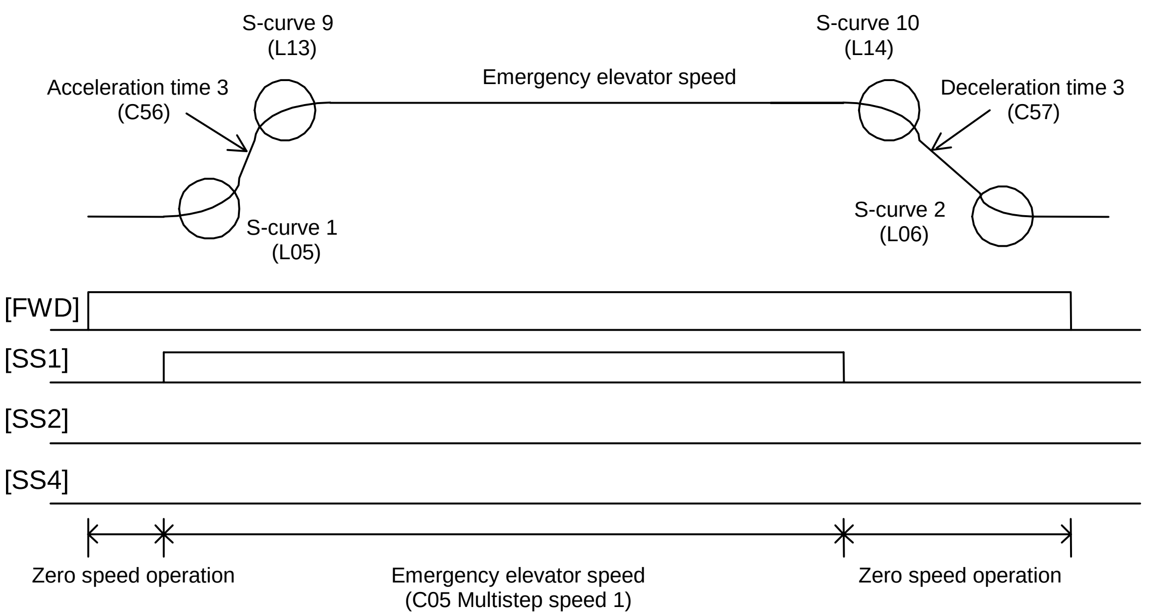

(b) Operation speed 2



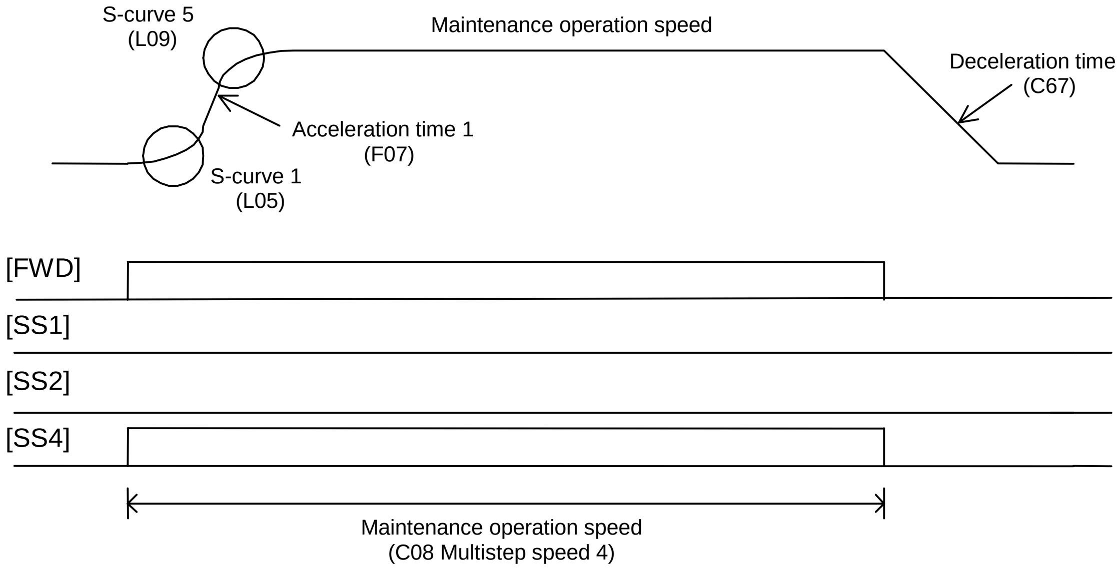
(c) Operation speed 3



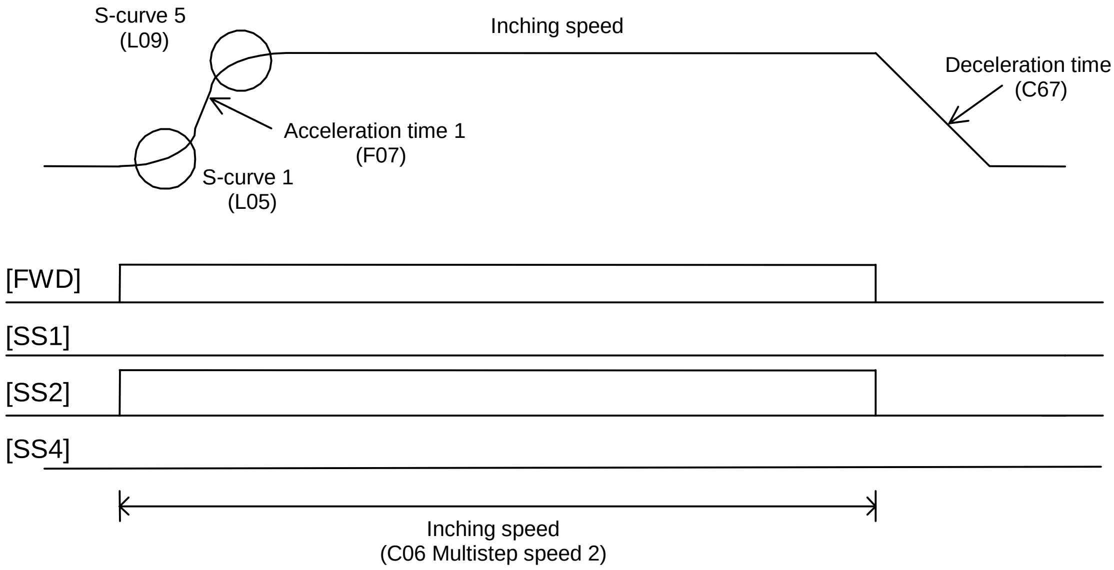

(d) Emergency elevator speed



(e) Maintenance operation speed

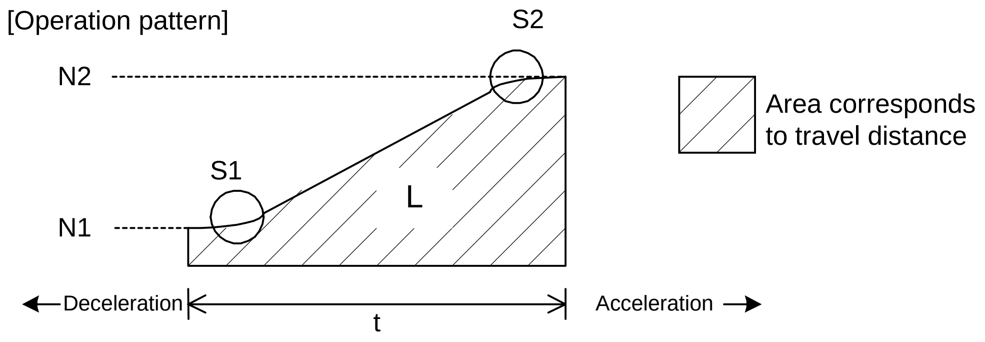



(f) Inching speed



# 4. Control and Operation

(1) How to calculate acceleration/deceleration times and travel distance




[Description of symbols]

Nmax [r/min]: Maximum motor speed
N1 [r/min] : Speed reference before acceleration (after deceleration)
N2 [r/min] : Speed reference after acceleration (before deceleration)
S1 [%]: S-curve portion at the beginning of acceleration (at the end of deceleration)
S2 [%]: S-curve portion at the end of acceleration (at the beginning of deceleration)
T [s] : Acceleration (deceleration) reference time (time from zero to Nmax (Nmax to 0))
Vmax [m/min]: Elevation speed at the maximum motor speed (Maximum elevation speed)
t [s] : Acceleration (deceleration) time
L [m] : Travel distance

1) When the S curve portion fits in a specified speed range ………… $\frac{N2-N1}{Nmax} \geq \frac{S1+S2}{100}$

Acceleration (deceleration) time

$$t = \left(\frac{N2-N1}{Nmax} + \frac{S1+S2}{100}\right) \times T \quad \text{[Equation 1]}$$

Travel distance

$$L = \frac{T \times Vmax}{120} \times \left[\frac{S1^2 - S2^2}{30000} + \frac{S2}{50} \times \frac{N2-N1}{Nmax} + \left(\frac{N2-N1}{Nmax}\right)^2\right] + \frac{t \times Vmax}{60} \times \frac{N1}{Nmax}$$

……………………………… [Equation 2]

2) When the S curve portion exceeds a specified speed range ……… $\frac{N2-N1}{Nmax} < \frac{S1+S2}{100}$

Acceleration (deceleration) time

$$t = \frac{S1+S2}{50}\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}} \times T \quad \text{[Equation 3]}$$

Travel distance

$$L = \left(\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}}\right)^3 \times \frac{T \times Vmax}{90} \times \frac{S1^2 + 2 \times S2^2 + 3 \times S1 \times S2}{10000} \times \frac{t \times Vmax}{60} \times \frac{N1}{Nmax}$$

……………………………… [Equation 4]

## 4.4 Function Description (Arranged by Function)

### 4.4.1 If You Think Defective

⚠ **WARNING**

- After the inverter protective function was activated and you removed the cause, if you reset the alarm while the operation command has been set to ON, the inverter restarts. Reset the alarm after you confirm the operation command has been set to OFF.

**You may be injured.**

### If you think defective

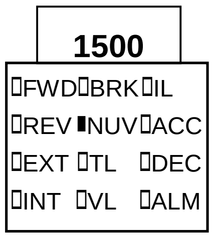
An inverter may not operate as instructed while you think you specified the operation command and the speed reference properly or you may not reset the alarm to restart operation. Also an alarm may occur frequently to obstruct the operation of a facility.
If this is the case, use the KEYPAD panel to identify the cause of the malfunction or the alarm. If you still cannot identify the cause or you suspect an inverter fault or damaged parts, contact the shop you purchased the inverter or the FUJI's sales representative.

#### 4.4.1.1 What You Should Check First

This section describes how to use the KEYPAD panel to investigate causes though the protective function is not activated, but an inverter does not operate as instructed. Then the flowcharts illustrate the procedures.

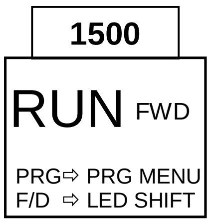
(1) Is the inverter ready for operation?

It takes about one second before an inverter becomes ready for operation after you turn on the main circuit. You can view the "CHARGE" lamp on the front of an inverter with 18.5 kW or more capacity to confirm this state. Also you should use the "I/O check" screen of the KEYPAD panel to check if "■NUV" is displayed as shown in the right figure. This status indicates that the inverter is ready for operation.
If "□NUV" is displayed, the power may not be supplied to the inverter. Check the input power line to the main circuit.
When you do not use a DCR, you should connect a jumper wire between P1 and P(+) terminals. Check if the jumper wire is not disconnected.




(2) Have you instructed an operation command?

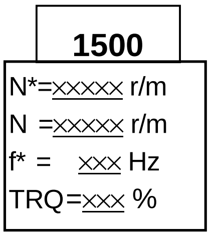
Following the procedure described above to confirm that the inverter is ready.
When you direct the operation command (FWD), "RUN" must be displayed as in the right figure.
If the display remains "STOP", the inverter has not received your operation command.
When you enter the operation command from the KEYPAD panel, a green indicator RUN LED turns on.
You can see the indicator on the LCD monitor to check the available source of the operation command (LOC: KEYPAD panel, REM: External signal, and COMM: link).
You should change the function code F02 "Operation method" and H30 "Serial link" to change the source of the operation command.
If you have installed an option, you cannot use RS485 to enter the operation command (the option has higher priority). When you have several options, the priority may be fixed. See the description of applicable options.



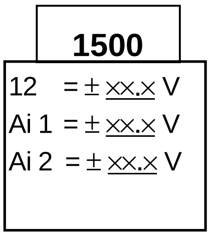
When you use the UPAC, you should enter the operation command as well.  See the description of the UPAC for more details.

(3) Have you entered the speed reference?

Confirm the speed reference (N*) on the "Operation monitor" when you have directed the speed reference by the KEYPAD panel, external analog input, or through the link (T-Link or RS485) or the UPAC.  If the "N*" is blank, the inverter has not received the speed reference.




When you use the analog input [12] to provide the speed reference, you can check the voltage on the "I/O check" screen of the KEYPAD panel.
Since the displayed voltage is the one the inverter recognizes, you can check the [12] input on this screen.
When you use the [12] and the value fluctuates, you can check if the analog reference itself fluctuates.
In the same manner, check the auxiliary speed reference supplied to the analog input Ai1 and Ai2.

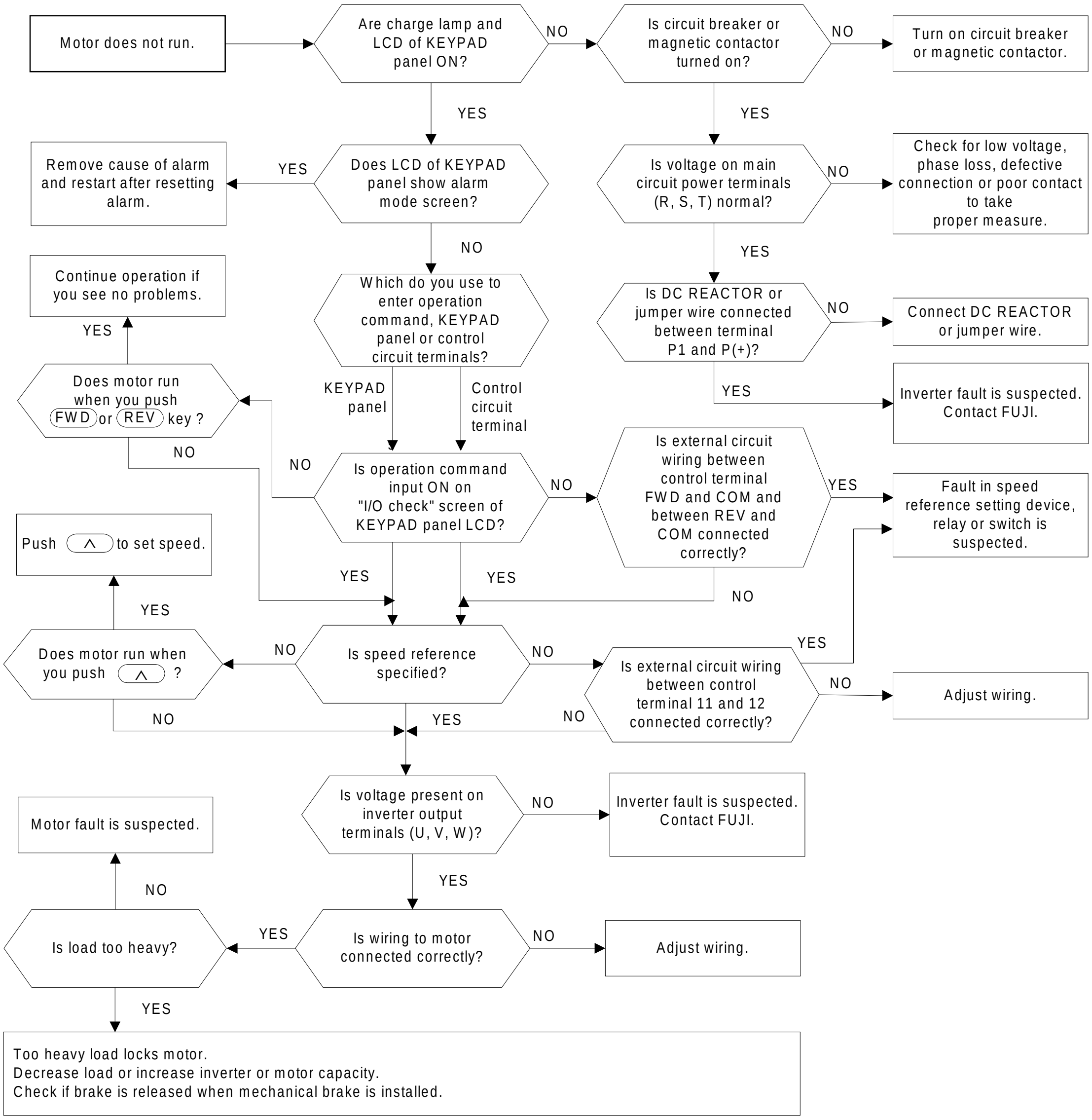


## 4.4.1.2 Diagnosing Unstable Operation

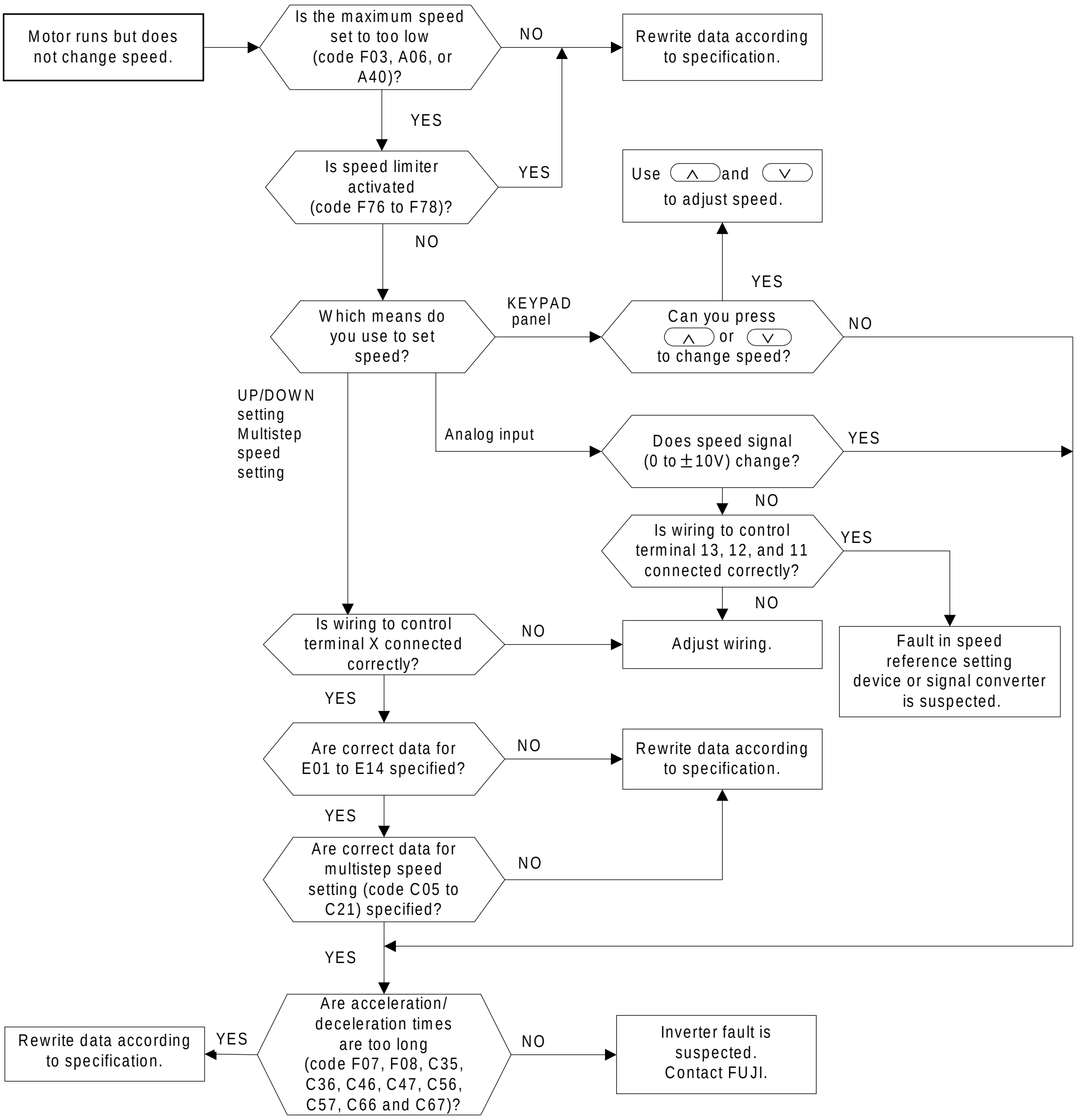
This section shows individual flowcharts for vector control, sensorless vector control and V/f control.

(1) Vector control and sensorless vector control

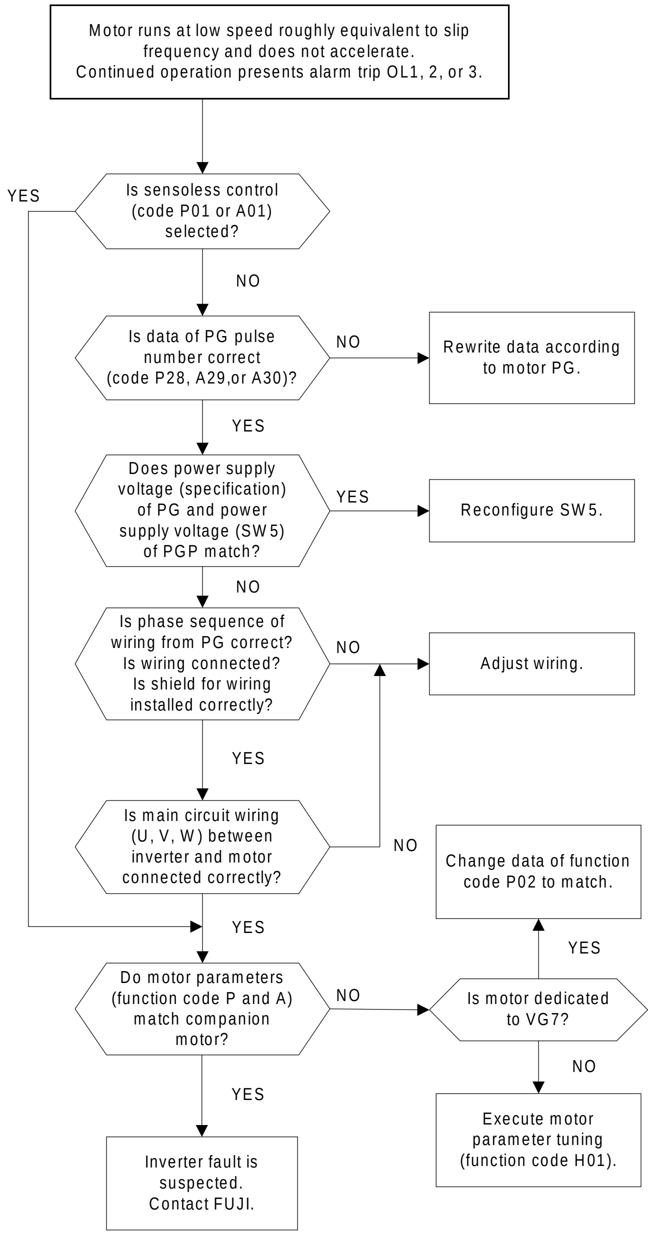
1) Motor does not run.



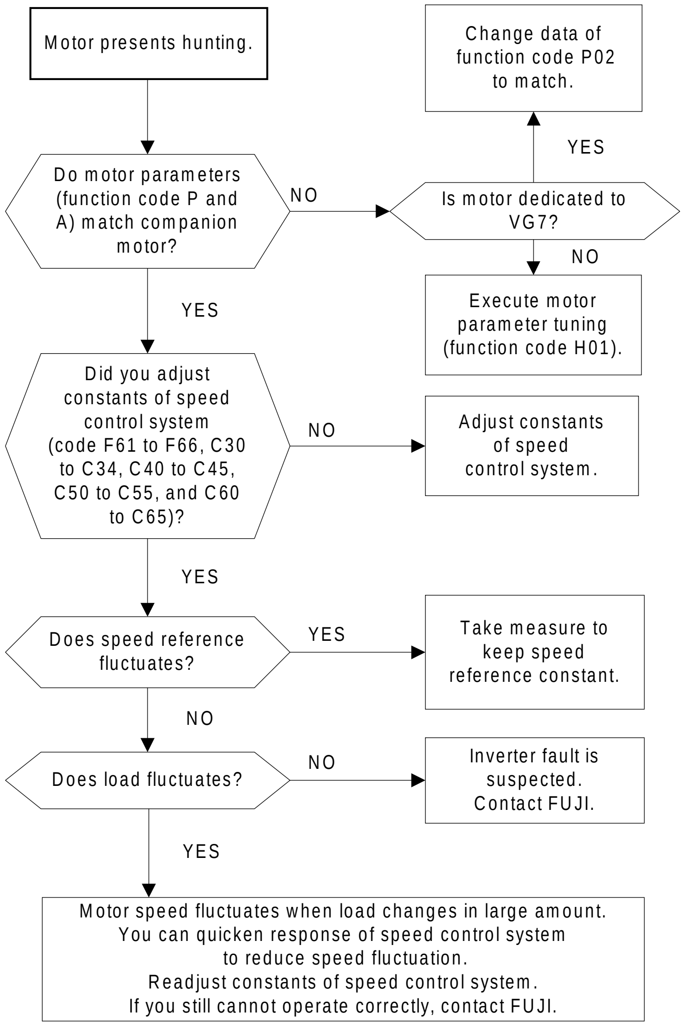
2) Motor runs but does not change speed



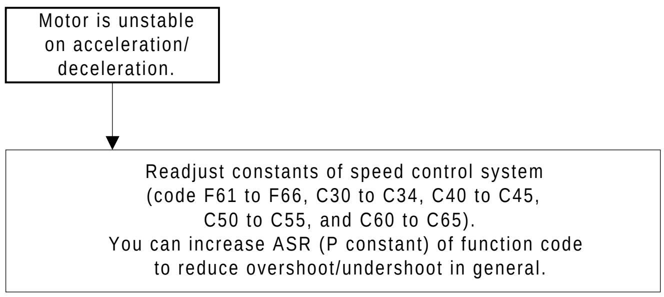
## 3) Motor runs only at low speed



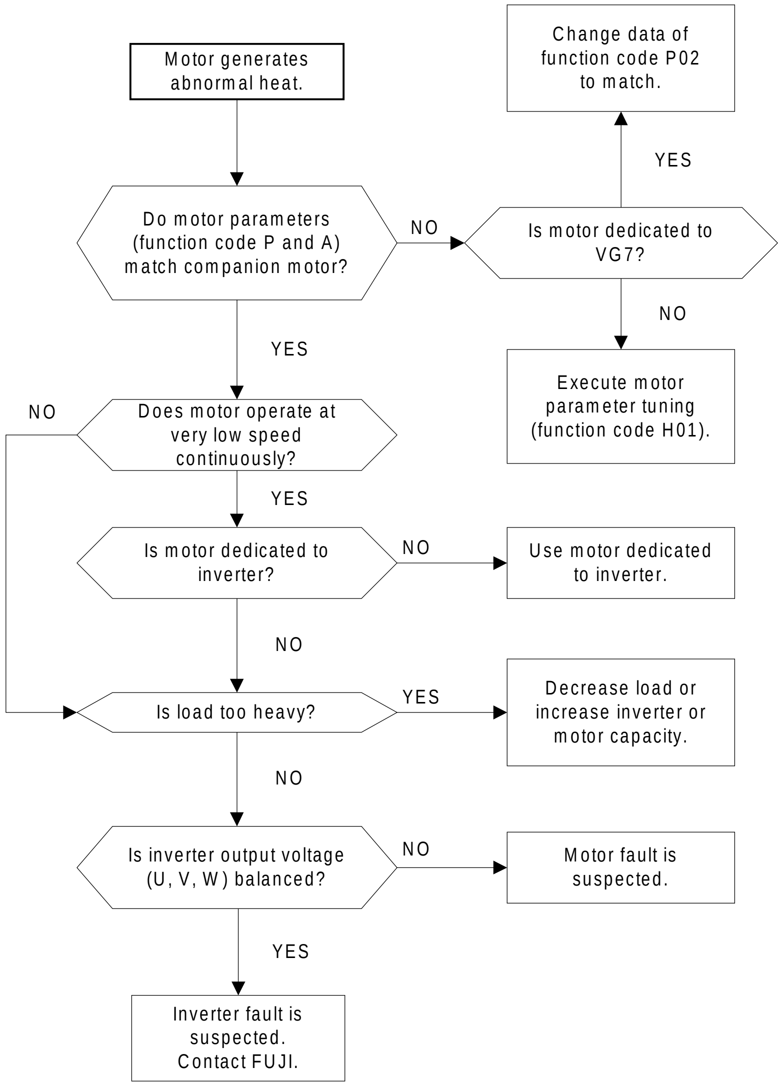
4) Motor presents hunting




5) Motor is unstable on acceleration/deceleration



6) Motor generates abnormal heat

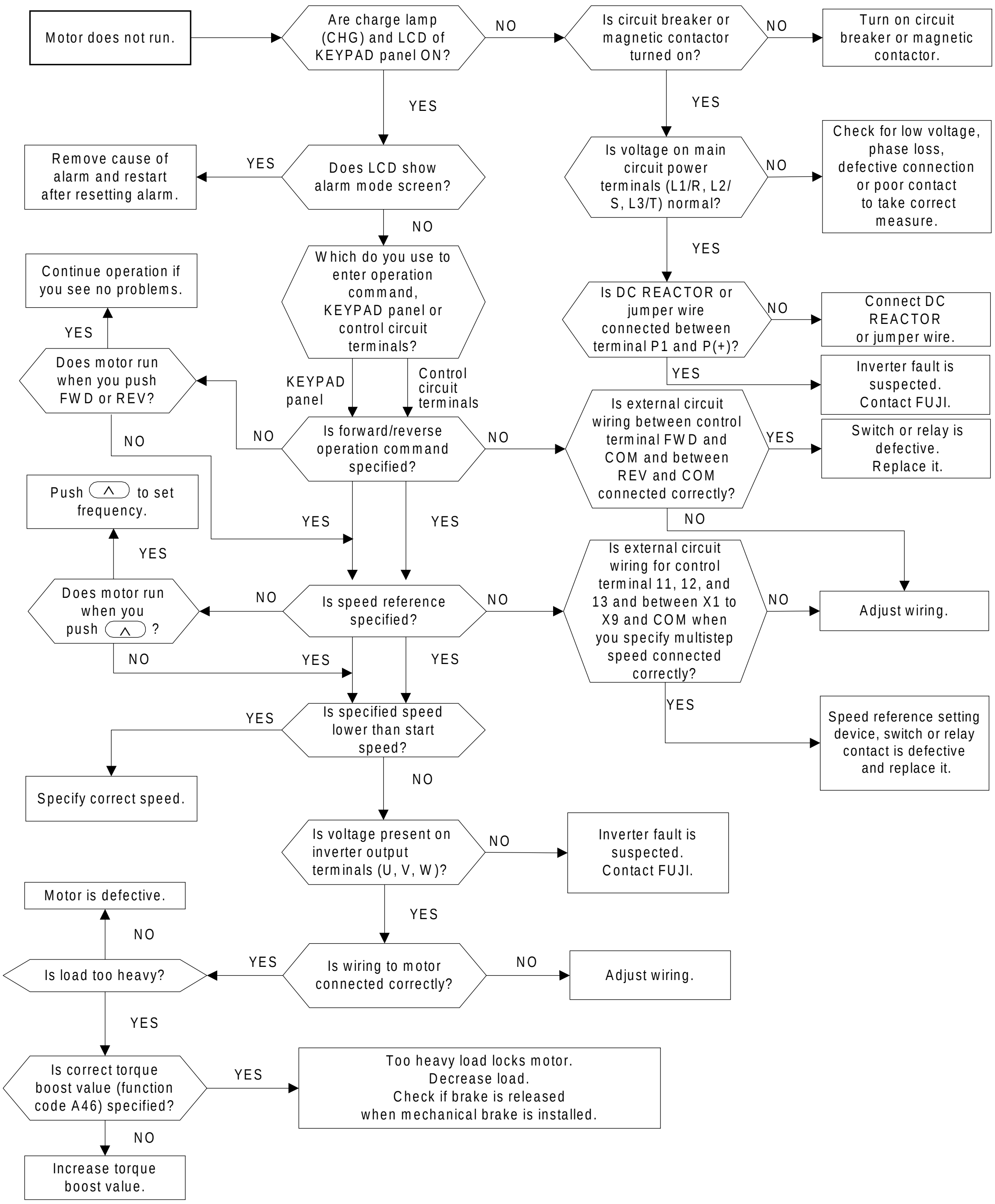



7) Motor runs inversely against direction reference

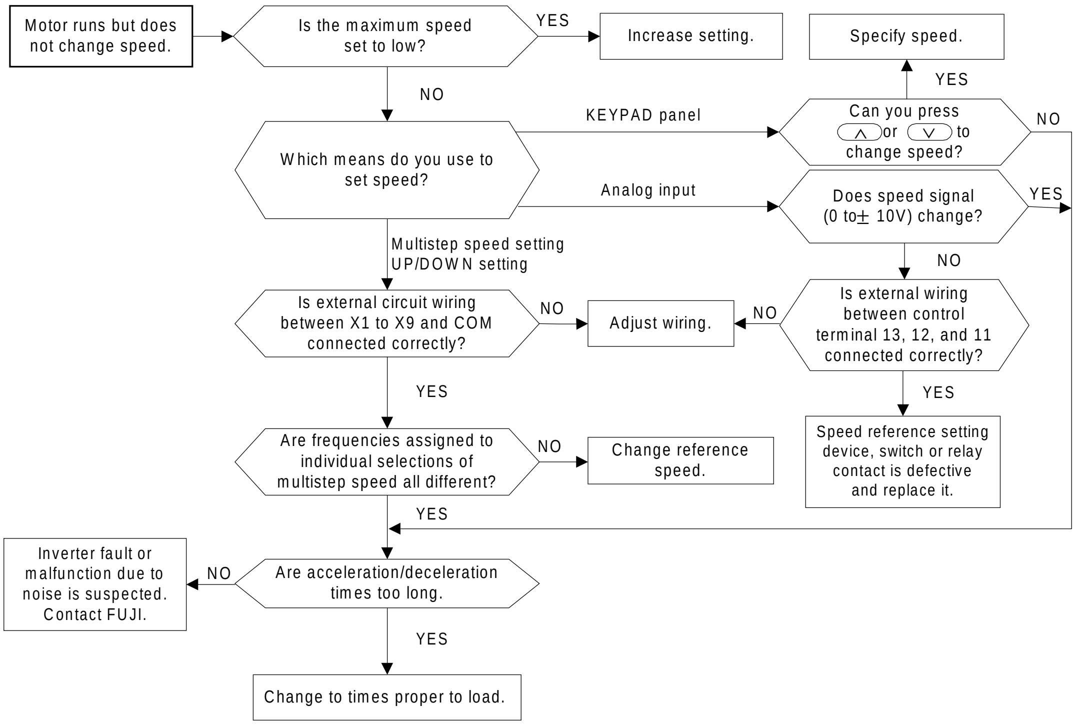
Phase sequence of main circuit wiring (U, V, W) between inverter and motor does not match in sensorless control.
Or, function data for speed reference are incorrect.

(2) V/f control

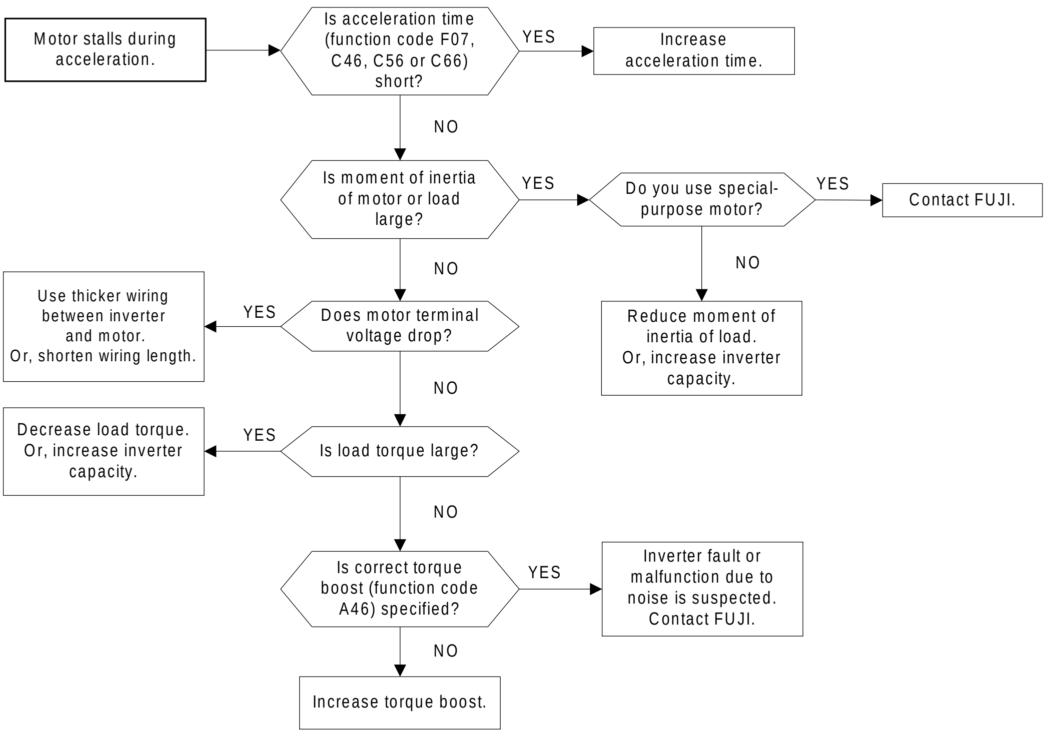
1) Motor does not run.



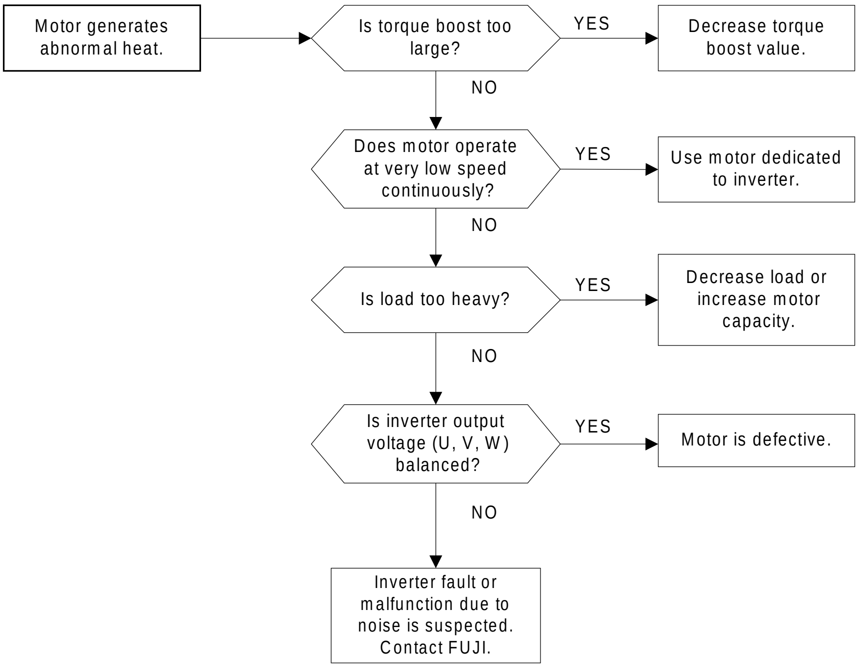
## 2) Motor runs but does not change speed




## 3) Motor stalls during acceleration



4) Motor generates abnormal heat



## 4.4.1.3 List of Inverter Protective Functions

| ⚠WARNING |
|---|
| • The motor coasts when an alarm is issued. Install a brake on the driven machine side if you need to stop the motor.<br>**An accident may occur.**<br>• When you reset the inverter while applying the operation command, the motor restarts suddenly. Make sure the operation command is turned off before you restart. |

| Function | Description | Display | Related function code |
|---|---|---|---|
| DB resistor overheating | When the built-in braking resistor overheats, the inverter stops discharging and running.<br>You must set the function codes E35 to 37 corresponding to the resistor (built-in/external). | dbH | E35 - 37 |
| DC fuse blown | When a fuse at the main DC circuit blows due to a short-circuit in the IGBT circuit, the inverter stops operation. This function prevents secondary disaster. A damage to the inverter is suspected and contact FUJI immediately. | dCF | |
| Ground fault | Activated by a ground fault in the inverter output circuit. If a large current flows due to ground fault, the overcurrent protective function may operate to protect the inverter. Connect a separate earth-leakage protection relay or an earth-leakage circuit breaker for accident prevention such as human damage and fire. | EF | |
| Excessive position deviation | Activated when the position deviation between the reference and the detected values exceeds the function code o18 "Excessive deviation value" in synchronized operation.<br>The option code "o" becomes valid and is displayed on the KEYPAD panel after installing options. | d0 | o18 |
| Memory error | Activated when a fault such as "write error" occurs in the memory. | Er1 | |
| KEYPAD panel communication error | Activated if a communication error is detected between the inverter control circuit and the KEYPAD panel when the start/stop command from the KEYPAD is valid (function code F02=0).<br>Note: KEYPAD panel communication errors do not indicate the alarm display and issue the alarm relay output when the inverter is operated by external signal input or the link function.<br>The inverter continues operating. | Er2 | F02 |
| CPU error | Activated when a CPU error occurs due to noise. | Er3 | |
| Network error | Activated if a communication error occurs due to noise when the inverter is operated through T- Link, SX bus or field bus. | Er4 | o30,31 |
| RS485 communication error | Activated if:<br>- RS485 communication error occurs while the function code H32 is set to 0 to 2.<br>- A disconnection continues for more than the specified period of 0.1 to 60.0 with the function code H38. | Er5 | H32,H33<br>H38 |
| Operation procedure error | Activated if multiple network options (T- Link, SX bus, and field bus) are installed. Though you can install multiple SI, DI and PG options, this error is issued if the two SW settings are identical. | Er6 | |
| Output wiring error | Activated when the measured data are out of the motor characteristic data range during executing tuning or the wires are not connected in the inverter output circuit. | Er7 | H01,H71 |
| A/D converter error | Activated when an error occurs in the A/D converter circuit. | Er8 | |
| Speed disagreement | Activated when the deviation between the speed reference (speed setting) and the motor speed (detected speed, predicted speed) becomes excessive. | Er9 | |
| UPAC error | Activated on a hardware fault in the UPAC option or a communication error between the inverter control circuit and the UPAC option. | ErA | |

| Function | Description | Display | Related function code |
|---|---|---|---|
| Inter-inverter communication error | Activated if a communication error occurs in inter-inverter communication over the optical option or simplified RS485. | Erb | |
| Input phase loss | The inverter is protected from being damaged due to input phase loss. | Lin | |
| Undervoltage | Activated if the DC link circuit voltage decreases to the undervoltage level due to a reduction in the supply voltage. The alarm output is not issued when the DC link circuit voltage decreases and the function code F14 is set to "3 to 5".<br>■ Undervoltage detection level:<br>200V series: 186Vdc, 400V series: 371Vdc. | LU | F14 |
| NTC thermistor disconnection | Activated if the thermistor circuit is disconnected when the application of NTC thermistors to corresponding motors (M1, 2, 3) is specified with the function codes P30, A31 and A47. | nrb | P30,A31, A47 |
| Overcurrent | Activated if the momentary value of the inverter output current exceeds the overcurrent detection level due to a short-circuit or ground fault. | OC | |
| Overheating at heat sink | Activated if the temperature of the heat sink to cool the rectifier diodes and the IGBTs increases due to cooling fan stoppage. | OH1 | |
| External alarm | The inverter stops on receiving the external alarm signal (THR). It is activated by a terminal signal when the control circuit terminals (THR assignment) are connected to alarm terminals of external devices such as a braking unit or a braking resistor. | OH2 | E01 - E04 |
| Inverter internal overheat | Activated if the ambient temperature of the control PC board increases due to poor ventilation of the inverter. | OH3 | |
| Motor overheat | Activated if the temperature detected by the NTC thermistor built in the VG7 dedicated motor exceeds the data of the function code E30 "Motor overheat protection". | OH4 | E30,E31 |
| Motor 1 overload | Activated when the motor 1 current (inverter output current) exceeds the operation level set by function code F11. | OL1 | F11 |
| Motor 2 overload | Activated when the motor 2 current (inverter output current) exceeds the operation level set by function code A33. | OL2 | A33 |
| Motor 3 overload | Activated when the motor 3 current (inverter output current) exceeds the operation level set by function code A49. | OL3 | A49 |
| Inverter unit overload | Activated if the output current exceeds the overload characteristic of the inverse time characteristic. | OLU | |
| Overspeed | Activated if the motor speed (detected speed value/predicted speed value) exceeds 120% of the specified value by the function code "maximum speed". | OS | F03,A06, A40 |
| Overvoltage | Activated if the DC link circuit voltage exceeds the overvoltage level due to an increase of supply voltage or regenerative braking current from the motor. However, the inverter cannot be protected from excessive voltage (high voltage, for example) supplied by mistake.<br>■ Overvoltage detection level<br>200V series: 400Vdc, 400V series: 800Vdc | OU | |
| PG error | Activated when the pulse generator terminal PA/PB circuits are disconnected. It is not activated when the sensorless control or the V/f control is selected. | Pg | |
| Charging circuit error | Activated if the bypass circuit of the DC link circuit is not formed (the magnetic contactor for the charging circuit bypass is not closed) two minutes after power is supplied. | PbF | |

Note 1: All protective functions are reset automatically if the control power voltage decreases to where maintaining the operation of the inverter control circuit is impossible.

Note 2: Fault history data is stored for the last ten trips.

Note 3: Stoppage due to a protective function can be reset by the RST key of the KEYPAD or turning OFF and then ON between the X terminal (RST assigning) and the CM. Note that this action is invalid if the cause of an alarm is not found and resolved.

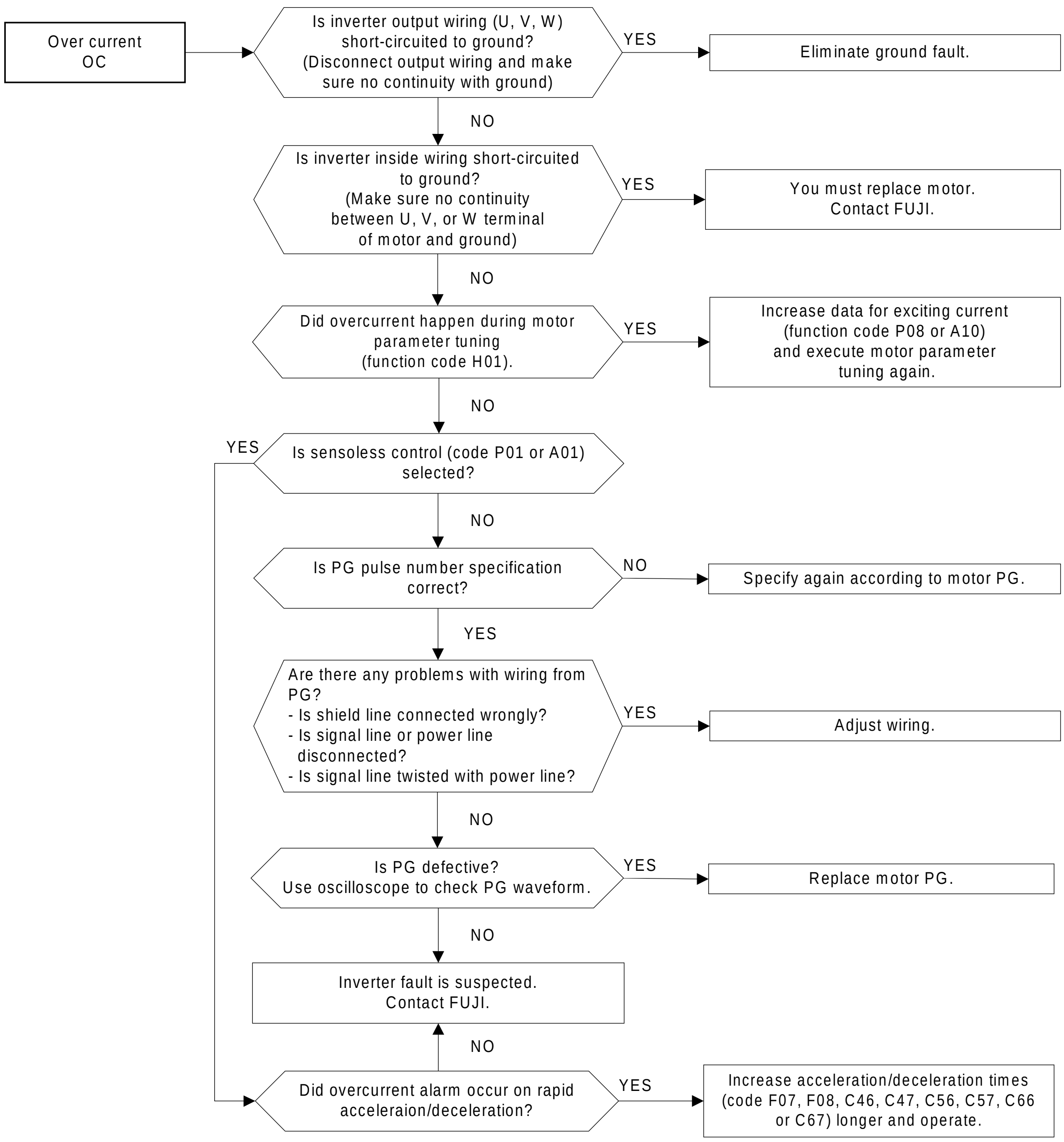
Note 4: In addition to these protective functions, there can be further protective from surge voltage by connecting surge suppressors to the main circuit power terminals (L1/R, L2/S, L3/T) and the auxiliary control power terminals (R0, T0).

## 4.4.1.4 Diagnosing Activated Protective Function

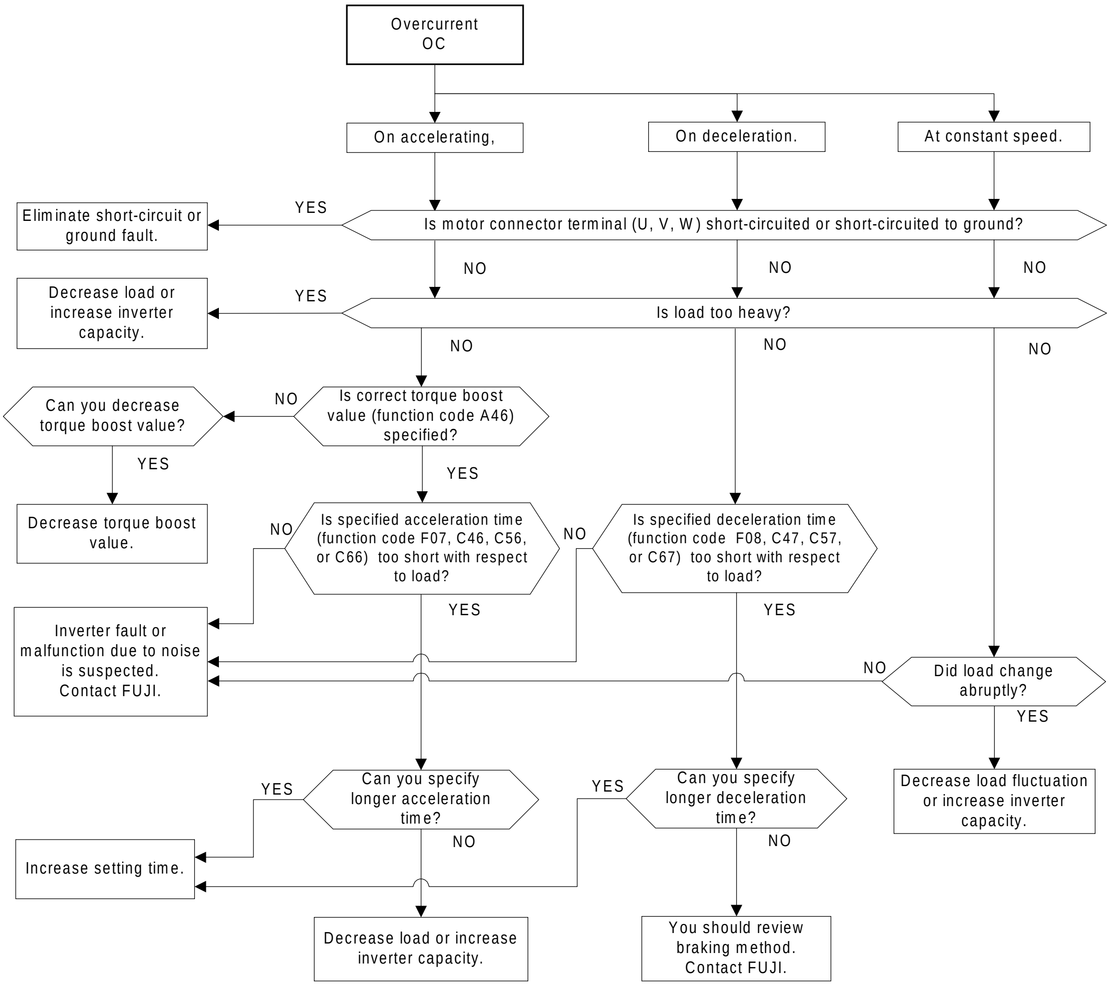
VG7 inverter includes various protective functions to prevent damages to connected machines, accidents, fires or physical injuries of customers.
When the protective function is activated, the inverter immediately trips (discontinues output) and enters into the alarm mode. The alarm mode displays the description of the alarm on the LCD screen of the KEYPAD panel, flashes alarm code (such as OC or OH1) on the LED display and informs the customer of the alarm mode. The trip (discontinued output) shifts the rotating motor into coasting state.
The alarm mode continues until you enter the reset command. Make sure to direct the reset command after you isolate the source of the alarm or replace parts.
When you have eliminated the source of the alarm, the inverter returns to the operation mode on the reset command and is ready to restart.

(1) Overcurrent

1) Vector control and sensorless vector control

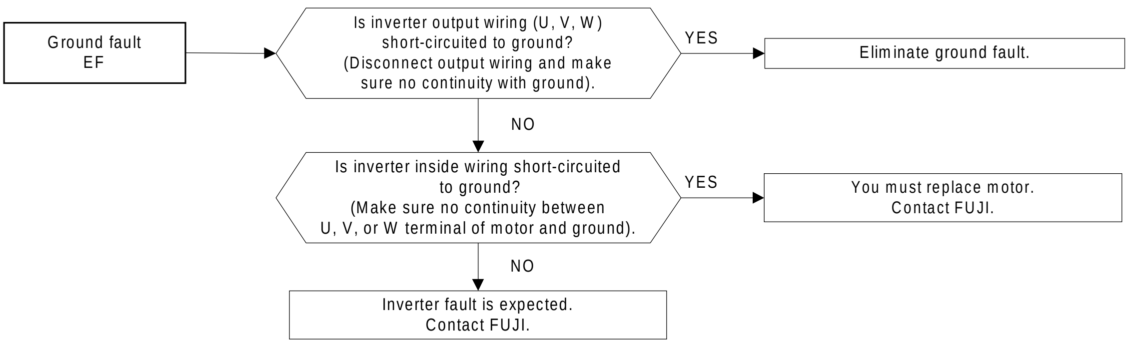


2) V/f control




## (2) Ground fault

| ⚠WARNING |
|---|
| • Eliminate the cause before turn on the power. **You may start fire.** |

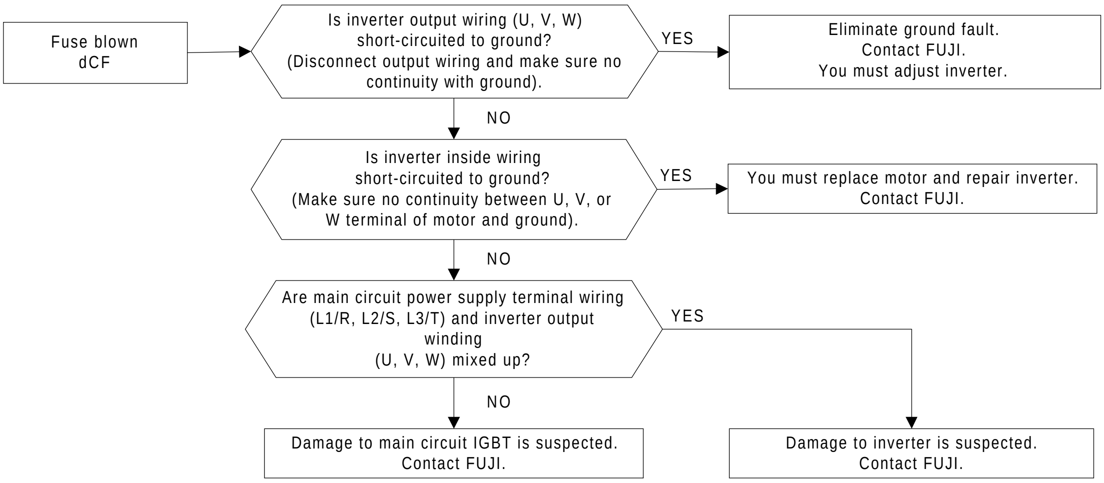



Note: The protective function from ground fault is installed on models of 18.5kW or more.

(3) Fuse blown

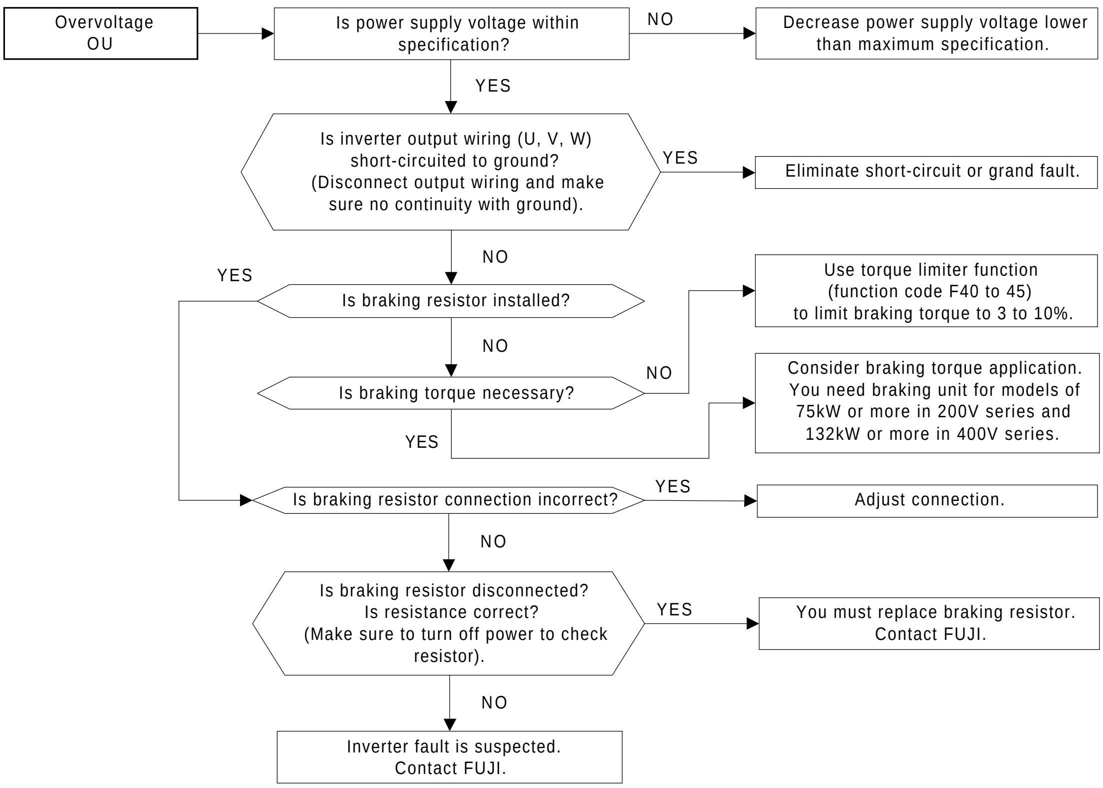
| ⚠WARNING |
|---|
| • Replace inverter before turn on the power.<br>**You may start fire.** |

The fuse is provided to prevent a secondary disaster such as a fire. You cannot operate inverter with the fuse blown. When this alarm is issued, turn off the power immediately, identify the cause following the description below, and replace the inverter.
When this alarm is issued, do not turn on the power and contact us.

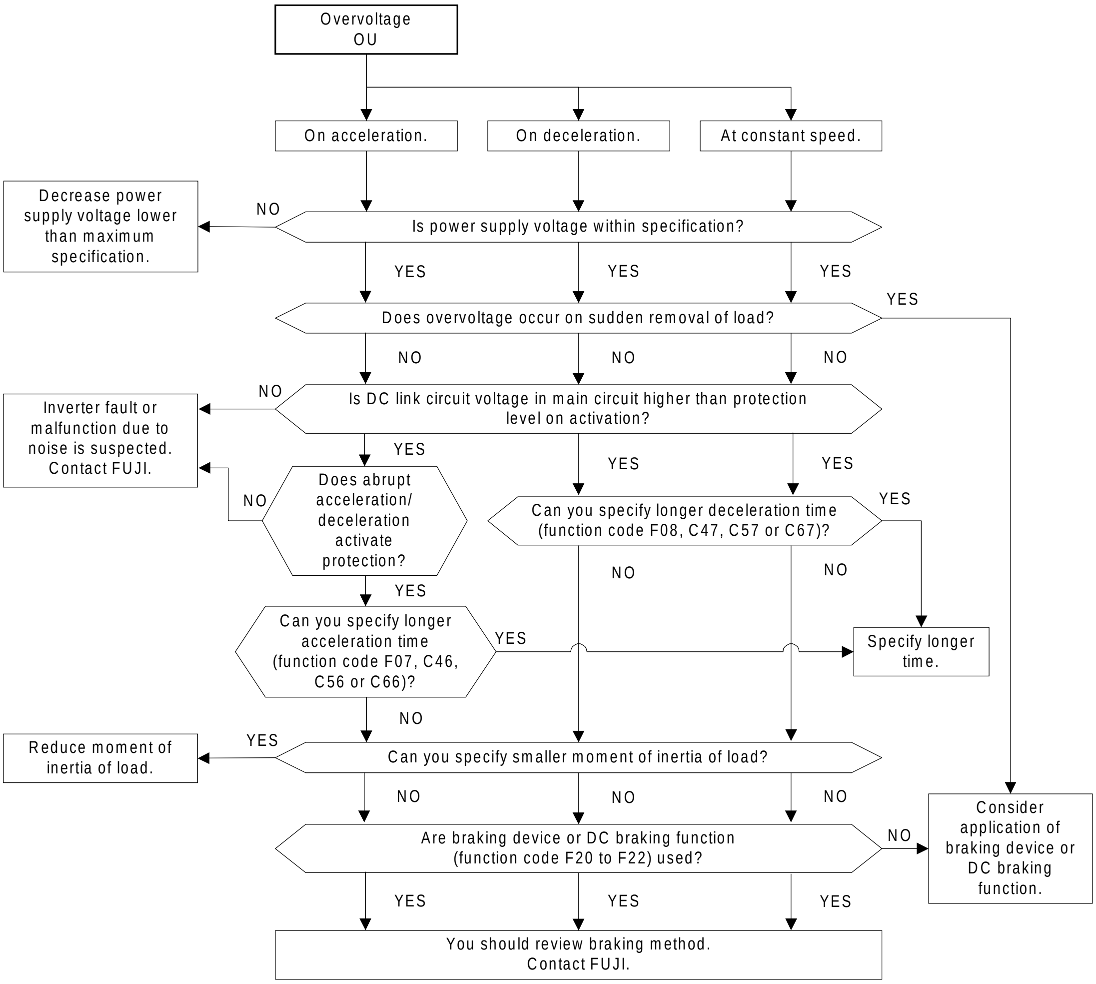



(4) Overvoltage

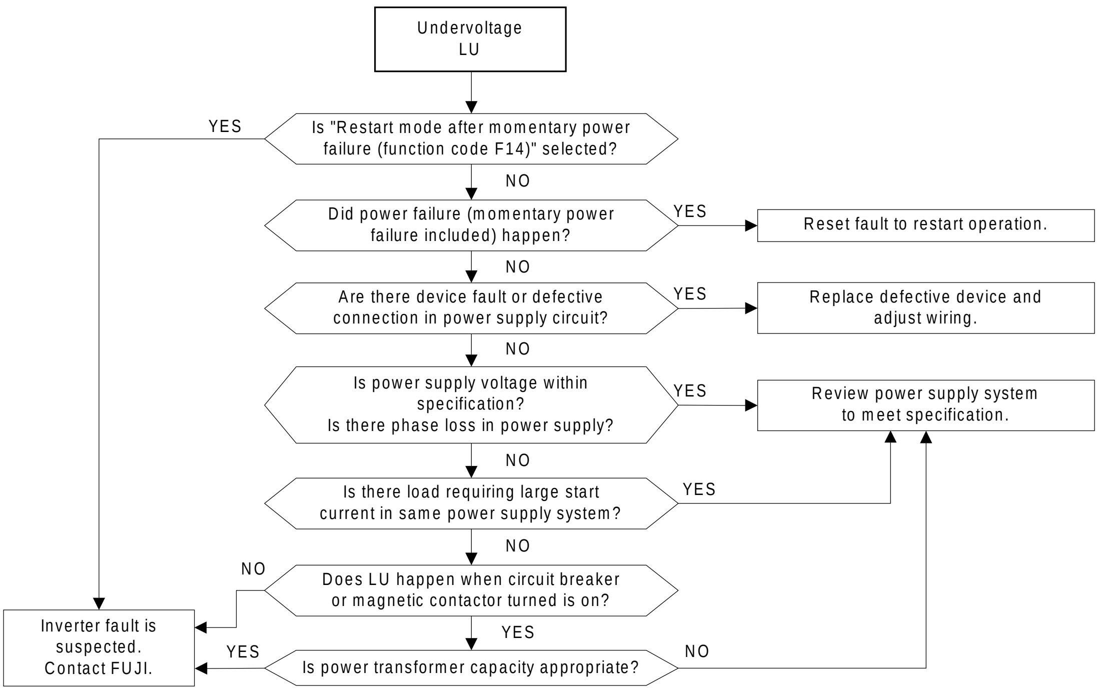
1) Vector control and sensorless vector control



2) V/f control

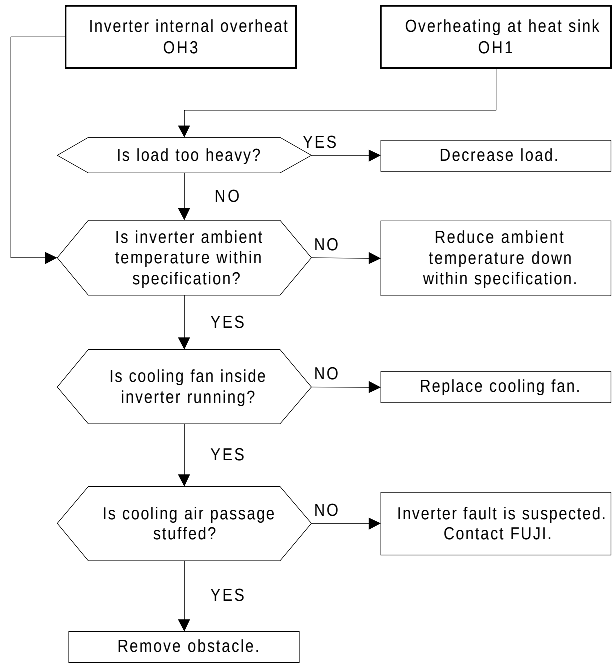



(5) Undervoltage

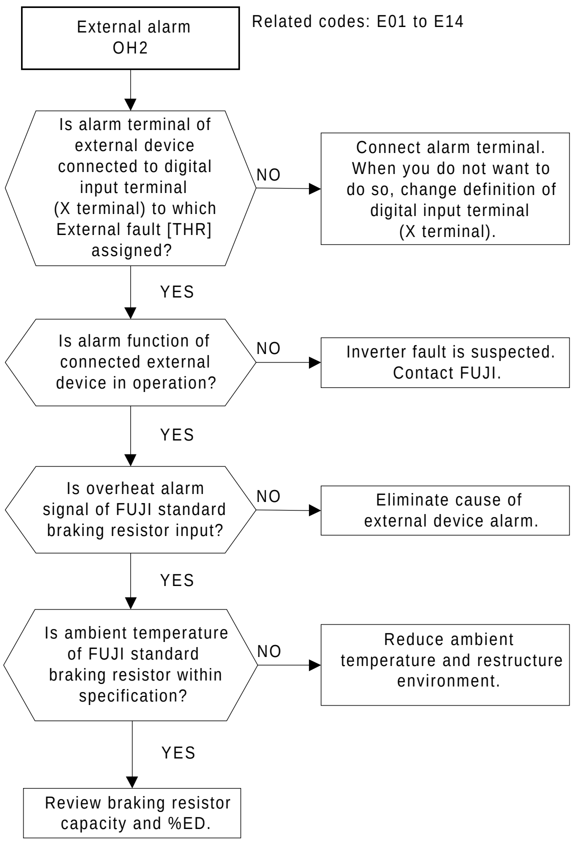


(6) Inverter internal overheat and overheating at heat sink

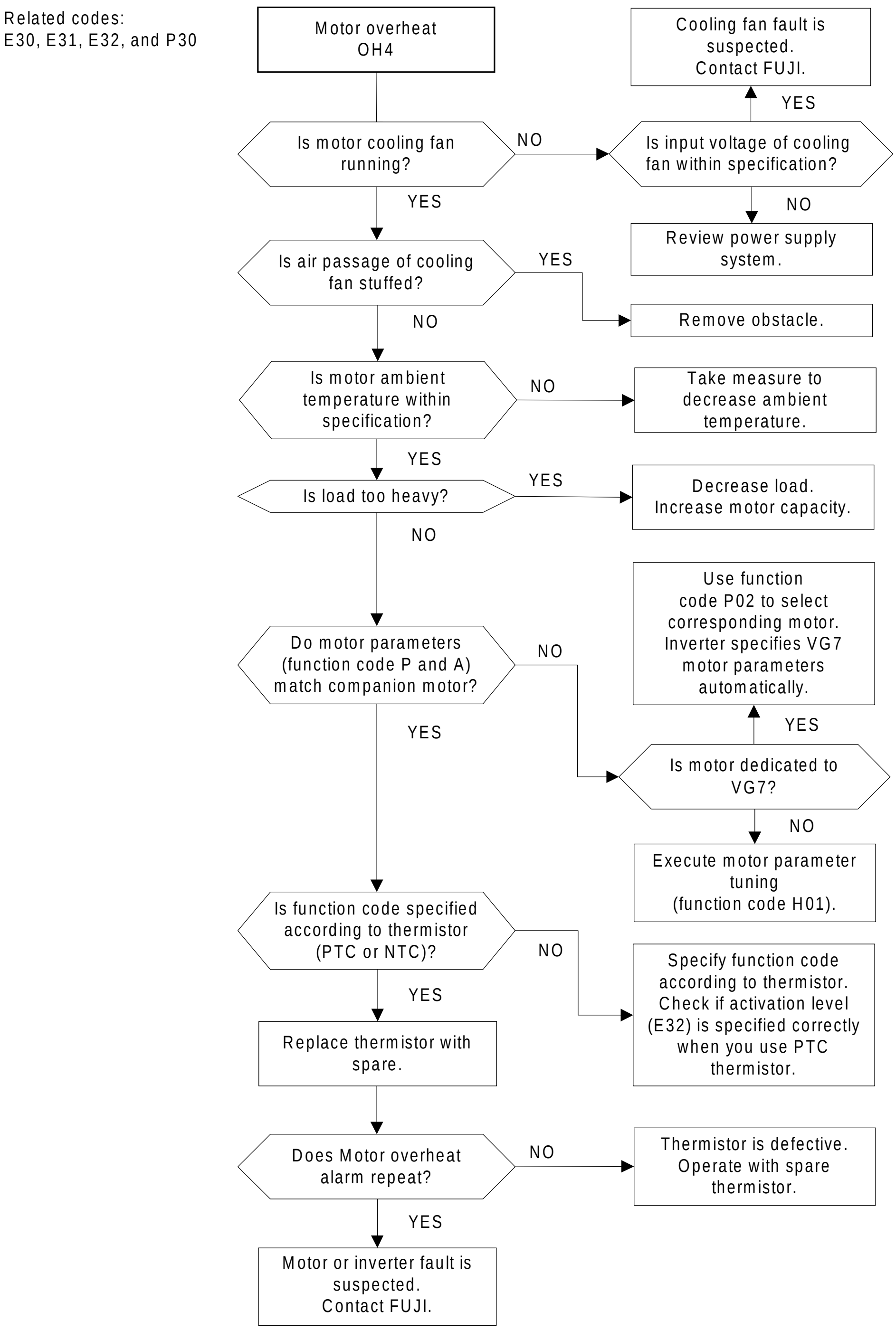
| ⚠ CAUTION |
| --- |
| • Heatsink becomes very hot and do not tough it.<br>**You may get burnt.** |



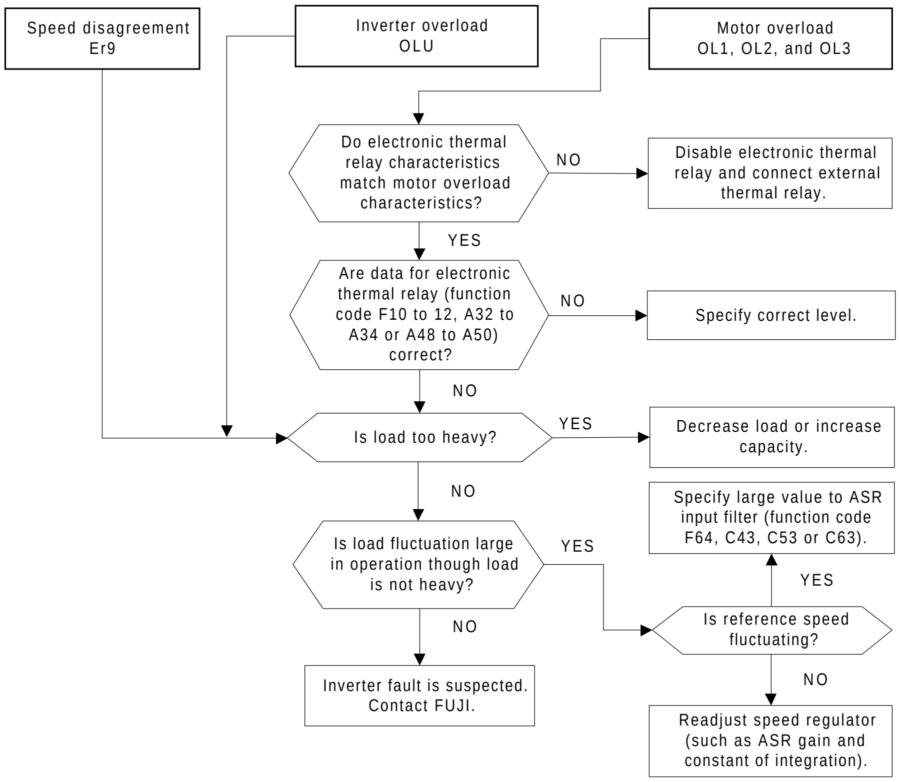

(7) External alarm



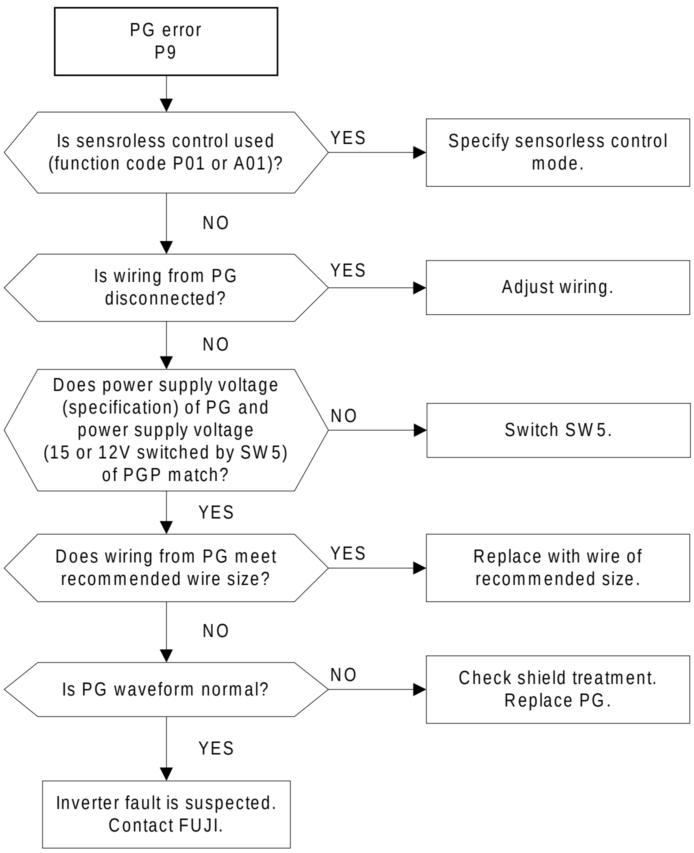
(8) Motor overheat



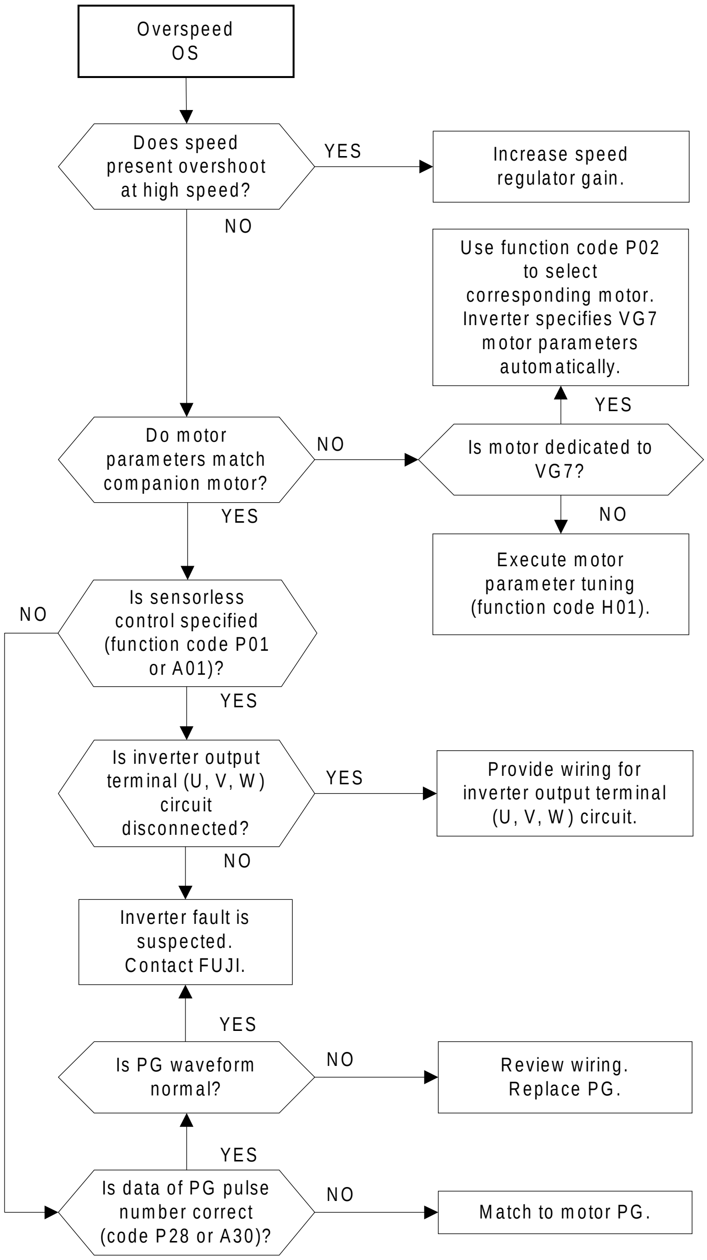
## (9) Inverter overload and motor overload



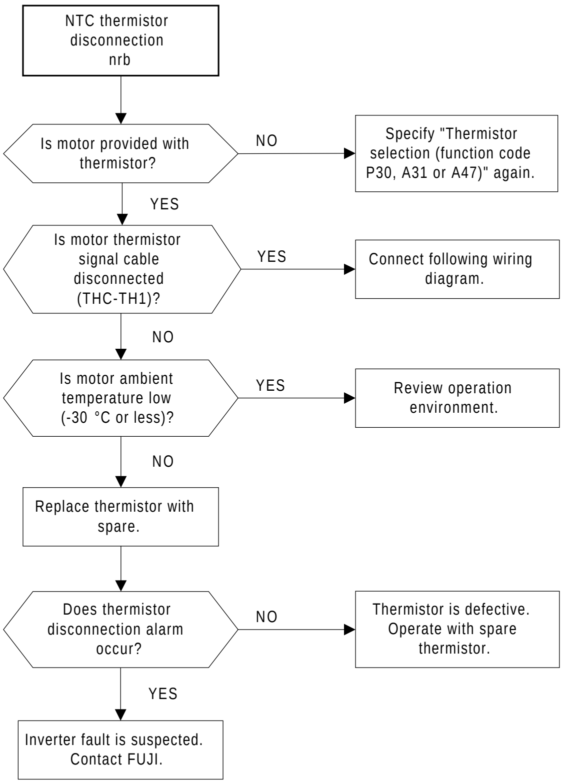

## (10) PG error



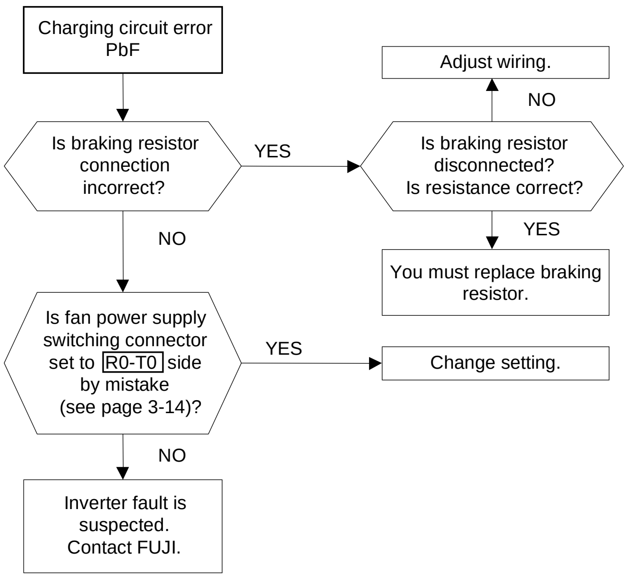
(11) Overspeed



## (12) NTC thermistor disconnection




## (13) Charging circuit error

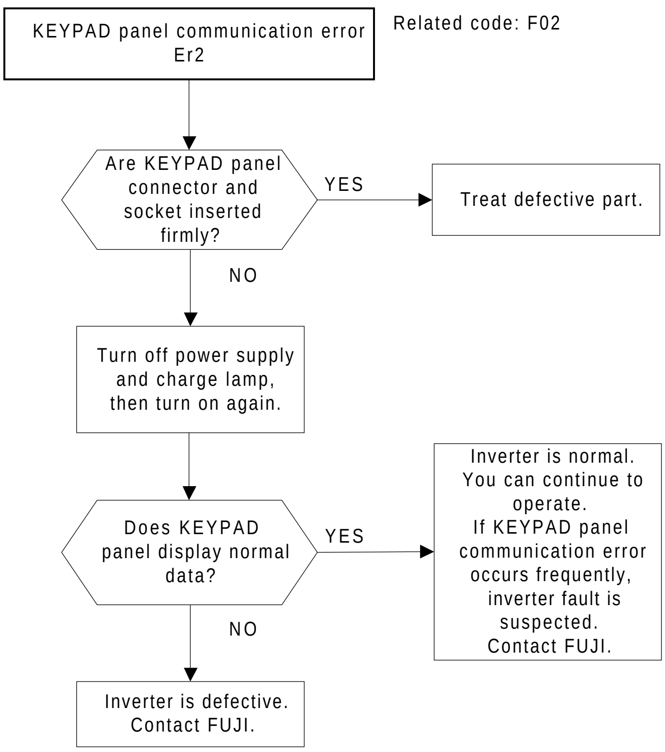


(14) Memory error (Er1)

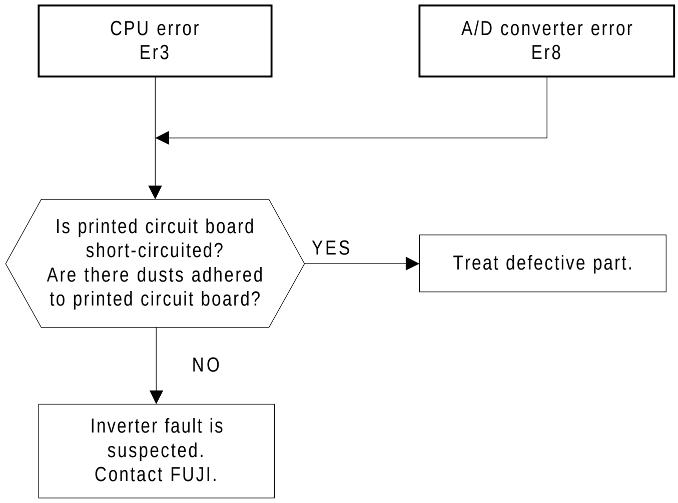
Review the function data before you turn off the power when the memory error occurs. When the data are correct, the error is limited to data in the back up memory. Only if you can use "All save" to save data without reoccurence of Memory error, you can operate the inverter. Check the printed circuit board visually for dusts.

When the function data are abnormal, or memory error occurs frequently while function data are normal, an inverter fault is suspected. Contact FUJI.

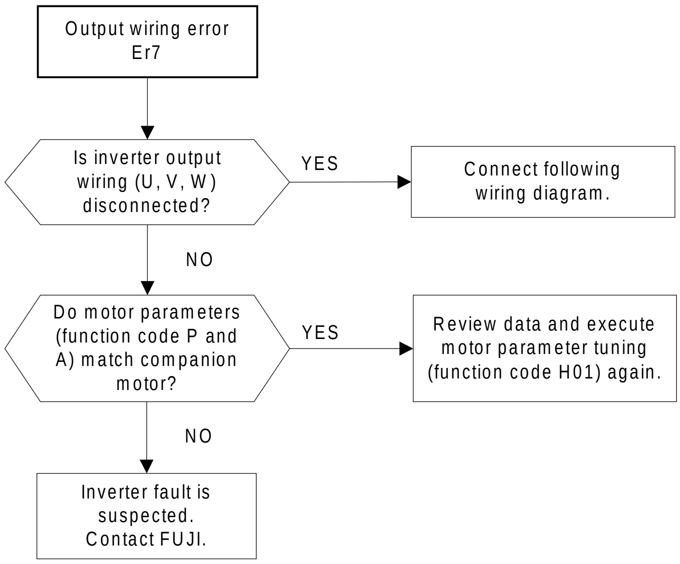
(15) KEYPAD panel communication error



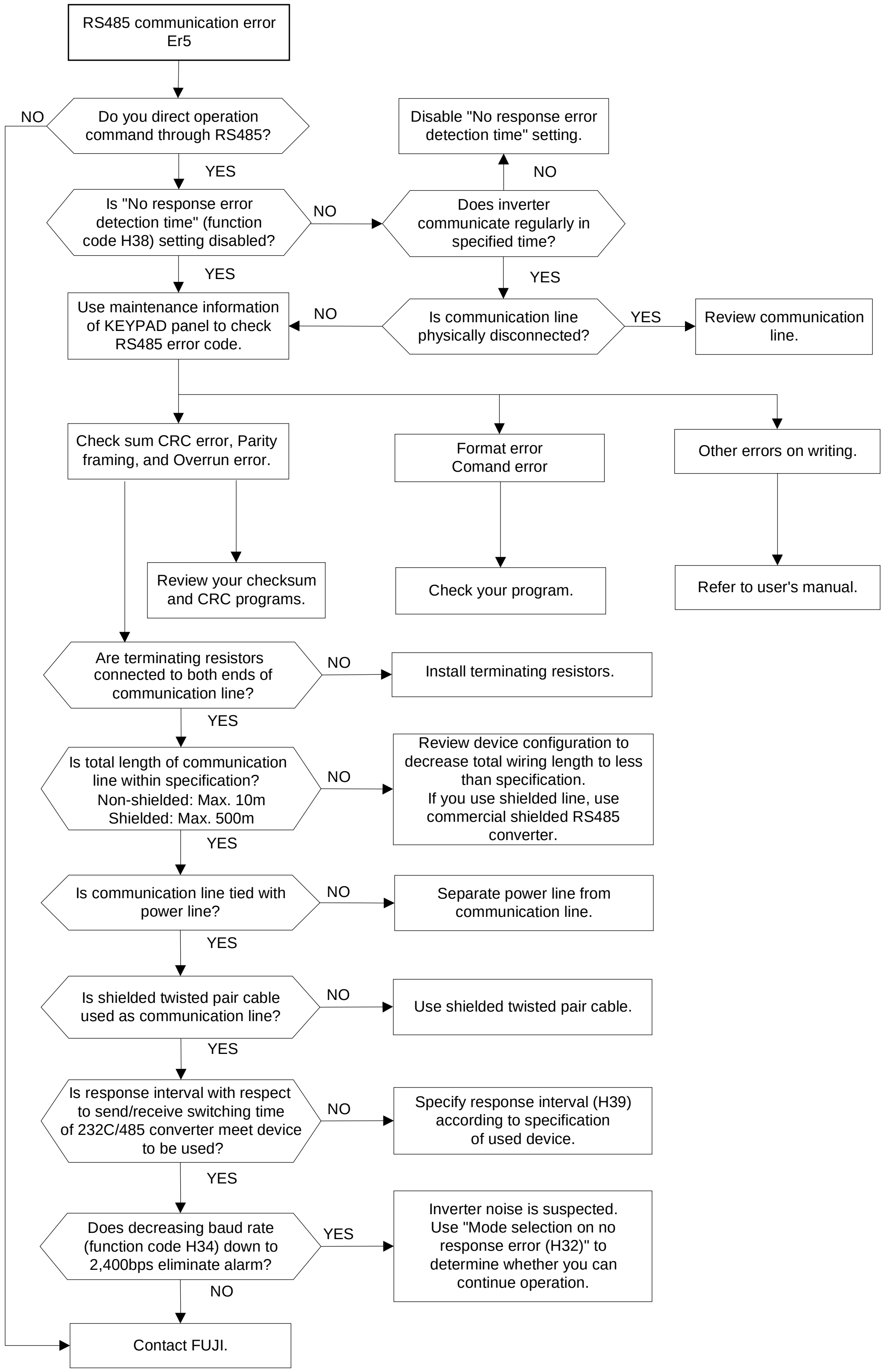
(16) CPU error and A/D converter error




(17) Output wiring error

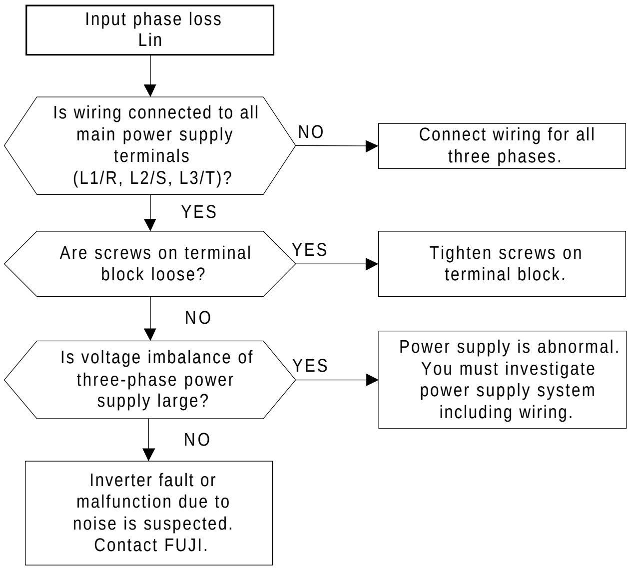


(18) RS485 communication error

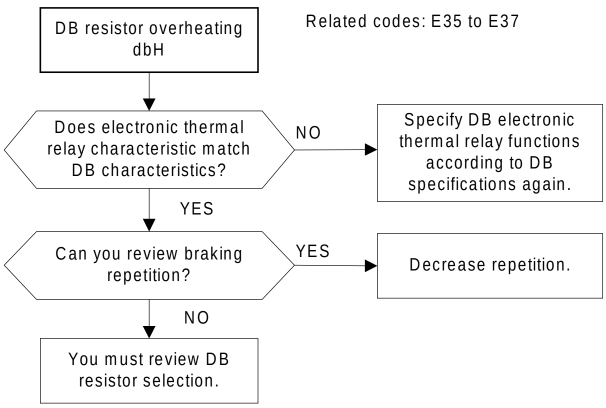


(19) Input phase loss

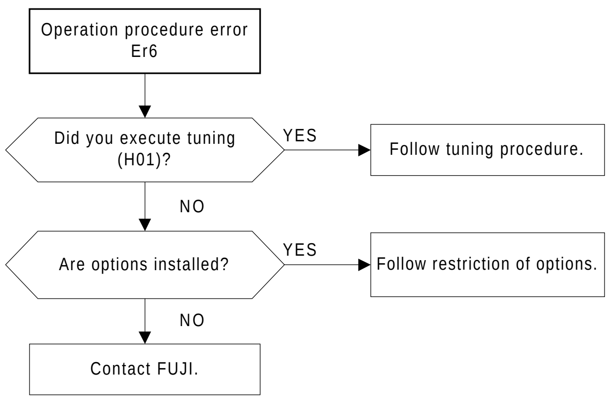
| ⚠CAUTION |
| --- |
| • Turn on the power after you eliminate faults.<br>**You may start fire.** |




(20) DB resistor overheating




(21) Operation procedure error




(22) Others

The following alarms are related to options. See User's Manual for details.

Er4 : Network error. When T-Link, SX bus or field bus option is installed.

ErA : UPAC error. When UPAC option is installed.

Erb : Inter-inverter communication error. When RS or SI option is installed.

- MEMO -

THE INVERTER

V

# Ⅴ. KEYPAD Panel

# 5. KEYPAD Panel

| ⚠ WARNING |
|---|
| • If the user set the function codes wrongly or without completely understanding this user's manual, the motor may rotate with a torque or at a speed not permitted for the machine.<br>**Accident or injury may result.**<br>• The STOP key is effective only when its function has been set. Install an emergency stop switch separately.<br>**Accident may result.** |

## 5.1 Appearance of KEYPAD Panel

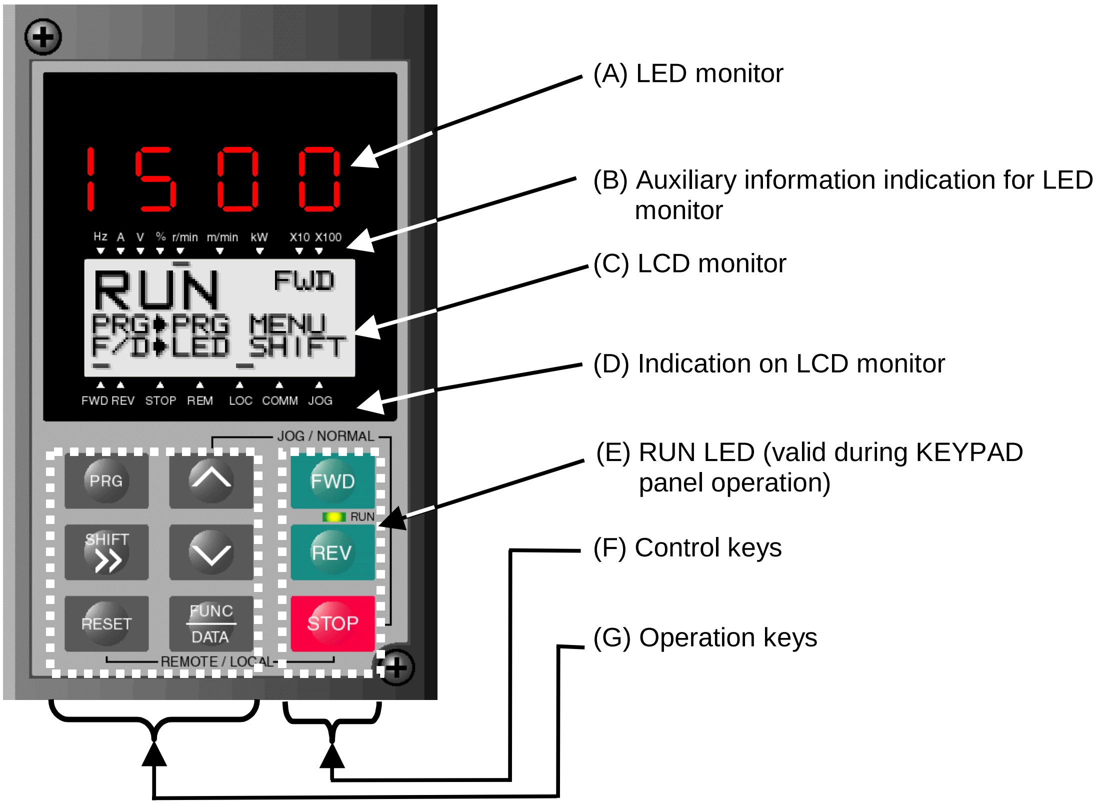



Figure 5-1-1 Appearance of KEYPAD Panel

(A) LED monitor:

Four-digit 7-segment display
Used to display various items of monitored data such as setting frequency, output frequency and alarm code.

(B) Auxiliary information indication for LED monitor:

Selected units or multiple of the monitored data (on the LED monitor) are displayed on the top line of the LCD monitor. The ■ symbol indicates selected units or multiple number. The symbol ▲ indicates there is an upper screen not currently displayed.

(C) LCD monitor:

Used to display such various items of information as operation status and function data. An operation guide message, which can be scrolled, is displayed at the bottom of the LCD monitor.

(D) Indication on LCD monitor:

Displays one of the following operation status with ■.
FWD: Forward operation REV: Reverse operation STOP: Stop
Displays the selected operation method:
REM: External signal LOC: KEYPAD panel COMM: Communication terminal JOG: Jogging mode
The symbol ▼ indicates there is a lower screen not currently displayed.

(E) RUN LED (valid during KEYPAD panel operation):

Indicates that an operation command is being input by pressing the FWD or REV key.

(F) Control keys:

Used for inverter run and stop
FWD : Forward operation command REV : Reverse operation command STOP : Stop command

(G) Operation keys:

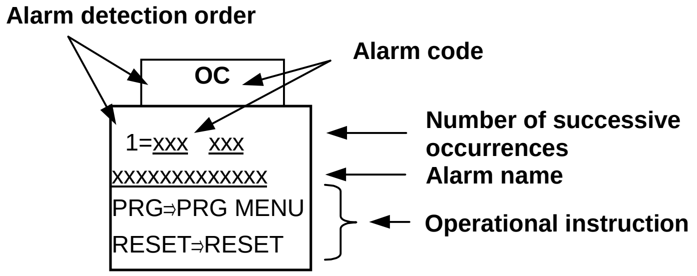
Used for screen switching, data change, frequency setting, etc.
The Table 5-1-1 shows the main function of the operation keys.

Table 5-1-1 Functions of Operation Keys

| Operation key | Main function |
|---|---|
| PRG | Used to switch the current screen to the menu screen or switch to the initial screen in the operation/alarm mode. |
| FUNC DATA | Used to switch the LED monitor or to determine the entered frequency, function code, or data. |
| Λ , V | Used to change data, move the cursor up or down, or scroll the screen. |
| SHIFT >> | Used to move the cursor horizontally at data change. When this key is pressed with the up or down key, the cursor moves to the next function block. |
| RESET | Used to cancel current input data and switch the displayed screen. If an alarm occurs, this key is used to reset the trip status (valid only when the alarm mode initial screen is displayed). |
| STOP + Λ | Used to switch normal operation mode to jogging operation mode or vice versa. The selected mode is displayed on the LCD monitor. |
| STOP + RESET | Switches operation method (from KEYPAD panel operation to external signal operation or vice versa). When these keys are pressed, function F02 data is also switched from 0 to 1 or from 1 to 0. The selected mode is displayed on the LCD indicator. (REM, LOC) |

# 5. KEYPAD Panel

## 5.2 Alarm Mode




When a single alarm occurs, the alarm mode screen appears where the content of the alarm is indicated.

Figure 5-2-1 Alarm Mode Screen

When multiple alarms occur at the same time, the contents of the alarms can be checked using the ∧ and ∨ keys.

Table 5-2-1 Alarm Detection Order

| Operating keys | | LED display | LCD display | Content |
|---|---|---|---|---|
| | | 5. | 5 | Alarm No. 5 |
| | | 4. | 4 | Alarm No. 4 |
| ∧ ↑ | ∨ ↓ | 3. | 3 | Alarm No. 3 |
| | | 2. | 2 | Alarm No. 2 |
| | | 1. | 1 | Alarm No. 1 (multiple alarms) |
| | | Blank | 0 | Latest alarm (single alarm/already has been reset) |
| | | Blank | -1 | 1st latest alarm |
| | | Blank | -2 | 2nd latest alarm |
| | | Blank | -3 | 3rd latest alarm |
| | | Blank | -4 | 4th latest alarm |
| | | Blank | -5 | 5th latest alarm |
| | | Blank | -6 | 6th latest alarm |
| | | Blank | -7 | 7th latest alarm |
| | | Blank | -8 | 8th latest alarm |
| | | Blank | -9 | 9th latest alarm |
| | | Blank | -10 | 10th latest alarm |

# 5.3 KEYPAD Operation System (Hierarchical Structure of LCD Screens)

## 5.3.1 During Normal Operation

The basic KEYPAD operation system (hierarchical structure of screens) is illustrated below.

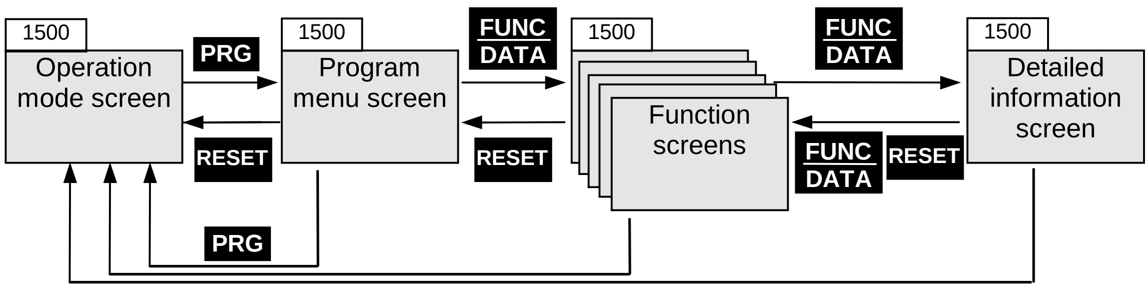



Figure 5-3-1 KEYPAD Operation in Operation Mode

## 5.3.2 When an Alarm Occurs

When an alarm occurs, the KEYPAD screen system is switched from the normal operation mode to the alarm mode. The alarm mode screen appears where the alarm information is indicated.
The program menu, function, and detailed information screens are similar to those of normal operation.
The program menu screen can be switched to the alarm mode screen using **PRG** only.

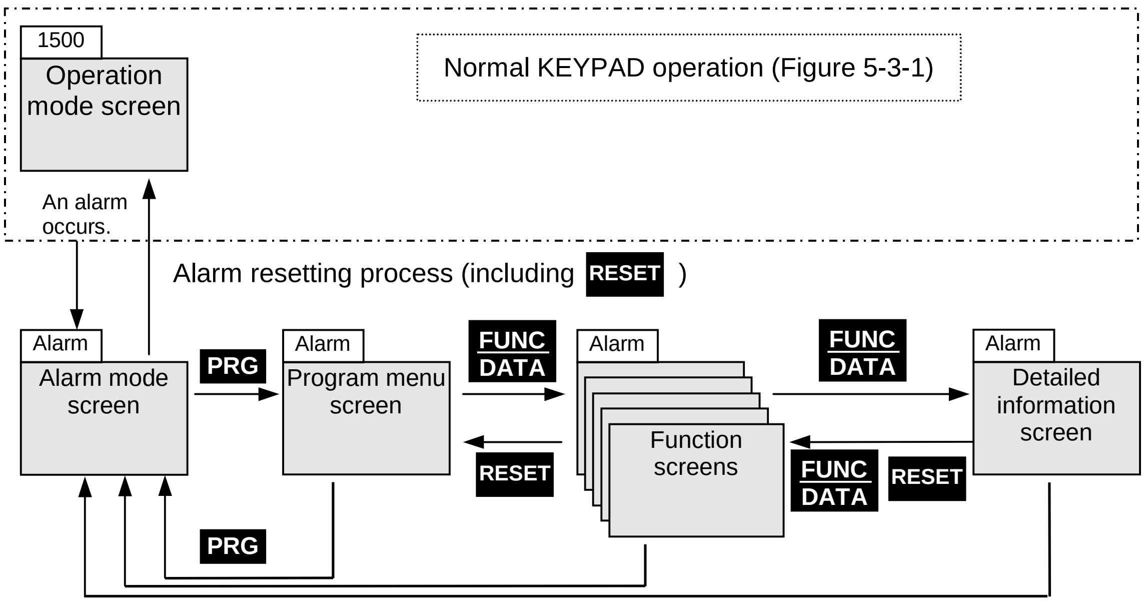



Figure 5-3-2 KEYPAD Operation in Alarm Mode

KEYPAD Panel

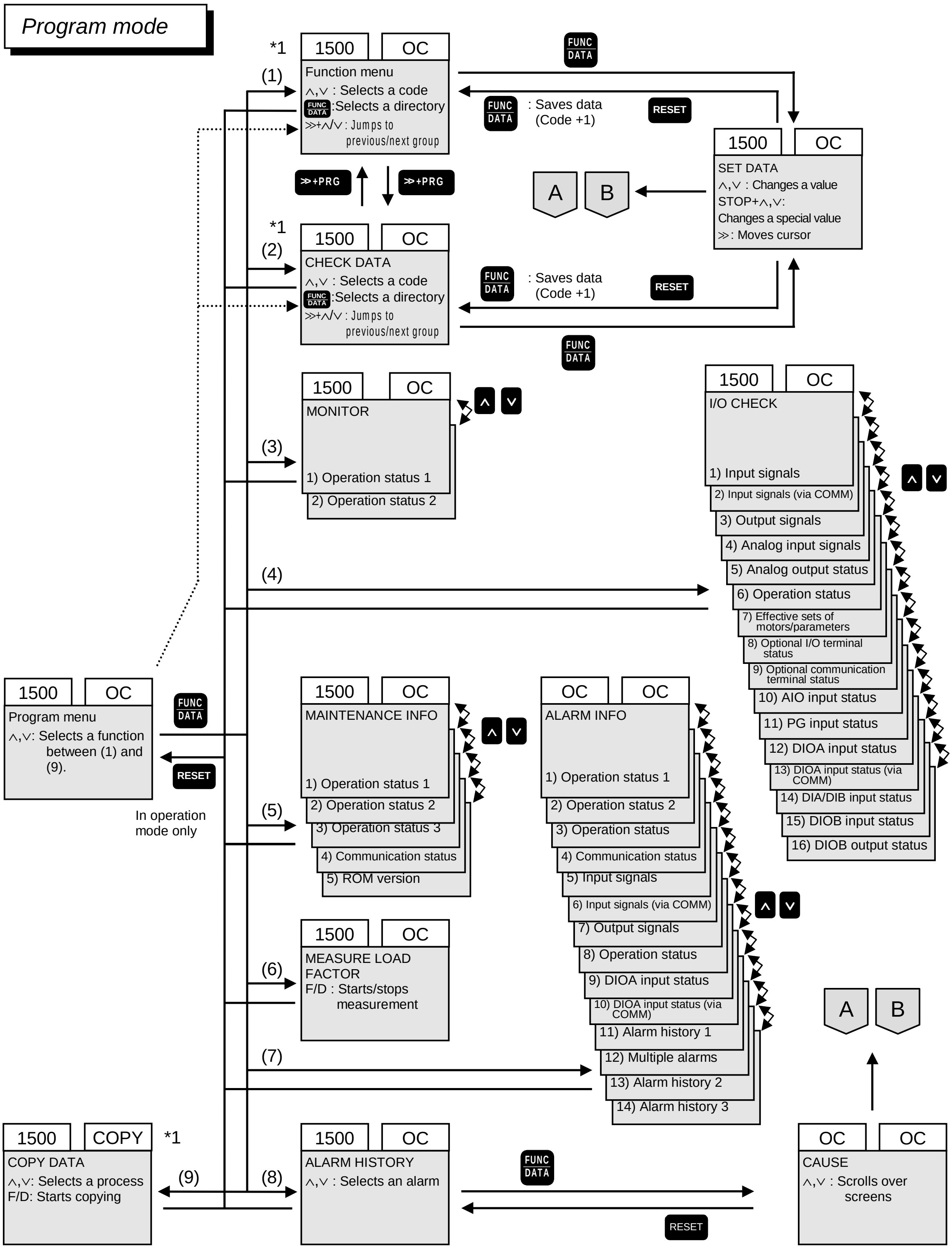
Table 5-3-1 Outline of Indications on Different Screens

<table>
<tr><th>No.</th><th>Screen name</th><th>Description</th></tr>
<tr><td>1</td><td>Operation mode</td><td>You can change motor speed or switch LED monitor when this screen is shown on KEYPAD during normal operation.</td></tr>
<tr><td>2</td><td>Program menu<br>(Program mode)</td><td>Function menu is shown on this screen for your selection. Select a desired function from menu and press FUNC DATA to call screen for selected function. Menu contains the following options as KEYPAD functions.
<table>
<tr><th>No.</th><th>Menu item</th><th>Outline</th></tr>
<tr><td>1</td><td>Function menu</td><td>If this is selected, a name list of function codes appears. Select a desired code to call data setting screen for that code where its setting can be checked or changed.</td></tr>
<tr><td>2</td><td>CHECK DATA</td><td>If this is selected, a data list of function codes appears. Select a desired code to check its setting. Similar to the SET DATA above, data setting screen can be selected where its setting can be changed.</td></tr>
<tr><td>3</td><td>MONITOR</td><td>This screen is used as operation status monitor to check various data.</td></tr>
<tr><td>4</td><td>I/O CHECK</td><td>This screen is used to check status of inverter and optional analog input/output and digital input/output signals.</td></tr>
<tr><td>5</td><td>MAINTENANCE INFO</td><td>This screen is used to check maintenance information including inverter status, life expectancy, communication errors, and ROM version.</td></tr>
<tr><td>6</td><td>MEASURE LOAD FACTOR</td><td>Maximum and average currents and average braking power can be measured to determine load factor.</td></tr>
<tr><td>7</td><td>ALARM INFO</td><td>This screen is used to check operation status and I/O status at the time of the latest alarm.</td></tr>
<tr><td>8</td><td>ALARM HISTORY</td><td>This screen is used to check the latest alarm, multiple alarms that occurred at the same time, and alarm history. Select an alarm and press FUNC DATA to check cause of that alarm and troubleshooting information.</td></tr>
<tr><td>9</td><td>COPY DATA</td><td>Function code settings for an inverter can be stored and copied to another inverter.</td></tr>
</table></td></tr>
<tr><td>3</td><td>Function screens</td><td>When a function is selected from program menu, the corresponding function screen appears for execution of that function.</td></tr>
<tr><td>4</td><td>Detailed information screen</td><td>Functions that cannot be executed by function screens (change of function code settings and indication of causes of alarms) are displayed by detailed information screen.</td></tr>
</table>

# 5.4 KEYPAD Operating Procedures

## 5.4.1 Transition of Screens

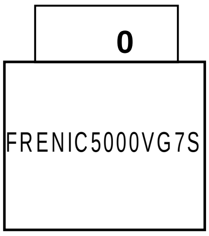
The KEYPAD operation (hierarchical structure of screens) in the program mode is illustrated below.




*1: The functions whose use has been limited by password (function codes L01 and L02) cannot be selected until the password is entered. Unless limited, they can be selected at any time.

## 5.4.2 Operation Mode

*Initial screen*

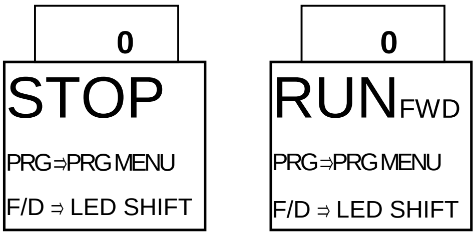



The screen shown on the left appears for five seconds after power-on. Then, the screen is replaced by the operation mode screen.

*Operation mode screens*

W/o operation command

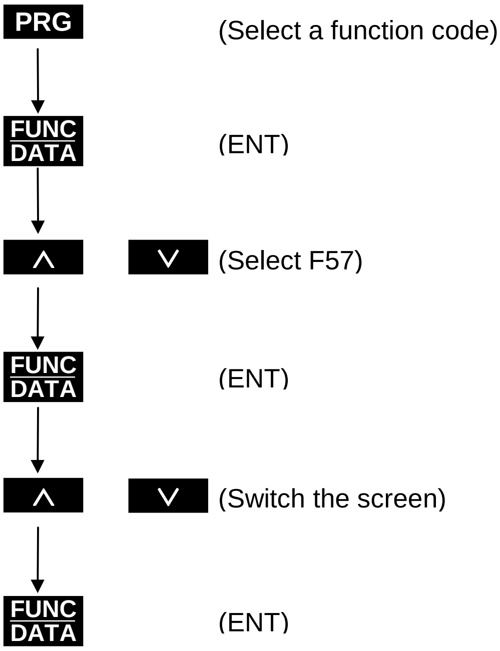
W/operation command



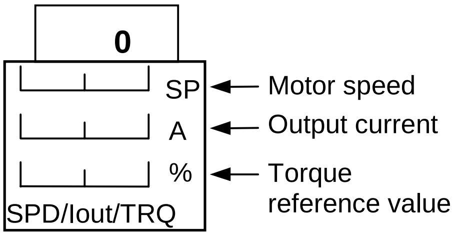

The operation mode screen takes the descriptive form where the inverter operation status and operational instruction are indicated or the graphical form where the operation status is expressed by bar graphs.

The form can be switched with function code F57 (LCD monitor).
(The descriptive form is initially selected.)

To switch to the bar graph screen:




*Bar graph screen*




Motor speed:
The full scale represents the maximum speed.

Output current:
The full scale represents 200% of the rated inverter output.

Torque reference value:
The full scale represents 200% of the rated motor torque.

## 5.4.3 Digital Speed Setting Procedure

*Digital speed setting screen*

```
1500
<DIG SET SP>
       LOCAL
50~24000
F/D ⇒ STORE
```

Press the ∧ or ∨ key with the operation mode screen to call the digital speed setting screen. (If you do nothing for five minutes, the screen will return to the operation mode.)

*Digital speed setting procedure*

```
1500            ← Preset speed
<DIG SET SP>    ← Screen name
       LOCAL    ← Speed setting mode
50~24000        ← Setting range
F/D ⇒ STORE     ← Operation guide
```

Press the ∧ or ∨ key again with the digital speed setting screen to change the digital speed. Keep pressing the ∧ or ∨ key to change the speed in tens, hundreds, or thousands.

```
1500
<DIG SET SP>
       LOCAL
50~24000
F/D ⇒ STORE
```

Press the SHIFT ≫ key to shift the place where the value is to be changed. (LEDs at the selected place will blink.)

```
1500
<DIG SET SP>
       LOCAL
50~24000
EXECUTING...
```

Press the FUNC DATA key to store the currently entered speed.

```
1500
<DIG SET SP>
      REMOTE    ← Current speed setting mode
50~24000
F/D ⇒ STORE
```

If the KEYPAD setting mode has not been selected (Remote or PID screen), the current speed setting mode is indicated on the LCD. If REMOTE is indicated, you can check but cannot change the speed using the ∧ and ∨ keys.

## 5.4.4 Switching the LED Monitor Indication

Press the FUNC DATA key with the operation mode screen to switch the LED monitor indication. The information given by the monitor changes each time the FUNC DATA key is pressed and the current mode is indicated on the LCD.

Table 5-4-1 Monitor Indication

| | LED monitor | | Digital setting mode | | Unit | Resolution |
|---|---|---|---|---|---|---|
| | Running | Stopping | Digital speed setting | PID command | | |
| 0 | Detected speed 1 *0) | Setting speed 4 *0) | Speed reference from KEYPAD | PID reference from KEYPAD | r / min | 0-9999: 1-10,000 resolution 10,000-24,000: 10 |
| 1 | Speed setting 4 *0) | | | | r / min | 0-9999: 1-10,000 resolution 10,000-24,000: 10 |
| 2 | Reference output frequency | | | | Hz | 0.1 to 400.0: 0.1 resolution |
| 3 | Reference torque current | | | | % | 1 % |
| 4 | Reference torque | | | | % | 1 % |
| 5 | Calculated torque | | | | % | 1 % |
| 6 | Input power | | | | F 60= 0;kW F 60= 1;HP | 0.01 to 99.99 : 0.01 100.0 to 999.9 : 0.1 1000 to : 1 |
| 7 | Detected output current | | | | A | 0.01 to 99.99 : 0.01 100.0 to 999.9 : 0.1 1000 to : 1 |
| 8 | Detected output voltage | | | | V | 1 V |
| 9 | Detected DC link circuit voltage | | | | V | 1 V |
| 10 | Reference flux value | | | | % | 1 % |
| 11 | Calculated flux value | | | | % | 1 % |
| 12 | Motor temperature *1) | | | | - | 1 |
| 13 | Load shaft detected speed | Load shaft reference speed | Load speed from KEYPAD | | r / min | 1 |
| 14 | Detected line speed | Reference line speed | Speed reference from KEYPAD | | m / min | 1 |
| 15 | Adjusted value of Ai (12) | | | | % | 0.1 % |
| 16 | Adjusted value of Ai (Ai1) | | | | % | 0.1 % |
| 17 | Adjusted value of Ai (Ai2) | | | | % | 0.1 % |
| 18 | Adjusted value of Ai (Ai3) *2) | | | | % | 0.1 % |
| 19 | Adjusted value of Ai (Ai4) *2) | | | | % | 0.1 % |
| 20 | PID reference value *3) | | | | - | 0.00 to ± 9.99 : 0.01 10.0 to ± 99.9 : 0.1 100 to ± 999 : 1 |
| 21 | PID feedback value *3) | | | | | |
| 22 | PID output value *3) | | | | | |
| 23 | Optional monitor 1 (HEX) *4) | | | | HEX | 1 |
| 24 | Optional monitor 2 (HEX) *4) | | | | HEX | 1 |
| 25 | Optional monitor 3 (DEC) *4) | | | | DEC | 1, × 10 |
| 26 | Optional monitor 4 (DEC) *4) | | | | DEC | 1, × 10 |
| 27 | Optional monitor 5 (DEC) *4) | | | | DEC | 1, × 10, × 100 |
| 28 | Optional monitor 6 (DEC) *4) | | | | DEC | 1, × 10, × 100 |

*0): Indicated as an absolute value. *1): If the system is programmed not to indicate the motor speed, "--" appears. *2): Not indicated when optional AIO unit is not connected.
*3): Not indicated when the PID is inactive. *4): Indicated or not indicated, depending on the application.

## 5.4.5 Menu Screen

```
⇒1.DATA SET
 2.DATA CHECK
 3.OPR MNTR
 4.I/O CHECK
```

Press the PRG key with the operation mode screen to call the menu screen.

Move the arrow at the left of the screen to a desired menu using the ∧ or ∨ key. Press the FUNC/DATA key to call the screen for the selected menu.

## 5.4.6 Function Code Setting Procedure

```
RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT
```

↓ PRG

```
⇒1.DATA SET
 2.DATA CHECK
 3.OPR MNTR
 4.I /O CHECK
```

↓ FUNC/DATA

```
F00 DATA PRTC
F01 SPD CMD 1
F02 OPR METHOD
F03 M1- Nmax
```

Press the PRG key with the operation mode screen to call the menu screen. Move the arrow to "1. SET DATA" using the ∧ or ∨ key. Press the FUNC/DATA key to call the function code setting screen.

Select a desired function code on the function code setting screen using the ∧ or ∨ key.

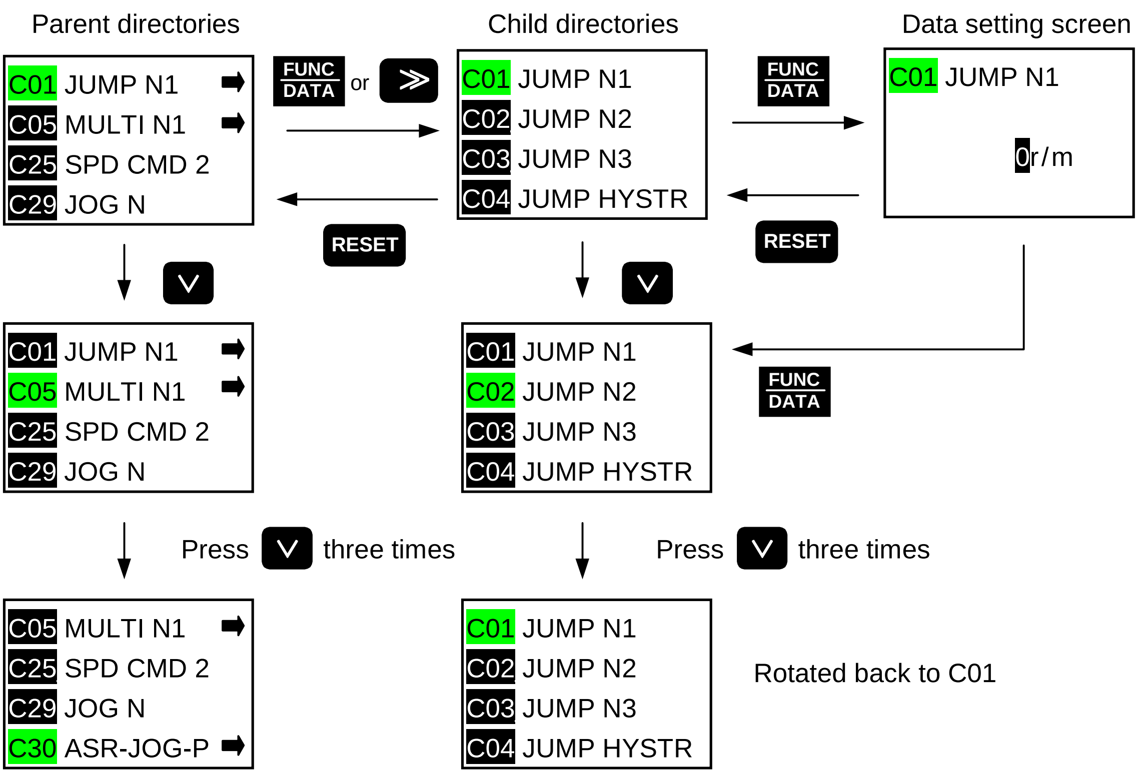
# 5. KEYPAD Panel

(1) KEYPAD Directory Structure

The directory structure described herein is the same as used for personal computers where a group of function codes are contained in each directory.

For example, function codes C01 to C04 are all related with the mechanical resonance point of the load and considered as the same. Therefore, C02 to C04 are not indicated in the parent directory list. In this case, ➔ appears to the right of C01 to indicate that it has child directories. To open the directory for a function code identified with ➔, move the cursor to that code using the ∧ or ∨ key and press the FUNC DATA key.

An Example of Selecting a Function Code with Child Directories




- ➔ appears to the right of each function code with child directories.
- Press the >> key once (do not keep pressing longer than a second) to call the child directory list for the selected function code.

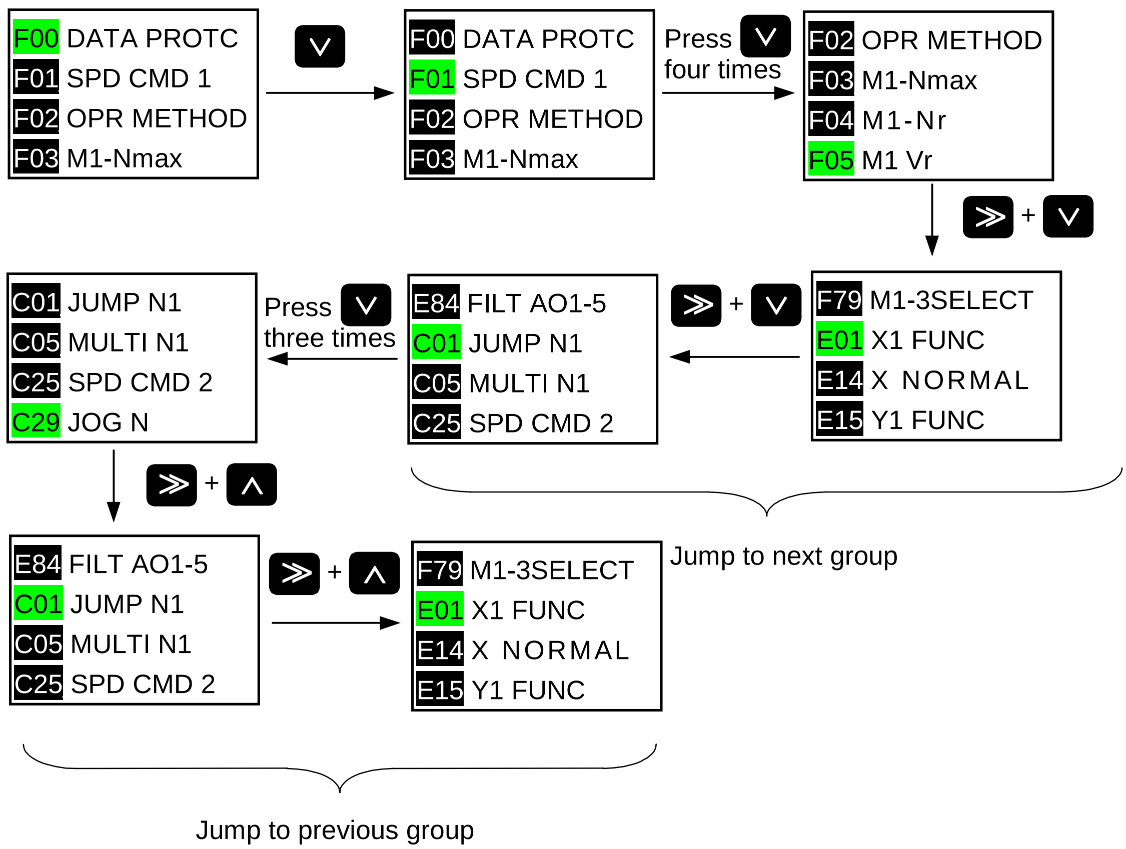
Each function code consists of an alphabet and number.  The alphabet represents the function group.

Table 5-4-2  Function Code Groups

| Function codes | Functions | Remark |
|---|---|---|
| F00 to F80 | Fundamental functions | |
| E01 to E84 | Extension terminal functions | |
| C01 to C73 | Control functions of frequency | |
| P01 to P30 | Motor 1 parameters | |
| H03 to H73 | High performance functions | |
| A01 to A50 | Alternative motor parameters | |
| o01 to o41 | Optional functions | Selectable when relevant optional unit is mounted. |
| L01 to L14 | Lifter functions | |
| U01 to U64 | User functions | |

(2) Jumping by Group

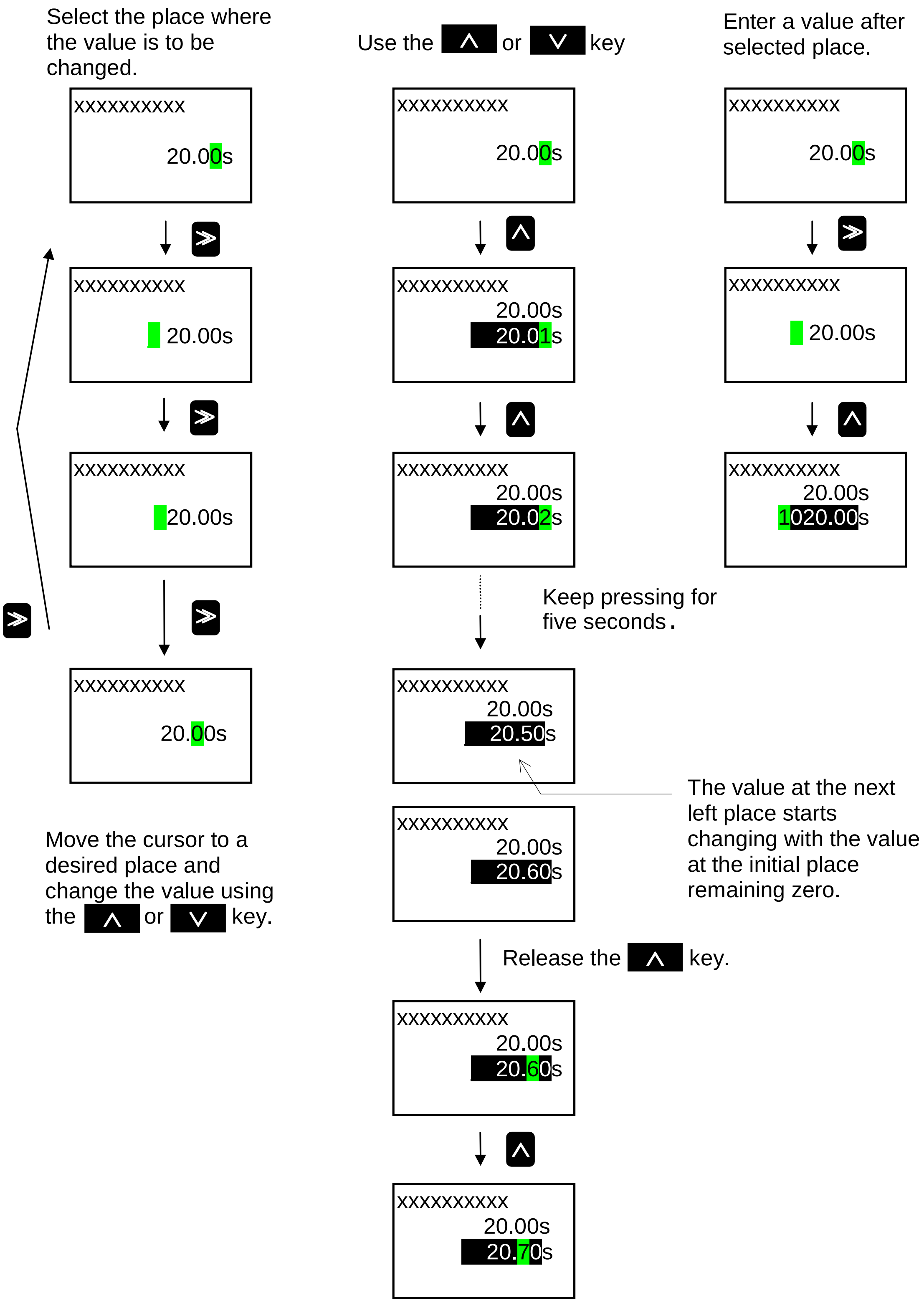
When selecting a function code not shown on the screen, press the ≫ and ∧ or ≫ and ∨ keys to jump to the previous or next group.



(3) Setting Procedures

Ordinary setting procedures

To change a setting, keep pressing the ∧ or ∨ key or select a place using the cursor and directly enter a new value.

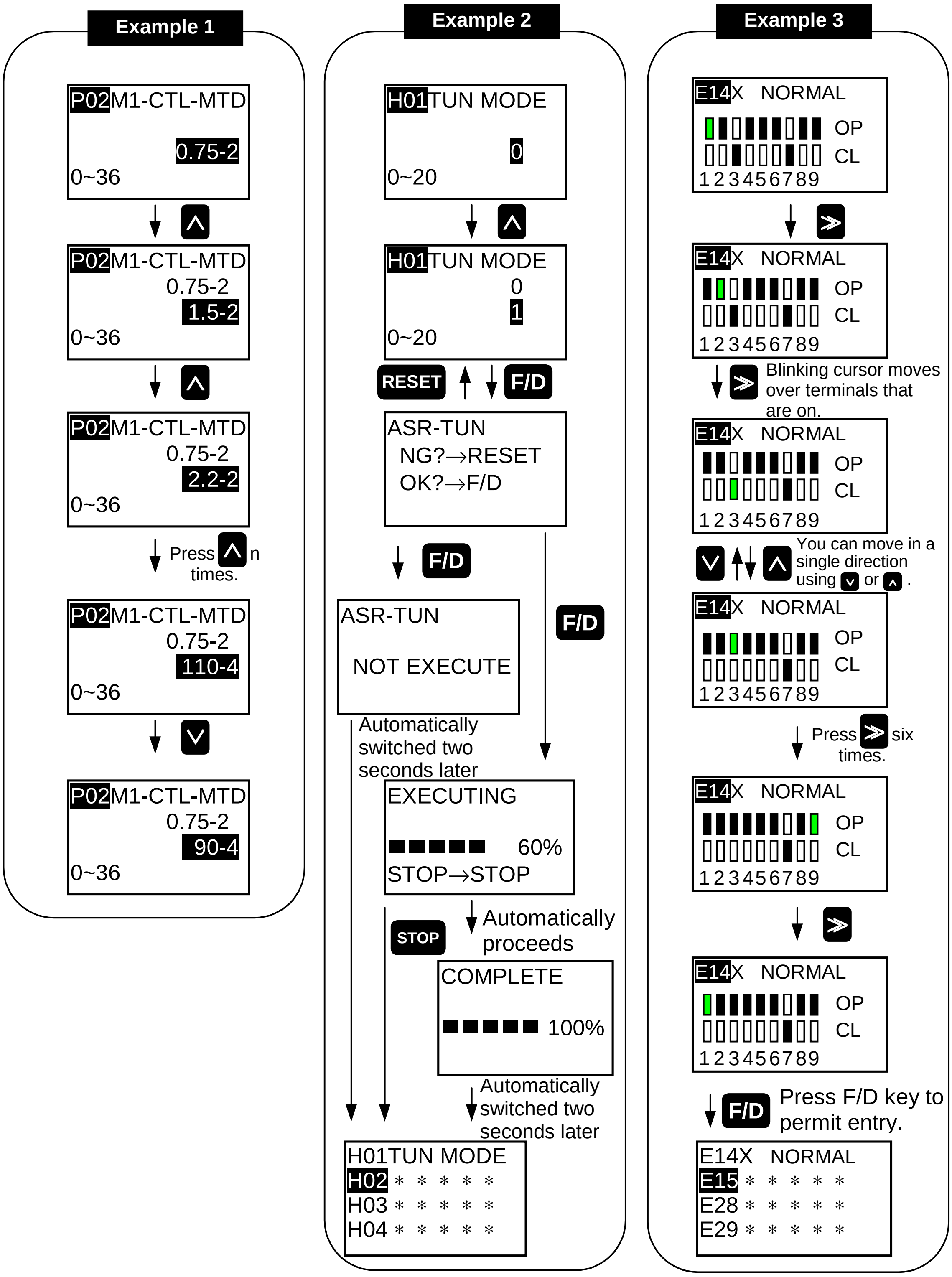


Select a function code. Press FUNC DATA to call the data setting screen.
Press ∧ or ∨ with the data setting screen to increase or decrease the value in the minimum unit on the LCD.
Keep pressing ∧ or ∨ to increase or decrease the setting in tens, hundreds, or thousands for rapid changing. It is also possible to select a place using ≫ and directly enter a value. Once any setting is changed, the previous value is also indicated for your reference. Press FUNC DATA to store the new value.
Press RESET to return to the function menu screen without storing the value.
Any function code setting is not reflected on the inverter operation until stored by pressing FUNC DATA . Some settings cannot be changed when protected or during operation or for another reason. The conditions required for changing them should be satisfied. The reason why the settings cannot be changed is indicated below.

Table 5-4-3 Reasons for Disabling the Change

| Indication | Reason | Remedy |
|---|---|---|
| NO SIGNAL (WE) | The edit enable command function via general-purpose input terminal has been selected. | Turn on the terminal for function codes set to 19 (edit enable command selected) between E01 and E13. |
| DATA PRTCTD | Data is protected by function code F00. | Set function code F00 to 0. |
| INV RUNNING | An attempt was made to change a function code with the inverter running though the change has been disabled during inverter operation. | Stop the inverter. |
| FWD/REV ON | An attempt was made to change a function code with the FWD/REV command on though the change has been disabled with the FWD/REV command on. | Turn the FWD/REV command off. |

Examples of special setting procedures




- Example 1 shows an example of list selection.
  For conventional models, only function codes are listed and the settings should have been changed or stored by referring to the manual. With the list selection capability, codes are listed on the LCD with their contents so that you can change or store the settings while checking the contents. The list selection screens for different function codes are shown in the subsequent pages.
- Example 2 shows an example of transition of screens during tuning process.
- Example 3 shows an example of setting control I/O terminals.
- Some function codes in addition to the above should be programmed in the same manner. Change the settings in reference to the above examples.

## (4) List Selection Screens for Function Codes

List selection screens (common to all languages)

1) Data protection
(function code F00)

| Code | List |
|---|---|
| 0 | 0 : CHG OK |
| 1 | 1 : PROTECT |

2) Speed setting N1 and N2
(function codes F01 and C25)

| Code | List |
|---|---|
| 0 | 0 : KEYPAD |
| 1 | 1 : 12 INPUT |
| 2 | 2 : 12-ABS |
| 3 | 3 : U/D-0 |
| 4 | 4 : U/D-BEF |
| 5 | 5 : U/D-CRP |
| 6 | 6 : DIA CRD |
| 7 | 7 : DIB CRD |

3) Operation method
(function code F02)

| Code | List |
|---|---|
| 0 | 0 : KEYPAD |
| 1 | 1 : FWD , REV |

4) Electronic thermal relay (select)
(function codes F10, A32, and A48)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ACT-GEN |
| 2 | 2 : ACT-INV |

5) 30RY operation mode
(function code F36)

| Code | List |
|---|---|
| 0 | 0 : EXT-TRP |
| 1 | 1 : EXT-NOR |

6) Torque limiter mode 1
(function code F40)

| Code | List |
|---|---|
| 0 | 0 : INVALID |
| 1 | 1 : TORQUE |
| 2 | 2 : POWER |
| 3 | 3 : TRQ CUR |

7) Torque limiter mode 2
(function code F41)

| Code | List |
|---|---|
| 0 | 0 : 4Q LVL1 |
| 1 | 1 : DR/GEN |
| 2 | 2 : UP/LOW |
| 3 | 3 : 4Q SEL |

8) Torque limiter value (level 1)
(function code F42)

| Code | List |
|---|---|
| 0 | 0 : F44 DAT |
| 1 | 1 : AI(TL1) |
| 2 | 2 : DIA CRD |
| 3 | 3 : DIB CRD |
| 4 | 4 : PID OUT |

9) Torque limiter value (level 2)
(function code F43)

| Code | List |
|---|---|
| 0 | 0 : F45 DAT |
| 1 | 1 : AI(TL2) |
| 2 | 2 : DIA CRD |
| 3 | 3 : DIB CRD |
| 4 | 4 : PID OUT |

11) LED monitor (Display selection)
(function code F55)

| Code | List | Code | List |
|---|---|---|---|
| 0 | 00 : SPEED | 15 | 15 : 12 ADJ |
| 1 | 01 : SPD RF | 16 | 16 : Ai1ADJ |
| 2 | 02 : FREQ | 17 | 17 : Ai2ADJ |
| 3 | 03 : TRQ CR | 18 | 18 : Ai3ADJ |
| 4 | 04 : TRQ RF | 19 | 19 : Ai4ADJ |
| 5 | 05 : TRQ CL | 20 | 20 : PID RF |
| 6 | 06 : M PWR | 21 | 21 : PID FB |
| 7 | 07 : EFT CR | 22 | 22 : PID OU |
| 8 | 08 : EFT VL | 23 | 23 : OPMON1 |
| 9 | 09 : DC LNK | 24 | 24 : OPMON2 |
| 10 | 10 : M FLXR | 25 | 25 : OPMON3 |
| 11 | 11 : M FLXC | 26 | 26 : OPMON4 |
| 12 | 12 : M TMP | 27 | 27 : OPMON5 |
| 13 | 13 : LD SPD | 28 | 28 : OPMON6 |
| 14 | 14 : LIN SP | | |

10) Torque reference monitor
(function code F51)

| Code | List |
|---|---|
| 0 | 0 : TRQ POR |
| 1 | 1 : DRV / GEN |

12) LED monitor
(Display at stopping state)
(function code F56)

| Code | List |
|---|---|
| 0 | 0 : REFER |
| 1 | 1 : DETECT |

13) LCD monitor (Display selection)
(function code F57)

| Code | List |
|---|---|
| 0 | 0 : GUIDANC |
| 1 | 1 : GRAPH D |

14) LCD monitor
(Language selection)
(function code F58)

| Code | List |
|---|---|
| 0 | 0 : JAPANES |
| 1 | 1 : ENGLISH |
| 2 | 2 : GERMANY |
| 3 | 3 : FRENCH |
| 4 | 4 : SPANISH |
| 5 | 5 : ITALIAN |
| 6 | 6 : CHINESE |

15) Output unit (HP/kW)
selection (function code F60)

| Code | List |
|---|---|
| 0 | 0 : kW DISP |
| 1 | 1 : HP DISP |

16) Motor selection
(function code F79)

| Code | List |
|---|---|
| 0 | 0 : M1 CONT |
| 1 | 1 : M2 SEL |
| 2 | 2 : M3 SEL |

17) Current rating switching
(function code F80)

| Code | List |
|---|---|
| 0 | 0 : CT |
| 1 | 1 : VT |
| 2 | 2 : HT |

18) X function selection
(function codes E01 to E13)

| Code | List | Code | List | Code | List | Code | List |
|---|---|---|---|---|---|---|---|
| 0 | 00 : SS1 | 16 | 16 : CPN2 / 1 | 32 | 32 : H42CCL | 48 | 48 : PIDINV |
| 1 | 01 : SS2 | 17 | 17 : UP | 33 | 33 : H43CCL | 49 | 49 : PG-CCL |
| 2 | 02 : SS4 | 18 | 18 : DOWN | 34 | 34 : F40CCL | 50 | 50 : LU-CCL |
| 3 | 03 : SS8 | 19 | 19 : WE-KP | 35 | 35 : TL2 / 1 | 51 | 51 : H-TB |
| 4 | 04 : RT1 | 20 | 20 : KP / PID | 36 | 36 : BPS | 52 | 52 : STOP1 |
| 5 | 05 : RT2 | 21 | 21 : IVS | 37 | 37 : TB1 | 53 | 53 : STOP2 |
| 6 | 06 : HLD | 22 | 22 : IL | 38 | 38 : TB2 | 54 | 54 : STOP3 |
| 7 | 07 : BX | 23 | 23 : WE-LK | 39 | 39 : DROOP | 55 | 55 : DIA |
| 8 | 08 : RST | 24 | 24 : LE | 40 | 40 : ZH-AI1 | 56 | 56 : DIB |
| 9 | 09 : THR | 25 | 25 : U-DI | 41 | 41 : ZH-AI2 | 57 | 57 : MT-CCL |
| 10 | 10 : JOG | 26 | 26 : STM | 42 | 42 : ZH-AI3 | 58 | 58 : O-DI1 |
| 11 | 11 : N2 / N1 | 27 | 27 : SYC | 43 | 43 : ZH-AI4 | 59 | 59 : O-DI2 |
| 12 | 12 : M-CH2 | 28 | 28 : LOCK | 44 | 44 : REVAI1 | 60 | 60 : O-DI3 |
| 13 | 13 : M-CH3 | 29 | 29 : EXITE | 45 | 45 : REVAI2 | 61 | 61 : O-DI4 |
| 14 | 14 : DCBRK | 30 | 30 : N-LIM | 46 | 46 : REVAI3 | 62 | 62 : O-DI5 |
| 15 | 15 : CLR | 31 | 31 : H41CCL | 47 | 47 : REVAI4 | 63 | 63 : O-DI6 |

19) Y function selection
(function codes E15 to E27)

| Code | List | Code | List | Code | List |
|---|---|---|---|---|---|
| 0 | 00 : RUN | 16 | 16 : SW-M2 | 32 | 32 : M-OH |
| 1 | 01 : N-EX | 17 | 17 : SW-M3 | 33 | 33 : M-OL |
| 2 | 02 : N-AG | 18 | 18 : BRK | 34 | 34 : DB-OL |
| 3 | 03 : N-AR | 19 | 19 : AL1 | 35 | 35 : LK-ERR |
| 4 | 04 : N-DT1 | 20 | 20 : AL2 | 36 | 36 : ANL |
| 5 | 05 : N-DT2 | 21 | 21 : AL4 | 37 | 37 : ANC |
| 6 | 06 : N-DT3 | 22 | 22 : AL8 | 38 | 38 : TBH |
| 7 | 07 : LU | 23 | 23 : FAN | 39 | 39 : O-DO1 |
| 8 | 08 : B / D | 24 | 24 : TRY | 40 | 40 : O-DO2 |
| 9 | 09 : TL | 25 | 25 : U-DO | 41 | 41 : O-DO3 |
| 10 | 10 : T-DT1 | 26 | 26 : INV-OH | 42 | 42 : O-DO4 |
| 11 | 11 : T-DT2 | 27 | 27 : SY-C | 43 | 43 : O-DO5 |
| 12 | 12 : KP | 28 | 28 : LIFE | 44 | 44 : O-DO6 |
| 13 | 13 : STOP | 29 | 29 : U-ACC | 45 | 45 : O-DO7 |
| 14 | 14 : RDY | 30 | 30 : U-DEC | 46 | 46 : O-DO8 |
| 15 | 15 : MF-DT | 31 | 31 : INV-OL | 47 | 47 : O-DO9 |

20) Ai function selection
(function codes E49 to E52)

| Code | List | Code | List |
|---|---|---|---|
| 0 | 00 : OFF | 12 | 12 : M - TMP |
| 1 | 01 : AUX - N1 | 13 | 13 : N - OR |
| 2 | 02 : AUX - N2 | 14 | 14 : U - AI |
| 3 | 03 : TLREF1 | 15 | 15 : PID - FB |
| 4 | 04 : TLREF2 | 16 | 16 : PID - RF |
| 5 | 05 : TB - REF | 17 | 17 : PID - G |
| 6 | 06 : T - REF | 18 | 18 : O - AI |
| 7 | 07 : IT - REF | | |
| 8 | 08 : CRP - N1 | | |
| 9 | 09 : CRP - N2 | | |
| 10 | 10 : MF - REF | | |
| 11 | 11 : LINE - N | | |

21) AO function selection
(function codes E69 to E73)

| Code | List | Code | List |
|---|---|---|---|
| 0 | 00 : N - FB1 + | 16 | 16 : TMP - M |
| 1 | 01 : N - FB1 ± | 17 | 17 : TMP - I |
| 2 | 02 : N - REF2 | 18 | 18 : IM - REF |
| 3 | 03 : N - REF4 | 19 | 19 : IM |
| 4 | 04 : N - FB2 ± | 20 | 20 : MF - REF |
| 5 | 05 : LIN - N ± | 21 | 21 : MF |
| 6 | 06 : ITREF ± | 22 | 22 : T |
| 7 | 07 : ITREF + | 23 | 23 : IT |
| 8 | 08 : T - REF ± | 24 | 24 : I - U |
| 9 | 09 : T - REF + | 25 | 25 : I - W |
| 10 | 10 : I - AC | 26 | 26 : V - U |
| 11 | 11 : V - AC | 27 | 27 : V - W |
| 12 | 12 : PWR | 28 | 28 : TBL |
| 13 | 13 : V - DC | 29 | 29 : TBG |
| 14 | 14 : P10 | 30 | 30 : U - AO |
| 15 | 15 : N10 | 31 | 31 : O - AO |

22) Motor control method
(function codes P01 and A01)

| Code | List |
|---|---|
| 0 | 0 : PG VECT |
| 1 | 1 : SNSRLES |
| 2 | 2 : EMULAT |
| 3 | 3 : SM VECT |

23) Motor
(see the next page)

24) Thermistor selection
(function codes P30, A31, and A47)

| Code | List |
|---|---|
| 0 | 0 : UNUSED |
| 1 | 1 : NTC |
| 2 | 2 : PTC |
| 3 | 3 : M - TMP |

25) Tuning operation selection
(function code H01)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ASR - TUN |
| 2 | 2 : R1 , L |
| 3 | 3 : AUT - STP |
| 4 | 4 : AUT - ROT |

26) Fan stop operation
(function code H06)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ACTIVE |

27) Rev. phase sequence lock
(function code H08)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ACTIVE |

23-1) M1 motor selection
(function code P02) with F60 set to 0 (kW)

| Code | List | Code | List |
|---|---|---|---|
| 0 | 00:0.75-2 | 19 | 19:7.5-4 |
| 1 | 01:1.5-2 | 20 | 20:11-4 |
| 2 | 02:2.2-2 | 21 | 21:15-4 |
| 3 | 03:3.7-2 | 22 | 22:18.5-4 |
| 4 | 04:5.5-2 | 23 | 23:22-4 |
| 5 | 05:7.5-2 | 24 | 24:30-4 |
| 6 | 06:11-2 | 25 | 25:37-4 |
| 7 | 07:15-2 | 26 | 26:45-4Y |
| 8 | 08:18.5-2 | 27 | 27:45-4S |
| 9 | 09:22-2 | 28 | 28:55-4 |
| 10 | 10:30-2 | 29 | 29:75-4 |
| 11 | 11:37-2 | 30 | 30:90-4 |
| 12 | 12:45-2Y | 31 | 31:110-4 |
| 13 | 13:45-2S | 32 | 32:132-4 |
| 14 | 14:55-2 | 33 | 33:160-4 |
| 15 | 15:75-2 | 34 | 34:200-4 |
| 16 | 16:90-2 | 35 | 35:220-4 |
| 17 | 17:3.7-4 | 36 | 36:P-OTR |
| 18 | 18:5.5-4 | 37 | 37:OTHER |

23-2) M1 motor selection
(function code P02) with F60 set to 1 (HP)

| Code | List | Code | List |
|---|---|---|---|
| 0 | 00: 1-2 | 19 | 19: 10-4 |
| 1 | 01: 2-2 | 20 | 20: 15-4 |
| 2 | 02: 3-2 | 21 | 21: 20-4 |
| 3 | 03: 5-2 | 22 | 22: 25-4 |
| 4 | 04:7.5-2 | 23 | 23: 30-4 |
| 5 | 05: 10-2 | 24 | 24: 40-4 |
| 6 | 06: 15-2 | 25 | 25: 50-4 |
| 7 | 07: 20-2 | 26 | 26: 60-4Y |
| 8 | 08: 25-2 | 27 | 27: 60-4S |
| 9 | 09: 30-2 | 28 | 28: 75-4 |
| 10 | 10: 40-2 | 29 | 29:100-4 |
| 11 | 11: 50-2 | 30 | 30:125-4 |
| 12 | 12: 60-2Y | 31 | 31:150-4 |
| 13 | 13: 60-2S | 32 | 32:175-4 |
| 14 | 14: 75-2 | 33 | 33:200-4 |
| 15 | 15:100-2 | 34 | 34:250-4 |
| 16 | 16:125-2 | 35 | 35:300-4 |
| 17 | 17: 5-4 | 36 | 36:P-OTR |
| 18 | 18:7.5-4 | 37 | 37:OTHER |

28) Energy-saving operation
(function code H10)

| Code | List |
|---|---|
| 0 | 0:INACTIV |
| 1 | 1:ACTIVE |

29) Active drive
(function code H19)

| Code | List |
|---|---|
| 0 | 0:INACTIV |
| 1 | 1:ACTIVE |

30) PID control (operation mode)
(function code H20)

| Code | List |
|---|---|
| 0 | 0:INACTIV |
| 1 | 1:ACTIVE |
| 2 | 2:ACT-INV |

31) PID control
(Command selection)
(function code H21)

| Code | List |
|---|---|
| 0 | 0:KPAD,12 |
| 1 | 1:PIDS |

32) Link function protection
(function code H29)

| Code | List |
|---|---|
| 0 | 0:CHG OK |
| 1 | 1:PROTECT |

33) Serial link
(function code H30)

| Code | List |
|---|---|
| 0 | 0:MONITOR |
| 1 | 1:REFER |
| 2 | 2:COMMAND |
| 3 | 3:REF,COM |

34) RS485 (Mode select on no response error)
(function code H32)

| Code | List |
|---|---|
| 0 | 0:EMG STP |
| 1 | 1:STP LIM |
| 2 | 2:STP ERR |
| 3 | 3:DRV CNT |

35) RS485 (Baud rate)
(function code H34)

| Code | List |
|---|---|
| 0 | 0 : 38400 |
| 1 | 1 : 19200 |
| 2 | 2 : 9600 |
| 3 | 3 : 4800 |
| 4 | 4 : 2400 |

36) RS485 (Data length)
(function code H35)

| Code | List |
|---|---|
| 0 | 0 : 8BITS |
| 1 | 1 : 7BITS |

37) RS485 (Parity check)
(function code H36)

| Code | List |
|---|---|
| 0 | 0 : NON |
| 1 | 1 : EVEN |
| 2 | 2 : ODD |

38) RS485 (Stop bits)
(function code H37)

| Code | List |
|---|---|
| 0 | 0 : 2BITS |
| 1 | 1 : 1BIT |

39) RS485 protocol selection
(function code H40)

| Code | List |
|---|---|
| 0 | 0 : FUJI |
| 1 | 1 : SX(LDR) |
| 2 | 2 : RTU |

40) Torque reference selection
(function code H41)

| Code | List |
|---|---|
| 0 | 0 : ASR |
| 1 | 1 : AI-TS |
| 2 | 2 : DIA CRD |
| 3 | 3 : DIB CRD |
| 4 | 4 : COMM |
| 5 | 5 : PID |

41) Torque current reference selection
(function code H42)

| Code | List |
|---|---|
| 0 | 0 : ASR |
| 1 | 1 : AI-ITCS |
| 2 | 2 : DIA CRD |
| 3 | 3 : DIB CRD |
| 4 | 4 : COMM |

42) Magnetic-flux reference selection
(function code H43)

| Code | List |
|---|---|
| 0 | 0 : IN-CALC |
| 1 | 1 : AI-FLUX |
| 2 | 2 : H44 DAT |
| 3 | 3 : COMM |

43) Observer type selection
(function code H46)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : DISTURB |
| 2 | 2 : VIBRAT |

44) Line speed feedback selection
(function code H53)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : AI-LINE |
| 2 | 2 : DI-PGLD |
| 3 | 3 : HI SEL |

45) Overvoltage suppressing function
(function code H57)

| Code | List |
|---|---|
| 1 | 0 : INACTIV |
| 2 | 1 : ACTIVE |

46) Overcurrent suppressing function
(function code H58)

| Code | List |
|---|---|
| 1 | 0 : INACTIV |
| 2 | 1 : ACTIVE |

47) Load adaptive control function definition 1
(function code H60)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : METHOD1 |
| 2 | 2 : METHOD2 |
| 3 | 3 : METHOD3 |

48) Load adaptive control definition 2 (function code H61)

| Code | List |
|---|---|
| 0 | 0 : FWD - UP |
| 1 | 1 : FWD - DWN |

49) Reserved 2 (function code H71)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ACR - TUN |
| 2 | 2 : VGAIN - T |
| 3 | 3 : V OFFST |
| 4 | 4 : I - UMBLC |
| 5 | 5 : POLE - TU |

50) DIA/DIB function selection (function codes o01 and o02)

| Code | List |
|---|---|
| 0 | 0 : BINARY |
| 1 | 1 : BCD |

52) Action on communication error (function code o30)

| Code | List |
|---|---|
| 0 | 0 : EMG STP |
| 1 | 1 : STP LIM |
| 2 | 2 : STP ERR |
| 3 | 3 : DRV CNT |

53) Communication format (function code o32)

| Code | List |
|---|---|
| 0 | 0 : 4W+4W |
| 1 | 1 : 8W+8W |

54) Multiwinding system (function code o33)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ACTIVE |

55) UPAC function (function code o38)

| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : ACTIVE |
| 2 | 2 : ACT - INI |

56) Fixed S-shaped pattern (function code L04)

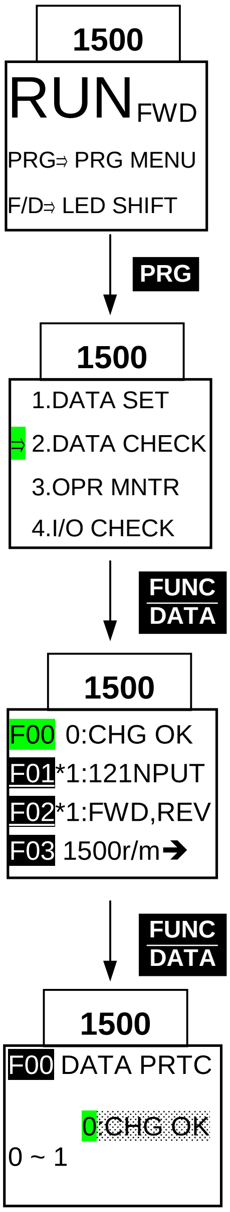
| Code | List |
|---|---|
| 0 | 0 : INACTIV |
| 1 | 1 : METHOD1 |
| 2 | 2 : METHOD2 |
| 3 | 3 : METHOD3 |

58) Inverter capacity (function code n01)

| Code | List | Code | List | Code | List |
|---|---|---|---|---|---|
| 0 | 00 : 0.75 - 2 | 11 | 11 : 37 - 2 | 22 | 22 : 22 - 4 |
| 1 | 01 : 1.5 - 2 | 12 | 12 : 45 - 2 | 23 | 23 : 30 - 4 |
| 2 | 02 : 2.2 - 2 | 13 | 13 : 55 - 2 | 24 | 24 : 37 - 4 |
| 3 | 03 : 3.7 - 2 | 14 | 14 : 75 - 2 | 25 | 25 : 45 - 4 |
| 4 | 04 : 5.5 - 2 | 15 | 15 : 90 - 2 | 26 | 26 : 55 - 4 |
| 5 | 05 : 7.5 - 2 | 16 | 16 : 3.7 - 4 | 27 | 27 : 75 - 4 |
| 6 | 06 : 11 - 2 | 17 | 17 : 5.5 - 4 | 28 | 28 : 90 - 4 |
| 7 | 07 : 15 - 2 | 18 | 18 : 7.5 - 4 | 29 | 29 : 110 - 4 |
| 8 | 08 : 18.5 - 2 | 19 | 19 : 11 - 4 | 30 | 30 : 132 - 4 |
| 9 | 09 : 22 - 2 | 20 | 20 : 15 - 4 | 31 | 31 : 160 - 4 |
| 10 | 10 : 30 - 2 | 21 | 21 : 18.5 - 4 | 32 | 32 : 200 - 4 |

| Code | List | Code | List |
|---|---|---|---|
| 33 | 33 : 220 - 4 | 44 | 44 : OTR - 6 |
| 34 | 34 : 250 - 4 | 45 | 45 : OTR - 7 |
| 35 | 35 : 280 - 4 | 46 | 46 : OTR - 8 |
| 36 | 36 : 315 - 4 | 47 | 47 : OTR - 9 |
| 37 | 37 : 355 - 4 | 48 | 48 : OTR - 10 |
| 38 | 38 : 400 - 4 | | |
| 39 | 39 : OTR - 1 | | |
| 40 | 40 : OTR - 2 | | |
| 41 | 41 : OTR - 3 | | |
| 42 | 42 : OTR - 4 | | |
| 43 | 43 : OTR - 5 | | |

## 5.4.7 Checking the Function Code Settings




Press the PRG key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to "2. CHECK DATA" using the ∧ or ∨ key. Press the FUNC/DATA key to call a list of function codes and their settings to the LCD.

Select the function code which is to be checked using the ∧ or ∨ key with the same procedure as described in 5.4.6 "Function Code Setting Procedure".

Select a function code and change its setting. Press the FUNC/DATA key to store the new value as you do on the function code setting screen.

## 5.4.8 Operation Status Monitor

Press the **PRG** key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to "3. MONITOR" using the ∧ or ∨ key. Press the **FUNC DATA** key to check the current inverter operation status on the LCD.

1500
RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT

↓ PRG

1500
1.DATA SET
2.DATA CHECK
⇒ 3.OPR MNTR
4.I/O CHECK

↓ FUNC DATA

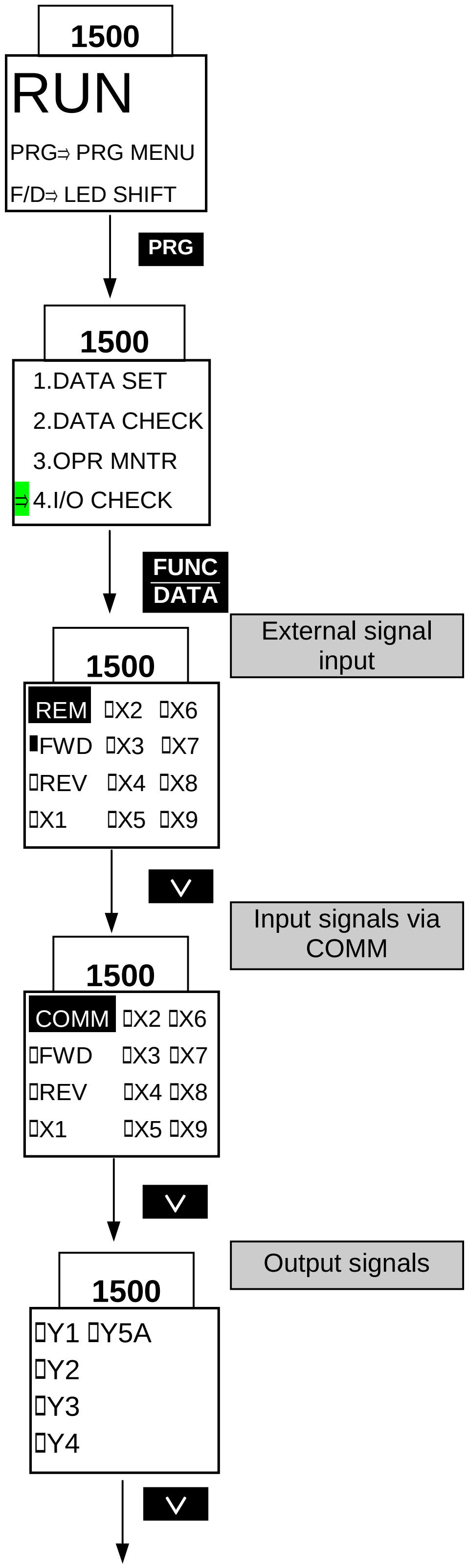
There are two operation status monitor screens. Press the ∧ or ∨ key to call the other screen.

1500 ← LED monitor (The latest alarm code blinks quickly when an alarm is issued.)
N*= xxxxx. xr/m ← Speed setting 4 (rounded to a decimal)
N = xxxxx. xr/m ← Detected speed 1 (rounded to a decimal)
f* = xxx. xHz ← Reference output frequency
TRQ= xxx% ← Reference torque

↓ ∨

1500
TMP = ± xxx°C ← Motor temperature ("---" appears with NTC thermistor not connected)
Iout=xxxx. xx A ← Detected output current
Vout= xxx V ← Detected output voltage
FLX*= xxx% ← Reference flux value

## 5.4.9 I/O Check




Press the PRG key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to "4. I/O CHECK" using the ∧ or ∨ key. Press the FUNC/DATA key to check the status of inverter and optional analog input/output and digital input/output units on the LCD.

There are sixteen I/O check screens. Press the ∧ or ∨ key to call the previous or next screen. The I/O status of each optional unit is only indicated when the optional unit is mounted.

This screen is used to check input signals to the terminal block (REM).

□ : Signal off , ■ : Signal on

This screen is used to check input signals via the link (COMM).

□ : Signal off , ■ : Signal on

This screen is used to check the on/off status of the functions assigned to Y1 to Y5A.

□ : Signal off , ■ : Signal on

**Analog input signals (AI)**

```
1500
12 =± xx. xV
Ai1=± xx. xV
Ai2=± xx. xV
```

This screen is used to check analog input voltages to the terminal block (–10.0 to +10.0 V).

[1] Analog input signal (12)
[2] Analog input signal (Ai1)
[3] Analog input signal (Ai2)
[4] Not used

∨

**Analog output status (AO)**

```
1500
AO1 =± xx. xV
AO2 =± xx. xV
AO3 =± xx. xV
```

This screen is used to check the status of the functions assigned to analog output terminals (–10.0 to +10.0 V).

[1] Analog output signal (AO1)
[2] Analog output signal (AO2)
[3] Analog output signal (AO3)
[4] Not used

∨

**Operation status**

```
1500
□FWD□BRK□IL
□REV□NUV□ACC
□EXT □TL  □DEC
□INT □VL  □ALM
```

This screen is used to check the inverter operation status.
□ : Signal off , ■ : Signal on

FWD: Forward operation
EXT: Pre-exciting
BRK: Braking

TL: Torque limiting
IL: Current limiting
DEC: Decelerating

REV: Reverse operation
INT: Inverter shut off
NUV: DC link circuit voltage established (ready for operation)
VL: Voltage limiting
ACC: Accelerating
ALM: Alarm output (for any fault)

∨

**Effective sets of motors/parameters**

```
1500
□PARA 1 □M1
□PARA 2 □M2
□PARA 3 □M3
□PARA 4 □JOG
```

Indicates currently effective sets.
□ : Signal off , ■ : Signal on

PARA 1 (F07, F08, and F61 to F70) JOG (C30 to C38)
PARA 2 (C40 to C49)
PARA 3 (C50 to C59)
PARA 4 (C60 to C69)
M1 (F03 to F05, F10 to F12, and P codes)
M2 (A01 to A34)
M3 (A35 to A50)

∨

**Status of optional I/O units**

```
1500
□DIA     □DIB
□DIOA    □DIOB
□AIO     □PMPG
□PG-LD□PG-PD
```

Indicates the status of optional I/O units.
□ : Signal off , ■ : Signal on

DIA, DIB (OPC-VG7-DIA, DIB)
DIOA, DIOB (OPC-VG7-DIOA, DIOB)
AIO (OPC-VG7-AIO)
PMPG (OPC-VG7-PMPG)
PG-LD, PD (OPC-VG7-PG)

∨

**1500**
□PG-PR □PG-SD
□UPAC □SX
□TL □FIELD
□SI-UP □SI-MW

Status of optional I/O communication units

Indicates the status of optional I/O communication units.
□ : Signal off , ■ : Signal on

PG-PR, SD (OPC-VG7-PG)
UPAC (OPC-VG7-UPAC)
SX (OPC-VG7-SX)
TL (OPC-VG7-TL)
FIELD (optional field bus)
SI-UP, MW (OPC-VG7-SI)

∨

* The following information is indicated when the optional AIO unit is mounted.

**1500**
Ai3 =±xx. x V
Ai4 =±xx. x V
AO4 =±xx. x V
AO5 =±xx. x V

I/O status of optional AIO unit

[1] I/O status 1 of AIO (Ai3) ... “---” appears with AIO not connected.
[2] I/O status 1 of AIO (Ai4) ... “---” appears with AIO not connected.
[3] I/O status 2 of AIO (AO4) ... “---” appears with AIO not connected.
[4] I/O status 2 of AIO (AO5) ... “---” appears with AIO not connected.

∨

**1500**
SD =± xxxxxp/s
LD =± xxxxxp/s
PR =± xxxxxp/s
PD =± xxxxxp/s

Input status of inverter/optional PG (SD, LD, PR, and PD)

[1] Input status of inverter/PG (SD) signal; Open collector: Phase A/B x4 frequency, SD: line driver phase A/B
[2] Input status of PG (LD) signal ... “---” appears with PG (LD) not connected.
[3] Input status of PG (PR) signal ... “---” appears with PG (PR) not connected.
[4] Input status of PG (PD) signal ... “---” appears with PG (PD) not connected.

∨

* The following information is indicated when the optional DIOA unit is mounted.

**1500**
R□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of optional DIOA unit

□ : Signal off , ■ : Signal on

∨

**1500**

```
C□X11□Y11□Y15
  □X12□Y12□Y16
  □X13□Y13□Y17
  □X14□Y14□Y18
```

Input status of DIOA (via COMM)

□ : Signal off , ■ : Signal on

∨

* The following information is indicated when the optional DIA/DIB unit is mounted.

**1500**

```
□DIA □BCD□BIN
A = XXXXX
□DIB □BCD□BIN
B = XXXXX
```

Input status of optional DIA/DIB unit

[1 and 3] Function codes o01 and o02 are used to switch the optional unit between DIA and DIB (BCD or binary) and between BCD and binary respectively.

□ : Signal off , ■ : Signal on

[2] Input status of optional DIA unit
[4] Input status of optional DIB unit

∨

* The following information is indicated when the optional DIOB unit is mounted.

**1500**

```
X□21□25□29□33
 □22□26□30□34
 □23□27□31□35
 □24□28□32□36
```

Input status of optional DIOB unit

□ : Signal off , ■ : Signal on

∨

**1500**

```
□Y21□Y25□Y29
□Y22□Y26□Y30
□Y23□Y27
□Y24□Y28
```

Output status of optional DIOB unit

□ : Signal off , ■ : Signal on

## 5.4.10 Maintenance Information

1500
RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT

Press the PRG key with the operation mode screen to call the menu screen. Move the arrow at the left of the screen to "5. MAINTENANCE INFO" using the ∧ or ∨ key. Press the FUNC DATA key to call the information necessary for maintenance and inspection on the LCD.

1500
1.DATA SET
2.DATA CHECK
3.OPR MNTR
4.I/O CHECK
⇒ 5.MAINTENANC

There are five maintenance information screen. Press the ∧ or ∨ key to call the previous or next screen.

Operation status 1

1500
TIME= xxxxxh
EDC = xxxV
TMPI= xxx°C
TMPF= xxx°C

[1] Cumulative operation hours
[2] Detected DC link circuit voltage
[3] Maximum inverter inside air temperature
(within an hour)
[4] Maximum heat sink temperature
(within an hour)

∨

Operation status 2

1500
Imax=xxxx.xxA
CAP = xxx. x%

[1] Maximum effective current (within an hour)
[2] Main capacitor capacity

∨

**1500**

Operation status 3

TCAP= xxxxxh
(61000h)
TFAN= xxxxxh
(25000h)

[1] Cumulative operation hours of capacitor on PC board
[2] Estimated remaining life of capacitor on PC board (fixed)
[3] Cooling fan operation hours
[4] Estimated remaining life of cooling fan (fixed)

**1500**

Communication status

NRK=xxxxx
NRR=xxxxx xx
NRO=xxxxx xx
NRL=xxxxx xx

This screen indicates the number of communication errors that have occurred with each unit and the code representing the cause of the latest error. For details of codes, see the description of each optional unit or RS485.

[1] Number of communication retries for KEYPAD
[2] Number of communication retries and latest error code for RS-485
[3] Number of communication retries and latest error code for T-Link/SX
[4] Number of communication retries and latest error code for optional SI/RS unit

Numbers of communication errors detected by the inverter. "--" appears when no error has occurred.

**1500**

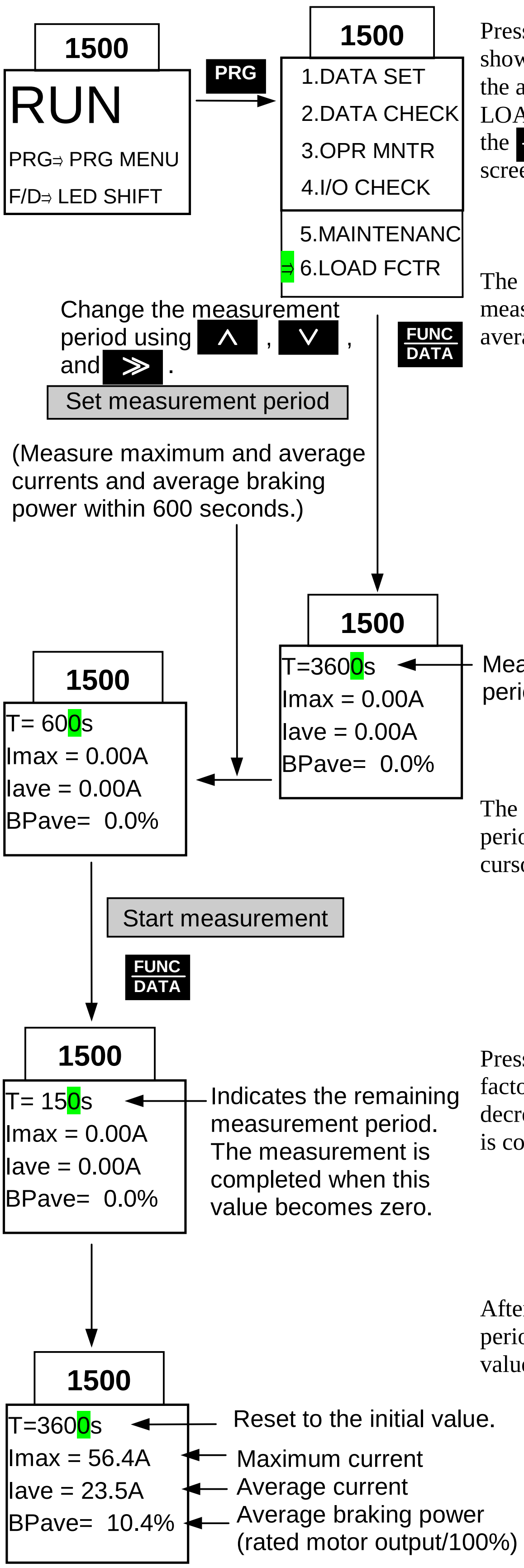
ROM version

MAIN=H1xxxx
MTR =H2xxxx
KP =K0xxxx

The screen indicates the ROM number of the inverter control CPU. Fuji Electric may ask the ROM version in case of a malfunction.

[1] ROM version of main control CPU (MAIN)
[2] ROM version of motor control CPU (MTR)
[3] ROM version of KEYPAD
[4] Not used

## 5.4.11 Measurement of Load Factor




Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to "6. MEASURE LOAD FACTOR" using the ∧ or ∨ key. Press the FUNC/DATA key to call the load factor measurement screen on the LCD.

The load factor measurement screen indicates the measured maximum current, average current, and average braking power within a preset period.

The cursor resides at the last digit of the measurement period. You can change the value at the place where the cursor resides. Press the ≫ key to move the cursor.

Press the FUNC/DATA key to start the measurement of the load factor. The indicated measurement period is gradually decremented after this key is pressed. The measurement is completed when this value becomes zero.

After the measurement is completed, the measurement period is reset to the initial value and the measured values are indicated.

## 5.4.12 Alarm Information

1500
RUN
PRG⇒ PRG MENU
F/D⇒ LED SHIFT

Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to "7. ALARM INFO" using the ∧ or ∨ key. Press the FUNC DATA key to indicate the various operation status upon the occurrence of the last alarm on the LCD.

PRG

1500
1.DATA SET
2.DATA CHECK
3.OPR MNTR
4.I/O CHECK
5.MAINTENANC
6.LOAD FCTR
⇒ 7.ALM INF

There are eleven alarm information screens. Press the ∧ or ∨ key to call the previous or next screen.

FUNC DATA

OC
N*= xxxxxr/m
N = xxxxxxr/m
f* = xxx. xHz
TRQ= xxxx%

Operation status 1 upon the occurrence of alarm

[1] Speed setting 4 upon the occurrence of alarm
[2] Detected speed 1 upon the occurrence of alarm
[3] Reference output frequency upon the occurrence of alarm
[4] Reference torque upon the occurrence of alarm

∨

OC
TMP = ± xxx°C
Iout =xxxx. xxA
Vout = xxxV
FLX* = xxx%

Operation status 2 upon the occurrence of alarm

[1] Motor temperature upon the occurrence of alarm ("---" appears with NTC not connected)
[2] Detected output current upon the occurrence of alarm
[3] Detected output voltage upon the occurrence of alarm
[4] Reference magnetic-flux upon the occurrence of alarm

∨

**OC**

TIME =xxxxxh
Mout =xxx. xkW
TMPI= xxxx°C
TMPF= xxxx°C

Operation status upon the occurrence of alarm

[1] Cumulative operation hours upon the occurrence of alarm
[2] Reference motor output (in kW or HP) upon the occurrence of alarm…… kW or HP can be selected with code F60.
[3] Inverter inside air temperature upon the occurrence of alarm
[4] Heat sink temperature upon the occurrence of alarm

Temperatures measured when the alarm was detected

∨

**OC**

NRK=xxxxx
NRR=xxxxx
NRO=xxxxx
NRL=xxxxx

Communication status upon the occurrence of alarm

[1] Number of communication retries for KEYPAD upon the occurrence of alarm
[2] Number of communication retries for RS-485 upon the occurrence of alarm
[3] Number of communication retries for T-Link/SX upon the occurrence of alarm
[4] Number of communication retries for optional SI/RS unit upon the occurrence of alarm

Numbers of communication errors detected by the inverter

∨

**OC**

| | | |
|---|---|---|
| REM | □X2 | □X6 |
| □FWD | □X3 | □X7 |
| □REV | □X4 | □X8 |
| □X1 | □X5 | □X9 |

Input signal status upon the occurrence of alarm

□ : Signal off , ■ : Signal on

∨

**OC**

| | | |
|---|---|---|
| COMM | □X2 | □X6 |
| □FWD | □X3 | □X7 |
| □REV | □X4 | □X8 |
| □X1 | □X5 | □X9 |

Input signal status via COMM upon the occurrence of alarm

□ : Signal off , ■ : Signal on

∨

**OC**

□Y1 □Y5A
□Y2
□Y3
□Y4

Output signal status upon the occurrence of alarm

□ : Signal off , ■ : Signal on

∨

**OC**

□FWD□BRK□IL
□REV□NUV□ACC
□EXT□TL□DEC
□INT□VL□ALM

Operation status upon the occurrence of alarm

□ : Signal off , ■ : Signal on

∨

* The following information is indicated when the optional DIOA unit is mounted.

**OC**

R□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of optional DIOA unit (terminal information) upon the occurrence of alarm

□ : Signal off , ■ : Signal on

∨

**OC**

C□X11□Y11□Y15
□X12□Y12□Y16
□X13□Y13□Y17
□X14□Y14□Y18

Input status of optional DIOA unit (via COMM) upon the occurrence of alarm

□ : Signal off , ■ : Signal on

∨

**OC**

0/1=xxx xxx
–1=xxx xxx
–2=xxx xxx
–3=xxx xxx

Alarm history 1

Latest alarm

Alarm history (–1 to –3)
(Updated each time an alarm is issued. If the same alarm with the previous one is given, only the number of cases increases.)

∨

**OC**

5=xxx
4=xxx
3=xxx
2=xxx

Multiple alarms

Multiple alarms (indicated while pending).

∨

**OC**

Alarm history 2

−4=xxx xxx
−5=xxx xxx
−6=xxx xxx
−7=xxx xxx

Alarm history (−4 to −7)
(Updated each time an alarm is issued. If the same alarm with the previous one is given, only the number of cases increases.)

∨

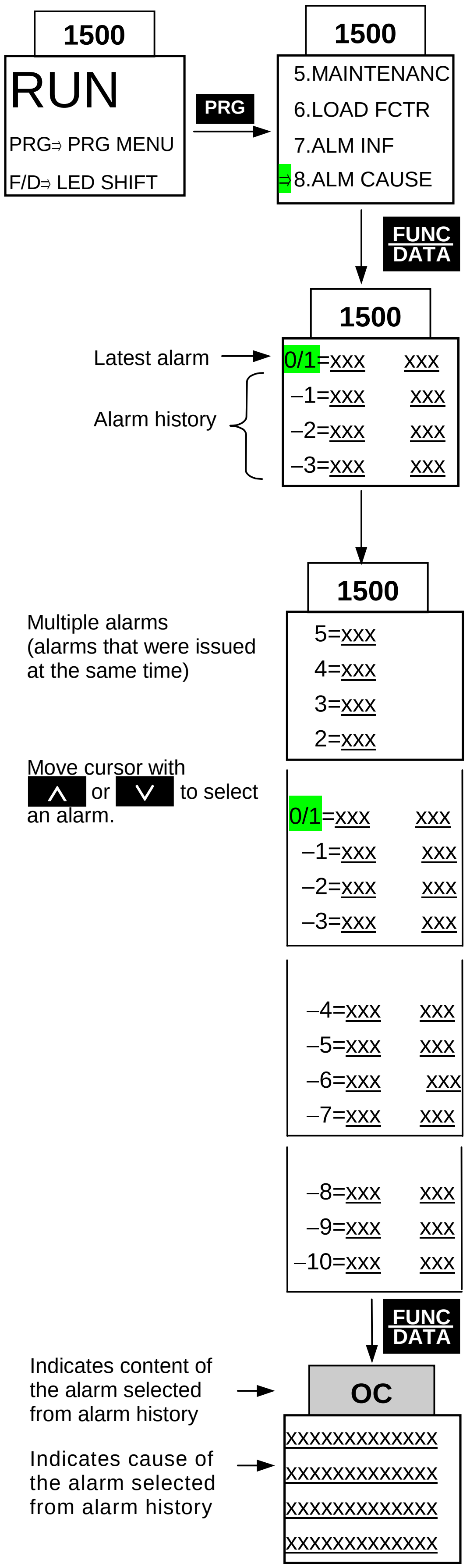
**OC**

Alarm history 3

−8=xxx xxx
−9=xxx xxx
−10=xxx xxx

Alarm history (−8 to −10)
(Updated each time an alarm is issued. If the same alarm with the previous one is given, only the number of cases increases.)

## 5.4.13 Alarm History and Causes

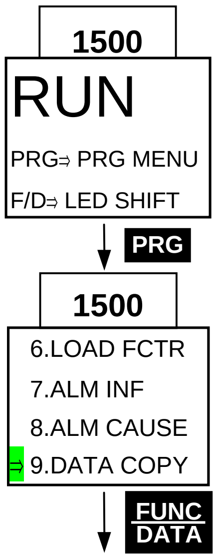



Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to "8. ALARM CAUSES" using the ∧ or ∨ key. Press the FUNC/DATA key to call the alarm history on the LCD.

Press the ∧ or ∨ key to select an alarm the information of which is to be checked. Press the FUNC/DATA key to call the troubleshooting information for the selected alarm.

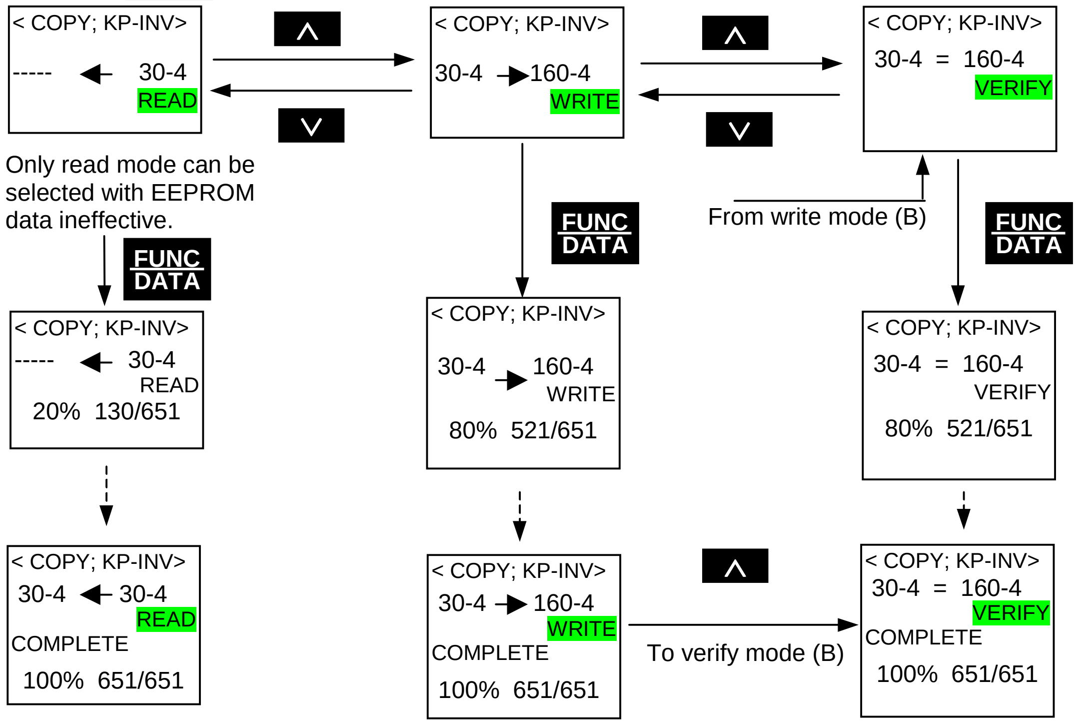
If all the information for the selected alarm is not shown on the screen at a time, scroll over the descriptive information using the ∧ and ∨ keys.

# 5.4.14 Copying Data




Press the PRG key with the operation mode screen shown on the KEYPAD to call the menu screen. Move the arrow at the left of the screen to `9. COPY DATA' using the ∧ or ∨ key. Press the FUNC DATA key to call the copy mode screen on the LCD.

You can select the read, write, or verify mode on the copy mode screen using the ∧ or ∨ key.




Copy data with the following procedure.

1) Download the function code settings to the KEYPAD panel.
2) Remove the KEYPAD panel from the inverter.
3) Mount the KEYPAD panel to another inverter.
4) Upload the function code settings to the inverter.

- The verify mode is used to check the consistency between the data stored in the KEYPAD panel and those in the inverter.

Data copy errors

(1) Writing disabled during operation

If an attempt is made to upload data to a running inverter or start the inverter during an uploading process, an error message appears as shown on the right.
Stop the inverter, press **RESET** , and try to upload again.

During operation

```
< COPY; KP-INV>
30-2 → 160-4
          WRITE
INV RUNNING
```

Press RESET or PRG to quit.

(2) Memory error

If an attempt is made to upload without downloading data to the KEYPAD memory (with the memory empty) or upload data to an inverter with a different capacity, model, or voltage class from the inverter from which the data was downloaded, an error message appears as shown on the right.

EEPROM check sum error

```
< COPY; KP-INV>
55-4 → 160-4
          WRITE
MEMORY ERROR
```

Press RESET or PRG to quit.

(3) Verification error

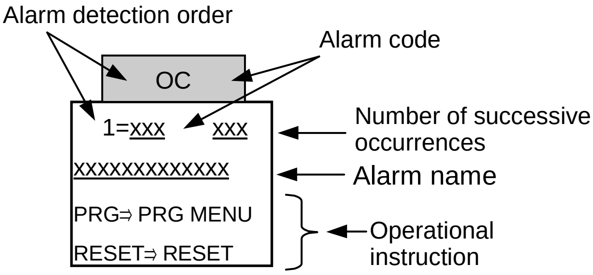
If the data stored in the KEYPAD memory is found by the data check (verification) to be inconsistent from that stored in the inverter, the relevant function code and error code appear. The data check is interrupted.
Press **FUNC/DATA** to resume the data check and check for other inconsistencies or **RESET** to exit the verify mode and proceed to another process.

Error found in write/verify mode

```
< COPY; KP-INV>
55-4 → 160-4
          WRITE
ERR:F25
```

Press F/D to continue or
RESET or PRG to quit

## 5.4.15 Alarm Mode




When a single alarm is issued, the alarm mode screen appears where the content of the alarm is indicated.

When multiple alarms are issued at the same time, the contents of the alarms can be checked using the ∧ and ∨ keys.

Table 5-4-4 Alarm Detection Order

| Operating keys | LED display | LCD display | Content |
|---|---|---|---|
| | 5. | 5 | Alarm No. 5 |
| ∧ ∨ | 4. | 4 | Alarm No. 4 |
| ↑ ↓ | 3. | 3 | Alarm No. 3 |
| | 2. | 2 | Alarm No. 2 |
| | 1. | 1 | Alarm No. 1 (multiple alarms) |
| | Blank | 0 | Latest alarm (single alarm/already reset) |
| | Blank | –1 | 1st latest alarm |
| | Blank | –2 | 2nd latest alarm |
| | Blank | –3 | 3rd latest alarm |
| | Blank | –4 | 4th latest alarm |
| | Blank | –5 | 5th latest alarm |
| | Blank | –6 | 6th latest alarm |
| | Blank | –7 | 7th latest alarm |
| | Blank | –8 | 8th latest alarm |
| | Blank | –9 | 9th latest alarm |
| | Blank | –10 | 10th latest alarm |

- The information given by the LCD and LED when multiple alarms are issued at the same time is different from that given when a single alarm is issued.
  - When multiple alarms are issued, the information about alarm No. 1 is given.
  - When a single alarm is issued, the information about the latest alarm is given.
- When multiple alarms are issued, only alarm No. 1 is recorded in the alarm history. No. 2 and subsequent ones are not recorded.
- When a single alarm is issued, the latest alarm is recorded in the alarm history.

- MEMO -

THE INVERTER

# VI. Standard Interface RS485

# 6. Standard Interface RS485

## 6.1 Overview

The FRENIC5000VG7S has an integrated RS485 communication system. You can use this communication system to connect the inverter unit serially with a host device (master) such as a personal computer or a PLC and to enable the host device to operate, to stop, or to monitor the inverter or to change the function codes of the inverter.

The following three types of communication protocols are available. Select a protocol according to your application or for your convenience.
You can use the function code H40 "Protocol selection" to select a protocol.

FGI (FUJI General Purpose RS485 Communication)
FGI is a protocol supported by the FUJI G, P, and E series inverters. This protocol is convenient for multidrop connection with these inverters and the VG7S's as slaves.

Loader Command (SX Protocol)
This is a protocol to use the FRENIC5000VG7S support loader, a personal computer software operating on the Microsoft Windows. This protocol uses a number of special commands to make best use of the functions and the performance of the support loader. This protocol is not open to users and you should use them only when you use the support loader.

Modbus RTU
Modicon has specified this protocol to link their PLC's together or their PLC and other slave devices (such as inverters) over network.
Though the standard Modbus Protocol supports RTU transmission mode and ASCII transmission mode, the VG7S supports only the RTU that has higher transmission density.

Though the standard integrated RS485 communication hardware has a full duplex connector connection, the communication protocol is half duplex procedure that repeats request and response. Since the internal hardware of the inverter supports half duplex, a half duplex connection outside of the inverter is available. Note that when you use the UPAC option, since the internal connection between the UPAC and the VG7S is multidrop and the UPAC only supports full duplex communication, the external half duplex communication is not available.

In general, the driver/receiver circuits of RS485 are balance circuits. The "balance" means a positive signal and a negative signal (combination of TX+ and TX- or RX+ and RX-) have equal status. These circuits will have a strong anti-noise characteristic when you combine the circuits with balance cables (twisted pair cables with shield).
Inverters are source of noise. Master instrumentation devices (personal computers and PLC's) and isolated converters (RS485/RS485, RS232C/RS485) may malfunction. If this is the cease, you need the measures against abnormal communication described in this section.

You can select an action if the communication line is disconnected or an error occurs when you direct an operation command via the RS485 communication. When a communication error occurs during operation, the Er5 alarm (RS485 alarm) will be released after an action you select. After the alarm, the inverter will shut off its output and coast to stop.

The RS485 communication utilizing the option OPC-VG7-RS (simplified inter-inverter link) is dedicated for an inter-inverter link with the UPAC as a master or for the POD connection. No part of the description in this section is applicable to that case. See the sections for the control options.

## 6.2 Common Specifications

### 6.2.1 Specifications

<table>
<tr><th colspan="2">Item</th><th colspan="5">Specification</th></tr>
<tr><td rowspan="23">Communications</td><td colspan="6">Slave side specifications</td></tr>
<tr><td>Communication protocol</td><td>Loader command</td><td colspan="3">Modbus RTU</td><td>FUJI general purpose RS485 communication</td></tr>
<tr><td>Compliant with</td><td>Special commands dedicated to support loader (not open to user)</td><td colspan="3">Modicon<br>Modbus RTU</td><td>FUJI general purpose RS485 communication</td></tr>
<tr><td>Applicable to</td><td>FRENIC5000VG7S</td><td colspan="3">FUJI general purpose inverter (E9, 11 series UN)<br>FRENIC5000VG7S</td><td>FUJI general purpose inverter (11 series)<br>FRENIC5000VG7S</td></tr>
<tr><td>Protocol selection</td><td>Function code H40="1"</td><td colspan="3">Function code H40="2"</td><td>Function code H40="0"</td></tr>
<tr><td>Message type</td><td>Command message</td><td colspan="3">RTU (Remote Terminal Unit) mode<br>ASCII mode is not supported<br>Query, Broadcast message</td><td>Polling/selecting<br>Broadcast</td></tr>
<tr><td>Electric specification</td><td colspan="5">EIA RS485</td></tr>
<tr><td>Communication rate</td><td colspan="4">2,400, 4,800, 9,600, 19,200, 38,400bps</td><td>2,400, 4,800, 9,600, 19,200bps</td></tr>
<tr><td>Synchronization type</td><td colspan="5">Asynchronous (UART)</td></tr>
<tr><td>Transmission type</td><td colspan="5">Half duplex</td></tr>
<tr><td>Communication form</td><td colspan="5">Direct connection to inverter, 1:N (1≤N≤31)</td></tr>
<tr><td>Character type</td><td colspan="4">HEX</td><td>ASCII 7 bits</td></tr>
<tr><td>Data length</td><td colspan="4">8 bits fixed</td><td>H35 data length setting<br>Seven bits or eight bits</td></tr>
<tr><td>Stop bit</td><td>1 bit fixed</td><td>2 bits *2)</td><td colspan="2">1 bit</td><td>H37 stop bit setting<br>One bit or two bits</td></tr>
<tr><td>Parity</td><td>Even parity fixed</td><td>No parity</td><td>Even parity</td><td>Odd parity</td><td>H36 parity setting<br>No, even, or odd parity</td></tr>
<tr><td>Error check type</td><td>Checksum (one byte BCC)</td><td colspan="3">CRC-16<br>Generation polynomial:<br>$X^{16}+X^{15}+X^{2}+1$</td><td>Checksum (2-byte BCC)</td></tr>
<tr><td>Station number selection</td><td>1 to 255: Station number</td><td colspan="3">0: Broadcast<br>1 to 247: Station number</td><td>99: Broadcast *1)<br>1 to 31: Station number</td></tr>
<tr><td>Frame length</td><td>Variable length</td><td colspan="3">Variable length</td><td>Standard transmission: 16-byte fixed length<br>High-speed transmission: 8-, 12-byte fixed length</td></tr>
<tr><td>Maximum transmission data (per one message)</td><td>Write: 16 words<br>Read: 99 words</td><td colspan="3">Write: 16 words<br>Read: 99 words</td><td>1 word</td></tr>
<tr><td>Disconnection detection time</td><td colspan="5">H38 (Time out) sets disconnection detection time.<br>This function is effective only during RS485 operation.</td></tr>
<tr><td>Wiring length</td><td colspan="5">Non-isolated: 10m max<br>Isolated: 500m max<br>• Use a commercial 485/485 isolator (repeater) or a 485/232C isolated converter for isolation.<br>• An inverter may be a source of noise. Use a converter superior in anti-noise capability.<br>Recommended converter: System Sacom KS-485PTI</td></tr>
</table>

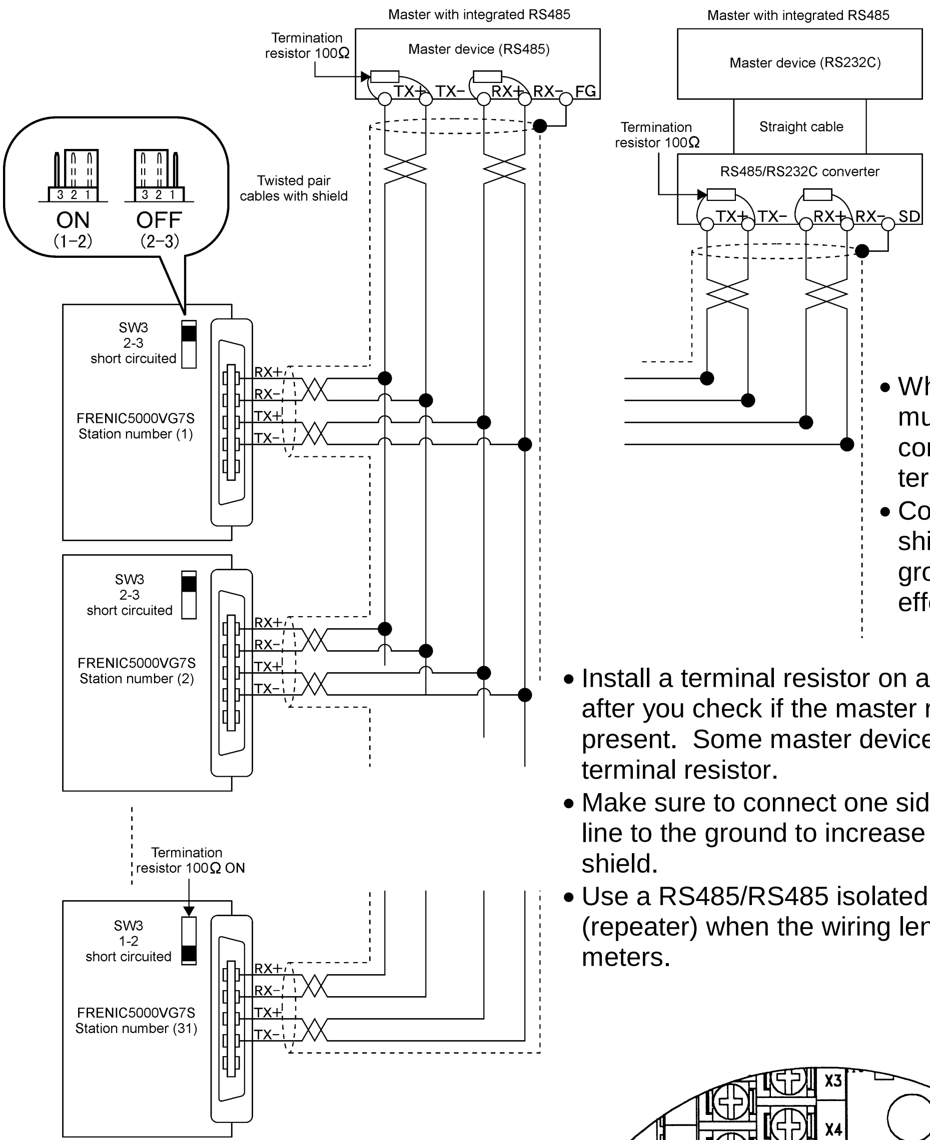
*1) The broadcast is available only for S01 to S12. You cannot broadcast other function codes.
*2) The parity selection automatically determines the stop bit in the RTU broadcast.

Standard Interface RS485

## 6.2.2 Basic Wiring Diagram

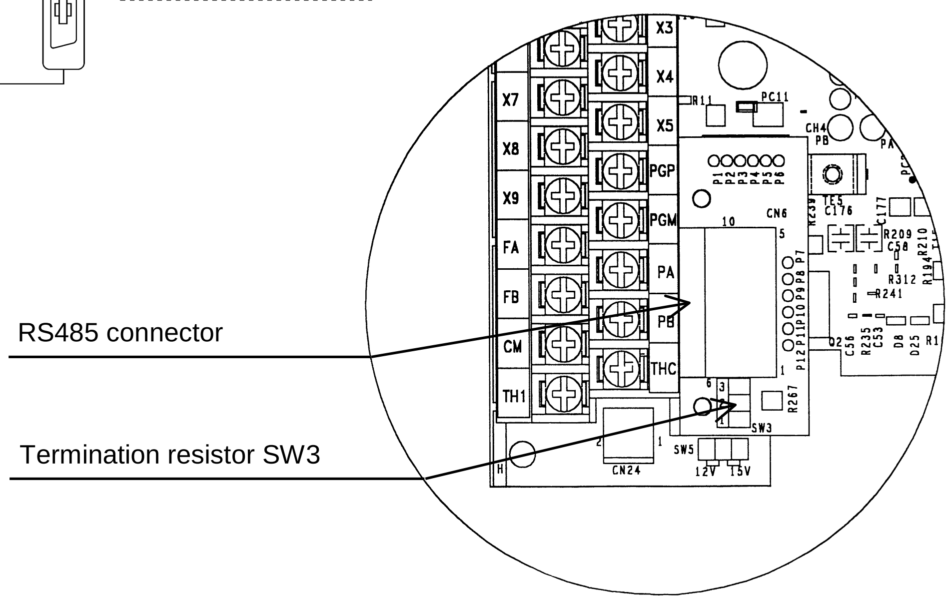
(1) Full Duplex Wiring Diagram

This wiring diagram describes a case when you select a separate transmission signal and a reception signal. The VG7S connector has assignments for full duplex signals (TX+, TX-, RX+, RX-).




- When you connect multiple units, connect them via a terminal box.
- Connecting the shield line to the ground may be effective for noise.

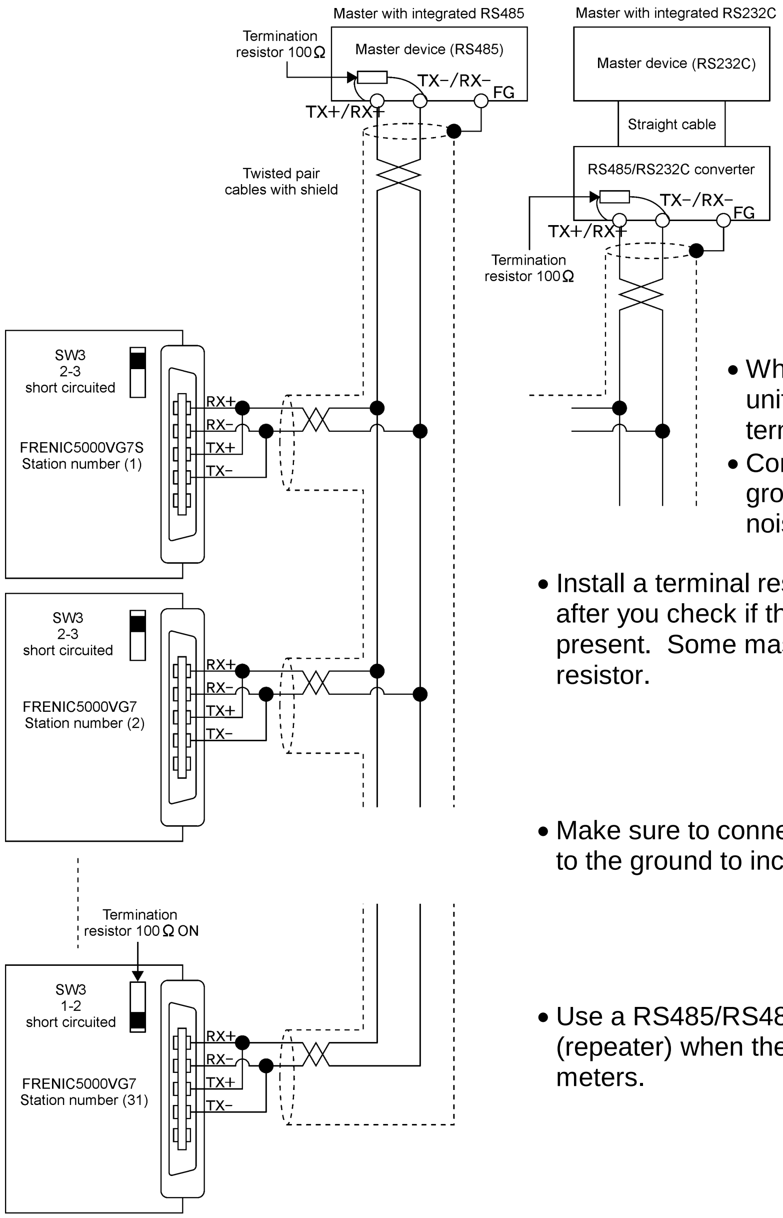
- Install a terminal resistor on a master device after you check if the master resistor is not present. Some master devices have a terminal resistor.
- Make sure to connect one side of the shield line to the ground to increase the effect of the shield.
- Use a RS485/RS485 isolated converter (repeater) when the wiring length exceeds ten meters.




Locations on the control print circuit board

(2) Half Duplex Wiring Diagram

This wiring diagram describes a case when you use common lines serving both for a transmission signal and a reception signal. Since the VG7S connector has assignments for full duplex signals (TX+, TX-, RX+, RX-), you should short-circuit lines from the VG7S connector as described in the diagram.




- When you connect multiple units, connect them via a terminal box.
- Connecting the shield line to the ground may be effective for noise.

- Install a terminal resistor on a master device after you check if the master resistor is not present. Some master devices have a terminal resistor.

- Make sure to connect one side of the shield line to the ground to increase the effect of the shield.

- Use a RS485/RS485 isolated converter (repeater) when the wiring length exceeds ten meters.

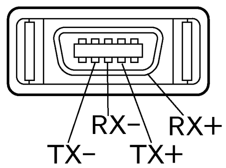
## 6.2.3 Connection Instructions

| ⚠WARNING |
|---|
| • Make sure to turn off (open) the power before performing connection work.<br>**You may get electric shock.** |

Connectors are used for RS485 connection.

- When you connect a master device to a VG7S one-to-one, we recommend a RS485/RS232C converter with a cable (2m) (Type: NP4H-CNV).
- For one-to-N connection, make sure to combine a connection plug (See (2) below) with a twisted pair cable with shield.

(1) Pin Assignment for PCB Mount Receptacle




Pin Assignment for RS485 Receptacle (Connector) Mounted on the PCB.

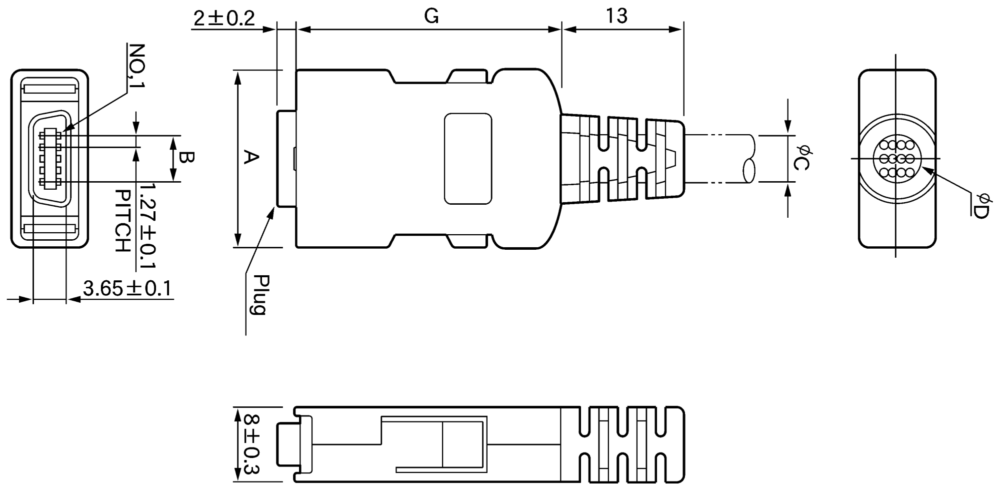
| Pin number | Name | Description | Pin Number | Name | Description |
|---|---|---|---|---|---|
| 1 | Do not use | | 7 | TX+ | Transmission (+) |
| 2 | | | | | |
| 3 | RX+ | Reception (+) | 8 | RX– | Reception (–) |
| 4 | Do not use | | 9 | TX– | Transmission (–) |
| 5 | | | | | |

(2) Recommended Plug Manufacturer

Recommended plug manufacturer for the RS485 receptacle on the print circuit board.

Manufacturer: Japan Aviation Electronics Ind.

Product Name: Pressure contact type plug (with food), 10-core, TX20A-10PH1-D2P1-D1

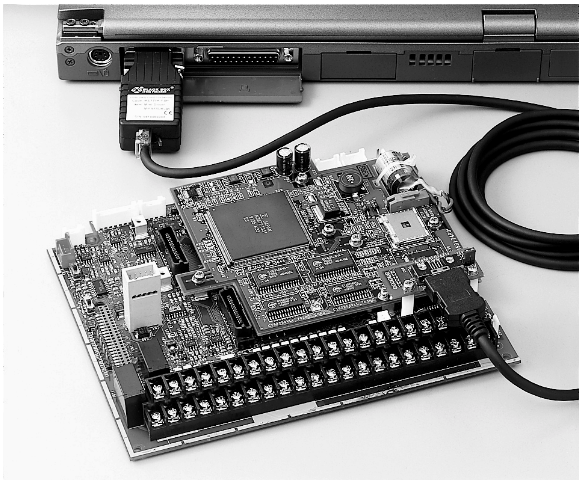



Dimensions

| Core number | Product name | A ±0.3 | B ±0.15 | ∅C | ∅D ±0.4 | G ±0.3 |
|---|---|---|---|---|---|---|
| 10 | TX20A-10PH1-D2P1-D1 | 19.08 | 5.08 | 5 | 5.3 | 28 |

(3) Cable with RS485 Converter

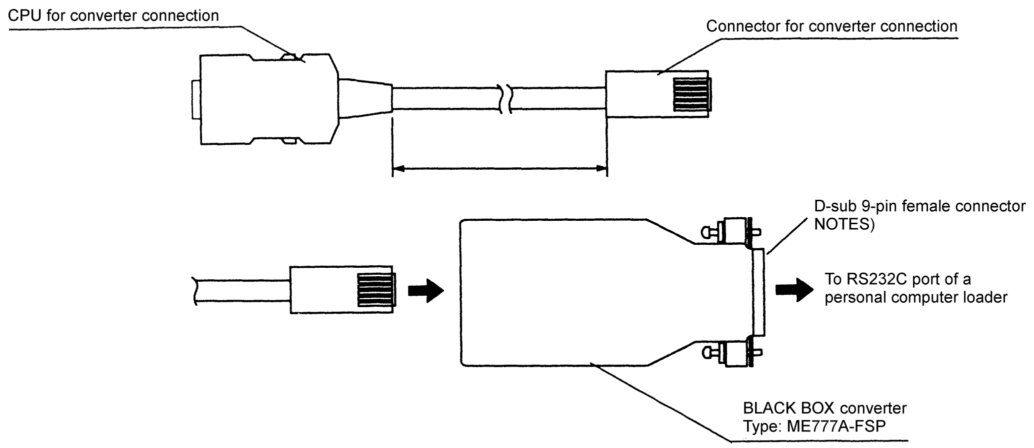
If a master device is a communication apparatus for RS232C, you need a RS485/RS232C converter.  You can find wiring diagrams with a converter inserted in 6.2.2 "Basic Wiring Diagram".



1) Wiring Structure

For one-to-one connection, use FUJI general purpose cable (cable with RS485/RS232C converter: NP4H-CNV) to connect to the RS485 connector on the PCB as in the right figure.

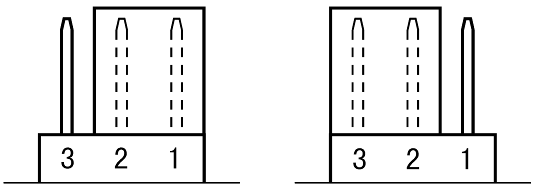
MICREX-SX series SPH D300win connection cable (with a converter)
Type: NP4H-CNV




Note: Connect a commercial converter cable if the RS232C port of your personal computer is not a D-sub 9-pin male connector.  Also use a commercial converter cable when the mounting screws interfere with the hooks of the RS232C port.

(4) Termination Resistor

Install 100Ω of termination resistors on the both ends of the system.  These termination resistors eliminate the reflection of signals.  The VG7S has a termination resistor as standard.  Set the short bar to the SW3.  Make sure to install on two positions, a master device and a terminal slave device (inverter).  Avoid installing at all positions, otherwise the signal capacity will be insufficient.



SHORT
(Short-circuit between 1 and 2)

OPEN
(Open between 1 and 2)

(5) Isolation

The control print circuit board is not isolated.  We recommend an RS485/RS485 isolated converter or an RS232C/RS485 converter with isolation capability to protect the control PCB from noise and to eliminate common mode noise.

## 6.2.4 Link Function

You can use the function code H30 and the X function "24: Operation selection through link [LE]" together to switch the sources (REM/LOC or COM) of reference data (S area). See also "4.2 Control Block Diagrams" for better understanding.
You can combine the function code H29 and the X function "23: Write enable through link [WE-LK]" to control write to the function codes (F, E, C, P, H, A, o, L, U) through the link. See also "4.2 Control Block Diagrams" for better understanding.

### 6.2.4.1 Enabling Link Operation

1) Switching to Link

You can assign "24: Operation selection through link [LE]" to an X function input terminal to change the mode as follows.

| Signal of "Operation selection through link" | Input to terminal | State |
|---|---|---|
| Assigned | - | "Operation through link disabled" mode |
| Not assigned | ON | |
| | OFF | "Operation through link enabled" mode |

Though you can write reference data and operation commands through the link in the "Operation through link disabled" mode, the data are not reflected. You can set data in the "Operation through link disabled" mode and switch to the "Operation through link enabled" mode to reflect the data.

2) Writing through Link

In the "Operation through link enabled" mode, you can use the function code H30 (Serial link) to switch the source of the operation command and reference data between the link (COM) and the remote/local. The remote and local means REM (terminal box) and LOC (KEYPAD panel) respectively.

| H30 setting | Operation through link enabled | | Operation through link disabled |
|---|---|---|---|
| | Reference data (S01 to S05, S08 to S12) | Operation command (FWD, REV) | |
| 0 | Link disabled (REM/LOC) | Link disabled (REM/LOC) | Link disabled (REM/LOC) |
| 1 | Link enabled (COM) | Link disabled (REM/LOC) | |
| 2 | Link disabled (REM/LOC) | Link enabled (COM) | |
| 3 | Link enabled (COM) | Link enabled (COM) | |

This function enables you to construct a flexible system where you can apply an operation command from the terminal box and apply a speed reference from RS485.

### 6.2.4.2 Enabling Writing through Link

1) Switching to Writing through Link

You can assign "23: Write enable through link [WE-LK]" to an X function input terminal to write in the function codes (F, E, C, P, H, A, o, L, and U).

| Signal of "Write enable through link" | Input to terminal | State |
|---|---|---|
| Assigned | - | "Write through link enabled" mode (Writing enabled to F to U) |
| Not assigned | ON | |
| | OFF | "Write through link disabled" mode (Writing disabled to F to U) |

2) Writing through Link

In "Write through link" enabled mode, you can use the function code H29 (Link function protection) to control writing to the function codes (F, E, C, P, H, A, o, L, and U).

| H29 setting | "Write through link enabled" mode | "Write through link disabled" mode |
|---|---|---|
| 0 | Codes (F, E, C, P, H, A, o, L, U) write-protected | Codes (F, E, C, P, H, A, o, L, U) write-protected |
| 1 | Codes (F, E, C, P, H, A, o, L, U) write-enabled | |

## 6.2.4.3 Prioritized Options for S Area

When you have installed a field option **(T-LINK, field bus, SX, SI (UPAC), or RS485 option)**, writing (operation commands and reference data) to the S area via RS485 communication is disabled and the option has priority. You can always read and write data for the function codes (F, E, C, P, H, A, o, L, U) through RS485.

## 6.2.5 Referencing to and Changing Data

When you have not installed a field option, you can always write to the S area (operation commands and reference data). Use "485 number" in the Chapter 13 "Function Code List" to read or write data for the other function codes (F, E, C, P, H, A, o, L, U, M) through RS485.
Note the setting range and the restriction on changes during operation, when you read or write these data.

## 6.2.5.1 Restrictions on Writing to Function Codes

There are following restrictions on writing (selecting) to the function codes (F, E, C, P, H, A, o, L, U).

1) Writing to Volatile Memory
The destination of the writing through RS485 is the volatile memory (RAM: Random Access Memory, stored data are disappeared when you turn off the power) to enable high-speed writing. When you want maintain the data after you turn off the power, use the function code H02 "All save" to store the data into the non-volatile memory. It takes about two seconds to use H02 to write into the non-volatile memory. Note that you cannot write new data while you are saving data.

2) "Writing through RS485 disabled" Mode
You will receive negative acknowledgement after you write to the following function codes.

| Code | Name | Reason |
|---|---|---|
| P02 | M1 motor selection | Changing P02 updates other codes automatically. Though this update will be written into the non-volatile memory, the change of P02 is written only into the volatile memory (disappears when you turn off the power) and the consistency among the codes is not maintained after power cycle. |
| H31 | Station address | Changing will disconnect the communication. |
| H34 to H37 | (UART setting) | These function codes specify RS485 communication hardware setting. |
| H40 | Protocol selection | Changing will disconnect the communication. |

3) "Consecutive writing disabled" Mode
You can use the Modbus RTU to write 16 words consecutively. Do not include the following function codes into a group of consecutive words, otherwise you will receive a negative acknowledgement. You can include the following function codes in a single writing in the FUJI general purpose communication or Modbus RTU.

| Code | Name | Reason |
|---|---|---|
| H01 | Tuning operation selection | Internal data are updated simultaneously with the execution of these functions and the consecutive data will overwrite the updated data. |
| H02 | All save | |
| H03 | Data initialization | |
| H67 | Trip data delete | |

4) Data Protection
- The function code F00 "Data protection" does not restrict the writing through RS485. F00 protects only the writing from the KEYPAD panel.
- The function code H29 "Link function protection" and the X function [WE-LK] restrict the writing through RS485 (see 6.2.4.2). **Note that you can write to H29**, even in the "Operation through link disabled" mode.

### 6.2.5.2 Negative Acknowledgement and Error Response

If there is an error in transmission data or you write when the inverter is not ready, you will get a negative acknowledgement or an error response and the writing is not processed. You can use the function code M26 or the "I/O Check" screen of the KEYPAD panel to check the description of the error. See the Type [34] "Communication error code" in the "Function Code List" for more information.
The Modbus RTU protocol uses a special code (Subcode) for the error response. See the section for the Modbus RTU.

### 6.2.5.3 No Response

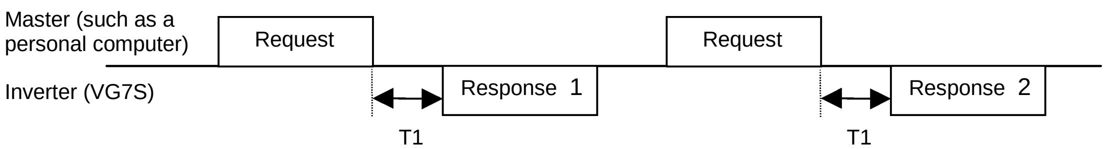
You will receive no response when the inverter hardware detects a parity framing error or the software detects a checksum error or a CRC error after the communication data are physically destructed. You can also use the function code M26 or the "I/O Check" screen of the KEYPAD panel to check the description of the no response.
When the interval between characters from the host exceeds 20ms due to hardware abnormality, the inverter does not respond and resets the communication up to then.

# 6.2.6 RS485 Function Codes

| Function code | | Data setting | Note |
|---|---|---|---|
| H31 | RS485 setting<br>(Station address) | 0 to 255<br>1 to 255: Address | Specifies a station number when connected to an inverter.<br>No response to broadcast |
| H32 | RS485 setting<br>(Action on error) | 0: Forced to stop<br>1: Stops in specified period after error<br>2: Stops if transmission error continues for specified period<br>3: Continues operation | Processes for RAS |
| H33 | RS485 setting<br>(Timer operation time) | 0.01 to 20.00s | |
| H34 | RS485 setting<br>(Transmission rate) | 0: 38,400bps<br>1: 19,200bps<br>2: 9,600bps<br>3: 4,800bps<br>4: 2,400bps | Initializes communication |
| H35 | RS485 setting<br>(Data length) | 0: 8 bit<br>1: 7 bit | |
| H36 | RS485 setting<br>(Parity bit) | 0: No<br>2: Even parity<br>3: Odd parity | |
| H37 | RS485 setting<br>(Stop bit) | 0: 2 bits<br>1: 1 bit | |
| H38 | RS485 continued communication disconnected time | 0.00 to 60.0s<br>0.0; Invalid | |
| H39 | Response interval time | 0.00 to 1.00s | |
| H40 | RS485 protocol selection | 0: FUJI general purpose communication protocol<br>1: SX protocol<br>2: Modbus RTU | Switches protocol |

## 6.2.6.1 Response Interval Time (H32)

This function code sets a time in which the inverter responds after a request from an upper level device such as a personal computer. This function allows a personal computer slow in response to set a response interval and to match the timing of an inverter.



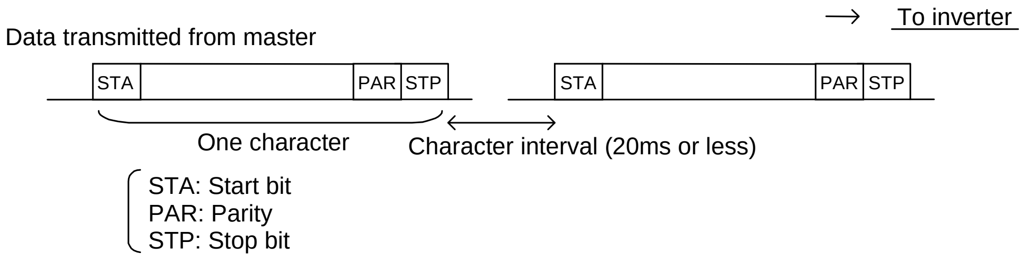

T1 = Response interval + Td (Response delay: 1ms to 5ms)
Use the function code H39 to set in the range from 0.00 to 1.00s

## 6.2.6.2 Continued Communication Disconnected Time (H38)

During link operation (S06 operation command FWD, REV) thorough RS485, if a communication disconnection from a master (PLC, PC) exceeds this specified period, a RS485 communication error (Er5) will occur. Disable this function (set to 0) when the communication is at a random cycle. When your communication is at a constant cycle, set the H38 to a period longer than that cycle and use the function of detecting disconnection.

## 6.2.6.3 Character Time Out Processing

A timer measuring a fixed period monitors the reception cycle. If the character interval of transmitted data from the master exceeds the period specified by the timer, a disconnection is assumed. The timer expires in 20ms determined by the character interval of 5ms to 4.6ms (12 to 11 bit/2400) at the lowest baud rate of 2,400bps. The inverter resets the communication if the character interval exceeds this period.




## 6.2.6.4 Time Out Processing on Master Side

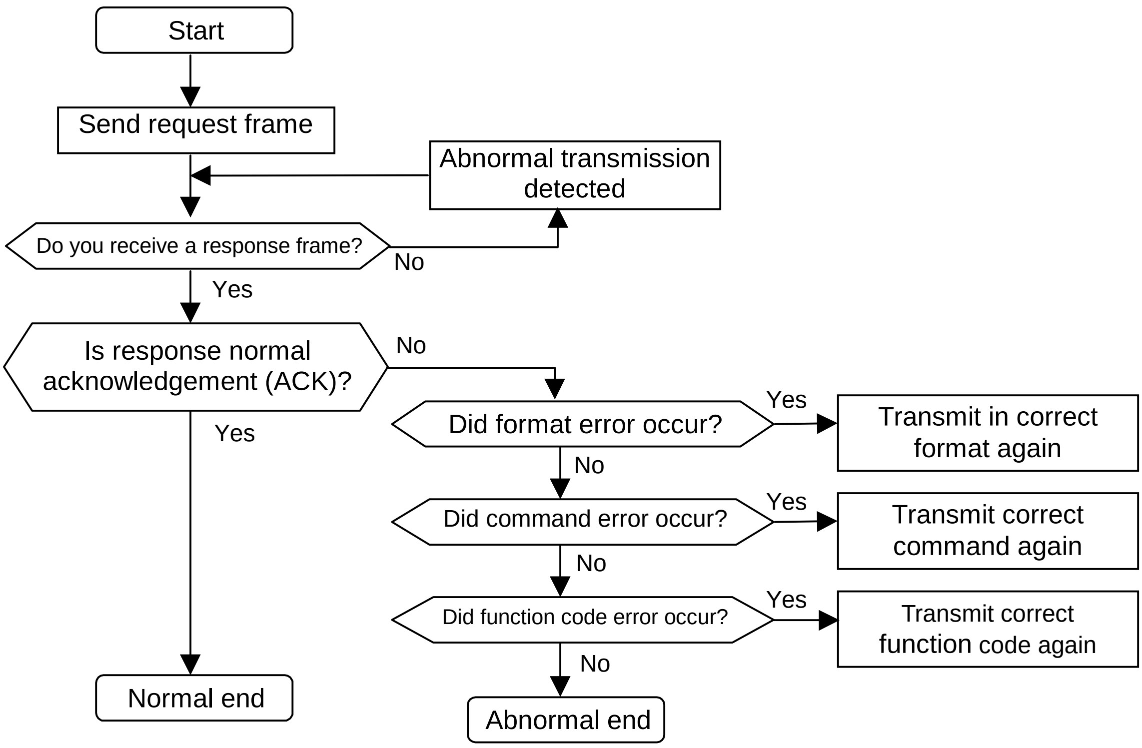
The master (PLC, PC) assumes a time out when a communication from the inverter discontinues for a certain period. The time out period is common to all FUJI inverters (G, C, E, VG) and is specified as 500ms. Set a longer period than this period as a time out period of the master. An inverter responds in a period combining an internal processing period (about 1ms) and a period set by an interval timer (H39 setting). Though you may set a time a little longer than the period set by an interval timer, set 500ms or longer to a master device assuming a connection to other models (G, E, series).

## 6.2.7 Host Side Procedure

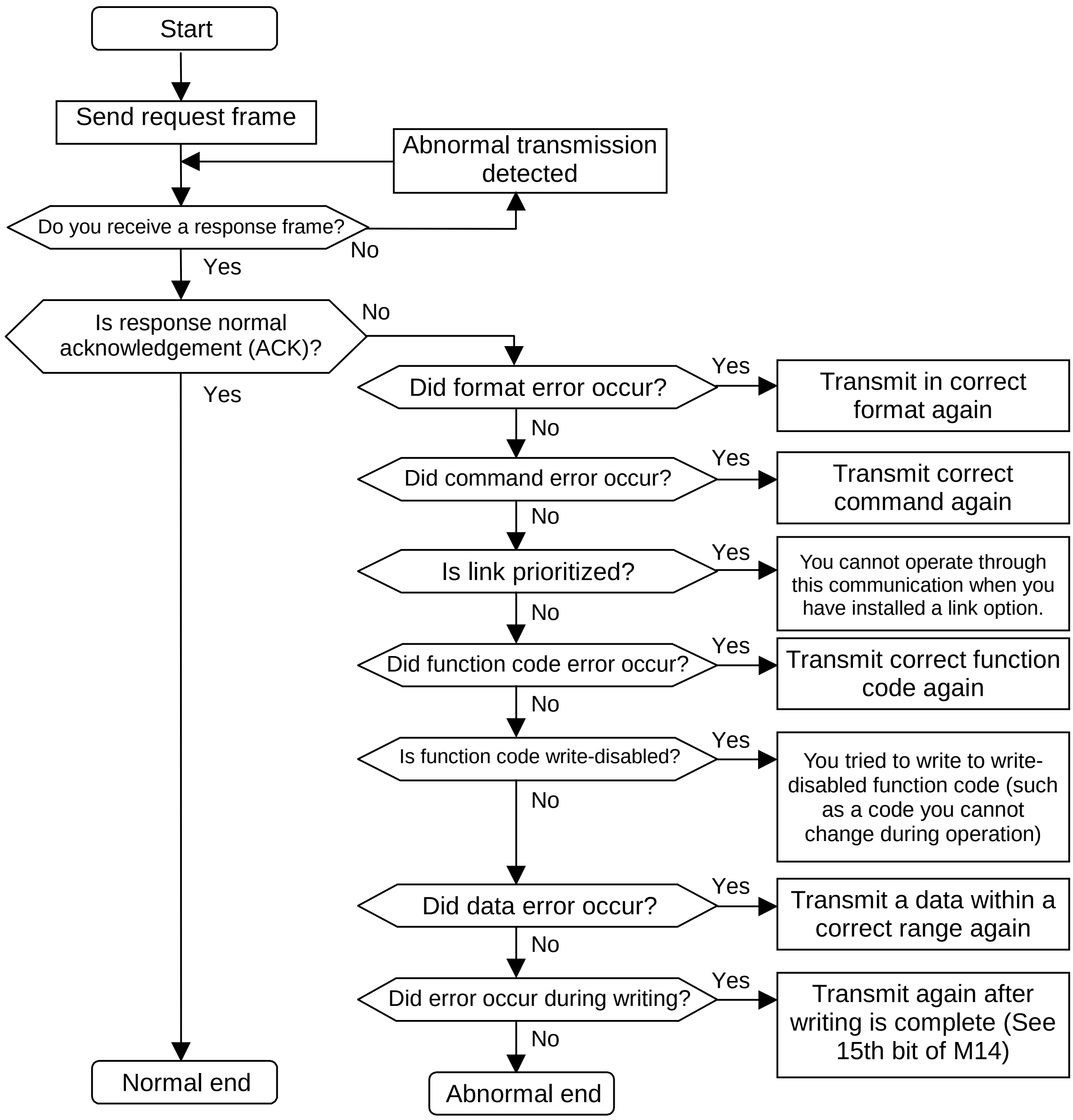
Refer to flowcharts of individual communication procedures for frame communication procedure.
Make sure to transmit the next frame after confirming a response both in reading and writing. When the master does not receives a response from an inverter in a certain period, assume a time out and execute a retry (if you start a retry before the time out, you cannot receive a request frame).

1) Retry Processing
The retry processing sends a data as sent before the no response error in a standard frame or polls to read out the error description (M26) to check if a normal acknowledgement is received (you need to check if a time out occurs again).
If you receive a normal acknowledgement, a transient communication error occurred due to noise or others and you can continue normal communication (there may be abnormality and you need an investigation if you have this phenomenon frequently).
If you have no response again, repeat retry. If the number of retry exceeds a specified value (usually three times), you can suspect a hardware problem or a software problem of a upper level device. If this is the case, you have to terminate the communication as an abnormal end and start investigation.

### 6.2.7.1 Reading Procedure



## 6.2.7.2 Writing Procedure



## 6.2.8 RAS Processing

### 6.2.8.1 Measures against Abnormal Communication

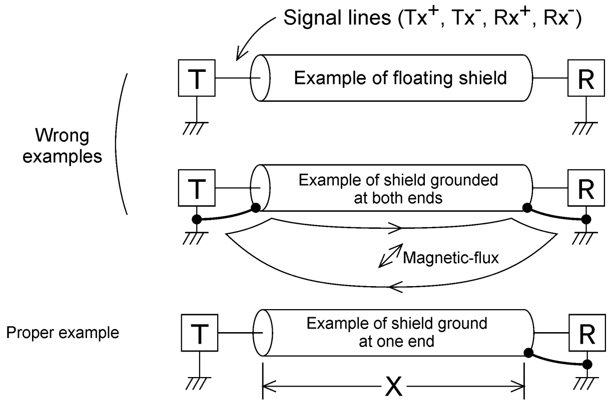
In some environments, the noise generated by the inverter may interfere normal communication or cause malfunctions of instrumentation devices and converters of a master. This section describes the measures against these situations.

(1) Measures at Receiving End of Noise

Isolated converter: Eliminates common mode noise exceeding the specified operation voltage range of a receiver generated in a case such as long distance wiring. Since a converter may malfunction due to noise, use a converter withstanding noise.

Twisted pair cable with shield: The shield is effective against electrostatic induction noise. Make sure to connect only one side of the shield to the ground.
The twisted lines are effective against electromagnetic induction noise. Use a cable with a twist pitch as short as possible. Consider individual shields for transmission and reception for long wiring where cross talk is a problem.

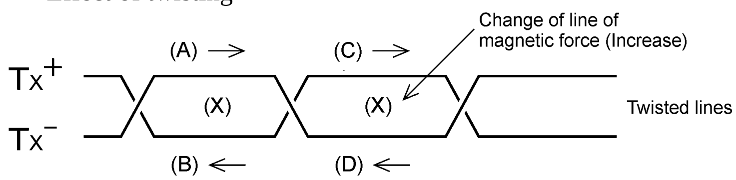
Effect of shield




The shield acts as an antenna to collect noise.

If the shield and ground form a loop and grounded points of the shield are separated in a long distance, an electric potential between the two grounded points may generate current flowing through the loop and induce noise. Also the change of the magnetic-flux inside the loop may induce noise.
You can eliminate the effect of electrostatic induction in the section indicated by X in the figure

Effect of twisting




When there is constant magnetic flux penetrating this page from front face to back face and the magnetic flux changes (increases), electromotive forces in the direction indicated by arrows are generated. The magnitude of electromotive forces from (A) to (D) are the same and the directions are indicated in the figure.
(B) and (C) on the Tx+ line are in the opposite direction each other and counteract each other. Also (A) and (D) counteract each other. Thus, the electromagnetic induction never induce normal mode noise. Note that the noise cannot be eliminated completely due to reasons such as uneven twist pitch. If Tx+ and Tx- are in parallel, normal mode noise will be induced.

Termination resistor: Install resistors equivalent to the cable impedance (100Ω at the both ends to restrain ringing.

Separate wiring installation: Install RS485 communication lines separately from the power lines (input: R, S, T and output: U, V, W) and do not tie them together. Separate installation will restrain induction noise.

Grounding: Do not share the same grounding between the instrumentation devices and the inverter. The grounding line may propagate noise. Use thick lines for grounding.

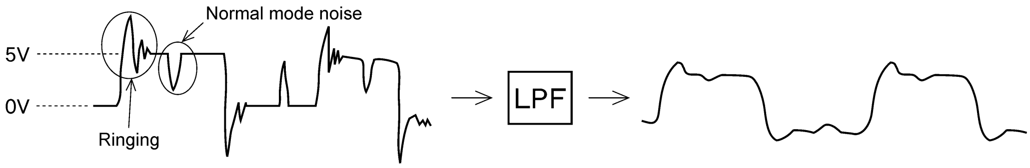
# 6. Standard Interface RS485

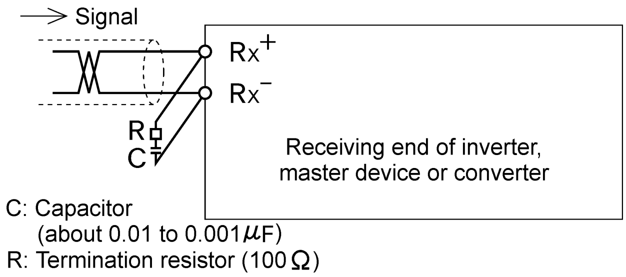
Isolating power supply: The power lines of the instrumentation devices may propagate noise. We recommend an insolated inverter power supply and application of an isolated transformer (TRAFY) for power supply or a noise cut transformer.

Filter: Install capacitors in parallel at input/output terminals to form a LPF (Low Pass Filter) eliminating ringing or high frequency noise.

Effect of Filtering

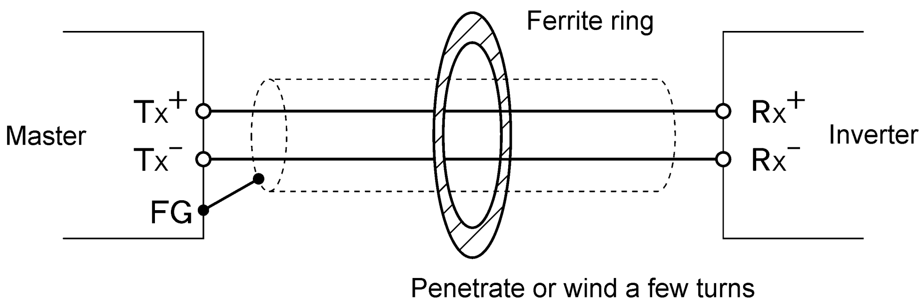
A low pass filter separates ringing due to a reflected signal and normal mode noise from a signal. Since the ringing is generally in higher frequency, the low pass filter can separate the signal.

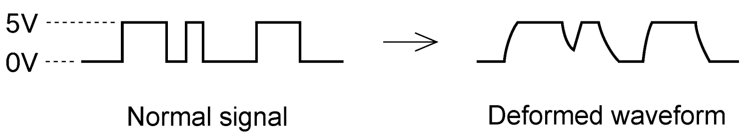



Adding inductance: Insert a choke coil serial to the signal lines or pass the signal lines through a ferrite ring to introduce an inductance into the circuit to create a high impedance against high frequency noise.

Adding inductive element




| ⚠CAUTION |
|---|
| When you apply a filter or add an inductive element, the signal waveform may be deformed at high-speed transmission. If this is the case, use the function code H34 to reduce the communication rate.   |

### (2) Measures at Source of Noise

| | |
|---|---|
| Carrier frequency: | You can use the function code F26 "Motor sound (Carrier frequency)" to decrease the carrier frequency to reduce noise. Note that reduced carrier frequency increase noise. |
| Installation: | You can install power lines through a metal pipe or use a metal control panel to contain noise (radiation/induction). |
| Isolating power source: | Install an isolated power supply transformer for the inverter power source to eliminate propagating noise (conduction). |

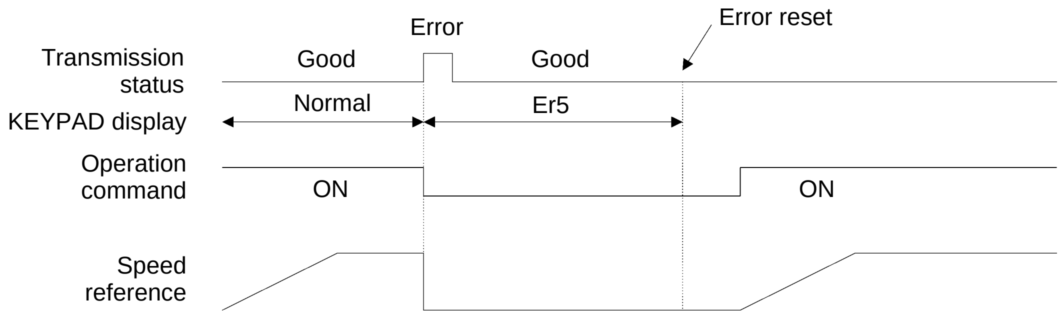
### (3) Measures Reducing Noise Level

Consider using ferrite rings (9.6.5) or EMC filters (9.6.2). First implement (1) and (2) and then implement (3) if the noise level does not go down below the permissible level of your facility.

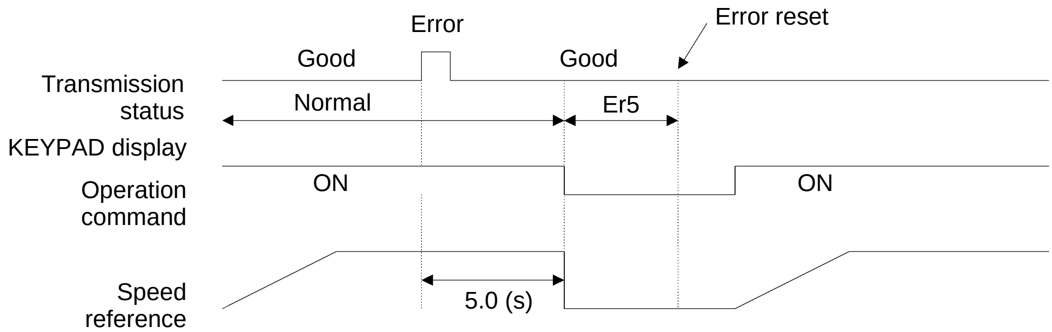
## 6.2.8.2 Actions on Communication Error

When you are providing operation commands and reference data, you can use a function handling communication error to continue inverter operation without shutting down the inverter. The following section describes examples corresponding to individual settings of the error handling function (the KEYPAD panel displays "Er5") when you direct operation commands from a master.

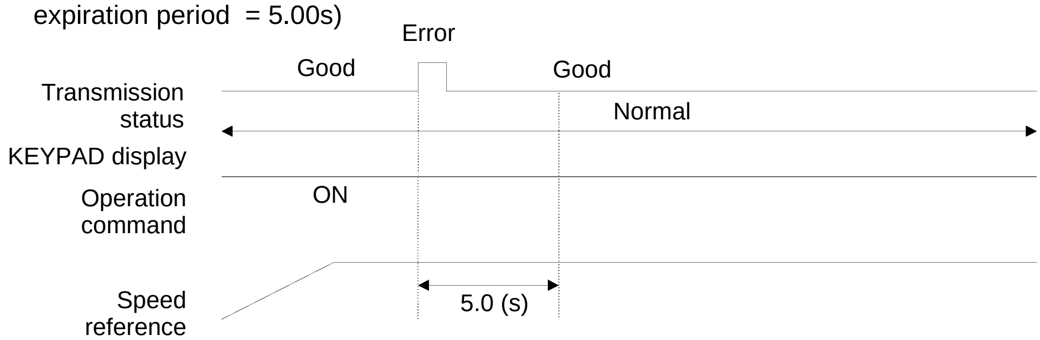
(1) H32 = 0, forced to stop mode (coasts to stop after error)



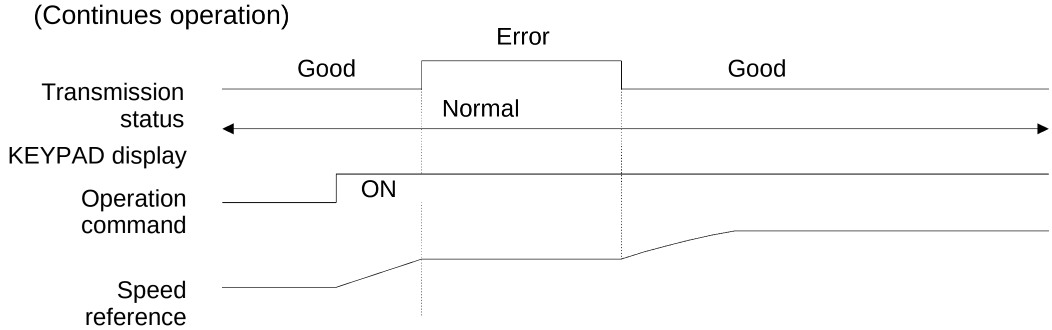

(2) H32 = 1, mode to coast to stop in a specified period by a function code after transmission error (Stops after a period specified by timer, H33: timer expiration period = 5.00s)




(3) H32 = 2, mode to continue operation if a transmission error is restored in a specified period by timer as in (b) (Stops after continued error for a period specified by timer, H33: timer expiration period = 5.00s)




(4) H32 = 3, mode to continue operation during transmission error (Continues operation)

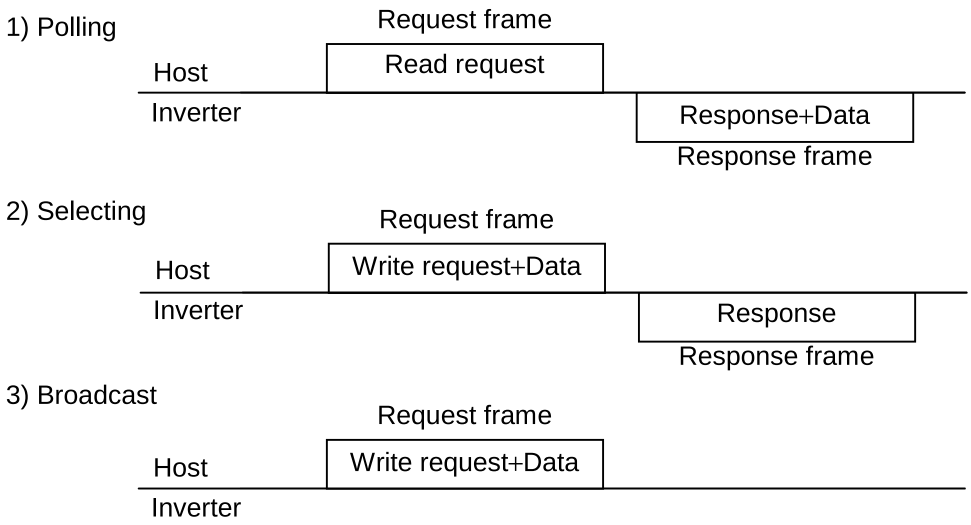


# 6.3 FUJI General Purpose Communication

## 6.3.1 Message Format

Messages are handled in polling/selecting manner.  An inverter is always waiting for selecting (write request) or polling (read request) from a host (personal computer or PLC).

When an inverter is ready and receives a request addressed to its station number from a host, if the inverter receives the frame successfully, the inverter returns a positive acknowledgement, and if the inverter fails to receive the frame, the inverter returns a negative acknowledgement.  Note that an inverter returns no response to a broadcast (selecting all stations at once).




Notes on broadcast (selecting all stations at once)
All inverters process a frame with a station number (station address) of 99 as a broadcast.  You can use a broadcast to provide an operation command or a reference data to all inverters at once (available for S01 to S06 in standard frame and for W, E, a to f, and m in option frame).

## 6.3.2 Transmission Frame

There are standard frame, which you can use for all communication functions and option frame, which is fast but limited to transmitting reference data to and monitoring an inverter in the transmission frame.

All characters (including BCC) constituting both the standard frame and the option frame are ASCII codes.  The lengths of the standard frames and the option frames are listed in the following table.

| Frame type | | | Frame length |
|---|---|---|---|
| Standard frame | Selecting | Request | 16 byte |
| | | Response | 16 byte |
| | Polling | Request | 16 byte |
| | | Response | 16 byte |
| Option frame | Selecting | Request | 12 byte |
| | | Response | 8 byte |
| | Polling | Request | 8 byte |
| | | Response | 12 byte |

## 6.3.2.1 Standard Frame

Request Frame (Host ⇒ Inverter)

| 0 | 1 2 | 3 | 4 | 5 | 6 7 | 8 | 9 12 | 13 | 14 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| SOH | Station number | ENQ | Com-mand | Type | Function code number | SP | Data | ETX | BCC | |
| 1 | 2 | 1 | 1 | 1 | 2 | 1 | 4 | 1 | 2 | (byte) |

Used for BCC (bytes 1 to 13)

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | ENQ | ENQ | $05_H$ | Transmission request |
| 4 | Command | <br>'R'<br>'W'<br>'A'<br>'E' | <br>$52_H$<br>$57_H$<br>$41_H$<br>$45_H$ | Request command<br>Polling (read)<br>Selecting (write)<br>Fast response selecting (write) *1)<br>Alarm reset |
| 5 | Type | <br>'F'<br>'E'<br>'C'<br>'P'<br>'H'<br>'A'<br>'L'<br>'U'<br>'o'<br>'S'<br>'M' | <br>$46_H$<br>$45_H$<br>$43_H$<br>$50_H$<br>$48_H$<br>$41_H$<br>$4C_H$<br>$55_H$<br>$6F_H$<br>$53_H$<br>$4D_H$ | Function code type<br>Fundamental functions<br>Extension terminal functions<br>Control functions<br>Motor parameters<br>High performance functions<br>Alternative motor parameters<br>Lift functions<br>User functions<br>Optional functions<br>Serial communication functions<br>Monitoring functions |
| 6 | Function code number | '0' to '4' | $30_H$ to $34_H$ | Function code number (Decimal, tens digit) |
| 7 | | '0' to '9' | $30_H$ to $39_H$ | Function code number (Decimal, ones digit) |
| 8 | SP | ' ' | $20_H$ | Not used (fixed to space) |
| 9 | Data | '0' to 'F' | $30_H$ to $3F_H$ | First data character (hexadecimal: thousands digit) |
| 10 | | '0' to 'F' | $30_H$ to $3F_H$ | Second data character (hexadecimal: hundreds digit) |
| 11 | | '0' to 'F' | $30_H$ to $3F_H$ | Third data character (hexadecimal: tens digit) |
| 12 | | '0' to 'F' | $30_H$ to $3F_H$ | Fourth data character (hexadecimal: ones digit) |
| 13 | ETX | ETX | $03_H$ | End of message |
| 14 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 15 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

*1) The VG7S returns response fast to any writings. The standard selecting (W) and the fast response selecting (A) behave in the same manner for the VG7S.

ACK Response Frame (Inverter ⇒ Host)

| 0 | 1 2 | 3 | 4 | 5 | 6 7 | 8 | 9 12 | 13 | 14 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| SOH | Station number | ACK | Com-mand | Type | Function code number | SP | Data | ETX | BCC | |
| 1 | 2 | 1 | 1 | 1 | 2 | 1 | 4 | 1 | 2 | (byte) |

Used for BCC

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | ACK | ACK | $06_H$ | Transmission response<br>Positive acknowledgement: No reception error and no logical error in request |
| 4 | Command | <br>'R'<br>'W'<br>'A'<br>'E' | <br>$52_H$<br>$57_H$<br>$41_H$<br>$45_H$ | Answer back to request command<br>Polling (read)<br>Selecting (write)<br>Fast response selecting (write)<br>Alarm reset |
| 5 | Type | <br>'F'<br>'E'<br>'C'<br>'P'<br>'H'<br>'A'<br>'L'<br>'U'<br>'o'<br>'S'<br>'M' | <br>$46_H$<br>$45_H$<br>$43_H$<br>$50_H$<br>$48_H$<br>$41_H$<br>$4C_H$<br>$55_H$<br>$6F_H$<br>$53_H$<br>$4D_H$ | Function code type<br>Fundamental functions<br>Extension terminal functions<br>Control functions<br>Motor parameters<br>High performance functions<br>Alternative motor parameters<br>Lift functions<br>User functions<br>Optional functions<br>Serial communication functions<br>Monitoring functions |
| 6 | Function code number | '0' to '4' | $30_H$ to $34_H$ | Function code number (Decimal, tens digit) |
| 7 | | '0' to '9' | $30_H$ to $39_H$ | Function code number (Decimal, ones digit) |
| 8 | Special | | | Not used |
| 9 | Data | '0' to 'F' | $30_H$ to $3F_H$ | First data character (hexadecimal: thousands digit) |
| 10 | | '0' to 'F' | $30_H$ to $3F_H$ | Second data character (hexadecimal: hundreds digit) |
| 11 | | '0' to 'F' | $30_H$ to $3F_H$ | Third data character (hexadecimal: tens digit) |
| 12 | | '0' to 'F' | $30_H$ to $3F_H$ | Fourth data character (hexadecimal: ones digit) |
| 13 | ETX | ETX | $03_H$ | End of message |
| 14 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 15 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

# 6. Standard Interface RS485

NAK Response Frame (Inverter ⇒ Host)

| 0 | 1 2 | 3 | 4 | 5 | 6 7 | 8 | 9 12 | 13 | 14 15 | |
|---|---|---|---|---|---|---|---|---|---|---|
| SOH | Station number | NAK | Com-mand | Type | Function code number | SP | Data | ETX | BCC | |
| 1 | 2 | 1 | 1 | 1 | 2 | 1 | 4 | 1 | 2 | (byte) |

Used for BCC

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | NAK | NAK | $15_H$ | Transmission response<br>Negative acknowledgement:<br>Logical error in request |
| 4 | Command *1) | <br>'R'<br>'W'<br>'A'<br>'E' | <br>$52_H$<br>$57_H$<br>$41_H$<br>$45_H$ | Answer back to request command<br>Polling (read)<br>Selecting (write)<br>Fast response selecting (write)<br>Alarm reset |
| 5 | Type *1) | <br>'F'<br>'E'<br>'C'<br>'P'<br>'H'<br>'A'<br>'L'<br>'U'<br>'o'<br>'S'<br>'M' | <br>$46_H$<br>$45_H$<br>$43_H$<br>$50_H$<br>$48_H$<br>$41_H$<br>$4C_H$<br>$55_H$<br>$6F_H$<br>$53_H$<br>$4D_H$ | Function code type<br>Fundamental functions<br>Extension terminal functions<br>Control functions<br>Motor parameters<br>High performance functions<br>Alternative motor parameters<br>Lift functions<br>User functions<br>Optional functions<br>Serial communication functions<br>Monitoring functions |
| 6 | Function code number *1) | '0' to '4' | $30_H$ to $34_H$ | Function code number (Decimal, tens digit) |
| 7 | | '0' to '9' | $30_H$ to $39_H$ | Function code number (Decimal, ones digit) |
| 8 | SP | ' ' | $20_H$ | Not used (fixed to space) |
| 9 | Data | ' ' | $20_H$ | Not used (fixed to space) |
| 10 | | ' ' | $20_H$ | Not used (fixed to space) |
| 11 | | '4', '5' | $34_H$, $35_H$ | Communication error code 1 (hexadecimal. tens digit) |
| 12 | | '0' to 'F' | $30_H$ to $3F_H$ | Communication error code 2 (hexadecimal. ones digit) |
| 13 | ETX | ETX | $03_H$ | End of message |
| 14 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 15 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

*1) A space (' '=$20_H$) is set when a transmission format error or a transmission command error.

## 6.3.2.2 Option Frame

Selecting Request Frame (Host ⇒ Inverter)

| 0 | 1 2 | 3 | 4 | 5 8 | 9 | 10 11 | |
|---|---|---|---|---|---|---|---|
| SOH | Station number | ENQ | Command | Data | ETX | BCC | |
| 1 | 2 | 1 | 1 | 4 | 1 | 2 | (byte) |

Used for BCC (bytes 1 to 9)

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | ENQ | ENQ | $05_H$ | Transmission request |
| 4 | Command | | | Request command |
| | | 'a' | $61_H$ | Speed reference 1 (S01) |
| | | 'b' | $62_H$ | Torque reference (S02) |
| | | 'c' | $63_H$ | Torque current reference (S03) |
| | | 'd' | $64_H$ | Magnetic-flux reference (S04) |
| | | 'e' | $65_H$ | Orientation position reference (S05) |
| | | 'f' | $66_H$ | Operation method 1 (S06) |
| | | 'm' | $6D_H$ | Reset command: Set "0" to all |
| 5 | Data | '0' to 'F' | $30_H$ to $3F_H$ | First data character (hexadecimal: thousands digit) |
| 6 | | '0' to 'F' | $30_H$ to $3F_H$ | Second data character (hexadecimal: hundreds digit) |
| 7 | | '0' to 'F' | $30_H$ to $3F_H$ | Third data character (hexadecimal: tens digit) |
| 8 | | '0' to 'F' | $30_H$ to $3F_H$ | Fourth data character (hexadecimal: ones digit) |
| 9 | ETX | ETX | $03_H$ | End of message |
| 10 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 11 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

# 6. Standard Interface RS485

Selecting Response Frame (Inverter ⇒ Host)

| 0 | 1 2 | 3 | 4 | 5 | 6 7 | |
|---|---|---|---|---|---|---|
| SOH | Station number | ACK/NAK | Command | ETX | BCC | |
| 1 | 2 | 1 | 1 | 1 | 2 | (byte) |

Used for BCC

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | ACK/NAK | ACK<br>NAK | $06_H$<br>$15_H$ | Transmission response<br>Positive acknowledgement: No reception error and no logical error in request<br>Negative acknowledgement: Logical error in request |
| 4 | Command | <br>'a'<br>'b'<br>'c'<br>'d'<br>'e'<br>'f'<br>'m' | <br>$61_H$<br>$62_H$<br>$63_H$<br>$64_H$<br>$65_H$<br>$66_H$<br>$6D_H$ | Request command<br>Speed reference 1 (S01)<br>Torque reference (S02)<br>Torque current reference (S03)<br>Magnetic-flux reference (S04)<br>Orientation position reference (S05)<br>Operation method 1 (S06)<br>Reset command: Set "0" to all |
| 5 | ETX | ETX | $03_H$ | End of message |
| 6 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 7 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

Polling Request Frame (Host ⇒ Inverter)

| 0 | 1 2 | 3 | 4 | 5 | 6 7 | |
|---|---|---|---|---|---|---|
| SOH | Station number | ENQ | Command | ETX | BCC | |
| 1 | 2 | 1 | 1 | 1 | 2 | (byte) |

Used for BCC

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | ENQ | ENQ | $05_H$ | Transmission request |
| 4 | Command | <br>'g'<br>'h'<br>'i'<br>'j'<br>'k' | <br>$67_H$<br>$68_H$<br>$69_H$<br>$6A_H$<br>$6B_H$ | Request command<br>Detected speed value (M06)<br>Calculated torque value (M07)<br>Calculated torque current value (M08)<br>Output frequency (M09)<br>Operation status (M14) |
| 5 | ETX | ETX | $03_H$ | End of message |
| 6 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 7 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

Polling Response Frame (Inverter ⇒ Host)

| 0 | 1 2 | 3 | 4 | 5 8 | 9 | 10 11 | |
|---|---|---|---|---|---|---|---|
| SOH | Station number | ACK/NAK | Command | Data | ETX | BCC | |
| 1 | 2 | 1 | 1 | 4 | 1 | 2 | (byte) |

Used for BCC (bytes 1 to 9)

| Byte | Field | Value | | Description |
|---|---|---|---|---|
| | | ASCII | Hexadecimal | |
| 0 | SOH | SOH | $01_H$ | Start of message |
| 1 | Station number | '0' to '3', '9' | $30_H$ to $33_H$, $39_H$ | Inverter station address (decimal, tens digit) |
| 2 | | '0' to '9' | $30_H$ to $39_H$ | Inverter station address (decimal, ones digit) |
| 3 | ACK/NAK | ACK<br>NAK | $06_H$<br>$15_H$ | Transmission response<br>Positive acknowledgement: No reception error and no logical error in request<br>Negative acknowledgement: Logical error in request |
| 4 | Command | <br>'g'<br>'h'<br>'i'<br>'j'<br>'k' | <br>$67_H$<br>$68_H$<br>$69_H$<br>$6A_H$<br>$6B_H$ | Request command<br>Detected speed value (M06)<br>Calculated torque value (M07)<br>Calculated torque current value (M08)<br>Output frequency (M09)<br>Operation status (M14) |
| 5 | Data | '0' to 'F' | $30_H$ to $3F_H$ | First data character (hexadecimal: thousands digit) |
| 6 | | '0' to 'F' | $30_H$ to $3F_H$ | Second data character (hexadecimal: hundreds digit) |
| 7 | | '0' to 'F' | $30_H$ to $3F_H$ | Third data character (hexadecimal: tens digit) |
| 8 | | '0' to 'F' | $30_H$ to $3F_H$ | Fourth data character (hexadecimal: ones digit) |
| 9 | ETX | ETX | $03_H$ | End of message |
| 10 | BCC | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 1 (hexadecimal, tens digit) |
| 11 | | '0' to 'F' | $30_H$ to $3F_H$ | Checksum 2 (hexadecimal, ones digit) |

## 6.3.2.3 Negative Acknowledgment Frame

When a response frame length depends on the command type, the response follows the length specified by that command type if the command type character is recognized successfully.

| Number | Frame/command type | Source of error | Negative acknowledgment frame | Error code (M26) |
|---|---|---|---|---|
| 1 | Standard frame<br>Option frame | ENQ is not detected at prescribed position | Standard frame (16-byte length) | Format error [74] |
| 2 | Other than prescribed command | Command other than prescribed commands (R, W, A, E, a to k, m) is detected | Standard frame (16-byte length) | Format error [75] |
| 3 | Selecting command (a to f, m) | ETX is not detected at prescribed position | Option frame (8-byte length) | Format error [74] |
| 4 | Polling command (g to k) | ETX is not detected at prescribed position | Option frame (12-byte length) | Format error [74] |

Note: When a negative acknowledgment is returned in a standard frame as in Number 1 or Number 2 in case of format error or command error, the contents of the Command field, the Type field, and the Function code number field are undetermined.

## 6.3.3 Description of Fields

### 6.3.3.1 Data Field

Standard frame

| 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|
| Special additional data | First data character | Second data character | Third data character | Fourth data character |

Option frame

| 5 | 6 | 7 | 8 |
|---|---|---|---|
| First data character | Second data character | Third data character | Fourth data character |

All data except for special ones are 16 bits in length. These data are hexadecimal ($0000_H$ to $FFFF_H$) and each digit is expressed by an ASCII code in the data field of a communication frame. A negative integer data (signed data) are expressed as a 2's complement.

Note 1: Use upper case for A to F of hexadecimal number.
Note 2: Set zero ('0') to the entire data filed of a polling request frame and send it.
Note 3: The data field of the ACK response frame is undetermined

Example) When you want use the function code S01 "Speed reference 1" to specify 500r/min (where the maximum speed is 1500r/min):

1) Calculate a value to set according to the data format of S01 (±20,000/maximum speed)

$$\text{Data} = 500\text{r/min} \times \pm 20{,}000/1{,}500\text{r/min} \text{ (+ for forward rotation and – for reverse rotation)}$$
$$= \pm 6{,}666.6$$
$$\approx \pm 6{,}667$$

2) Convert the data into a hexadecimal number (2's complement for a negative data)

Data = 6,667 (Forward rotation)
$= 1A0B_H$
Data = –6,667 (Reverse rotation)
$= 0 - 6{,}667 = 65{,}536 - 6{,}667 = 58{,}869$
$= E5F5_H$

3) Set the data

| Field position | Setting (Forward rotation) | | Setting (Reverse rotation) | |
|---|---|---|---|---|
| First data character | ASCII | '1' | ASCII | 'E' |
| Second data character | ASCII | A' | ASCII | '5' |
| Third data character | ASCII | '0' | ASCII | 'F' |
| Fourth data character | ASCII | 'B' | ASCII | '5' |

### 6.3.3.2 Checksum Field

This data is used to check an error of a communication frame in data transmission. The checksum is the lowest byte of a byte-wise addition of all fields except for the SOH and the checksum fields represented in ASCII code.
Example) When result of addition is $0123_H$:

| Field position | Setting | |
|---|---|---|
| Checksum 1 | ASCII | '2' |
| Checksum 2 | ASCII | '3' |

## 6.3.4 Communication Examples

The following section describes typical communication examples (All station numbers are assumed as 12)

### 6.3.4.1 Standard Frame

(1) Selecting (write) for S01 "Speed reference 1", 300r/min (reference) × 20,000/1,500 (maximum speed) = **4,000d** = $0FA0_H$

Request frame (Host ⇒ Inverter)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ENQ | W | S | 0 | 1 | SP | 0 | F | A | 0 | ETX | 7 | D |

ACK response frame (Inverter ⇒ Host)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ACK | W | S | 0 | 1 | SP | 0 | F | A | 0 | ETX | 7 | E |

NAK response frame (Inverter ⇒ Host) ........ Error due to link priority

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | NAK | W | S | 0 | 1 | SP | 0 | 0 | 4 | C | ETX | 7 | D |

(2) Polling (read) for M09 "Output frequency"

Request frame (Host ⇒ Inverter)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ENQ | R | M | 0 | 9 | SP | 0 | 0 | 0 | 0 | ETX | 5 | 3 |

ACK response frame (Inverter ⇒ Host) ........ 30.00Hz ($0BB8_H$ ⇒ 3,000d ⇒ 30,00)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ACK | R | M | 0 | 9 | SP | 0 | B | B | 8 | ETX | 8 | 0 |

### 6.3.4.2 Option Frame

(1) Selecting for Operation Command (Write)

Request frame (Host ⇒ Inverter) .................. FWD command

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ENQ | f | 0 | 0 | 0 | 1 | ETX | 9 | 2 |

ACK response frame (Inverter ⇒ Host)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ACK | f | ETX | D | 2 |

NAK response frame (Inverter ⇒ Host) ........ Refer to M26 "Communication error code" for source of error

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | NAK | f | ETX | E | 1 |

(2) Polling for Torque Reference (Read)

Request frame (Host ⇒ Inverter)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ENQ | h | ETX | D | 3 |

ACK response frame (Inverter⇒Host) .......... 85.0% ($2134_H$ ⇒ 8,500d ⇒ 85.00)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 1 | 2 | ACK | h | 2 | 1 | 3 | 4 | ETX | 9 | E |

(3) Selecting for Operation Command as Broadcast (Write)

Request frame (Host ⇒ Inverter) .................. REV command

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOH | 9 | 9 | ENQ | f | 0 | 0 | 0 | 2 | ETX | A | 2 |

No response is returned to a broadcast.

● ASCII Code Table

| | $00_H$ | $10_H$ | $20_H$ | $30_H$ | $40_H$ | $50_H$ | $60_H$ | $70_H$ |
|---|---|---|---|---|---|---|---|---|
| $0_H$ | NUL | DLE | SP | 0 | @ | P | ` | p |
| $1_H$ | SOH | DC1 | ! | 1 | A | Q | a | q |
| $2_H$ | STX | DC2 | ” | 2 | B | R | b | r |
| $3_H$ | ETX | DC3 | # | 3 | C | S | c | s |
| $4_H$ | EOT | DC4 | $ | 4 | D | T | d | t |
| $5_H$ | ENQ | NAK | % | 5 | E | U | e | u |
| $6_H$ | ACK | SYN | & | 6 | F | V | f | v |
| $7_H$ | BEL | ETB | ’ | 7 | G | W | g | w |
| $8_H$ | BS | CAN | ( | 8 | H | X | h | x |
| $9_H$ | HT | EM | ) | 9 | I | Y | i | y |
| $A_H$ | LF | SUB | * | : | J | Z | j | z |
| $B_H$ | VT | ESC | + | ; | K | [ | k | { |
| $C_H$ | FF | FS | , | < | L | \ | l | \| |
| $D_H$ | CR | GS | - | = | M | ] | m | } |
| $E_H$ | SO | RS | . | > | N | ^ | n | ~ |
| $F_H$ | SI | US | / | ? | O | _ | o | DEL |

This communication uses the codes indicated by the shading .

# 6. Standard Interface RS485

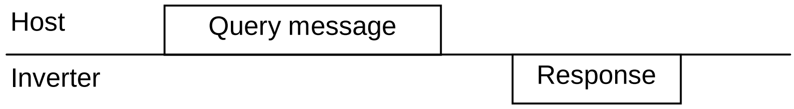
## 6.4 Modbus RTU

This protocol is created outside of Japan.

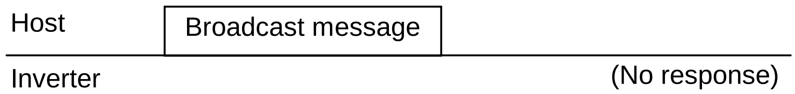
### 6.4.1 Message Format

The standard formats for RTU message transmission are described below.

1) Query processing




2) Broadcast processing




When an inverter is ready and receives a message addressed to itself, if the inverter determines that it received the massage successfully, the inverter processes the request and returns a normal response. If the inverter determines that it did not receive the massage successfully, the inverter returns an error response. The inverter does not return a response to a broadcast.

(1) Query
A host transmits a massage to a single inverter.

(2) Normal Response
After receiving a query, the inverter processes the request and returns a normal response.

(3) Error Response
After receiving a query, the inverter cannot process the request and returns an error response.
The error response includes a reason why the inverter cannot process the message.
The inverter does not return an error response to a CRC error or a physical transmission error.

(4) Broadcast
A master uses address 0 to transmit a message to all slaves. All slaves receiving the broadcast message execute a requested function. The timeout of the master terminates this process.

### 6.4.2 Transmission Frame

The following section describes the transmission frame. The details depend on the FC (Function Code) and see 6.4.2.1 "Reading FC Data", 6.4.2.2 "Writing Data for Single FC" and 6.4.2.3 "Writing Data for Consecutive FC's".

| 1byte | 1byte | max 203byte | 2bytes |
|---|---|---|---|
| Station Address | FC (Function Code) | Information | Error Check |

(1) Station Address
The Station Address in one byte in length and you can select from 0 to 247.
The Station Address 0 selects all slave stations and means a broad cast message.

(2) FC (Function Code)

The FC is one byte in length and you can use a value ranging from 0 to 255 to define a function code. The FC's indicated by shading are available. Do not use the FC's that are not available, otherwise you will receive an error response.

| FC | Description |
|---|---|
| 0 to 2 | Not used |
| 3 | Read data for FC, maximum 99 |
| 4 to 5 | Not used |
| 6 | Write data for single FC |
| 7 | Not used |
| 8 | Maintenance code |
| 9 to 15 | Not used |
| 16 | Write data for consecutive FC's, maximum 16 data |
| 17 to 127 | Not used |
| 128 to 255 | Reserved for Exception Response |

(3) Information

The Information field contains all information (such as FC, Byte Count, Data Number, and Data). See **6.4.2.1 "Reading FC Data", 6.4.2.2 "Writing Data for Single FC" and 6.4.2.3 "Writing Data for Consecutive FC's"** for more information on the Information field.

(4) Error Check

The Error Check field is two bytes in length and used for a CRC-16 type error check.
The frame length is necessary to obtain a CRC-16 code from the FC and the byte count data since the Information field length is variable.

## 6.4.2.1 Reading FC Data

(1) Query

| 1byte | 1byte | 2bytes | 2bytes | 2bytes |
|---|---|---|---|---|
| Station Number | 03 | Function Code | Number of Data to be Read (Maximum 99) | Error Check |

(2) Normal Response

| 1byte | 1byte | 1byte | 2 to 198bytes | 2bytes |
|---|---|---|---|---|
| Station Number | 03 | Byte Count | Read Data (Maximum 198) | Error Check |
| | | | Hi,Lo,Hi,Lo,Hi,Lo,… | |

(3) How to Set Query

- You cannot use the Broadcast for a Query. The Station Number 0 is not available.
- FC=03
- The FC is two bytes in length and consists of an identification code and a number (Example F40=F+40). The Hi byte corresponds to an identification code ranging F to L and the Lo byte corresponds to a number. The setting range for the Hi is 0 to 10 (F to U) and for the Lo is 0 to 99. For example, you should set "0014h" for F20,

| Set data | Identification code | Name | Set data | Identification code | Name |
|---|---|---|---|---|---|
| 0 | F | Fundamental functions | 6 | o | Optional functions |
| 1 | E | Extension terminal functions | 7 | S | Serial communication functions |
| 2 | C | Control functions | 8 | M | Monitoring functions |
| 3 | P | Motor parameters | 9 | L | Lift functions |
| 4 | H | High performance functions | 10 | U | User functions |
| 5 | A | Alternative motor parameters | | | |

- A read out data is two bytes in length. The setting range is 1 to 99 (in word). Set the Number of Data to be Read so as not to exceed the upper offset limit, 99, otherwise you will receive an error response.

(4) Interpreting Normal Response

- The range of the Byte Count is 2 to 198. The Byte Count is twice as large as the Number of Data to be Read (1 to 99) of a Query.
- The Read Data are arranged in the order of the Hi byte and the Lo byte of individual word data and the word data are arranged from the data of the specified function code in a query and its address, then the next data and its address, and so on. If you try to read a nonexistent function code (such as F09), you will receive "0000".

## 6.4.2.2 Writing Data for Single FC

(1) Query

| 1byte | 1byte | 2bytes | 2bytes | 2bytes |
|---|---|---|---|---|
| Station Number | 06 | Function Code | Data to be Written | Error Check |
| | | | Hi Lo | |

(2) Normal Response

| 1byte | 1byte | 2bytes | 2bytes | 2bytes |
|---|---|---|---|---|
| Station Number | 06 | Byte Count | Data to be Written | Error Check |
| | | | Hi Lo | |

(3) How to set Query

- You can set 0 to the station number for Broadcast. Then all inverters execute the request directed by the broadcast and return no response.
- FC=06
- The Function Code is two bytes in length and consists of an identification code and a number. See the table in 6.4.2.1 for more information on the identification code.
- The Data to be Written field is fixed two bytes in length.

(4) Interpreting Normal Response

- A normal response has the same frame as the query.

## 6.4.2.3 Writing Data for Consecutive FC's

(1) Query

| 1byte | 1byte | 2bytes | 2bytes | 1byte | 2 to 132 bytes | 2bytes |
|---|---|---|---|---|---|---|
| Station Number | 16 | Function Code | Number of Data to be Written | Byte Count | Data to be Written | Error Check |
| | | | | | Hi,Lo,Hi,Lo,··· | |

(2) Normal Response

| 1byte | 1byte | 2byte | 2byte | 2byte |
|---|---|---|---|---|
| Station Number | 16 | Byte Count | Data to be Written | Error Check |

(3) How to set Query

- You can set 0 to the station number for Broadcast. Then all inverters execute the request directed by the Broadcast and return no response.
- FC=16
- The Function Code is two bytes in length and consists of an identification code and a number. See the table in 6.4.2.1 for more information on the identification code.
- The Number of Data to be Written field is two bytes in length. The setting range is from 1 to 16. You will receive an error response to a number of 17 or more.
- The Byte Count is one byte in length. The setting range is from 2 to 32. The Byte Count must be set twice as large as the Number of Data to be Written.
- Set the lowest data (data for the function code specified in the Function Code) to the first two bytes and set higher data (the second data, the third data and so on) in the increasing order.

(4) Interpreting Normal Response

- A response returns the same values as those in its query in the Function Code and the Number of Data to be Written fields.

## 6.4.2.4 Maintenance Code

You can use this function code to check the connection of the communication line (hardware).

(1) Query

| 1byte | 1byte | 2bytes | 2bytes | 2bytes |
|---|---|---|---|---|
| Station Number | 08 | Diagnosis Code 00 00 | Data | Error Check |

(2) Normal Response

| 1byte | 1byte | 2bytes | 2bytes | 2bytes |
|---|---|---|---|---|
| Station Number | 08 | Diagnosis Code 00 00 | Data | Error Check |

(3) How to set Query

- You cannot use the Broadcast for a Query.
- FC=08
- The Diagnosis Code is two bytes in length and you should always specify 0x0000, otherwise you will receive an error response.
- The Data is two bytes in length and you can specify freely.

(4) Interpreting Normal Response

- A normal response is the same as its query.

## 6.4.2.5 Error Response

An invalid query will not be executed and be responded with an Error Response.

(1) Error Response

| 1byte | 1byte | 1byte | 2bytes |
|---|---|---|---|
| Station Number | Exception Func | Sub Code | Error Check |

(2) Interpreting Error Response

- The error response is the same as a query requesting a Station Number.
- The Exception Func is the sum of the FC in the query and 128.
  For example, when FC=3, then Exception Func=3+128=131 ($83_H$).
- The Subcode indicates the reason of invalidity as in the following table.

<table>
<tr><th>Subcode</th><th colspan="2">Item</th><th>Description</th><th>M26 code</th></tr>
<tr><td>1</td><td colspan="2">Invalid FC</td><td>FC other than 3, 6, 8, and 16 is received.</td><td>-</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Invalid address</td><td>Invalid function code</td><td>Function code out of range (for example F81) is received.</td><td rowspan="2">78</td></tr>
<tr><td>Invalid data number</td><td>Writing 16 words or more is attempted.</td></tr>
<tr><td>Abnormal diagnosis code (maintenance code)</td><td>Data other than "0" is set to Diagnosis Code.</td><td>-</td></tr>
<tr><td>3</td><td>Invalid data</td><td>Data range error</td><td>Data to be written is out of valid range.</td><td>80</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">NAK</td><td>Link priority</td><td>Writing operation command or reference data is attempted while a field option (such as T-KINK or SX) is installed.</td><td>76</td></tr>
<tr><td>Write disabled</td><td>1. Write disabled during operation<br>2. Write disabled (read only or M area)<br>3. Operation through link disabled<br>4. Write through RS485 disabled (H31, H34 to H37, H40, P02)<br>5. F04, F05, P03 to P27 (when M1 motor parameters are protected)</td><td>79</td></tr>
</table>

## 6.4.3 Error Check

### 6.4.3.1 CRC-16

This data is used to check for a error in a communication frame.
The CRC is one of the most effective error check systems. The sender side calculates and adds a CRC data at the end of a frame. The receiver side calculates a CRC data on a received data and compares these two CRC data.

(1) Brief Description of Steps to Calculate CRC Data

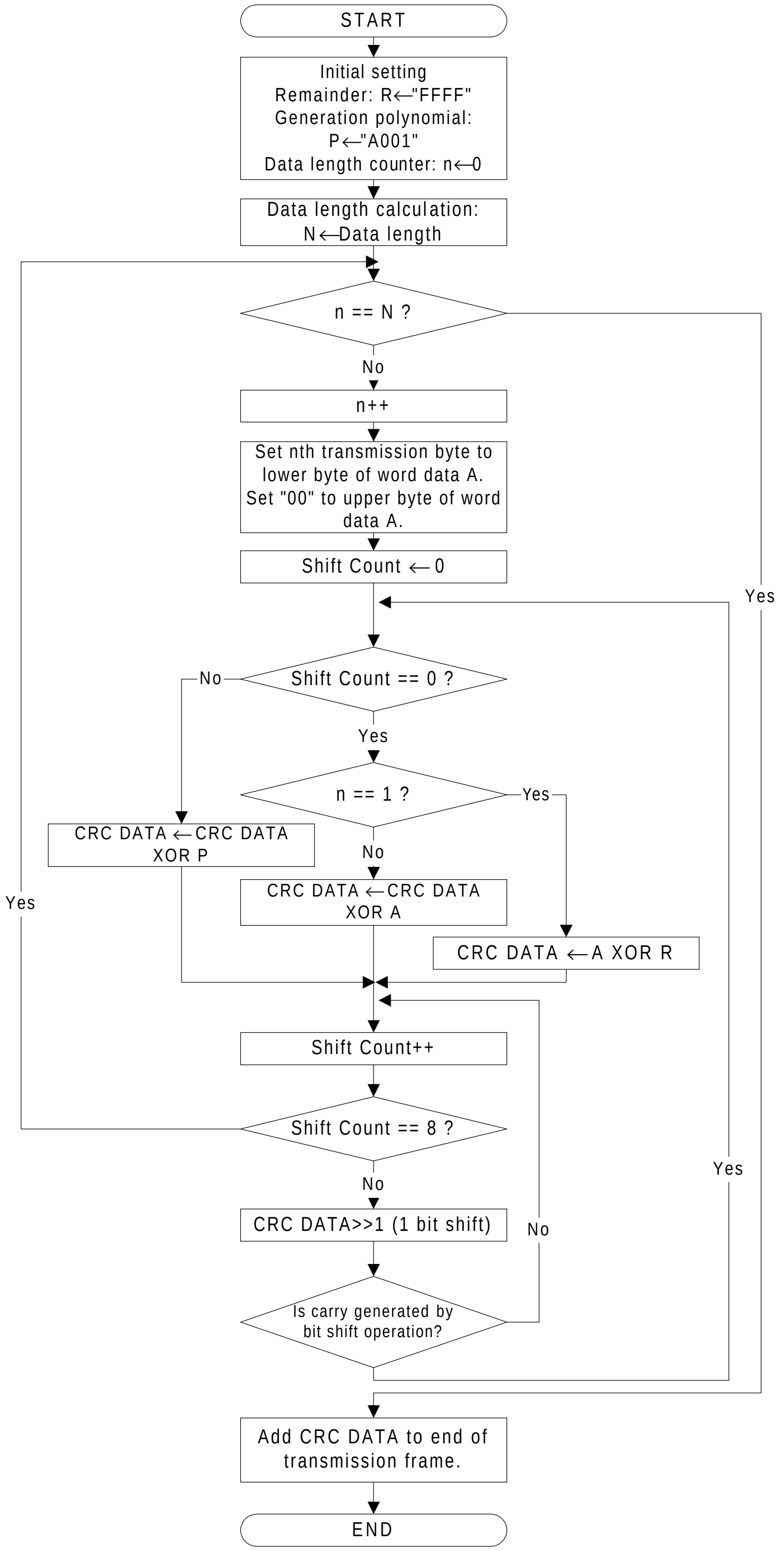
- A data expressed as a polynomial (1100 0000 0010 0001 is expressed as $X^{15}+X^{14}+X^{5}+1$) is divided by a generation polynomial (17 bits, $X^{16}+X^{15}+X^{2}+1$). The CRC data is obtained as a remainder (16 bits) of this division.
- Neglect the quotient, add the remainder at the end of a data, and send a message.
- A receiver side divides this message (with CRC data) by the generation polynomial and assumes that a transmission is executed without error if the remainder is 0.

(2) About CRC-16

The generation polynomial is expressed with powers of X such as $X^{3}+X^{2}+X$ instead of binary code 1101. Though you can choose an arbitrary generation polynomial, there are some defined/proposed standard polynomials to optimize error detection. The RTU protocol uses a generation polynomial of $X^{16}+X^{15}+X^{2}+1$ corresponding to 1 1000 0000 0000 0101 expressed in binary. In this case, a generated CRC is known as CRC-16.

## 6.4.3.2 CRC Algorithm

The following flowchart describes the calculation algorithm of CRC-16. See also a calculation example in 6.4.3.3.




- The CRC DATA occupies one word memory and is updated through calculation to be finally added to a transmission frame as a check code.
- The reception process is the same as that in the figure above. Note that the CRC data calculated on the transmission side and that on the reception side should be compared.

## 6.4.3.3 Example of CRC-16 Calculation

The following example is a data sent as a Query for a function code. The Station Number is 1, FC=03, the Function Code is P49 (code for P is 03 and 49 is 31hex), the Number of Data to be Read is 20, G.P. is a generation polynomial (1010 0000 0000 0001).

| Station Number | FC | Function Code | | Number of Data to be Read | |
|---|---|---|---|---|---|
| 01 | 03 | 03 | 31 | 00 | 14 |

| N | PROCESS | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Initial data R="FFFF" | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 2 | 1st data byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | |
| 3 | CRC = No.1 Xor No.2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 4 | Shift >> 2 (until flag=1) | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | CRC = No.4 Xor G.P. | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 6 | Shift >> 2 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | CRC = No.6 Xor G.P. | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 8 | Shift >> 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | CRC = No.8 Xor G.P. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 10 | Shift >> 2 (completion of 8 shifts) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 11 | CRC = No.10 Xor G.P. | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | |
| 12 | 2nd data byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |
| 13 | CRC = No.11 Xor No.12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | |
| 14 | Shift >> 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| 15 | CRC = No.14 Xor G.P. | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | |
| 16 | Shift >> 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| 17 | CRC = No.16 Xor G.P. | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | |
| 18 | Shift >> 2 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 19 | CRC = No.18 Xor G.P. | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | |
| 20 | Shift >> 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 21 | CRC = No.20 Xor G.P. | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22 | Shift >> 2 (completion of 8 shifts) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 3rd data byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |
| 24 | CRC = No.22 Xor No.23 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | |
| 25 | Shift >> 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 26 | CRC = No.25 Xor G.P. | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 27 | Shift >> 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 28 | CRC = No.27 Xor G.P. | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | |
| 29 | Shift >> 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 30 | CRC = No.29 Xor G.P. | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 31 | 4th data byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | |
| 32 | CRC = No.30 Xor No.31 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | |
| 33 | Shift >> 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |
| 34 | CRC = No.33 Xor G.P. | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | |
| 35 | Shift >> 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 36 | CRC = No.35 Xor G.P. | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | |
| 37 | Shift >> 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 38 | CRC = No.37 Xor G.P. | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | |
| 39 | Shift >> 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |
| 40 | CRC = No.37 Xor G.P. | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | |
| 41 | Shift >> 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 42 | CRC = No.41 Xor G.P. | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | |
| 43 | Shift >> 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| 44 | CRC = No.43 Xor G.P. | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | |
| 45 | 5th data byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 46 | CRC = No.44 Xor No.45 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | |
| 47 | Shift >> 5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| 48 | CRC = No.47 Xor G.P. | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | |
| 49 | Shift >> 3 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |

| N | PROCESS | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | Flag |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 50 | 6th data byte | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | |
| 51 | CRC = No.49 Xor No.50 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | |
| 52 | Shift >> 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| 53 | CRC = No.52 Xor G.P | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | |
| 54 | Shift >> 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 55 | CRC = No.54 Xor G.P | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | |
| 56 | Shift >> 2 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| 57 | CRC = No.56 Xor G.P | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | |
| 58 | Shift >> 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| | CRC data to be transmitted | 4 | | | | E | | | | 1 | | | | 4 | | | | |

The following table shows the data to be transmitted after the calculation above.

| Station Number | FC | Function Code | | Number of Data to be Read | | CRC Check | |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 03 | 31 | 00 | 14 | 14 | 4E |

## 6.4.3.4 Calculating Frame Length

You should obtain the variable message length to calculate a CRC-16 data. You can use the following table to determine the length of all message types.

| FC | Name | Query Broadcast message length except for CRC code | Response message length except for CRC code |
|---|---|---|---|
| 3 | Reading FC Data | 6 bytes | (3+3rd data length) bytes |
| 6 | Writing Data for Single FC | 6 bytes | 6 bytes |
| 8 | Maintenance Code | 6 bytes | 6 bytes |
| 16 | Writing Data for Consecutive FC's | (7+7th data length) bytes | 6 bytes |
| 125 to 255 | Exception Function | Not used | 3 bytes |

*7th or 3rd bit shows the number of counted bytes of the information.

## 6.4.4 Communication Examples

The following section describes typical communication examples (all station numbers are assumed to be 5).

### 6.4.4.1 Reading

(1) Read M06 "Detected speed value".

1) Query (Host ⇒ Inverter)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 05 | 03 | 08 | 06 | 00 | 01 | 67 | EF |

2) Normal Response (Inverter ⇒ Host)

| | | | | | | |
|---|---|---|---|---|---|---|
| 05 | 03 | 01 | 27 | 10 | A3 | B8 |

Detected speed value; $2710_H \Rightarrow 10{,}000d$

$$10{,}000 \times \frac{\text{Maximum speed}}{20{,}000} = 750\ [\text{r/min}]$$

(Maximum speed: 1,500r/min)

(2) Write 400r/min to S01 "Speed reference 1" (Maximum speed: 1,500r/min).

$$400\ [\text{r/min}] \times \frac{20{,}000}{1{,}500} = 5333d = 14D5_H$$

1) Query (Host ⇒ Inverter)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 05 | 06 | 07 | 01 | 14 | D5 | 16 | 65 |

2) Normal Response (Inverter ⇒ Host)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 05 | 06 | 07 | 01 | 14 | D5 | 16 | 65 |

# 6.5 How to Use PC Loader (Loader command protocol)

## 6.5.1 Advantages of PC Loader

### Real-time trace

**Real-time trace shows the current condition of the inverter more realistically in a graph by the high-speed sampling (10ms).**

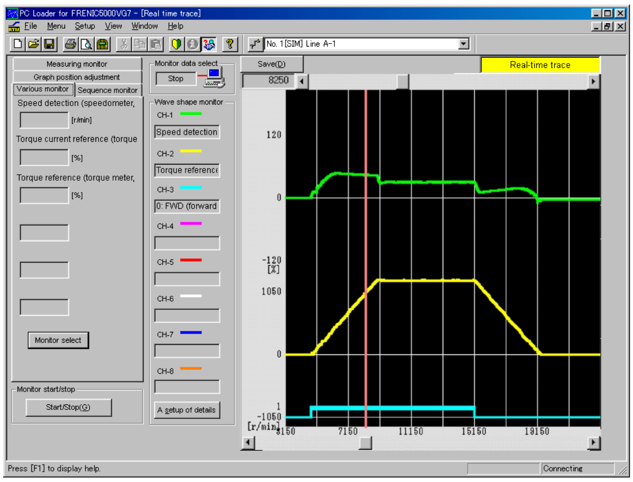



Figure 1 Real-time Trace

Real-time trace realizes the continuous waveform measurement of up to 30,000 points at the minimum intervals of 10ms (continues 5 minutes in case of 10ms sampling). This high-speed sampling discloses the detailed transition of the inverter at an unprecedented speed. Historical trace enables the continuous sampling of 100 points at the minimum intervals of 1ms.

All the required information such as speed detection, speed setting, line speed, torque current reference, motor voltage, motor current can be indicated in a graph with eight points at a time (in case all the data are digital signals). Additionally, the condition of that moment is indicated with digital values in the left columns of the screen. Therefore, you can understand the condition of the inverter at a glance. Furthermore, the time scale and Y scale of the graph can be set freely.

## Auto tuning

**Inverter will correct the motor in any environment condition. You can start the operation of the inverter immediately in everywhere.**

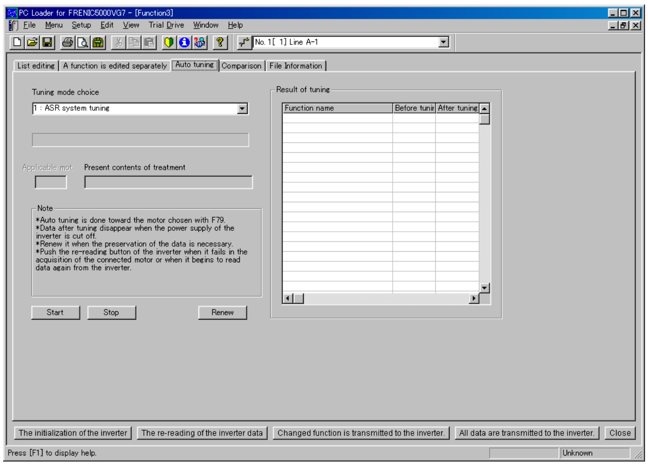



Figure 2 Auto Tuning

The settings of inverter in the motor was formerly very difficult for the people who were not accustomed to do it, because various kinds of the complicated configuration are required to operate the inverter correctly.
In this VG7S, the inverter will do the required settings automatically by itself. Complicated configuration or calculation is no more required.
You can perform the auto tuning through KEYPAD or, if using PC Loader, you can easily check the condition of the tuning or compare the data before and after tuning.
Auto tuning function also reduces the time for the settings. This is really the function for the customers.

## 6.5.2 Specifications

| Item | | Specifications | Remarks |
|---|---|---|---|
| System requirements | | | |
| | PC | PC/AT compatible machine | Excluding Macintosh |
| | OS | Microsoft Windows™ 95,98<br>Microsoft Windows™ NT 4.0 | Excluding Microsoft Windows 3.XX. |
| | Display | SVGA(800×600) or more is recommended | Trace screen corresponds to XGA. |
| Software | | | |
| | Language | Japanese, English | Selectable at the time of installation. |
| Software to be installed | | | |
| | Distribution medium | CD-ROM | |
| | Uninstallation | Possible | |
| | Custom set-up | Total installation type | Customization is impossible. |
| Communication setup | | | |
| | Interface | RS485 | |
| | Transmission speed | 2400, 4800, 9600, 19200, 38400bps | Changeable at communication setup. |
| | Synchronization method | Start-stop synchronization (UART) | |
| | Transmission Method | Full-duplex (physical level)<br>Half-duplex (protocol) | The connection method is full-duplex but the data exchange method repeats request and response alternately |
| | Communication style | Direct connection to inverter<br>1:n(1≤n≤31) | Changeable at connection setup. |
| | SX bus connection | Impossible | |
| | Network connection | Impossible | |
| | Data length | 8bit | Cannot be changed at communication setup.<br>Set the VG7S function code to be fixed. |
| | Stop bit | 1bit | |
| | Parity | Even parity | |
| | Flow control | Supports the selection of RTS or DTR control. | Changeable at communication setup. |
| | Error check method | Checksum method (1byte BCC) | |
| | Protocol | Following the SX bus protocol | Not opened. |
| | Time-out detection interval | Time-out × number of retries | Changeable at communication setup. |
| | No. of retries | Retry function executed in the case of data error or physical error. | Changeable at communication setup. |

# 6. Standard Interface RS485

| Loader standard specifications | | |
|---|---|---|
| **Function code setting specifications** | | |
| Edit by list | Refers/Changes the function code F, E, C, P, H, O, L, and U. The L code requires password. | |
| Edit by function | Individual setting for digital input · output, analog input/output is available. | |
| Automatic tuning | The condition of the tuning and its result can be compared. | |
| Comparison | Can compare the inverter data and the data in edit, files and the data in edit. The result can be printed out. | |
| File information | Inverter system, function codes, the date information when the file is read and comments can be input. | |
| Print·Save | Function codes can be printed and saved. CSV format is also available, therefore the file can be read by other applications. | |
| **Monitor function** | | |
| Multiple monitor | Monitors VG7S connected to RS485 by the periodical scanning, up to max. 31 machines | |
| I/O monitor | Monitors digital input/output. | |
| System monitor | Monitors ROM, option, inside control information, maintenance information. | |
| Error monitor | Indicates currently occurring alarm and alarm history. | |
| **Real-time trace · Historical trace specifications** | | |
| | Real-time trace | Historical trace |
| Sampling interval | 10,20,50,100,200,500ms | 1,2,5,10,20,50,100ms |
| No. of samplings | Max. 30,000 points<br>(In case of over 30,000, the data will disappear in order from the old one). | 100 points (the number of samplings can be set before and after the trigger). |
| Filter function | Can set manual or auto filter individually. | |
| No. of data | Max. 4 for analog, max. 8 for digital. (The number of data is limited when the analog and digital data are used in combination.) | |
| Analog data | Speed detection 1 (Speedometer, one-way deflection), Speed detection 1 (Speedometer, two-way deflection), Speed setting 2 (Before calculation for acceleration/deceleration), Speed setting 4 (ASR input), Speed detection 2 (ASR input), Line speed detection, Torque current reference (Torque ammeter, two-way deflection), Torque current reference (Torque ammeter, one-way deflection), Torque reference (Torque meter, two-way deflection), Torque reference (Torque meter, one-way deflection), Motor current, Motor voltage, Power consumption, DC link circuit voltage, +10V output test, –10V output test, Motor temperature, Heat sink temperature, excitation current command, excitation current detection, Magnetic-flux command, Magnetic-flux calculation, Torque calculation, Torque current detection, U,W phase motor current, U,W phase motor voltage, Torque bias balance adjustment, Torque bias gain adjustment, Universal AO, Option AO | |

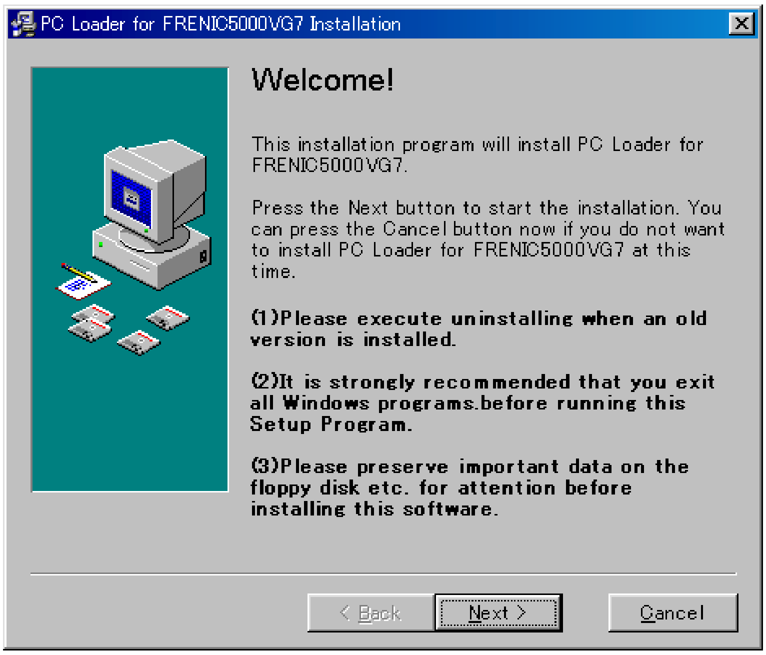
| | | |
|---|---|---|
| | Digital input data | Multistep speed selection, 1,2,4,8,ASR, Acceleration/deceleration selection 1,2, Self-hold selection, Coast-to-stop command, Alarm reset, External alarm, Jogging operation, Speed setting, N2/Speed setting N1, Motor M2 selection, Motor M3 selection, DC control braking command, ACC/DEC zero clear command, UP/DOWN setting, Creep speed switching, UP command, DOWN command, KEYPAD write enable command, PID control cancel, Forward operation/Reverse operation switch over, Interlock (52-2), Write enable through link command, Operation selection through link, Universal DI, Control method selection at the time of motor start, Synchronization command, Zero speed locking command, Pre-exciting command, Speed reference limit cancel, H41 [torque reference] cancel, H42 [torque current reference] cancel, H43 [magnetic-flux reference] cancel 34, F40 [torque limiter mode 1] cancel, Torque limiter (level 1, level 2 selection), Bypass, Torque bias command 1,2, Droop selection, Ai1,2,3,4, Zero hold, Ai1,2,3,4 Polarity change, PID output inverse changeover, PG alarm cancel, Undervoltage cancel, Ai torque bias hold, STOP1,2,3, DIA data latch, DIB data latch, Multi-winding function cancel, Option Di 1,2,3,4,5,6 |
| | Digital output data | Inverter running, Speed detected, Speed agreement, Reaching the preset speed, Speed detection 1,2,3, Stopping on undervoltage, Torque polarity detection (braking/driving), Torque limiting, Torque detection1,2, KEYPAD operation mode, Inverter stopping, Operation ready output, Magnetic-flux detection signal, Motor M2 selection status, Motor M3 selection status, Brake release signal, Alarm indication1,2,3,4, Cooling fan operating, Retry operation mode, Universal DO, Heat sink overheat early warning, Synchronization completion, Lifetime alarm, Under accelerating, Under decelerating, Inverter overload early warning, Motor temperature early warning, Motor overload early warning, DB overload early warning, Transmission error, Load adaptive control under limiting, Load adaptive control under calculation, Analog torque bias hold, Option DO 1,2,3,4,5,6,7,8,9 |
| | Print · Save | Trace data can be printed and saved. CSV format is also available, therefore the file can be read by other applications. |
| | Trial operation | |
| | Operation | FWD, REV, STOP command can be used. |
| | Speed setting | Digital speed setting command can be used. |
| | Control input | X1 to X9 can be input. |
| | Monitor | Speed command, actual speed, torque and operational status can be monitored. |

## 6.5.3 How to Install

(1) Setting CD-ROM and auto start

Set the CD-ROM into the CD-ROM drive slot with the face down.
The CD-ROM program automatically starts after a while.

(2) Welcome message




Before running this installation program, be sure to exit all application programs. (because installation of PC loader requires to restart the computer, which will delete the application data). When the CD-ROM is started, a welcome message (Figure 3) automatically appears.
Read the message carefully and click "Next (N)".

Figure 3 Welcome Message

Note 1: When the welcome message in Figure 3 does not appear after setting CD-ROM and waiting for a while, double click "my computer", and double click CD-ROM. Then, double click "AutoRun. exe".

Note 2: This subsection describes the installation method assuming that the PC loader is installed on MS-Windows95. The installation method may differ according to the OS version. If installing on the other OS, replace the description with the operations that corresponds to the OS to be used.

(3) End user software license agreement

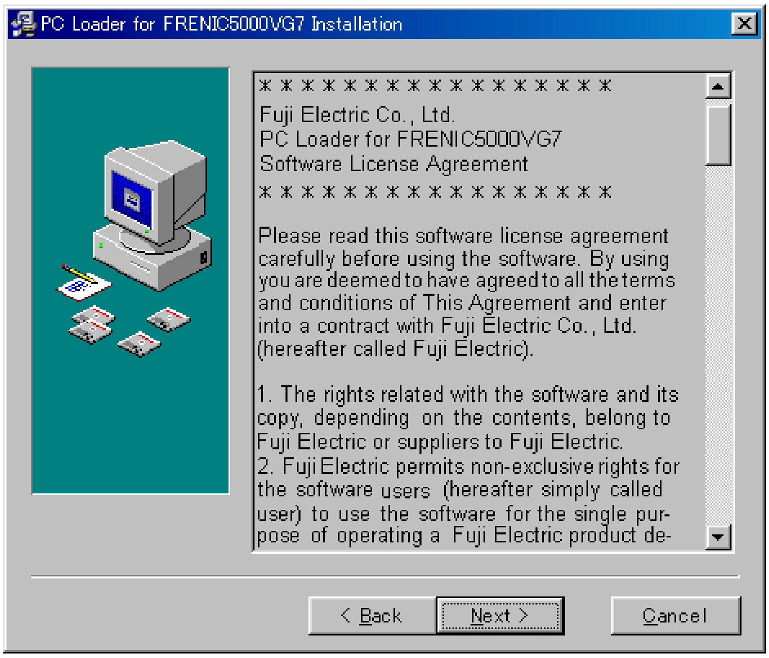



Figure 4 End User Software License Agreement

The end user software license agreement (Figure 4) will appear.

Read this agreement carefully, and if you agree with this, click “Next (N)”.

If not, click “Cancel”.

(4) Input of the user information

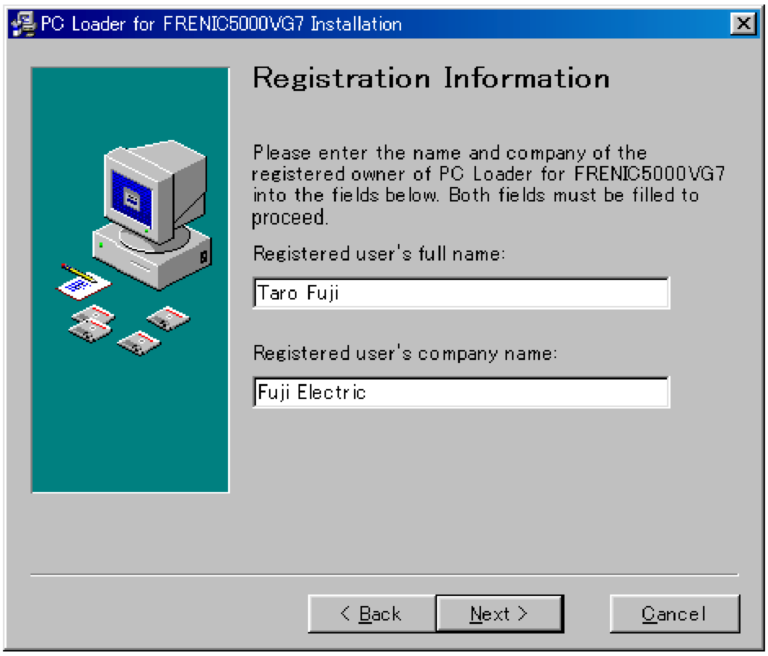



Figure 5 User Information

Always input the user name and the company name. Without these data, you cannot proceed to the next step.

After inputting the user name and the company name, click “Next (N)”.

(5) Locating the directory to be installed

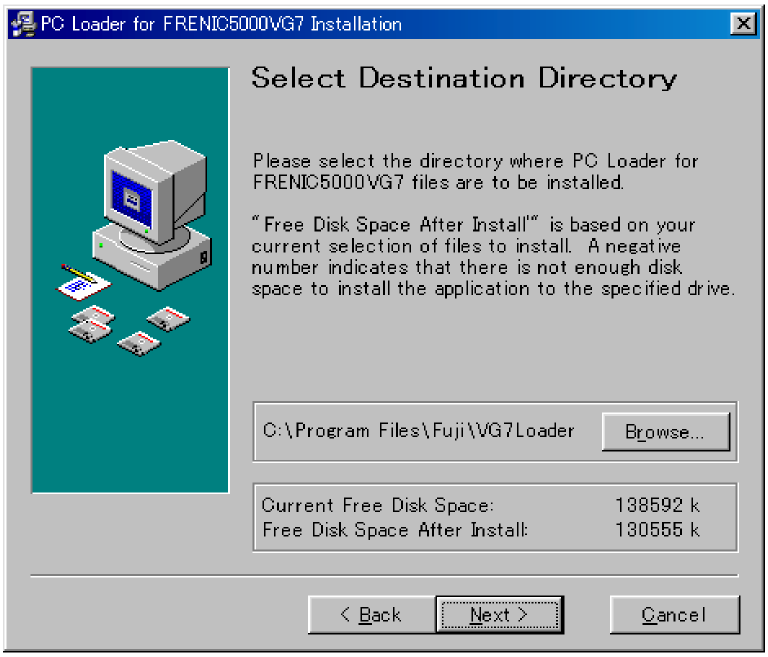



Figure 6 Locating the Directory to be Installed

The default directory where the software is installed is C:\ProgramFiles\Fuji\FRENIC. If there is no problem, install in this directory.

When you change the directory, click "Reference (R)". At the same time, confirm the free area.
After confirming the free area and changing the directory, click "Next (N)".

If the old version of the program is installed, the following screen will appear.

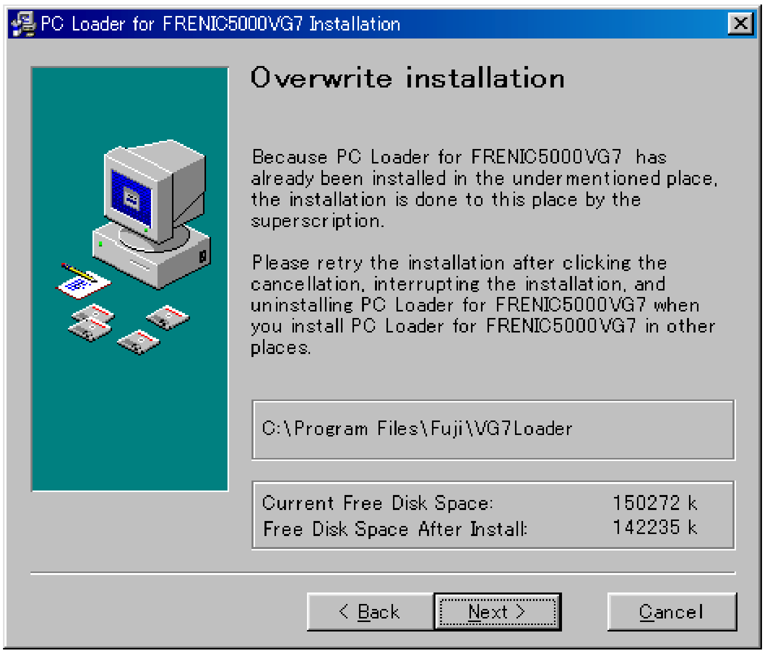
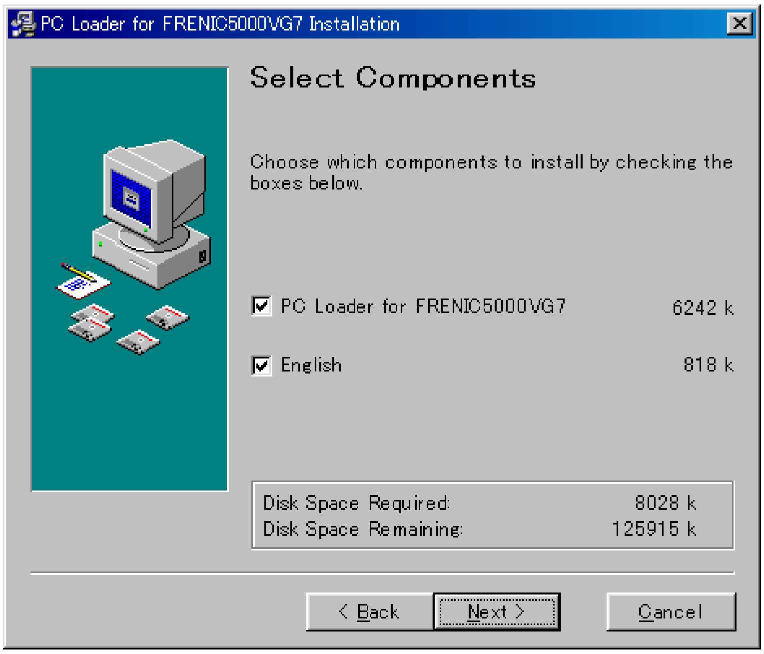



Figure 7 Rewrite Install

In this case, only the "Rewrite install" is available. If you want to change the directory for installation, click "Cancel" to stop installation. Uninstall the old version, and retry installation.

When installing the software by overwriting, click "Next (N)".

(6) Selecting the component to be installed




You can select the component to be installed. The following components are available:

(1) PC Loader for FRENIC5000VG7
(2) Japanese

Currently, both of these components should be installed. When these components are installed separately, the program cannot run.
Check two columns and click "Next (N)".

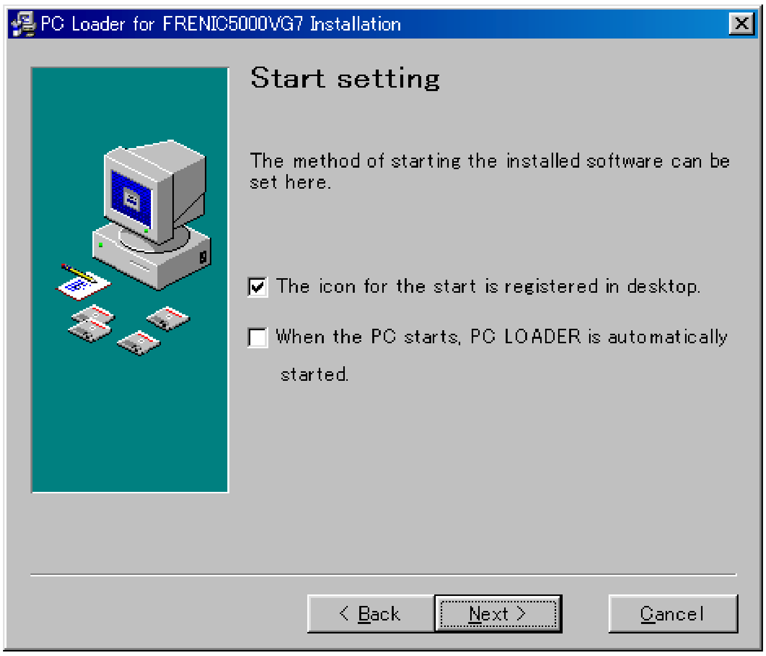
Figure 8 Selecting the Component

(7) Selecting the program manager group


By default, "Program manager group" is installed in "FRENIC5000VG7".
If there is no problem, proceed without adding any change.
Click "Next (N)" to go to the next step.

Figure 9 Selecting the Program Manager Group

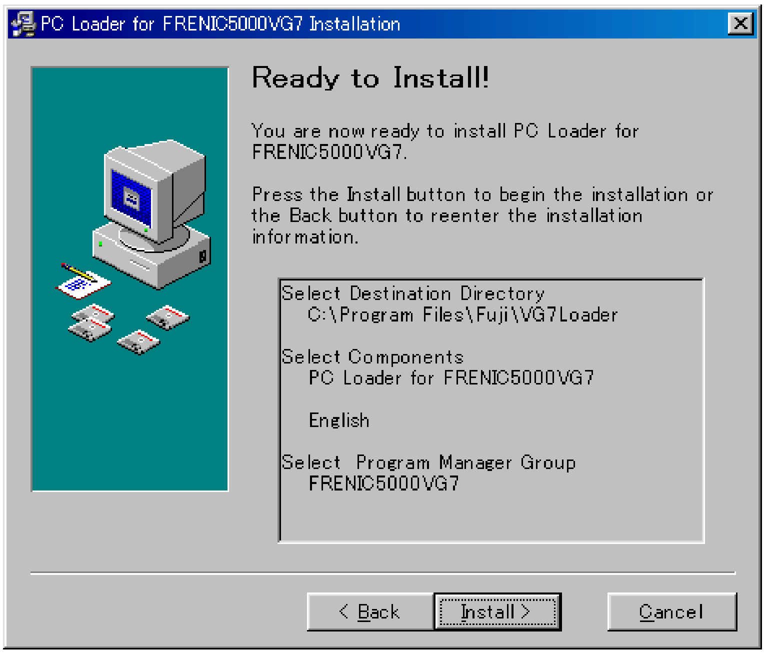
(8) Selecting the starting method




(1) If you want to create the startup icon on the desk top, check “Register the startup icon on the desk top”.
(2) If you want to start the PC LOADER automatically when starting the Windows, check “Start the PC LOADER automatically at the time of the computer start”. After the checking, click “Next (N)”.

Figure 10  Selecting the Starting Method

(9) Starting the copy to the computer

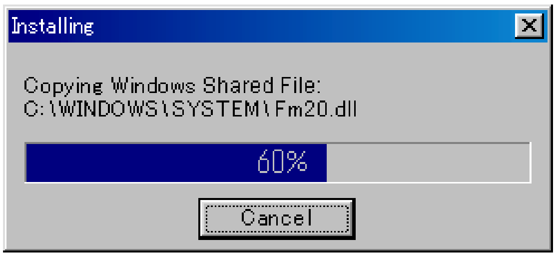



Click “Start (S)”, and the copy of the program from CD-ROM to the computer will start.
If you want to change the indicated settings, click “Back (B)” and set them again.

When “Start (S)” is clicked, the “Installing” screen will appear as shown in Figure 12.

Figure 11  Starting the Copy

(10) Indication of "Now copying"




When the "Start (S)" is clicked on the screen in Figure 11, the left dialog box appears, indicating that the PC LOADER is being installed. When the bar in the middle of the screen reaches 100%, the installation is completed.

Figure 12 Dialog Box Showing Progress of Installation

(11) Indication after the completion of the copy

On completion of program copy, the configuration of the PC will start. Wait until the message of "Rewriting the system configuration file. Wait a second" disappears.

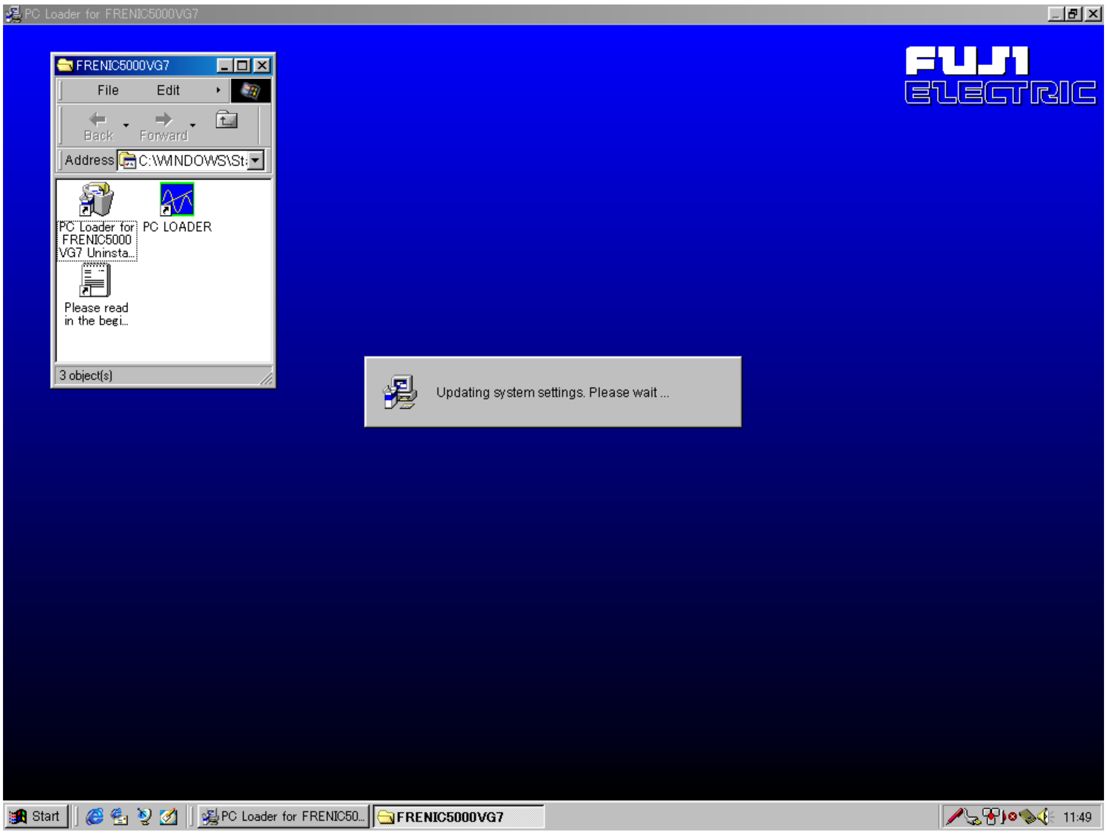



Figure 13 System Configuration is Being Set

(12) Installation completed

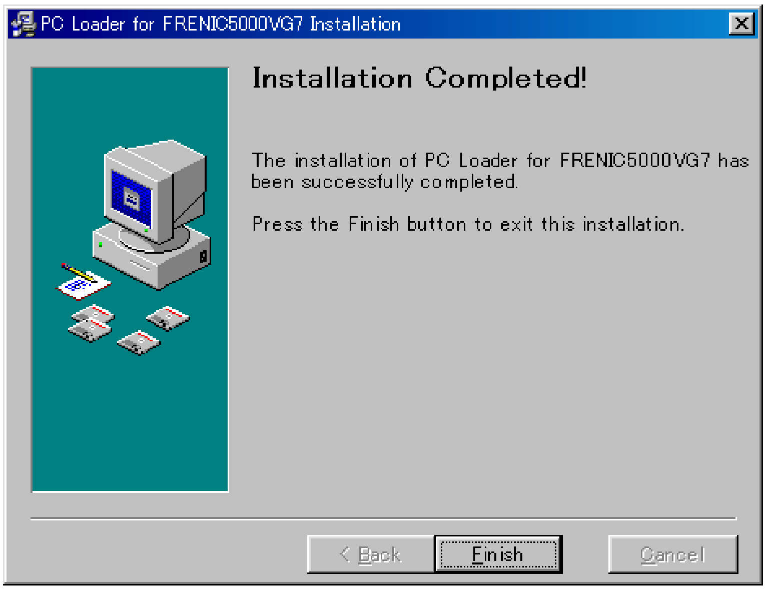



Figure 14 Installation Completed

When the installation is completed, the left screen will appear.
Click “Finish (F)” to complete installation.

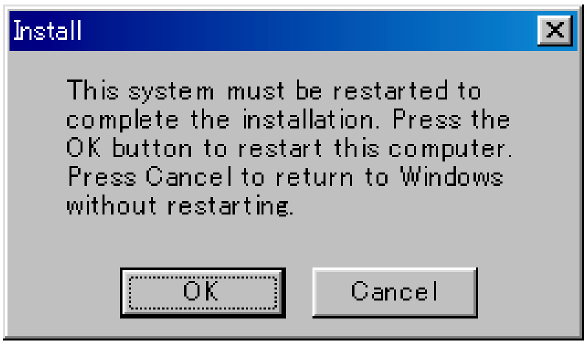



Figure 15 Finish

When clicking the “Finish(F)”, the left screen will appear.
The computer should be restarted to start the installed application.
If other applications are not closed, click ”Cancel” and exit all the applications.
After that, restart the computer.

## 6.5.4. Simple Operation Method

### 6.5.4.1 Start of PC Loader

The way of starting PC loader differs according to the selected starting method.

(1) If “Start the PC LOADER automatically at the time of the computer start” is selected, PC Loader will start automatically when the computer is started.

(2) If “Register the startup icon on the desk top” is selected, click this startup icon to start.

(3) Click PC LOADER in FRENIC5000VG7 folder.


Note: When the folder name is changed, the dialog box in the left figure shows the new folder name.

Figure 16 FRENIC5000VG7 Folder

(4) Select PC Loader in the start menu as shown in Figure 17.

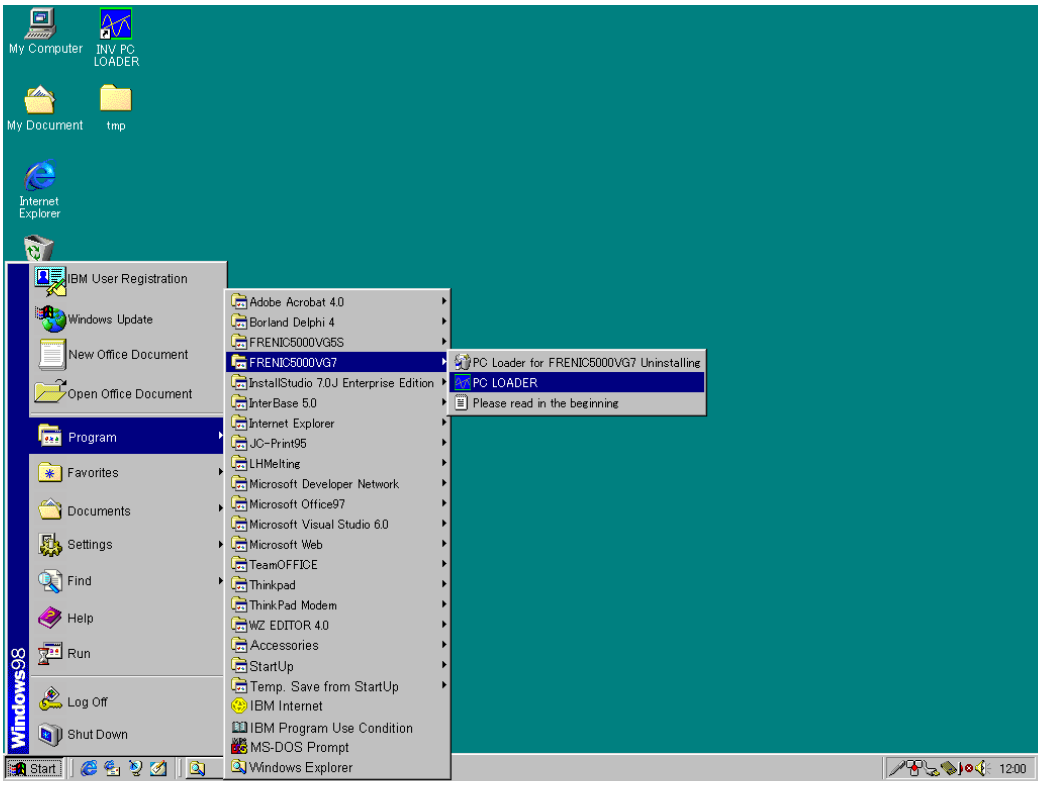



Figure 17 Start from the Start Menu

## 6.5.4.2 Communication Setup

Set the data for communication between the computer and the inverters.

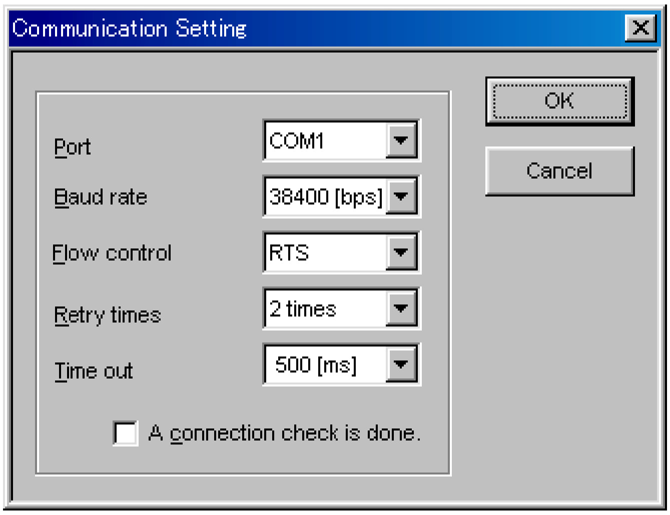



Figure 18 Communication Setup

(1) Selection of port
Select the connection port of the computer (four ports from COM1 to COM4 are available).

(2) Baud rate setting
Set the communication speed.

(3) Flow control
Select the flow control.

(4) Number of retries
Set the number of retries to be done automatically when the communication error occurs. You can select the number of times from zero to ten.

(5) Setting time-out error time
Set the time before timeout error occurs when no reply is returned from the inverter.

(6) To do the connection check or not
Select whether the communication line should be connected or not. If this box is checked, the communication will be made at any time, and the processing of the computer will delay by the time taken for communication. Always check here during the real-time processing.

## 6.5.4.3 Connection Setup

Next, select the inverters to which PC is connected for communication.

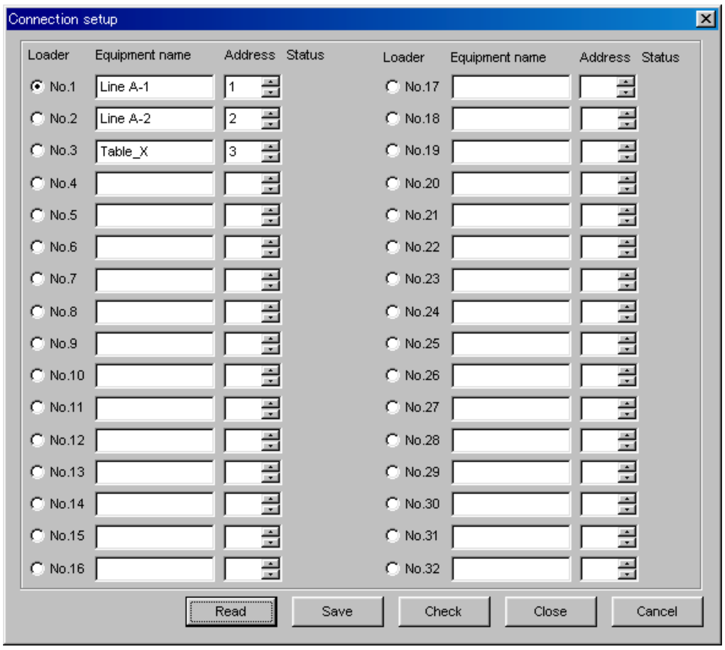



Figure 19 Connection Setup

(1) Loader connection
Select the inverters to be connected with the computer.

(2) Inverter equipment name
Enter the of the inverter name currently used. (You can input freely)

(3) Channel number
Set the inverter number.

(4) Communication status
When “Confirm Communication” is clicked, the ON/OFF status appears in this column.
(Refer to Figure 20.)

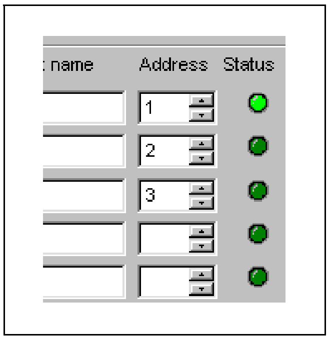



Figure 20 Communication Status

## 6.5.4.4 Function Code Setup

Edit, compare and initialize the function codes.

(1) Selecting the data to be edited

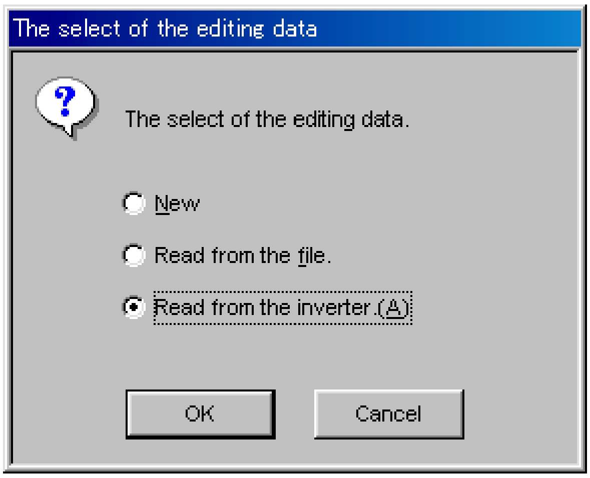



Figure 21 Selecting the Data to be Edited

"Selecting the data to be edited" window will appear when the function code setup mode starts. Select the data to be edited and Click OK, then the new edit screen will start.

• New File (N)
Select this button mainly when the computer is not connected to the inverter.
Edit the function codes based on the function codes prepared in the inverter support software.

• Read the file in the computer (F)
Select this button when editing the function code setup file which has been already saved.

• Load from the inverter (A)
Select this button when editing the function codes of the currently connected inverter.

**⚠CAUTION**

If "Load from the inverter" is selected although the computer is not connected to the inverter, "time-out" error will occur and the left dialog box shows an error message.


In this case, click "OK" and reconnect.

(2) Edit by list

Edits the function codes in the list.

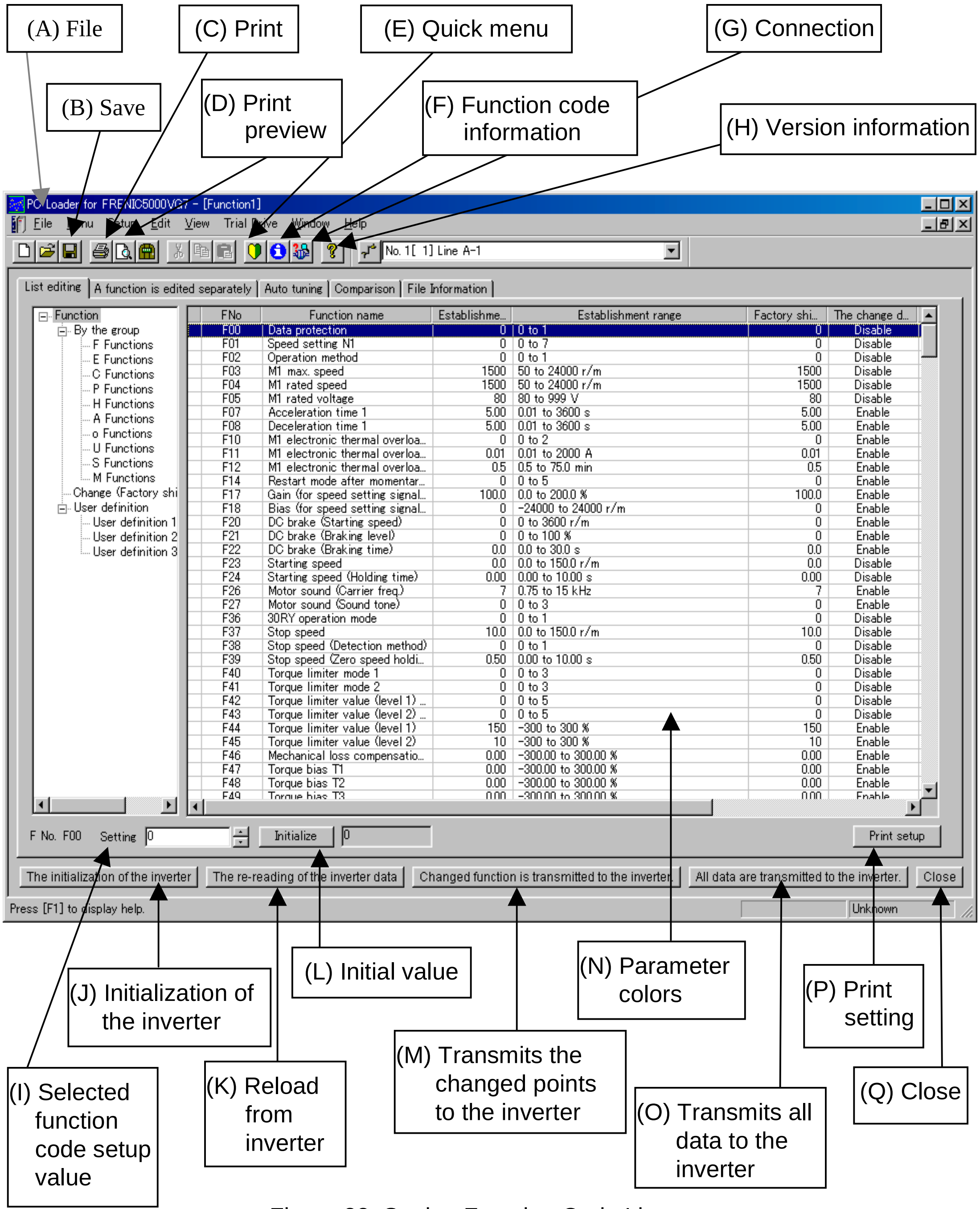



Figure 22  Setting Function Code List

(A) File

Used to open, save, and print the existing function code file.

(B) Save

Used to save the function codes being edited.

**If you choose the CSV format ( * . CSV) at the time of saving, the file can be opened by Microsoft Excel etc.**

*** Refer to "5 Read the file and save".**

(C) Print

Used to print the parameters being edited.

Prints in the form of a list.

(D) Print preview

Previews the printed image.

(E) Quick menu

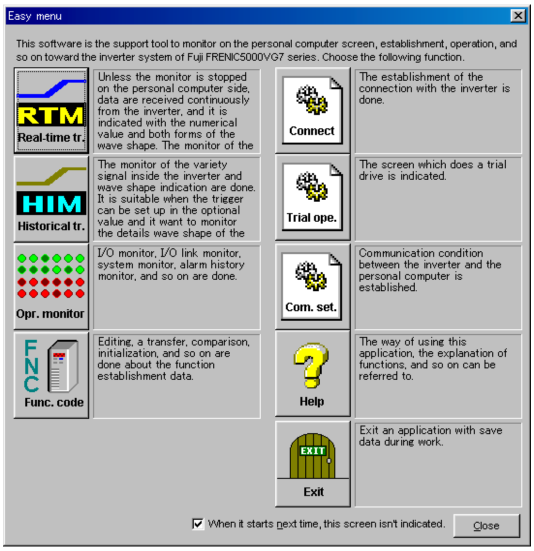



Figure 23 Quick Menu

This screen allows you to jump from the menu screen to each setting screen.

This screen covers all the fundamental data setting screens.

(F) Function code information

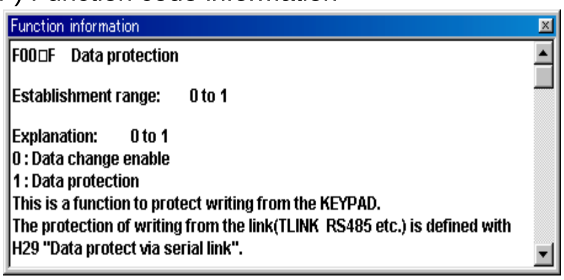



Figure 24 Function Code Information Window

The left window shows the information on the selected function code.

(G) Connection

Used to set the data communication as the persistent connection or not.

(H) Version information

Shows the version of this software.

(I) Selected function code setup value

Indicates the code number and the setup value of the currently selected function code.
You can edit the currently selected function code by either the numerical keys or the spin buttons on the right side of this data input column.

(J) Initialization of the inverter

Changes the function code setup value of the connected inverter to the factory setup value.

(K) Reload from inverter

Loads the function code setup values from the currently connected inverter and inserts it into the file being edited.
**Save the file before executing this function to prevent the file being edited from getting lost.**
Use this function to reconfirm the function codes transmitted to the inverter.

(L) Initial value

Sets the currently selected function code setup value as an initial value.

(M) Transmits the changed points to the inverter

Writes only the changed function codes to the connected inverter.

(N) Parameter colors

Black: Function codes which are not yet changed.
Blue: 1) Function codes which are already changed.
The color will become black after the change is written in the inverter correctly.
"*" before the function code shows that the current setup value differs from the factory setup value.

(O) Transmits all data to the inverter

Writes all of the function code setup value being edited in the connected inverter.

(P) Print setting

Sets the print condition.

(Q) Close

Quits the function code setup.


After changing the setup value, if the data is not saved, the screen as shown in the left figure will appear.
If you want to save the data, click "cancel" and save the data according to "(B) Save".

Figure 25  Notice that the Data are not Saved

(3) Edit by function

Edits the function codes by classifying the codes by function.

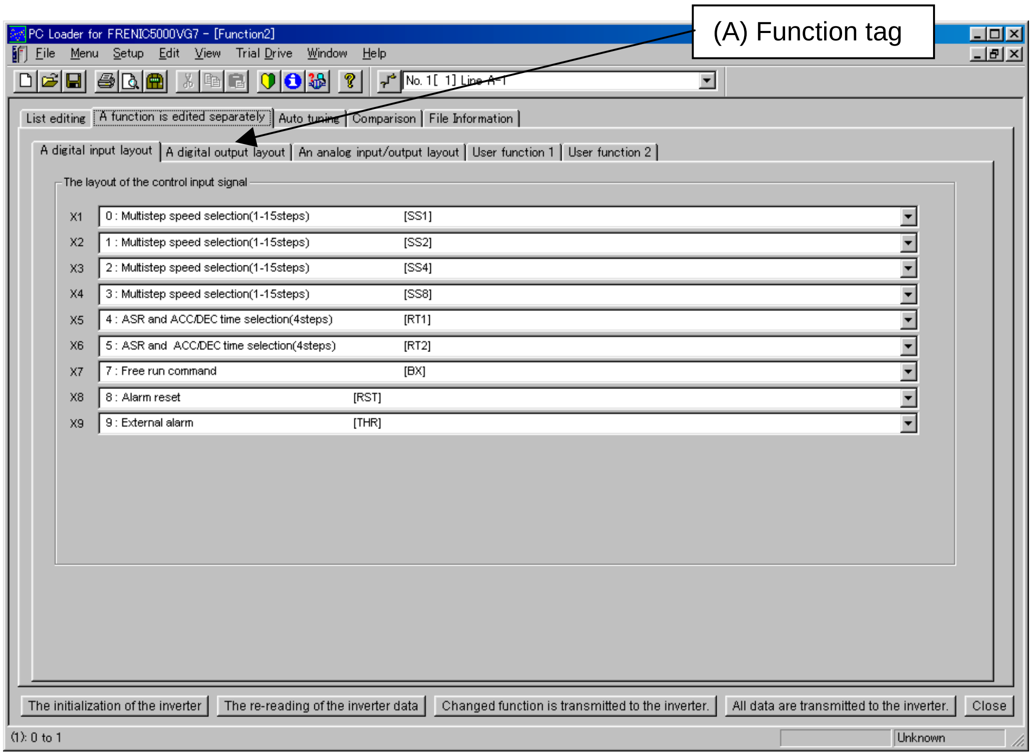



Figure 26 Edit by Function

(A) Function tag

Tags classified by the function.

1) Digital, analog input/output allocation

Selects the tag of the function to be edited.

Refer to (2) Edit by list for the procedure of initialization of the inverter etc.

User function

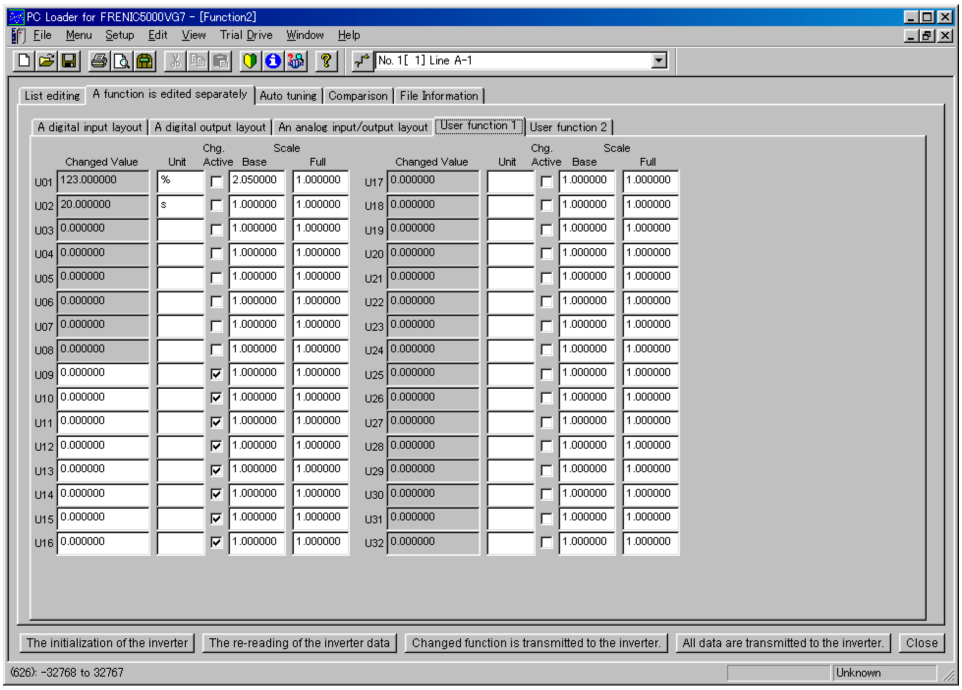



Figure 27 Edit by Function

The above table is used to convert the hexadecimal data used by the computer to the decimal data that you can easily understand. You can complete this table by entering required calculation values.

1) In case of loading the data from the inverter (reload of the inverter data)
   Regardless of the check in the converted value reference box, indicates the result of calculation of "communication data" × "base scale" ÷ "full scale" = "converted value" in the text box of the converted value.

2) In case the converted value reference box is not checked.
   The text box of the converted value is set as "**read only**" (edit is impossible). The color of the text box will also change.
   The indicated converted value will be changed according to the change of base scale and full scale. (Recalculated when the focus moves. The communication data will not be changed).

3) In case the converted value reference box is checked.
   The converted value can be edited in the text box. In this case, the communication data will also be changed (recalculated when the focus moves).
   The communication data will be changed according to the change of base scale and full scale. (Recalculated when the focus moves. The data of the converted value will not be changed).

4) When the U code is edited in the "edit by list" screen, the converted value will be recalculated regardless of the check in the converted value reference box.

(4) Auto tuning

Executes the auto tuning for each constant of the inverter.

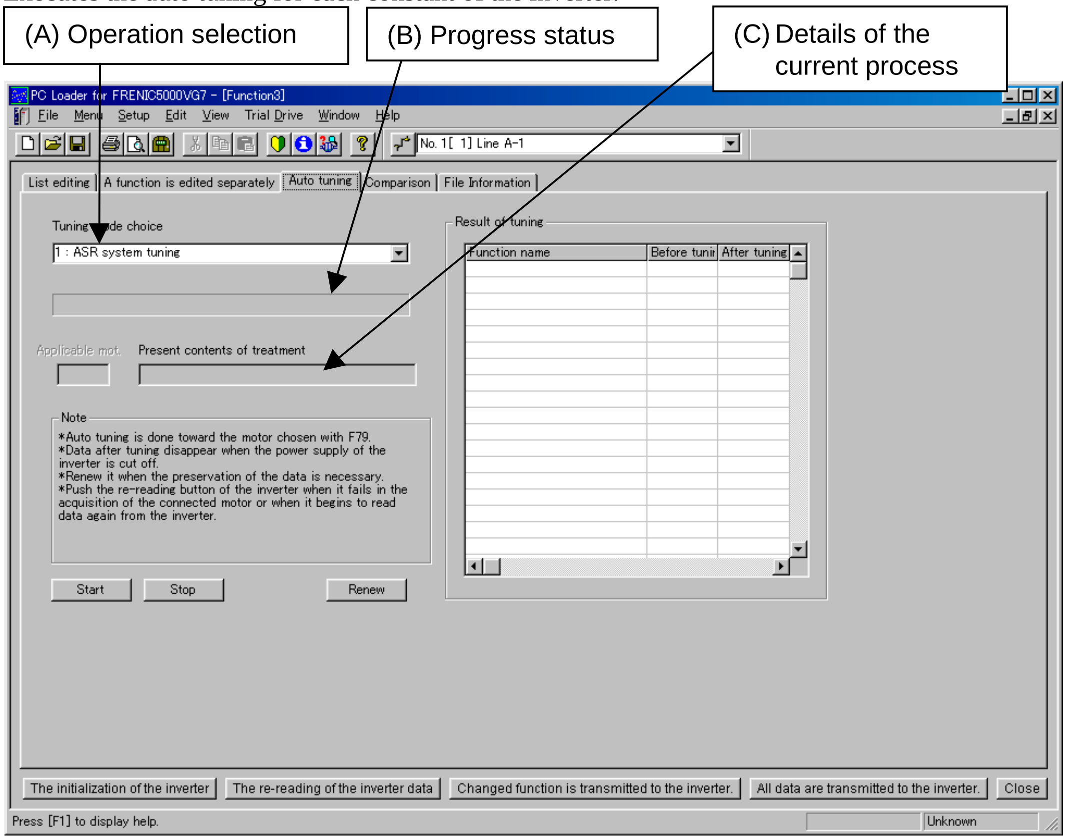
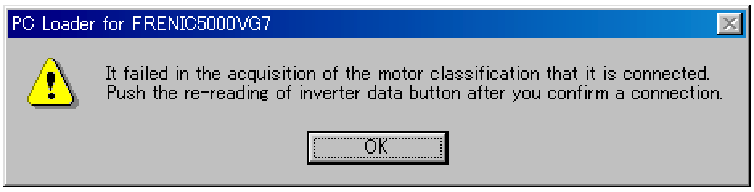



Figure 28 Auto Tuning

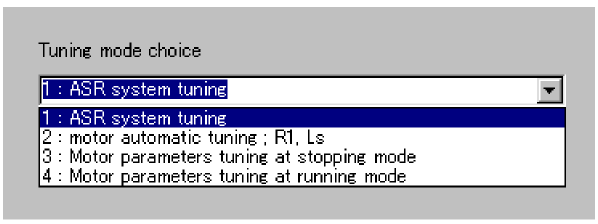
If the PC fails to acquire the motor type (not connected), the in the following message window will appear.




In this case, auto tuning cannot be executed until the inverter data successfully reloaded.

Figure 29 Acquisition Failed

(A) Selecting operation




Select the auto tuning operation from the pull-down menu as shown in the left figure.

Figure 30 Selection of the Operation

(B) Progress status

Indicates the progress status of the auto tuning by a bar (indicated in percent).

(C) Details of the current process

Indicates the details of the actual process during auto tuning.

(5) Comparison

Compares the following combinations.

1) Function codes being edited and data of the connected inverter.
2) Function codes being edited and the saved function code setup file.

3) Compares the function code being edited with the setup value of the function code of the connected inverter.

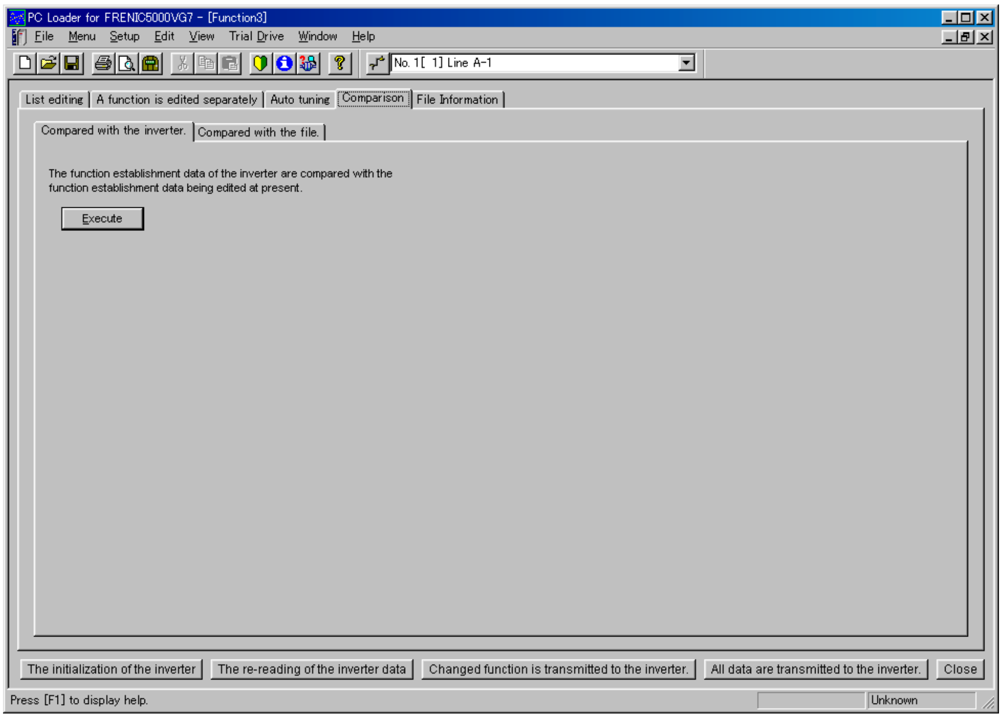



Figure 31 Comparison-inverter

4) Compares the function code being edited and the saved function code file.

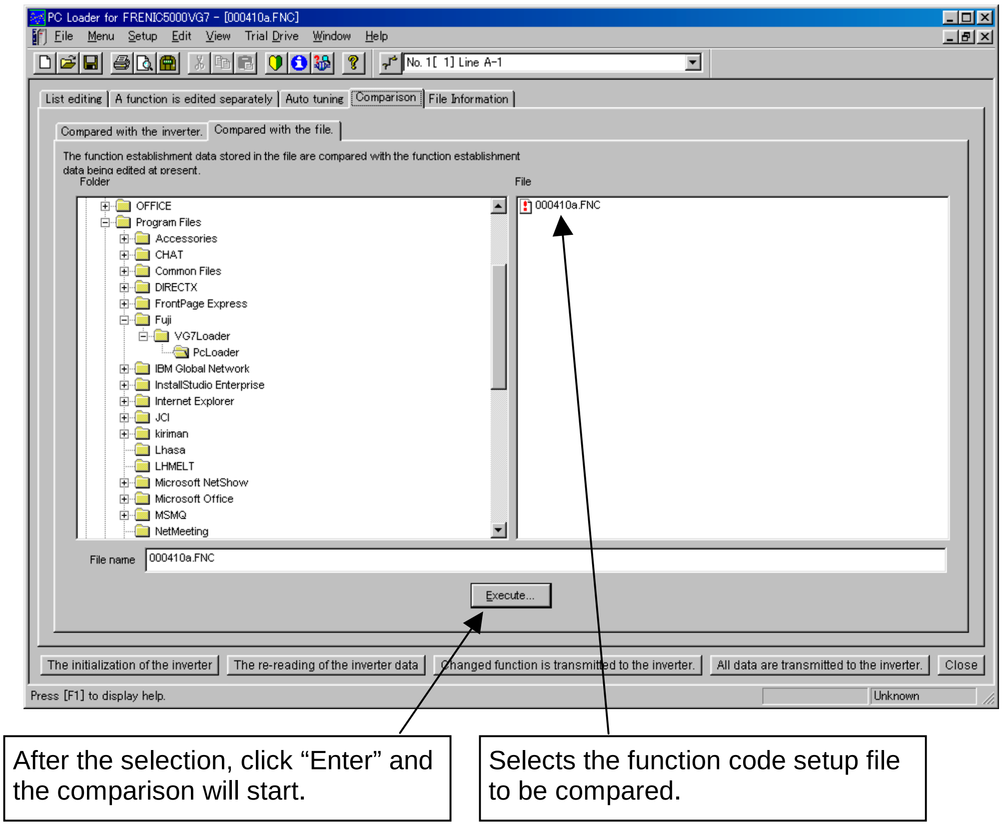
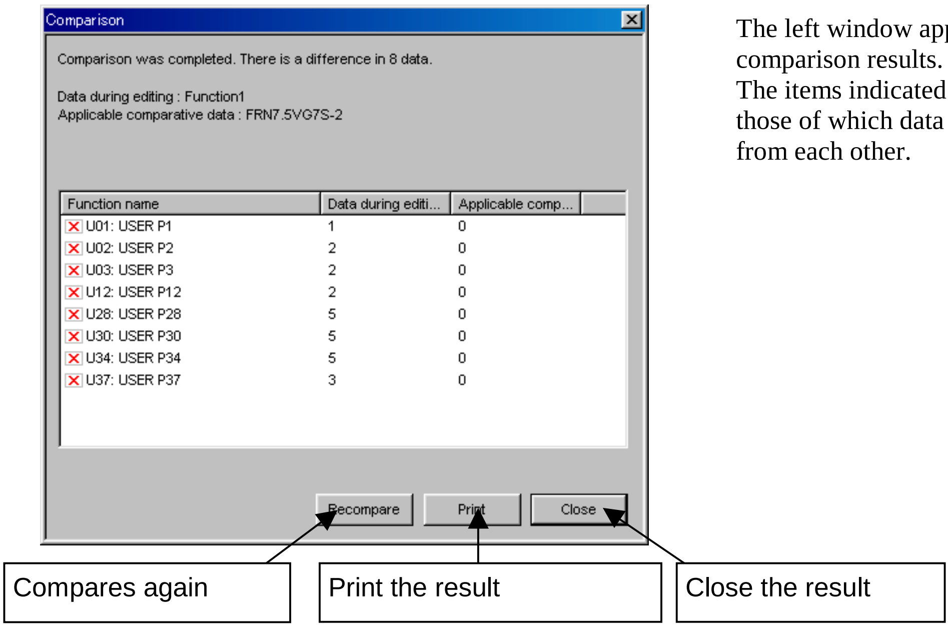



Figure 32 Comparison-file

5) The result of the comparison




The left window appears, showing comparison results.
The items indicated here are only those of which data are different from each other.

Figure 33 The Result of the Comparison

6) Print of the result of the comparison

Print out the comparison result.

*Comparison result* 2000/ 4/10 20:23:16

Source:Function1

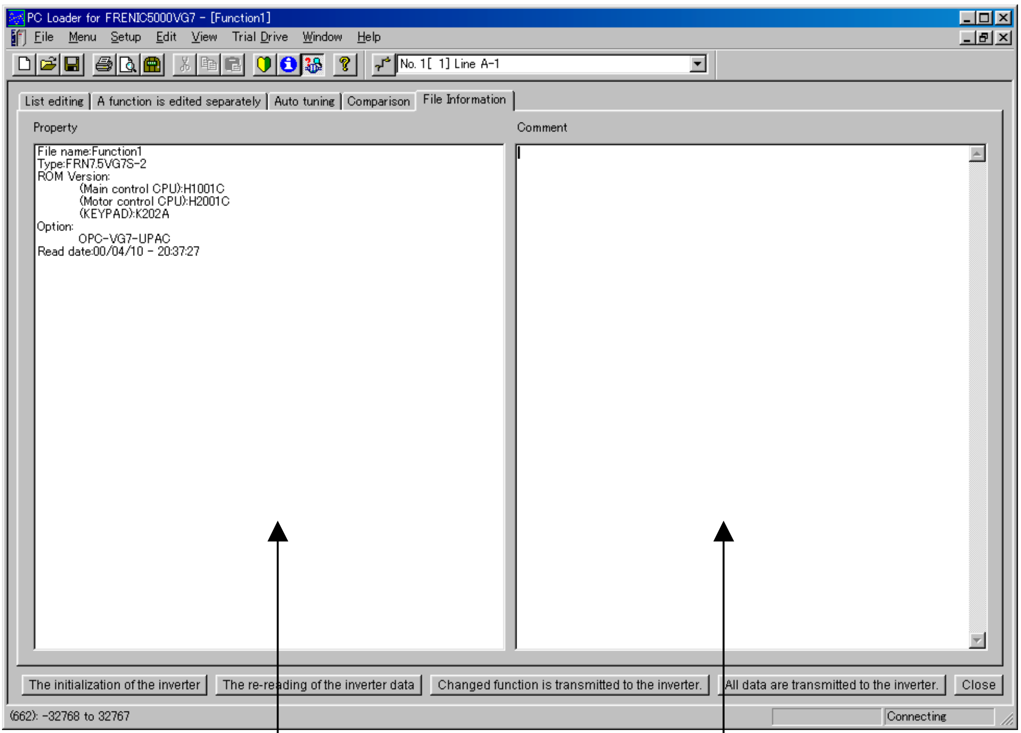
Destination:FRN7.5VG7S-2

Number of differences:8

| FNo. | Function code Name | Sorce | Destination |
|---|---|---|---|
| U01 | USER P1 | 1 | 0 |
| U02 | USER P2 | 2 | 0 |
| U03 | USER P3 | 2 | 0 |
| U12 | USER P12 | 2 | 0 |
| U28 | USER P28 | 5 | 0 |
| U30 | USER P30 | 5 | 0 |
| U34 | USER P34 | 5 | 0 |
| U37 | USER P37 | 3 | 0 |

Figure 34 Output Indication

(6) File information




Indicates the property of the function codes being edited.
- File name at the time of save.
- System condition of the loaded inverter.
- Date of load from the inverter.

You can add comments freely to the file being edited.
This comment will be saved automatically at the time of file save.
Up to 500 characters can be accepted.

Figure 35 File Information

## 6.5.4.5 Operation Monitor

(1) Multiple monitor

Indicates the operational status of the inverter whose terminal number is set by the connection setup.

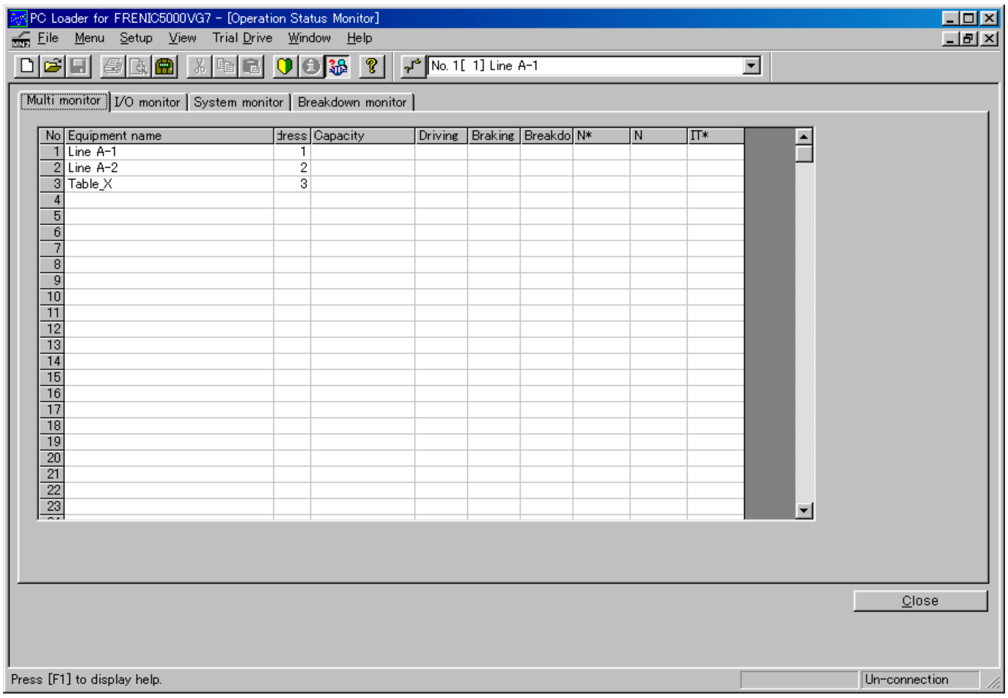



Figure 36 Multiple Monitor

| | |
|---|---|
| 1) Name of the equipment | : Indicates the name which was input in the connection setup. |
| 2) Terminal number | : Terminal number of the inverter |
| 3) Capacity | : The type (capacity) of the inverter |
| 4) In operation | : 1=In operation 0=Not in operation |
| 5) In braking | : 1=Braking 0=Not braking |
| 6) At fault | : 1=Alarming 0=not yet alarming |
| 7) Close | : Closes the operation monitor. |

Note: If the PC fails to acquire the inverter operational status, the data columns are left blank as shown at No.2 and No. 3 in the above screen.

(2) I/O Monitor

Indicates the ON/OFF of the input/output control signal of the connected inverter.

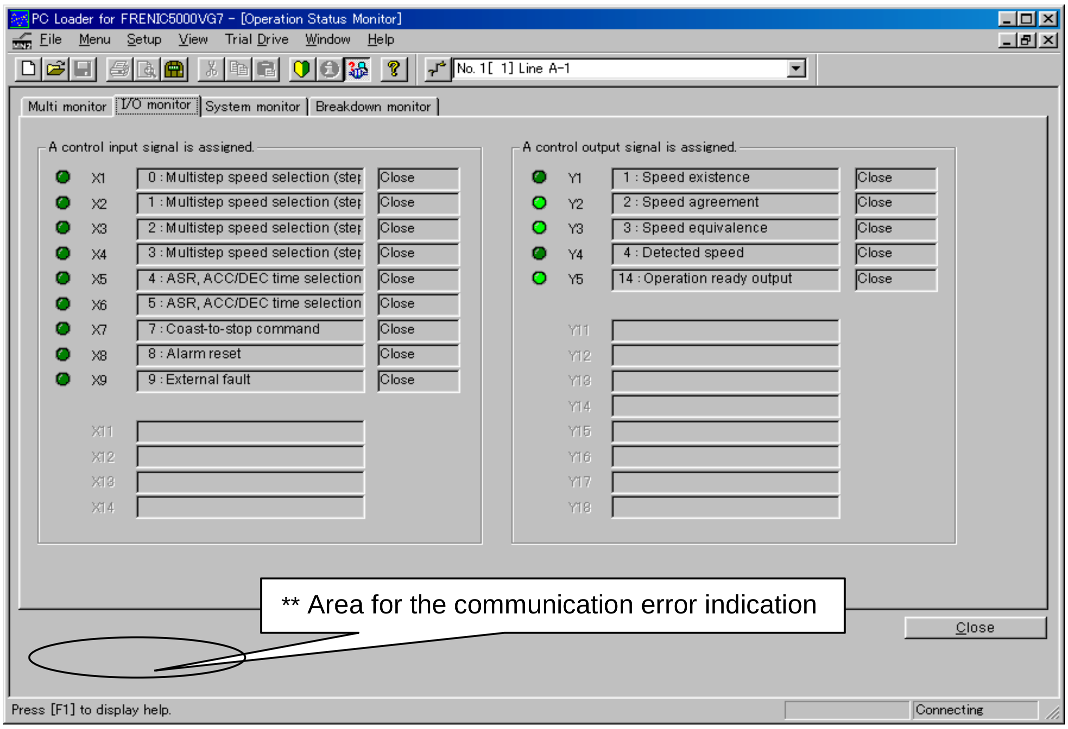



Figure 37 I/O Monitor

1) Status of the input/output control signal

 ON

 OFF

2) Close :Closes the operation monitor.

3) Communication error indication: The message in the following figure will appear if the acquisition of data from the inverter fails.


Figure 38 Communication Error Indication

System monitor and fault monitor will be indicated in the same way.

Note: The input/output control signals which cannot be used due to the option status will be indicated in gray; for example, X11 to X14, Y11 to Y18 in the above figure.

## (3) System monitor

Indicates the system condition of the connected inverter and motor.

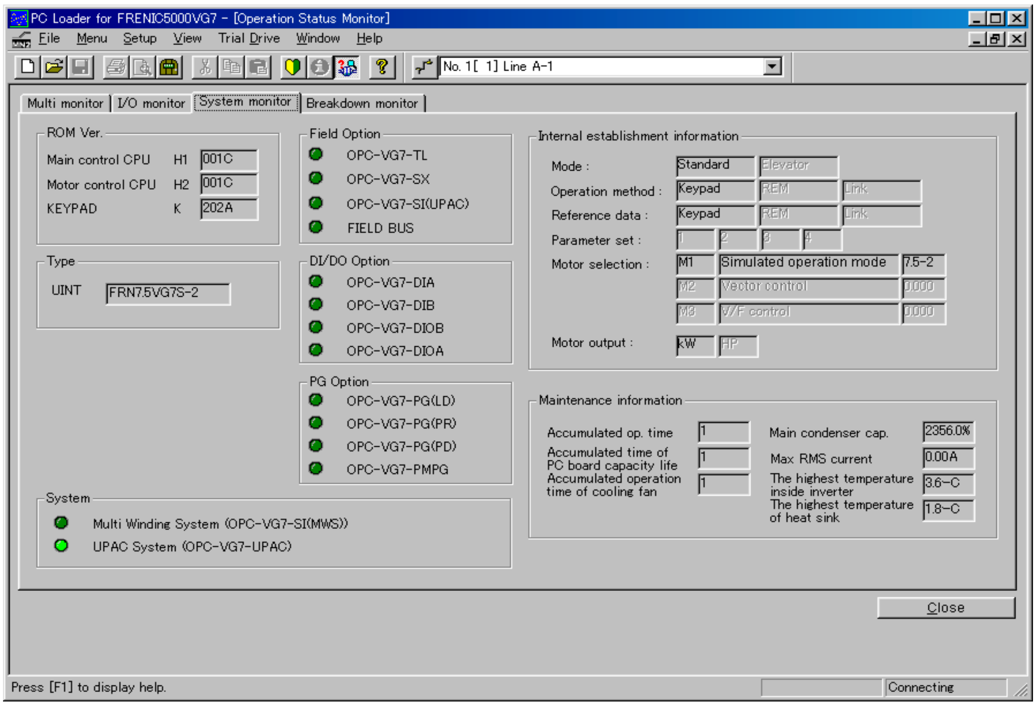



Figure 39 System Monitor

1) Condition of each option

(Green light on) :Loaded

(Green light off) :Not loaded

2) ROM Ver.

Indicates the ROM Ver. (version information of ROM) of two CPUs in the inverter (main control and motor control) and a CPU in KEYPAD panel. In case of the trouble of the inverter, we may sometimes require this ROM Ver. number.

3) Type

Indicates the unit information of the inverter (capacity, voltage).

4) Information of the internal configuration

| | | |
|---|---|---|
| Mode | : | Standard/Lift (function code H70). |
| Operation command | : | Effective input device among KEYPAD (LOC), terminal block (REM), and LINK (Link, COMM). |
| Command data | : | Effective input device among KEYPAD (LOC), terminal block (REMM), and LINK (Link, COMM). |
| Parameter set | : | Acceleration and deceleration time, switching-over status of ASR setup. |
| Motor selection | : | Selection of M1, M2, M3, control status, motor capacity |

5) Maintenance information

Indicates the data for judging the inverter’s life and load information.

6) Close : Closes the operation monitor screen.

(4) Fault Monitor

Indicates the alarms occurring in the connected inverter.

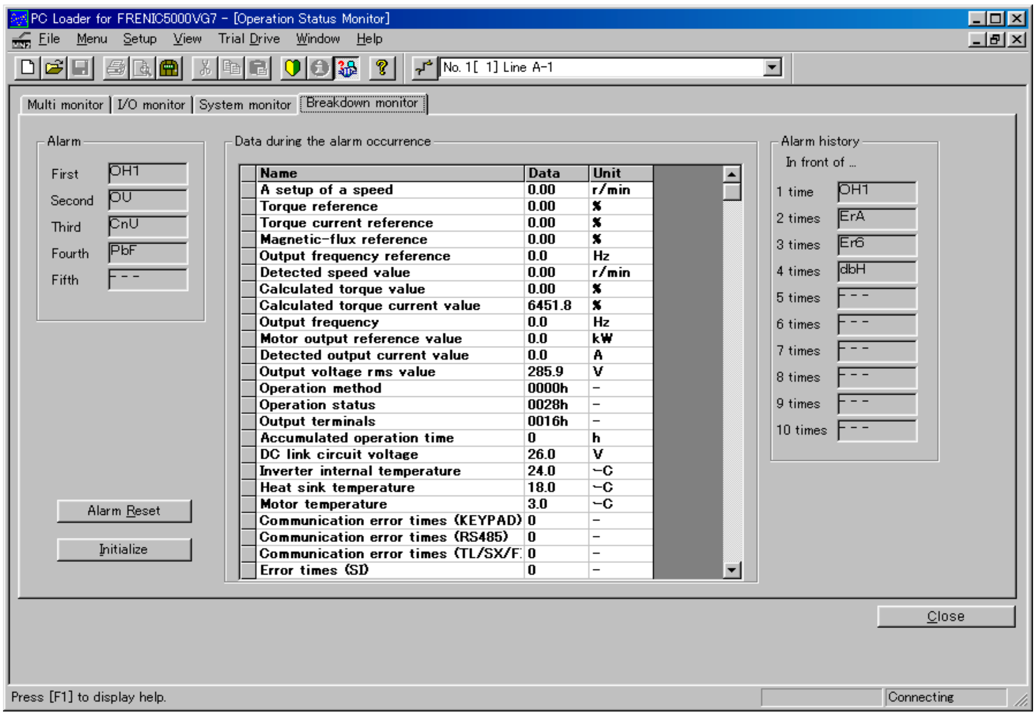



Figure 40 Fault Monitor

1) Alarm reset : Resets the alarm being activated.
2) Initialization of the alarm : Initializes the alarm history.
3) Close : Closes the operation monitor screen.

List of alarm display

| Display | Description | Display | Description | Display | Description |
|---|---|---|---|---|---|
| - - - | No alarm | Er7 | Output wiring error | OH4 | Motor overheat |
| CnU | Converter error | Er8 | A/D converter error | OL1 | Motor overload (M1) |
| dbH | DB resistor overheat | Er9 | Speed disagreement | OL2 | Motor overload (M2) |
| dCF | Fuse Fusion | ErA | UPAC error | OL3 | Motor overload (M3) |
| dO | Excessive position deviation | Erb | High-speed serial communication error | OLU | Inverter overload |
| EF | Ground fault | Lin | Input phase loss, Condenser error | OS | Overspeed |
| Er1 | Memory error | LU | Undervoltage | OU | Overvoltage |
| Er2 | KEYPAD communication error | nrb | NTC thermistor Disconnection | PbF | Charging circuit error |
| Er3 | CPU error | OC | Overcurrent | P9 | PG breakage |
| Er4 | Network error | OH1 | Cooling fin overheat | | |
| Er5 | RS-485 Communication error | OH2 | External alarm | | |
| Er6 | PL error | OH3 | Pt board surrounding temperature overheat | | |

## 6.5.4.6 Historical Real-time Trace

(1) Historical trace

Historical trace indicates the waveform before and after the trigger at the minimum sampling interval of 1ms. (Quantity of the waveform data: 100 points/ch)

The trigger must be always set because the data does not appear without the trigger.

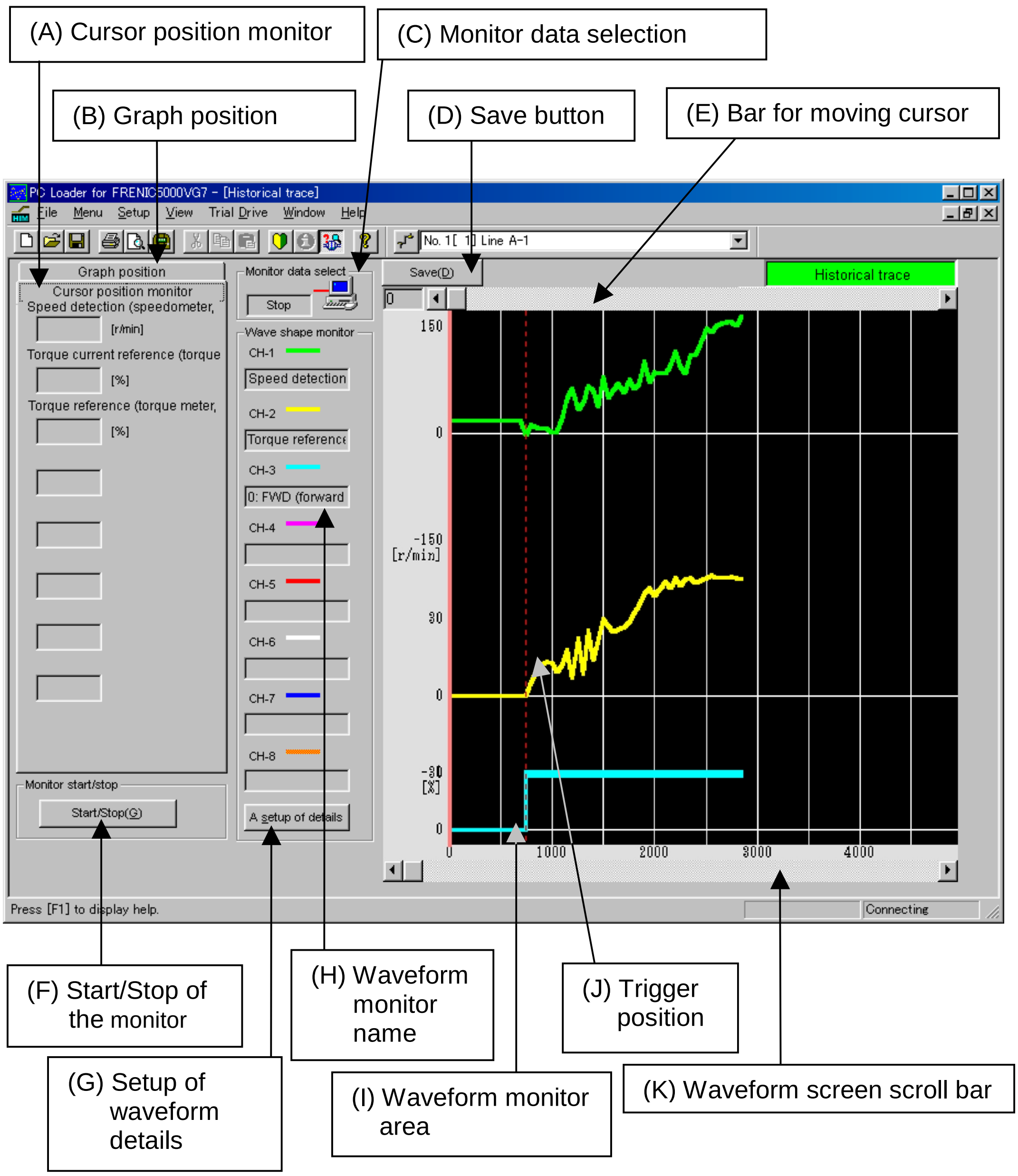



Figure 41 Historical Trace

Note 1: When the historical trace and real-time trace are on the screen, the terminal number cannot be changed.

Note 2: When changing the size of the historical trace screen, the size of the waveform monitor area is also changed.

(A) Cursor position monitor

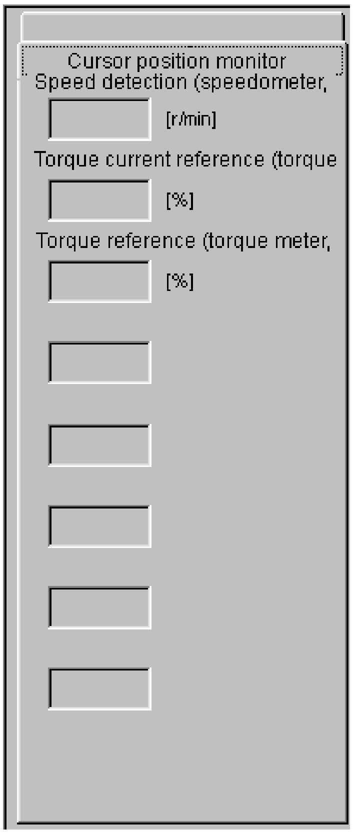



Figure 42 Cursor Position Monitor

The intersection data of the cursor position in the waveform monitor area and waveform are expressed numerically. Cursor position can be moved by (5) Bar for moving cursor.

(B) Graph position adjustment

Set the position where the waveform is indicated in the waveform monitor, amplitude, and time scale of one screen.

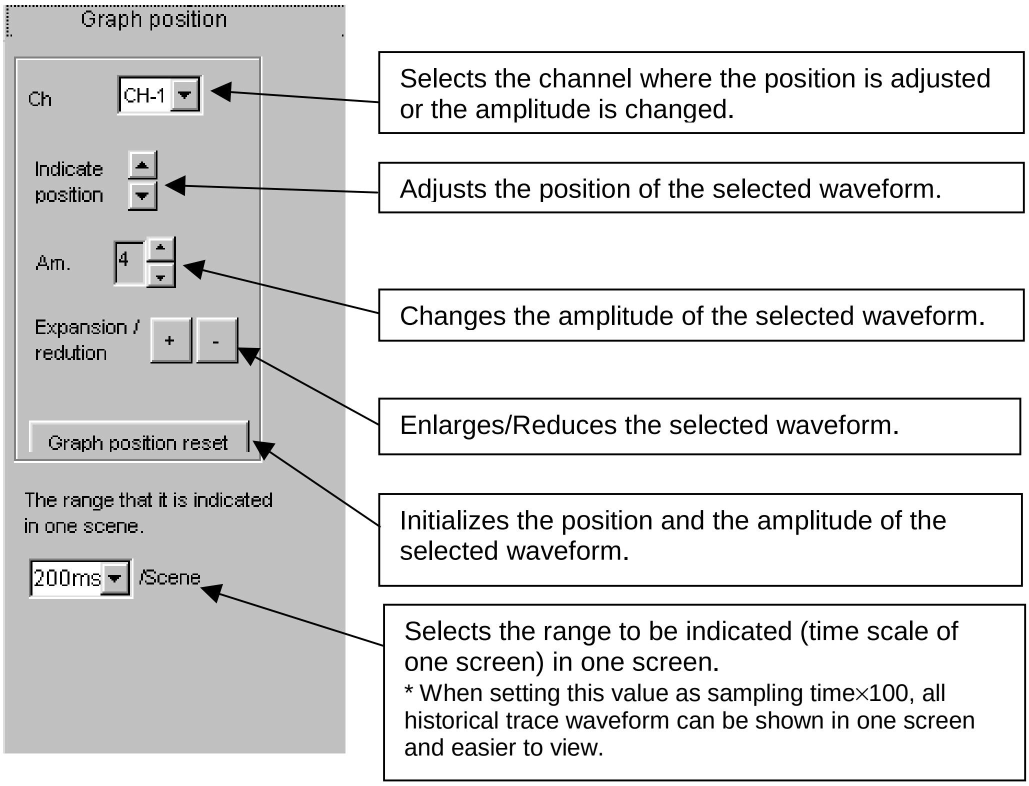
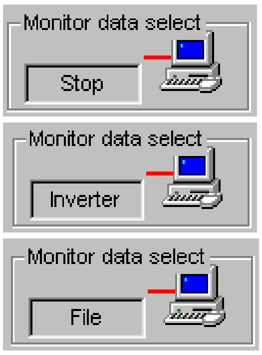



Figure 43 Graph Position Adjustment

(C) Monitor data selection

This window shows the status of the currently displayed waveform.




The indicated waveform is after or before the trace.

The indicated waveform is in trace.

The indicated waveform shows the data of the saved file.

Figure 44 Monitor Data Selection

(D) Save

Saves the traced waveform in the file.

(E) Bar for moving cursor

Moves the position of the cursor of the traced waveform.
The intersection value of the cursor position and the waveform is expressed numerically in (1) Cursor position monitor.

(F) Start/Stop of the monitor

Starts/Stops the historical trace.

(G) Setup of waveform details

1) Setup of the channel composition.

Sets the composition of the waveform to be traced.

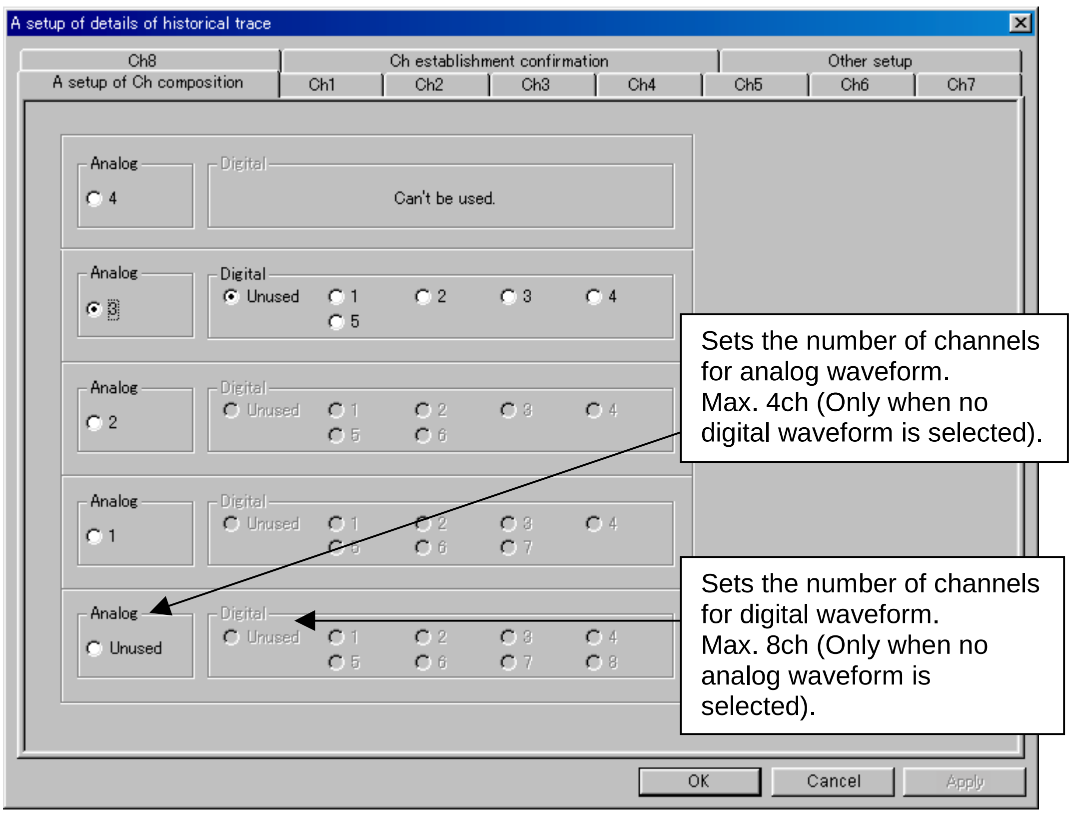



Figure 45 Historical trace - Setup of Waveform Details

2) Setup of analog channel

Selects the analog signal to be traced, and sets the filter and trigger.

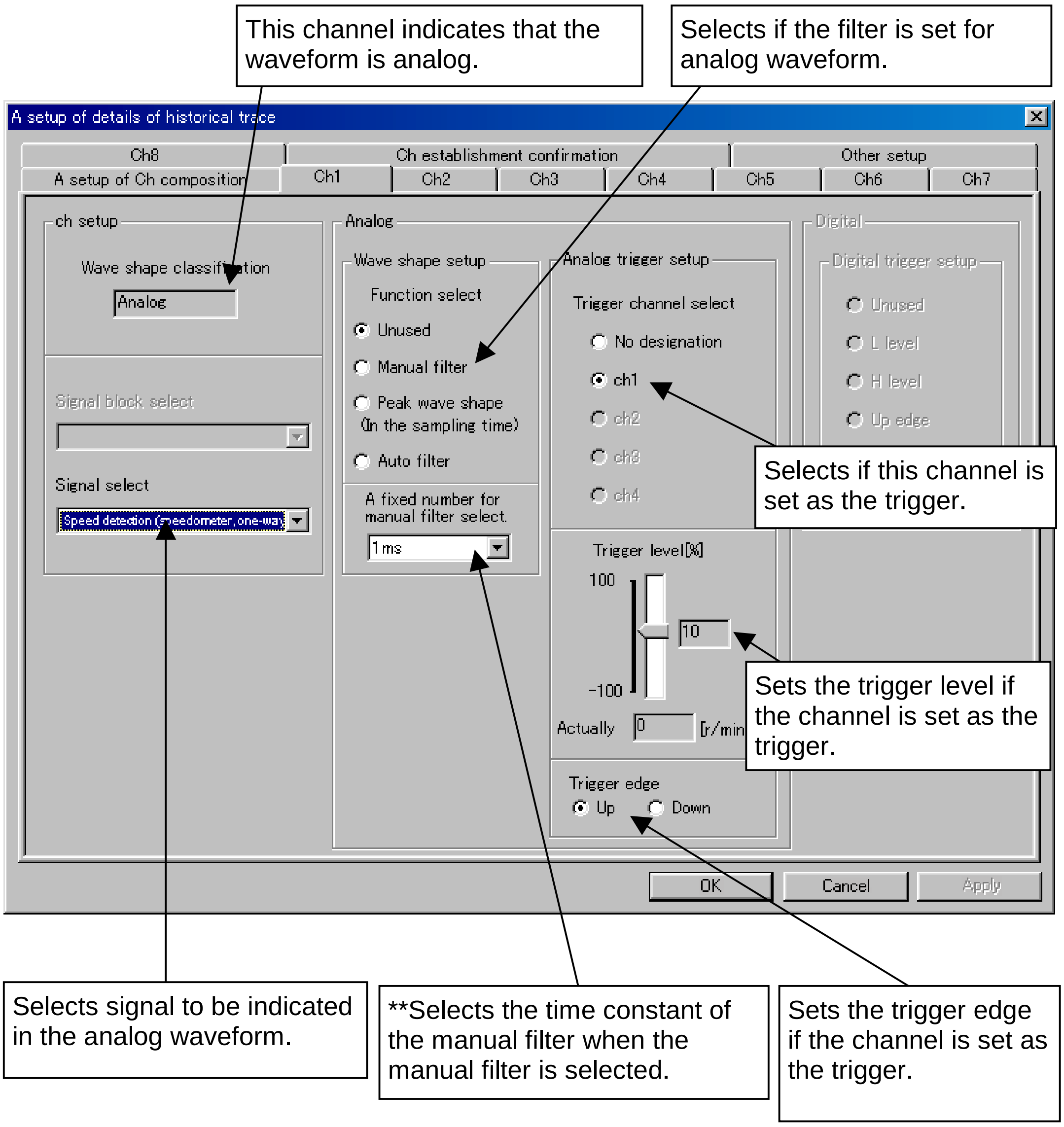
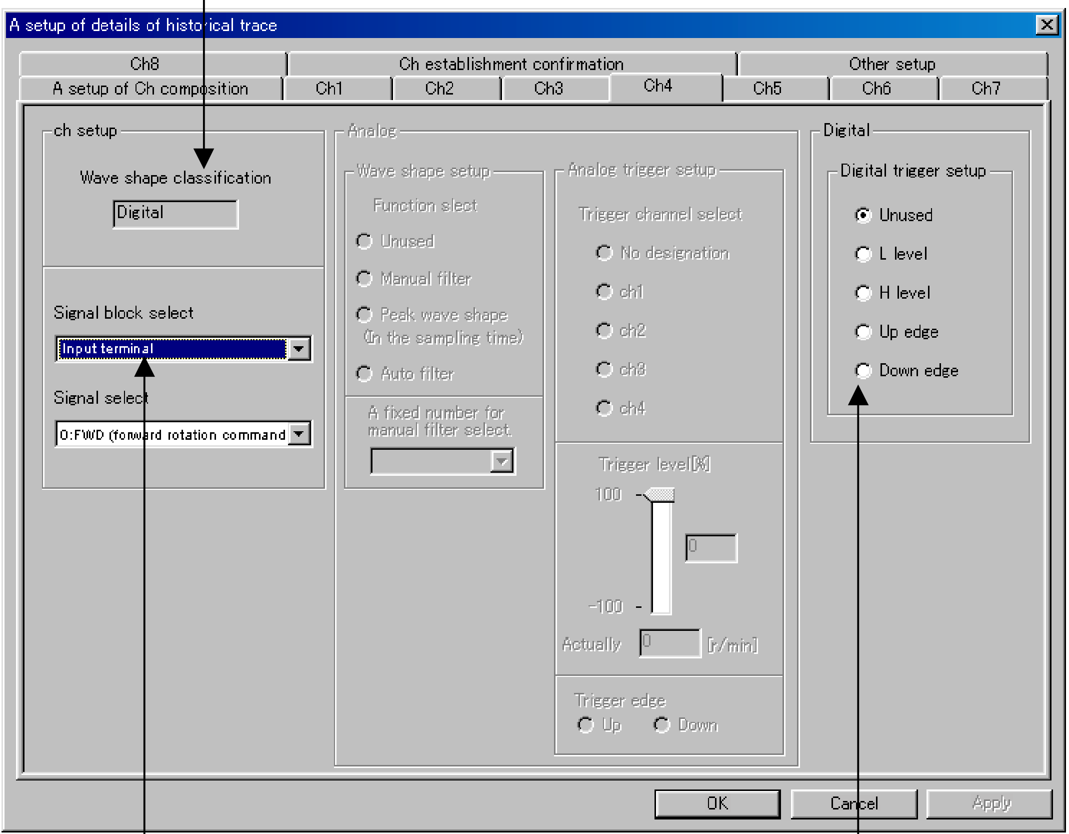



Figure 46 Historical Trace - Analog

3) Setup of digital channel

Selects the digital signal to be traced, and sets the trigger.

This channel indicates that the waveform is digital.




Selects signal to be indicated in the digital waveform.

Selects if this channel is set as the trigger.
Also sets the requirements of the trigger if this channel is set as the trigger.

Figure 47 Historical Trace - Digital

4) Review of the channel settings

The settings of each channel to be traced can be reviewed.

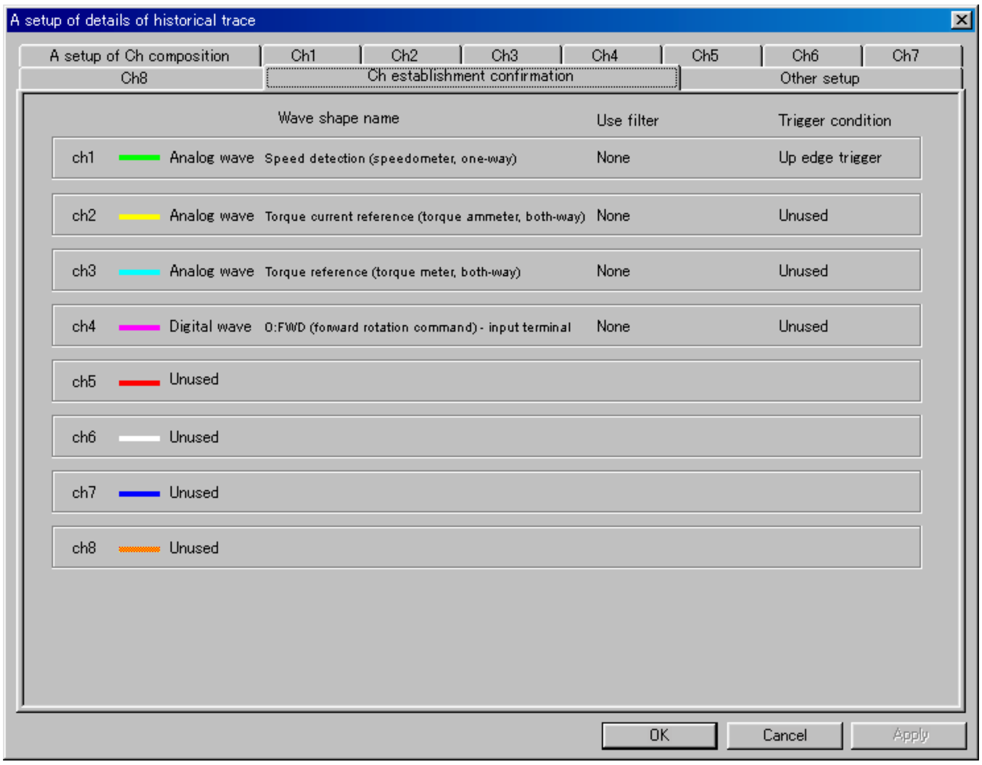



Figure 48 Historical Trace - Review of Channel Setting

5) Other settings

Sets the sampling intervals of the trace and the number of traces from the trigger position.

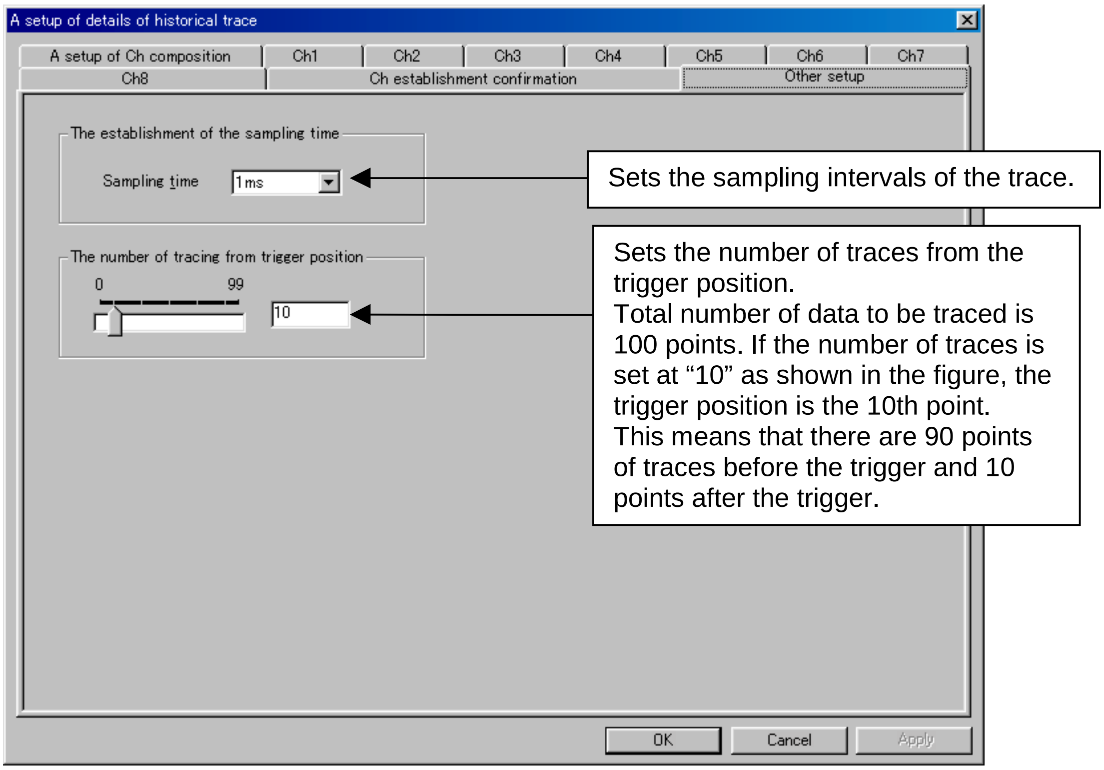



Figure 49 Historical Trace - Other Settings

(H) Waveform monitor name

Indicates the name of the traced waveform of each channel.

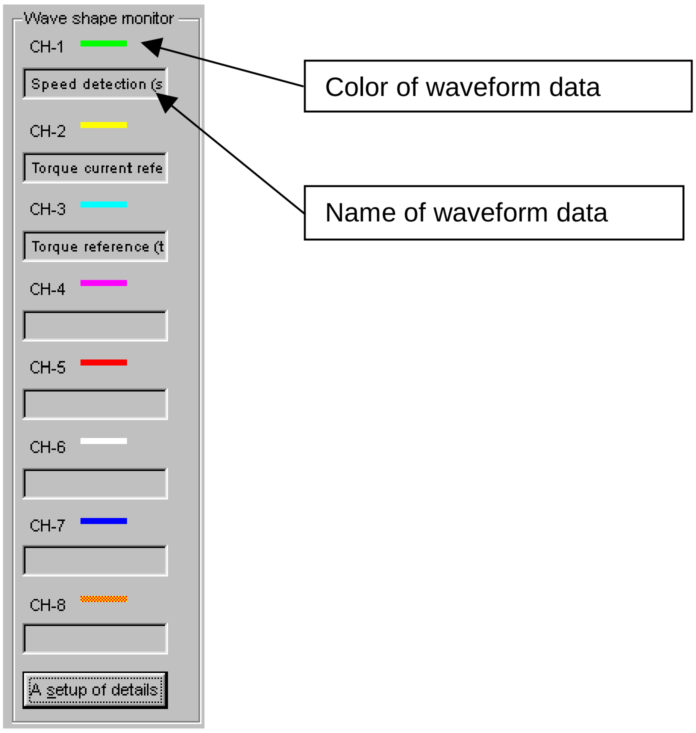
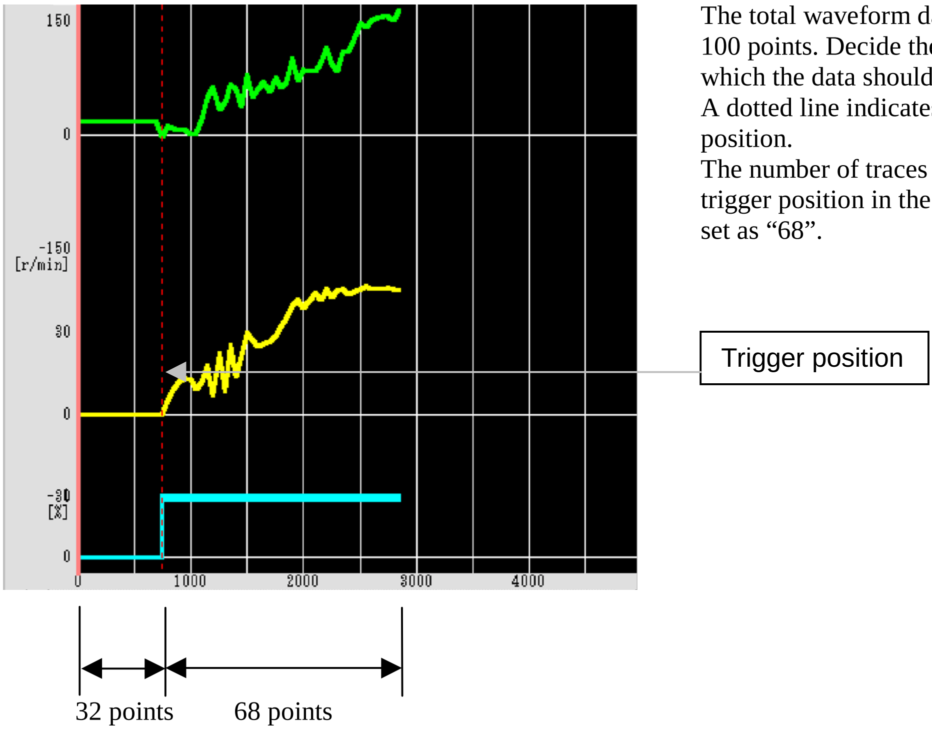



Figure 50 Historical Trace - Waveform Monitor

(I) Waveform monitor area

Shows the traced waveform.

(J) Position of trigger




The total waveform data consists of 100 points. Decide the points from which the data should be acquired. A dotted line indicates the trigger position.
The number of traces from the trigger position in the left figure is set as “68”.

Figure 51 Historical Trace - Position of Trigger

(K) Waveform screen scroll bar

Scrolls the waveform screen.
You can check before and after the currently indicated screen by scrolling.

(L) Print

Printing is executed when selecting “Print” from the menu.
“Print Preview” in the menu shows the image of print

(2) Real-time trace

Real-time trace realizes the continuous waveform measurement at the minimum sampling intervals of 10ms. (Total quantity of waveform data: approx. 30000 points/1ch)

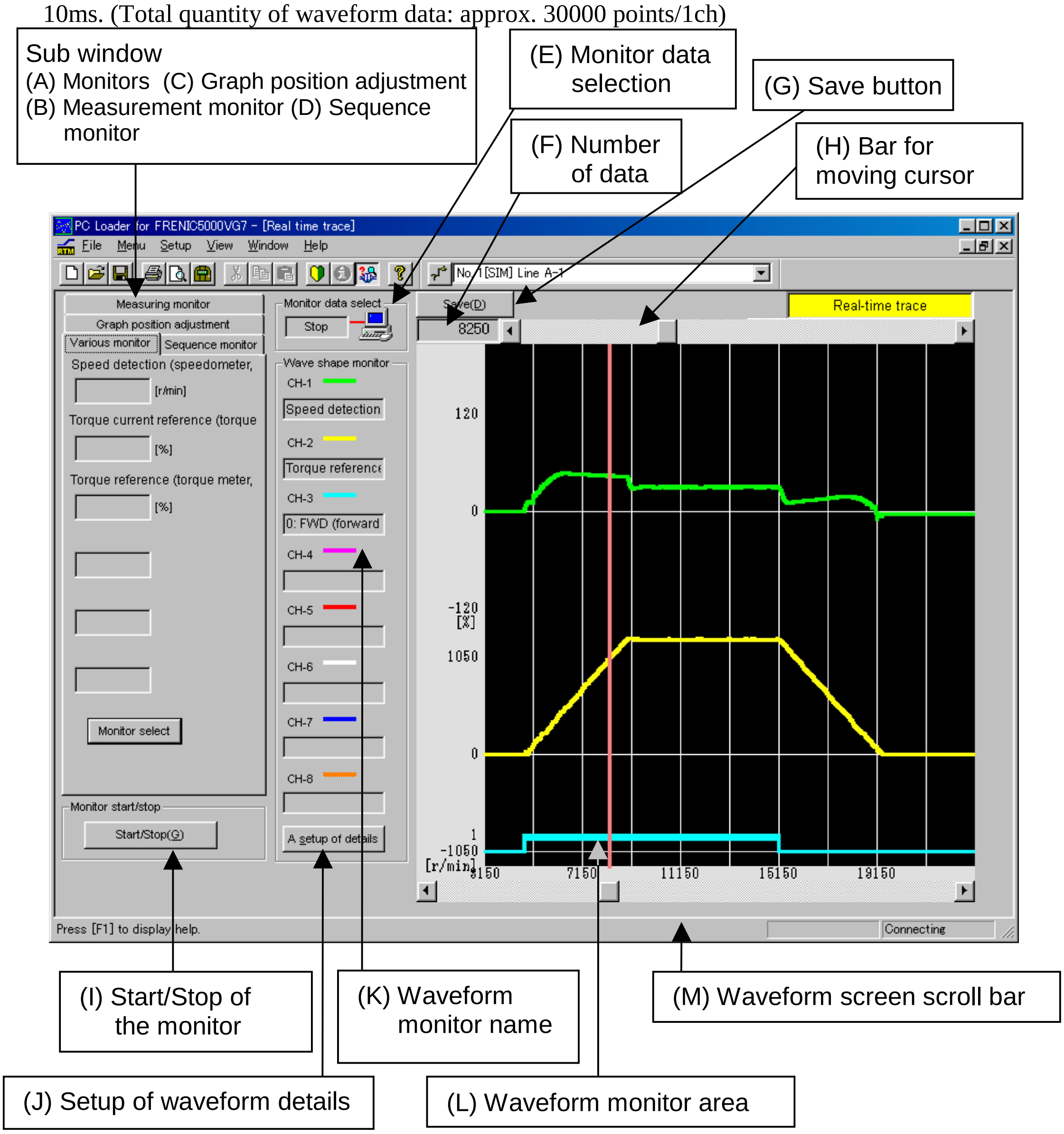



Figure 52 Real-time Trace

Note 1: The real-time trace screen and the trial operation screen cannot be opened at the same time. Choose either one.

Note 2: When the historical trace and real-time trace are on the screen, the terminal number cannot be changed.

Note 3: When the size of the real-time trace screen is changed, the size of waveform monitor area is also changed.

1) Tracing time

The real-time trace data totals approx. 30,000 points. If the sampling interval is set to 10ms, the tracing is possible for five minutes (30,000×10ms=300s=5 min.). If the tracing time exceeds five minutes, the older data will disappear in due order. This means the data taken for the latest five minutes is always kept.

(A) Monitors

The data selected in the “Monitor selection” are expressed numerically, separately from the traced waveform data.

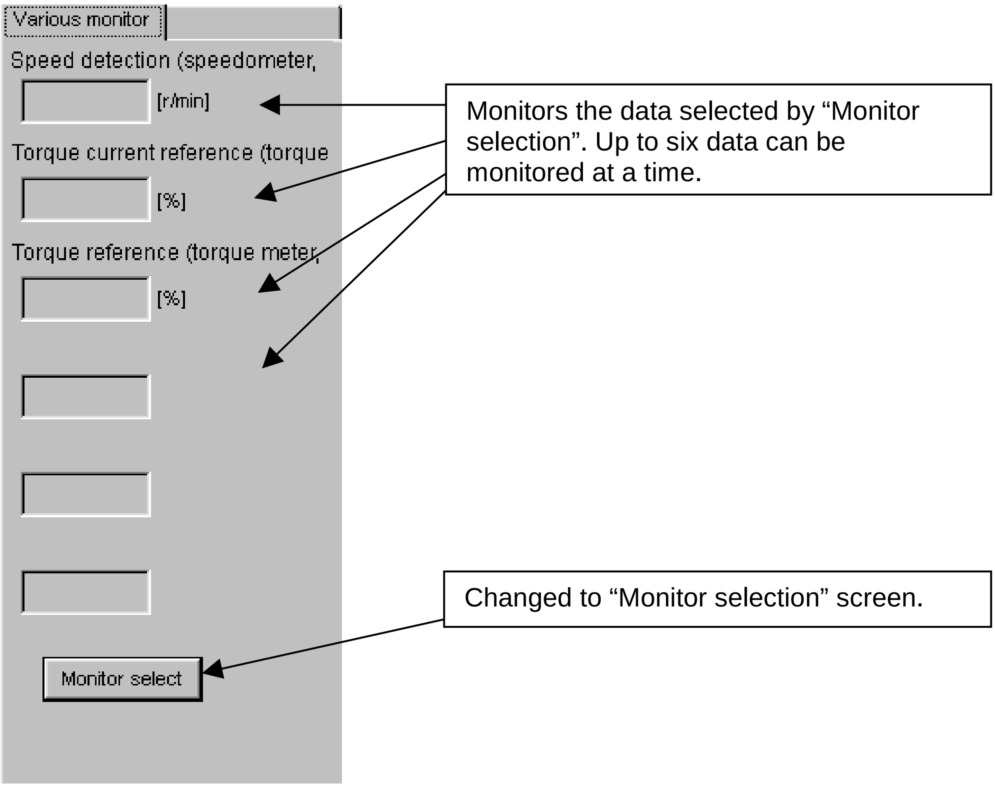



Figure 53  Real-time Trace - Monitors

1) In the “Monitor selection” screen, the data to be indicated in “Monitors” can be selected.

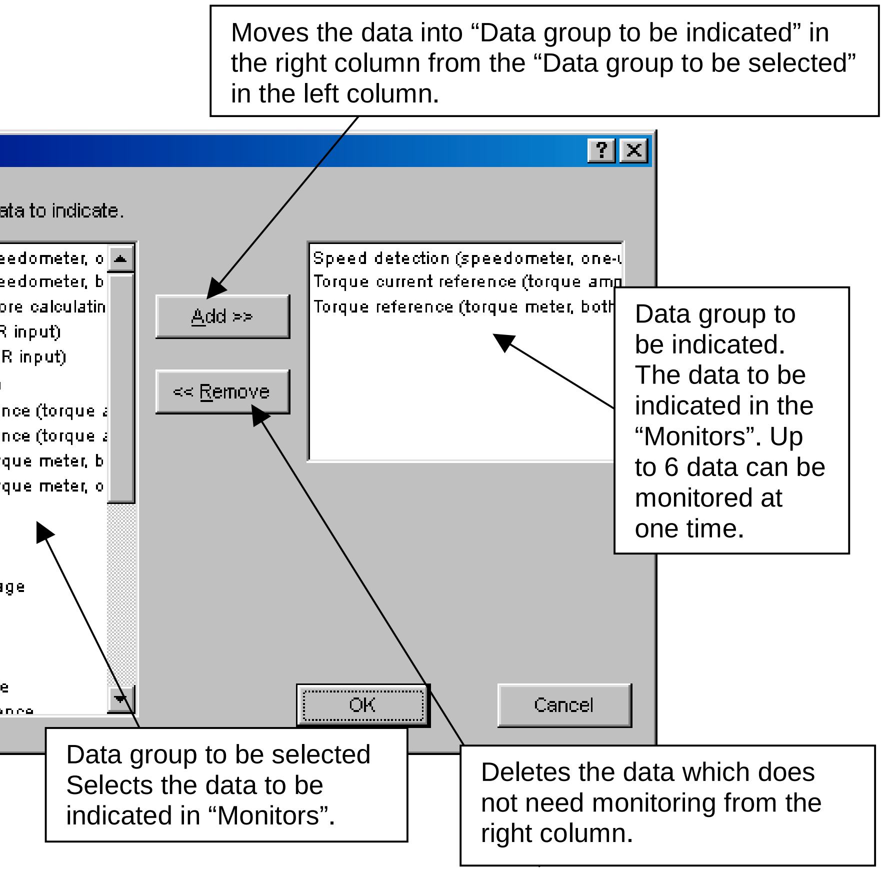
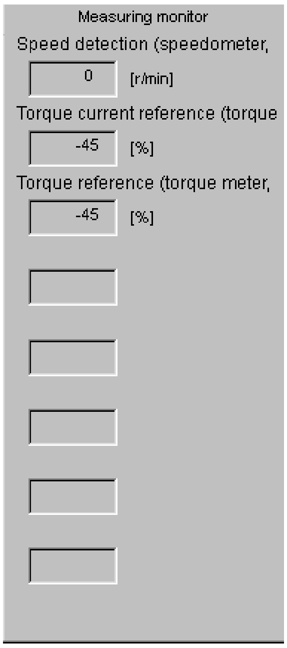



Figure 54
Monitor Selection

(B) Measurement monitor




The intersection value of the cursor position in the waveform monitor area and the waveform are expressed numerically. Cursor position can be changed by (H) Bar for moving cursor.

Figure 55 Measurement Monitor

(C) Graph position adjustment

Set the position where the waveform is indicated in the waveform monitor, amplitude, and time scale of one screen.

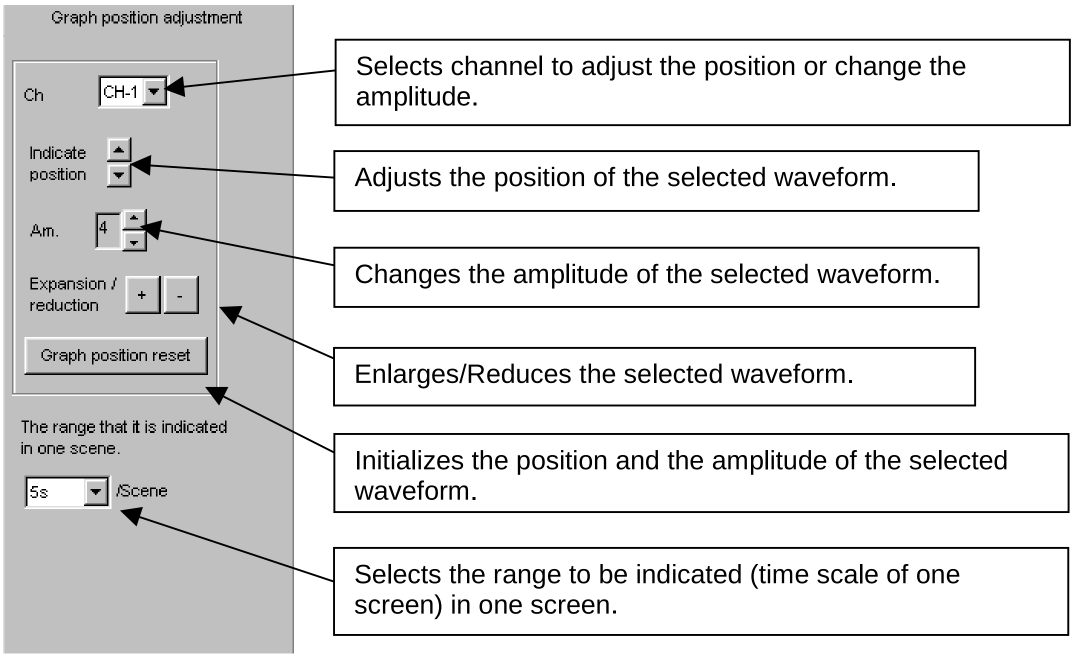



Figure 56 Graph Position Adjustment

(D) Sequence monitor

Indicates the sequence mode of the connected amplifier.

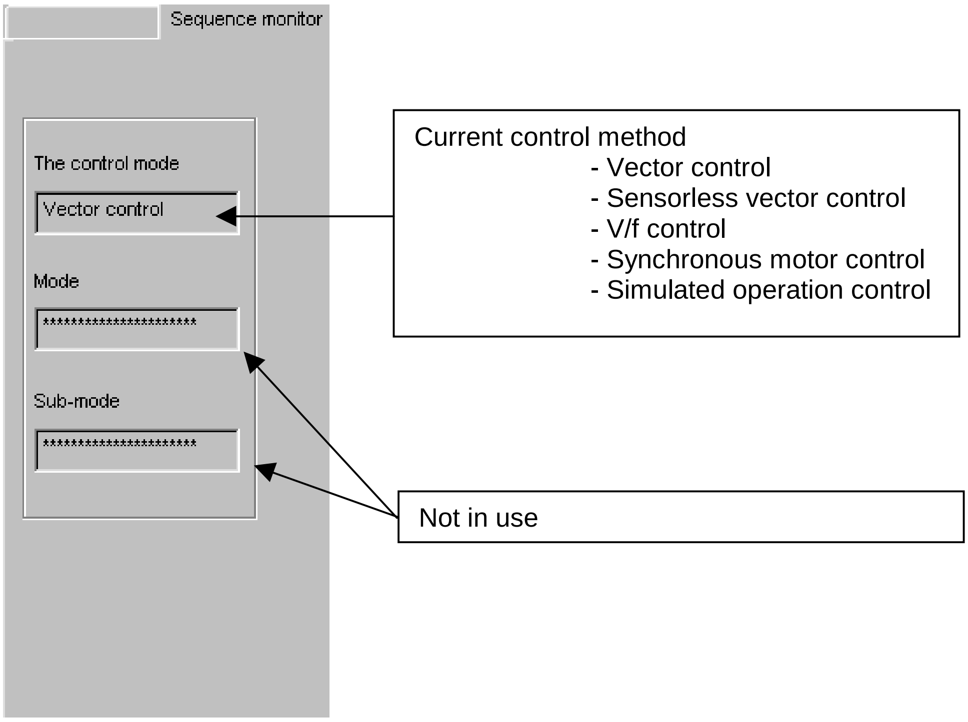
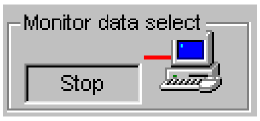


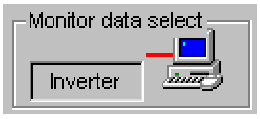

Figure 57  Sequence Monitor

(E) Monitor data selection

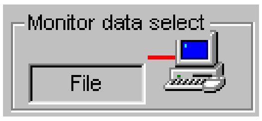
This window shows the status of currently indicated waveform.




The indicated waveform is after or before the trace.




The indicated waveform is in trace.




The indicated waveform shows the data of the saved file.

Figure 58   Monitor Data Selection

(F) Number of data

Indicates the number of traced data per channel.

(G) Save button

Saves the traced waveform in the file.

(H) Bar for moving cursor

Moves the position of the cursor of the traced waveform.

The intersection value of the cursor position and the waveform is indicated numerically in (a) Cursor position monitor.

(I) Start/Stop of the monitor

Starts/Stops the real-time trace.

(J) Setup of waveform details

Sets the details of the waveform to be traced.
Refer to "1) Historical trace (g) Setup of waveform details" for the details.

(K) Waveform monitor name

Indicates the name of the traced waveform of each channel.

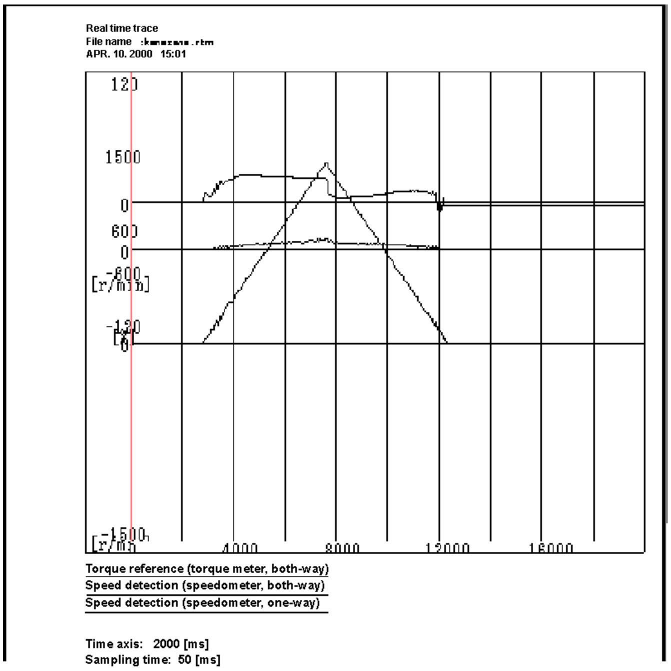
(L) Waveform monitor area

Shows the traced waveform.

(M) Waveform screen scroll bar

Scrolls the waveform screen.

(N) Print




Printing is executed when.
Printing is executed when selecting "Print" from the menu.
"Print Preview" in the menu show the image of print.

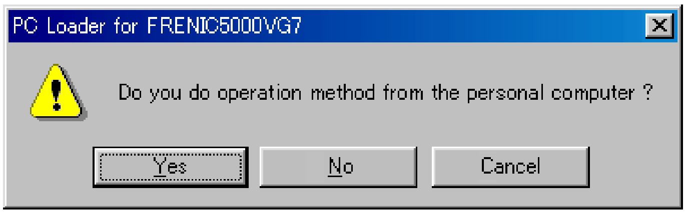
Figure 59 Print

## 6.5.4.7 Operation Procedure

When the “Trial operation ” in the menu bar is clicked, operation procedure for the connected inverter will be executed.

Note: **A motor actually rotates.**

When the test operation is selected, the following message window will appear.




If “Yes” is selected, the operation procedure of the trial operation will become effective.

If “No” is selected, the operation procedure of the trial operation will not be available.

Figure 60 Message Window for Selecting Operation Mode

Note 1: The real-time trace screen and the trial operation screen cannot be opened at the same time. Choose either one.

Note 2: When the tool bar for the trial operation is already shown, the message window for selecting the operation mode will not appear. In this case, the operation procedure will become effective.

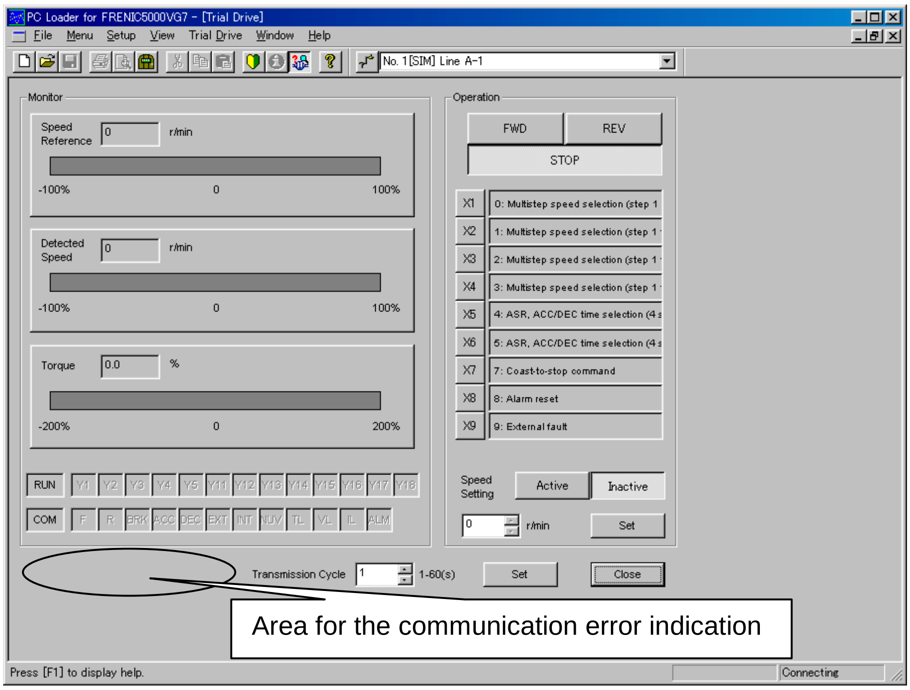



Figure 61 Trial Operation Screen

1) Speed command : Set the data in the range from–max. speed to+max. speed in r/min.
Click the “Reload” button to make the newly set value effective.

2) Transmission cycle : Set the data in the range from 1 to 60s.
Data is acquired and commands are transmitted to the inverter at the intervals set at the transmission cycle.
Click the “Reload” button to make the newly set value effective.

3) Close : Closes the trial operation.

4) Communication error indication: If the PC failed to acquire the inverter data, the following message will appear.


Figure 62  Communication Error Message

5) COM (Operation status) : If the inverter is under the following status, the corresponding symbol is displayed in black with the irrelevant symbols displayed in gray.

| | | |
|---|---|---|
| F | : | Motor is rotating in forward direction. |
| R | : | Motor is rotating in reverse direction. |
| BRK | : | Brake is being applied. |
| ACC | : | Motor speed is accelerated. |
| DEC | : | Motor speed is decelerated. |
| EXT | : | DC injection braking or pre-exciting |
| INT | : | Inverter is shut-off. |
| NUV | : | DC link voltage has been established. |
| TL | : | Torque is being limited. |
| VL | : | Voltage is being limited. |
| IL | : | Current is being limited. |
| ALM | : | Alarm output |

THE INVERTER

# Ⅶ. Control Options

# 7. Control Options

## 7.1 T-Link Interface Card

### 7.1.1 Product Guide

#### 7.1.1.1 Product Overview

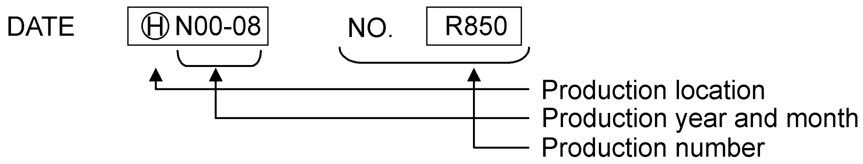
This product is an option for the vector control inverter FRENIC5000VG7S and links the FUJI programmable logic controller MICREX-F series and the inverter through the T-Link. The MICREX-F series PLC allows you to operate the inverter automatically and to monitor the inverter. You can also use the MICREX-F series PLC to change and monitor the setting of function codes required for the operation.

#### 7.1.1.2 Product Guarantee

The period of product guarantee is either twelve months after your purchase or eighteen months after production that comes first.
Note that the following cases will void the product guarantee.

- Improper operations, repairs or modifications
- Operation out of the standard specifications
- Drops or damages during transportation after your purchase
- Earthquakes, fires, winds, floods, lightning, abnormal voltages, and other natural disasters, or secondary disasters.

Production date and production number (displayed on the product)




#### 7.1.1.3 Standard Specifications

Table 1

| Item | | Specification |
|---|---|---|
| Name | | T-Link interface card |
| Type | | OPC-VG7-TL |
| Transmission type | | T-Link slave I/O transmission |
| Number of words to be occupied for transmission | | Use the function code o32 to select total of 16 words (MICREX to inverter: eight words, inverter to MICREX: eight words), or total of eight words (MICREX to inverter: four words, inverter to MICREX: four words) |
| Operation | Operation command | Forward/reverse command, alarm reset command, X1 to X14 commands |
| | Speed reference | Setting resolution: 0.005% |
| | Operation status output | Status such as running, braking, torque limiting, alarm relay signal, remote/local |
| | | Data displayed on the KEYPAD panel LED, such as motor speed reference, torque current reference and digital input/output information |
| Function code | | You can refer to or change only functions assigned to the link number in the "Function Code List" |
| Function codes for this option | | o30, o31, o32 (Displayed on the KEYPAD panel when the T-Link card is installed) |
| Protective function | | Er4: Communication error (Where option fails or inverter assumes communication with MICREX-F is disabled) |

# 7.1.2 Connections

## 7.1.2.1 Terminal Function Description

(1) Terminal Arrangement

| Terminal TB11 | T1 | T2 | SD |
|---|---|---|---|

(2) Terminal Description

Table 2

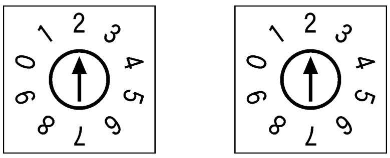
| Terminal symbol | Name | Description |
|---|---|---|
| T1<br>T2<br>SD<br>(Shield) | T-Link cable connection terminals | For T-Link cable connection |

Note: All terminals are open on delivery.

## 7.1.2.2 Switch Description

(1) Rotary Switches

Use rotary switch RSW1 and RSW2 to specify station number (address).




RSW1 0～9    RSW2 0～9

RSW1: Upper digit (×10)
RSW2: Lower digit (×1)

Note 1: Specify a unique address when you use multiple units.
Note 2: The factory setting is RSW1=0, and RSW2=0 (station number=00).

## 7.1.2.3 Basic Wiring Diagram

The figure below shows a basic wiring diagram. Follow the descriptions below when you conduct wiring work.

[Notes for Wiring]

(1) Use the following specified cables for the T-Link.
- Twisted pair cable from Furukawa Electric
  CPEV-SB ϕ0.9×one pair
- Twisted pair cable from Furukawa Electric
  KPEV-SB 0.5mm$^2$×one pair

Refer to the relevant literature of the MICREX for the specifications of the cables above.

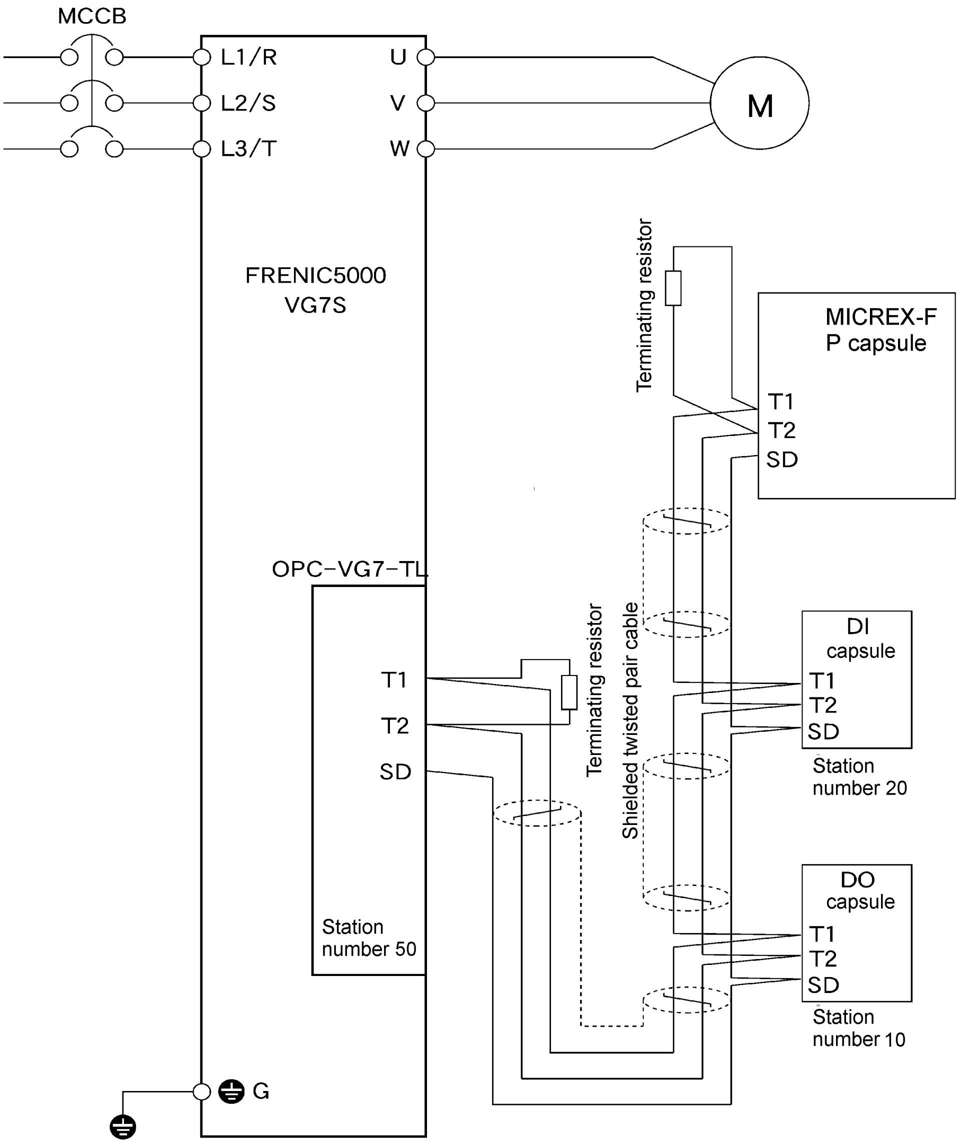
(2) Attach 100Ω terminating resistors provided with the P capsule on the both ends of the T-Link.

(3) Connect the T-Link cable without forming branches as described in the figure (form "daisy chain"). You cannot transmit data properly through a branched Link.

(4) Place cables for the T-Link as far as possible (30cm or more) from the main circuit wiring or other power lines to prevent malfunctions due to noises. Never install the T-Link and the main circuit wiring or other power lines in the same ducts.

[Example of Basic Wiring]

(This figure describes the only optional part. See other sections in this document or the instruction manual for the wiring of the FRENIC5000VG7S main unit.)



## 7.1.3 Function Codes for this Option

| Function code | Function | Data | Description |
|---|---|---|---|
| o30 | Action selection on communication error | 0 | Forced to stop immediately after a communication error occurs (Er4 trip: coast-to-stop) |
| | | 1 | After a communication error, continues operating for a period specified by the timer (Holding the last operation command directed through communication in the communication error state). Forced to stop after the timer expires (Er4 trip: coast-to-stop). Follows the command directed through communication if the communication recovers during the timer operation. Even then, forced to stop after the timer expires. |
| | | 2 | After a communication error, continues operating for a period specified by the timer (Holding the last operation command directed through communication in the communication error state). Forced to stop after the timer expires (Er4 trip: coast-to-stop) if the communication has not recovered. Returns to the normal operation if the communication recovers during the timer operation. |
| | | 3 | An alarm (Er4) is not issued on a communication error. Holding the last operation command directed through communication in the communication error state. |
| o31 | Action time on communication error | 00 to 20.0 | Timer for the operation period after a communication error. Effective when o10=1, 2 |
| o32 | Communication format | 0 | Format 1 (Standard format, 4W+4W) |
| | | 1 | Format 2 (8W+8W) |

- Use the [RST] terminal and the [RESET] key or a reset signal from MICREX-F or SX to reset Er4 after the cause of a communication error has been removed.
- The following conditions are considered as errors.

1) T-Link configuration error (redundant addresses, disconnection, no power supply to MICREX-F or SX)
2) Checksum error due to noise

- 0 is set to all function codes as a factory setting.
- Refer to the link numbers in the "Function Code List" for function codes available for access.

### 7.1.3 1 About o32

This function code allows you to select either of the following two communication formats.

1) o32=0: (Format 1, standard format, 4W+4W are occupied)
2) o32=1: (Format 2, 8W+8W words are occupied)

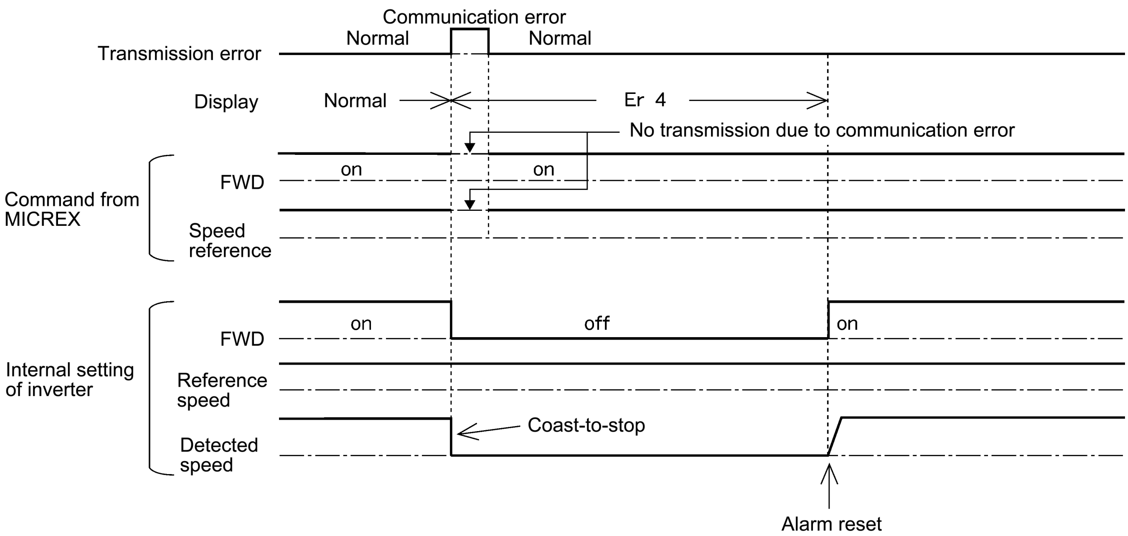
Control Options

## 7.1.3.2 About o30 and o31

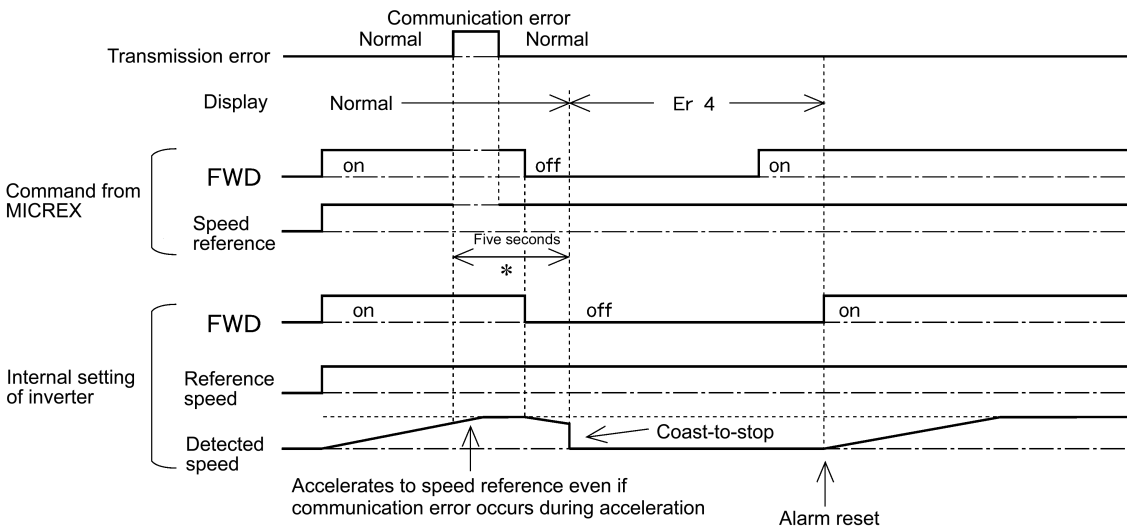
[Operation Description]
The following example shows an operation where MICREX-F or SX directs a FWD command and a communication error occurs during communication.

Note: The inverter holds the last command (operation command, speed reference or both) directed through the communication in this period if the inverter does not receives a new command or a specification after the communication recovers.

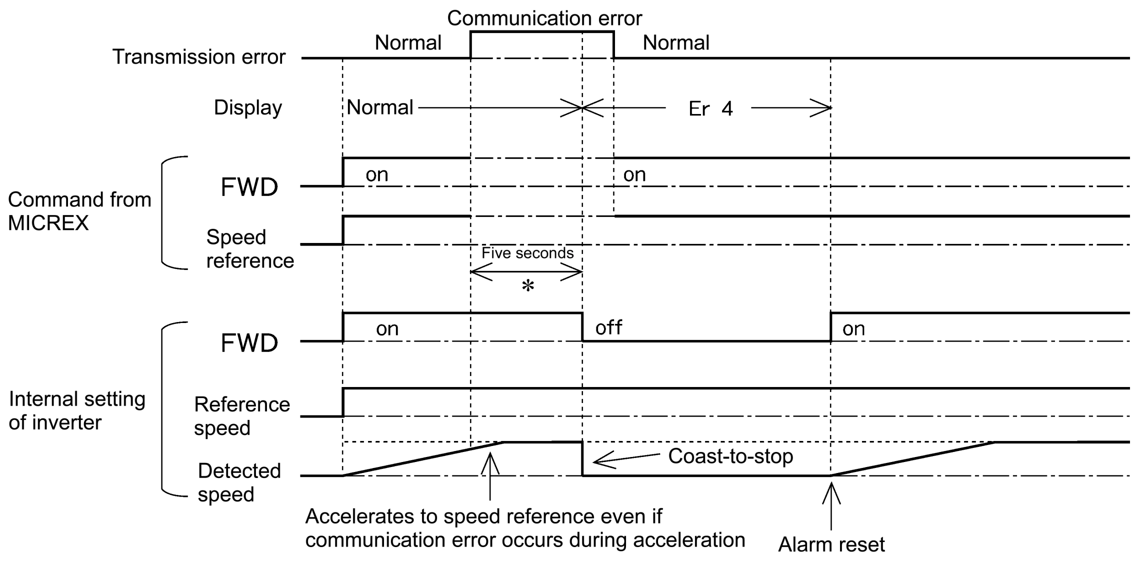
(1) o30=0



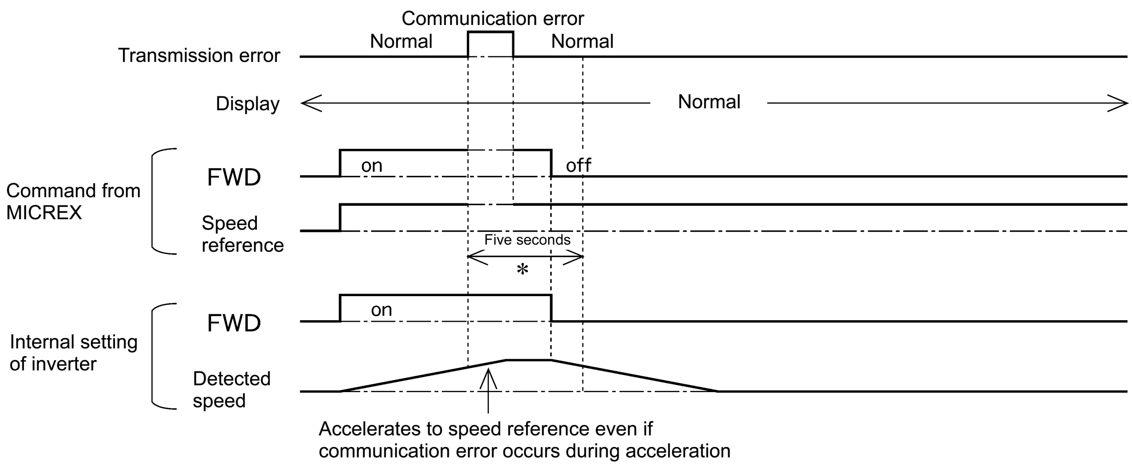

(2) o30=1, o31=5.0 (the mode to stop the inverter for five seconds after a communication error)



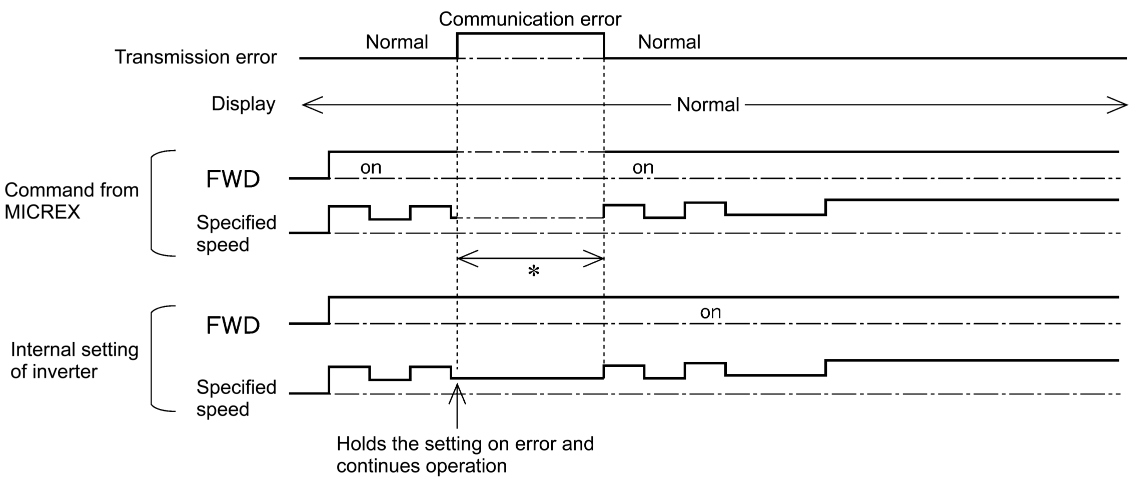
(3) o30=2, o31=5.0 (the communication does not recover from a communication error in five seconds and trips on Er4)




(4) o30=2, o31=5.0 (the communication recovers from a communication error in five seconds)




(5) o30=3

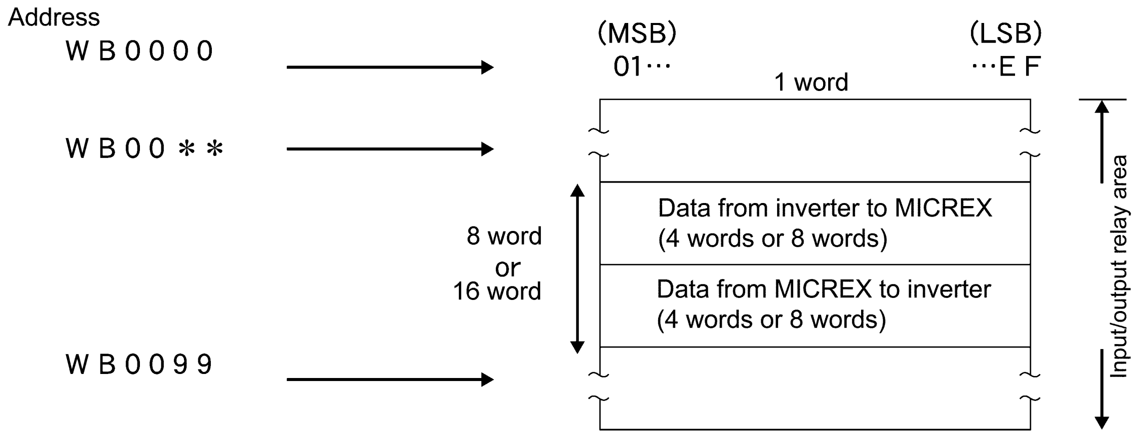



Control Options

## 7.1.4 Used Area and Addresses for Assigning Data

### 7.1.4.1 Used Area

One inverter uses consecutive eight words or sixteen words in the input/output relay area. You can use the dip switch RSW1 and RSW2 on the option card to set the lowest two digits of the address (WB00**in the figure).




### 7.1.4.2 Addresses for Assigning Data

(1) Format 1 (standard format 4W+4W)

| Upper address | Offset | (MSB) 01··· 7 | 8 ···EF (LSB) | Direction |
|---|---|---|---|---|
| WB00** | +0 | Operation status (M14) | | INV ⇓ MICREX |
| WB00** | +1 | Detected speed (M06) | | |
| WB00** | +2 | Address for polled function code | Blank (fixed to 0) | |
| WB00** | +3 | Data for polled function code | | |
| WB00** | +4 | Operation command, Di, RESET input (S06) | | MICREX ⇓ INV |
| WB00** | +5 | Speed reference (S01) | | |
| WB00** | +6 | Address for function code to select | Address for function code to poll | |
| WB00** | +7 | Data for function code to select | | |

(2) Format 2 (8W+8W)

| Upper address | Offset | (MSB) 01… 7 | 8 …EF (LSB) | |
|---|---|---|---|---|
| WB00** | +0 | Address for polled function code (1) | Address for polled function code (2) | INV ⇓ MICREX |
| WB00** | +1 | Address for polled function code (3) | Address for polled function code (4) | |
| WB00** | +2 | Data for polled function code (1) | | |
| WB00** | +3 | Data for polled function code (2) | | |
| WB00** | +4 | Data for polled function code (3) | | |
| WB00** | +5 | Data for polled function code (4) | | |
| WB00** | +6 | Detected speed (M4) | | |
| WB00** | +7 | Operation status (M06) | | |
| WB00** | +8 | Address for function code to select (1) | Address for function code to select (2) | MICREX ⇓ INV |
| WB00** | +9 | Address for function code to select (3) | Address for function code to select (4) | |
| WB00** | +10 | Data for function code to select (1) | | |
| WB00** | +11 | Data for function code to select (2) | | |
| WB00** | +12 | Data for function code to select (3) | | |
| WB00** | +13 | Data for function code to select (4) | | |
| WB00** | +14 | Address for function code to poll (1) | Address for function code to poll (2) | |
| WB00** | +15 | Address for function code to poll (3) | Address for function code to poll (4) | |

## 7.1.5 Link Function

You can use the function code H30 and the X function "24: Operation selection through link [LE]" together to switch the sources (REM/LOC or COM) of reference data (S area). See also "4.2 Control Block Diagrams" for better understanding.
You can combine the function code H29 and the X function "23: Write enable through link [WE-LK]" to control write to the function codes (F, E, C, P, H, A, o, L, U) through the link. See also "4.2 Control Block Diagrams" for better understanding.

### 7.1.5.1 Enabling Link Operation

(1) Switching to Link
You can assign "24: Operation selection through link [LE]" to an X function input terminal to change the mode as follows.

| Signal of "Operation selection through link" | Input to terminal | State |
|---|---|---|
| Not assigned | - | "Operation through link enabled" mode |
| Assigned | ON | |
| | OFF | "Operation through link disabled" mode |

Though you can write reference data and operation commands through the link in the "Operation through link disabled" mode, the data are not reflected. You can store data in the "Operation through link disabled" mode and switch to the "Operation through link enabled" mode to reflect the data.

(2) Writing through Link
In the "Operation through link enabled" mode, you can use the function code H30 (Serial link) to switch the source of the operation command and reference data between the link (COM) and the remote/local. The remote and local means REM (terminal block; External signal) and LOC (KEYPAD panel) respectively.

| H30 setting | Operation through link enabled | | Operation through link disabled |
|---|---|---|---|
| | Reference data (S01 to S05, S08 to S12) | Operation command (FWD, REV) | |
| 0 | Link disabled (REM/LOC) | Link disabled (REM/LOC) | Link disabled (REM/LOC) |
| 1 | Link enabled (COM) | Link disabled (REM/LOC) | |
| 2 | Link disabled (REM/LOC) | Link enabled (COM) | |
| 3 | Link enabled (COM) | Link enabled (COM) | |

This function enables you to construct a flexible system where you can apply an operation command from the terminal block and apply a speed reference from the RS485.

### 7.1.5.2 Enabling Writing through Link

(1) Switching to writing through link
You can assign "23: Write enable through link [WE-LK]" to an X function input terminal to write in the function codes (F, E, C, P, H, A, o, L, and U).

| Signal of "Write enable through link" | Input to terminal | State |
|---|---|---|
| Not assigned | - | "Write through link enabled" mode (Writing enabled to F to U) |
| Assigned | ON | |
| | OFF | "Write through link disabled" mode (Writing disabled to F to U) |

(2) Writing through link
In "Write through link" enabled mode, you can use the function code H29 (Link function protection) to control to write to the function codes (F, E, C, P, H, A, o, L, and U).

| H29 setting | "Write through link enabled" mode | "Write through link disabled" mode |
|---|---|---|
| 0 | Codes (F, E, C, P, H, A, o, L, U) write-protected | Codes (F, E, C, P, H, A, o, L, U) write-protected |
| 1 | Codes (F, E, C, P, H, A, o, L, U) write-enabled | |

## 7.1.6 Transmission Format

### 7.1.6.1 Data Format (Inverter ⇒ MICREX)

(1) Operation Status (1 is set to a bit when ON)

| (MSB) 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F (LSB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BUSY | ERR | WR | RL | ALM | DEC | ACC | IL | VL | TL | NUV | BRK | INT | EXT | REV | FWD |

- The ERR is set to "0" when writing/reading is successful. The ERR is set to "1" when the following writing/reading errors occur. When an error is present and the next writing/reading is successful, the ERR is reset to "0" automatically. If this bit is "1", repeat reading/writing until this bit becomes "0".

| | Read/write error |
|---|---|
| 1 | Access to unavailable function |
| 2 | Write to read-only function |
| 3 | Write to function to which you cannot write during operation |
| 4 | Write to function to which you cannot write when FWD/REV is ON |
| 5 | Write to data out of range |

- The BUSY is set to "1" during data is being written (processing). When you write data successively, write next data after this bit turns to "0". If you write data when this bit is "1", written data is neglected.

(2) Motor Speed

| (MSB) 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F (LSB) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Motor speed (decimal)×20,000÷maximum speed⇒16-bit data | | | | | | | | | | | | | | | |

The maximum speed is set by a function code. If you want a data in r/min, use the equation above for inverse operation. If a data is negative (2's complement), you will direct the reverse rotation.

(3) Address and Data for Polled Function Code

Format 1

| Address for polled function code | Blank (fixed to 0) |
|---|---|
| Data for polled function code | |

The link number corresponding to the function code polled by the MICREX is stored in the "Address for polled function code". And the data of the function code is stored in the "Data for polled function code". Refer to the "Function Code List" for the link number.

Format 2

| Address for polled function code (1) | Address for polled function code (2) |
|---|---|
| Address for polled function code (3) | Address for polled function code (4) |
| Data for polled function code (1) to<br>Data for polled function code (4) | |

The link numbers corresponding to the function codes polled by the MICREX are stored in the "Address for polled function code (1)" to "Address for polled function code (4)". And the data of these function codes are stored in the "Data for polled function code (1)" to "Data for polled function code (4)".

## 7.1.6.2 Data Format (MICREX ⇒ Inverter)

(1) Operation Command, Di, RESET Input (1 is set to a bit when ON)

(MSB) … (LSB)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RST | X14 | X13 | X12 | X11 | X9 | X8 | X7 | X6 | X5 | X4 | X3 | X2 | X1 | REV | FWD |

When the operation through the link is enabled as described in "7.1.5.1 Enabling Link Operation", FWD and REV are effective. X1 to X14 and RST are always enabled.

(2) Speed Reference

(MSB) … (LSB)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Speed reference (decimal)×20,000÷maximum speed⇒16-bit data | | | | | | | | | | | | | | | |

The equation above is the same as that for the motor speed. The maximum speed is set by a function code. You should use a 16-bit data calculated by the equation above for specification (Use a 2's complement for a negative value).
When the operation through the link is enabled as described in "7.1.5.1 Enabling Link Operation", reference data (such as speed reference) are effective.

(3) Address for Function Code to Poll or to Select and Data for Function Code to Select

Format 1

(MSB) … (LSB)

| 0–7 | 8–F |
|---|---|
| Address for function code to select | Address for function code to poll |
| Data for function code to select | |

Use the "Address for function code to select" (8 bits) and the "Data for function code to select" (16 bits) in the table above to write a function code data. Use the "Address for function code to poll" to specify a link number corresponding to a function code number to poll.

Format 2

(MSB) … (LSB)

| 0–7 | 8–F |
|---|---|
| Address for function code to select (1) | Address for function code to select (2) |
| Address for function code to select (3) | Address for function code to select (4) |
| Data for function code to select (1) ⇓ Data for function code to select (4) | |
| Address for function code to poll (1) | Address for function code to poll (2) |
| Address for function code to poll (3) | Address for function code to poll (4) |

Write link numbers to the "Address for function code to select (1)" to the "Address for function code to select (4)" (8 bits) corresponding to the function codes to select from the MICREX. You should write data to the "Data for function code to select (1)" to the "Data for function code to select (4)" as well.

Note: When you select, write a link number and its data at the same time.

Use the "Address for function code to poll (1)" to the "Address for function code to poll (4)" to specify a link numbers corresponding to function code numbers to poll.
When the writing through the link is enabled as described in "7.1.5.2 Enabling Writing through Link", selecting is effective. Remember the restrictions on writing such as "Write disabled on operation".

## 7.1.6.3 Data Transmission Examples

(1) Speed Reference

Directing a speed reference of 785r/min in froward (FWD) direction from MICREX.
(Conditions: function code H30 "Serial link"=3, maximum speed: 1500r/min, T-Link station number: 10, 8+8 words)
Set forward (FWD: ON) to S06 and a speed reference to S01.

| | | | | | |
|---|---|---|---|---|---|
| WB18 | 0 | 6 | 0 | 1 | Addresses to select function code S06 and S01 (link number 06h and 01h) |
| 19 | 0 | 0 | 0 | 0 | Dummy addresses for function code to select |
| 20 | 0 | 0 | 0 | 1 | Data for function code S06 is "FWD: ON" |
| 21 | 2 | 8 | E | 3 | Data for function code S01 is a speed reference, 785/1500×20,000=10,467=28E3[h] |
| | | ↓ | | | After acceleration is completed |
| WB16 | 2 | 8 | E | 3 | Monitored motor speed |

(2) Torque Reference Monitor

Monitoring torque reference value.
(Conditions: T-Link station number: 24, 8+8 words)

| | | | | | |
|---|---|---|---|---|---|
| WB38 | 1 | 0 | 0 | 0 | Address to monitor the torque reference (link number: 10h) |
| 39 | 0 | 0 | 0 | 0 | |
| | | ↓ | | | After reading is completed |
| WB24 | 1 | 0 | 0 | 0 | Reading is completed when the polled link number is returned to this area. |
| 25 | 0 | 0 | 0 | 0 | Monitored data of torque reference value |
| 26 | 1 | 3 | 8 | 8 | 1388 (h) × 100 (%) ÷ 10,000 = 50 (%) |
| 27 | 0 | 0 | 0 | 0 | |
| 28 | 0 | 0 | 0 | 0 | ↓ |
| 29 | 0 | 0 | 0 | 0 | Above result indicates that torque reference value is "50% in driving". |

(3) Function Code Data Setting

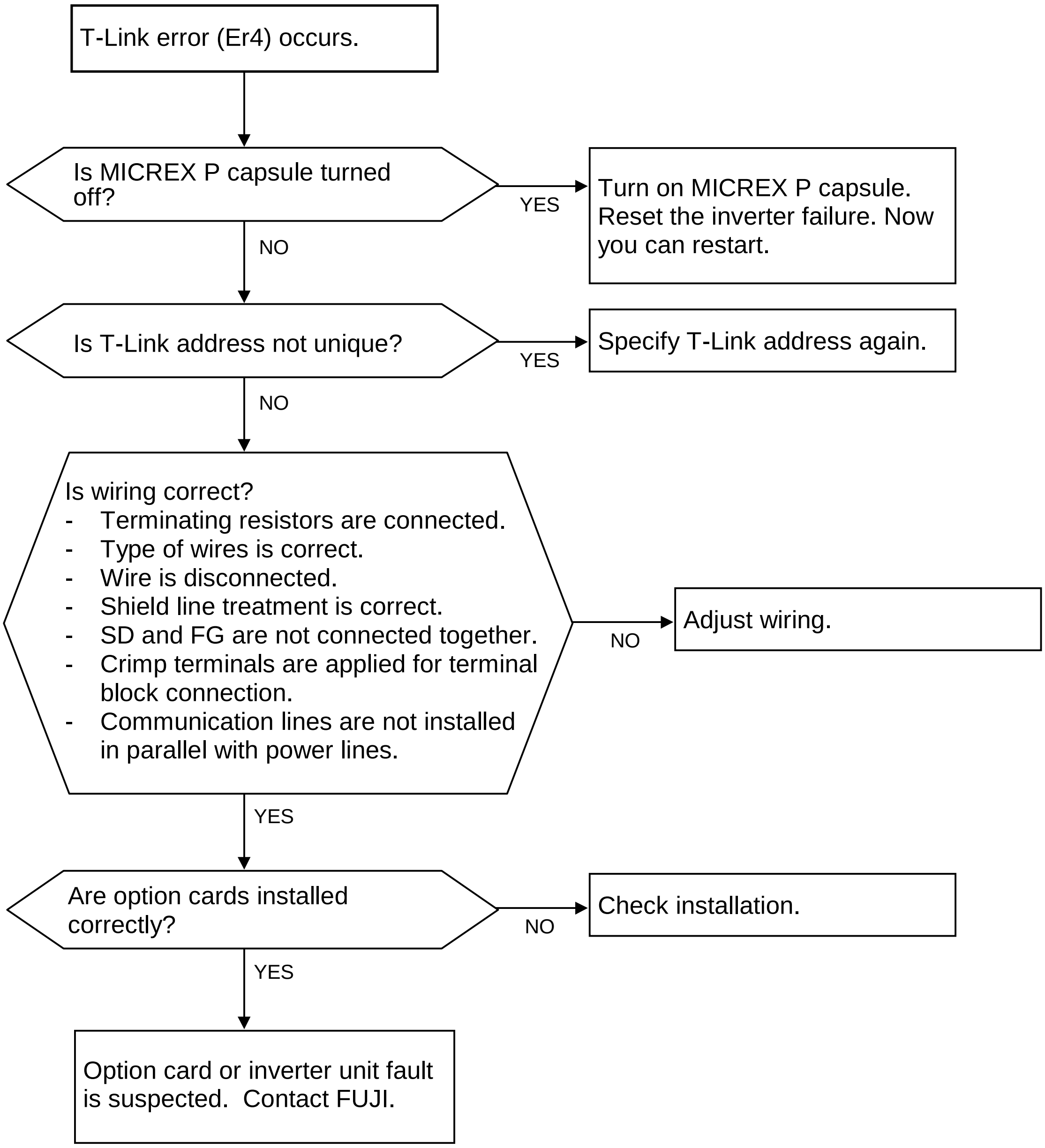
1) Setting 30.5sec to the acceleration time (function code S08)
(Conditions: T-Link station number: 58, 4+4 words)

| | | | | | |
|---|---|---|---|---|---|
| WB62 | 0 | 0 | 0 | 0 | Address to select function code S08 (link number 08h) |
| 63 | 0 | 0 | 0 | 0 | 131 (h) = 305, 305 × 0.1s = 30.5s |
| 64 | 0 | 8 | 0 | 8 | |
| 65 | 0 | 1 | 3 | 1 | Address to poll function code S08 for confirmation after setting |
| | | ↓ | | | |
| WB58 | * | * | * | * | Address for polled function code |
| 59 | * | * | * | * | 131 (h) = 305, 305 × 0.1s = 30.5s |
| 60 | 0 | 8 | 0 | 0 | This data indicated that setting is successful. |
| 61 | 0 | 1 | 3 | 1 | |

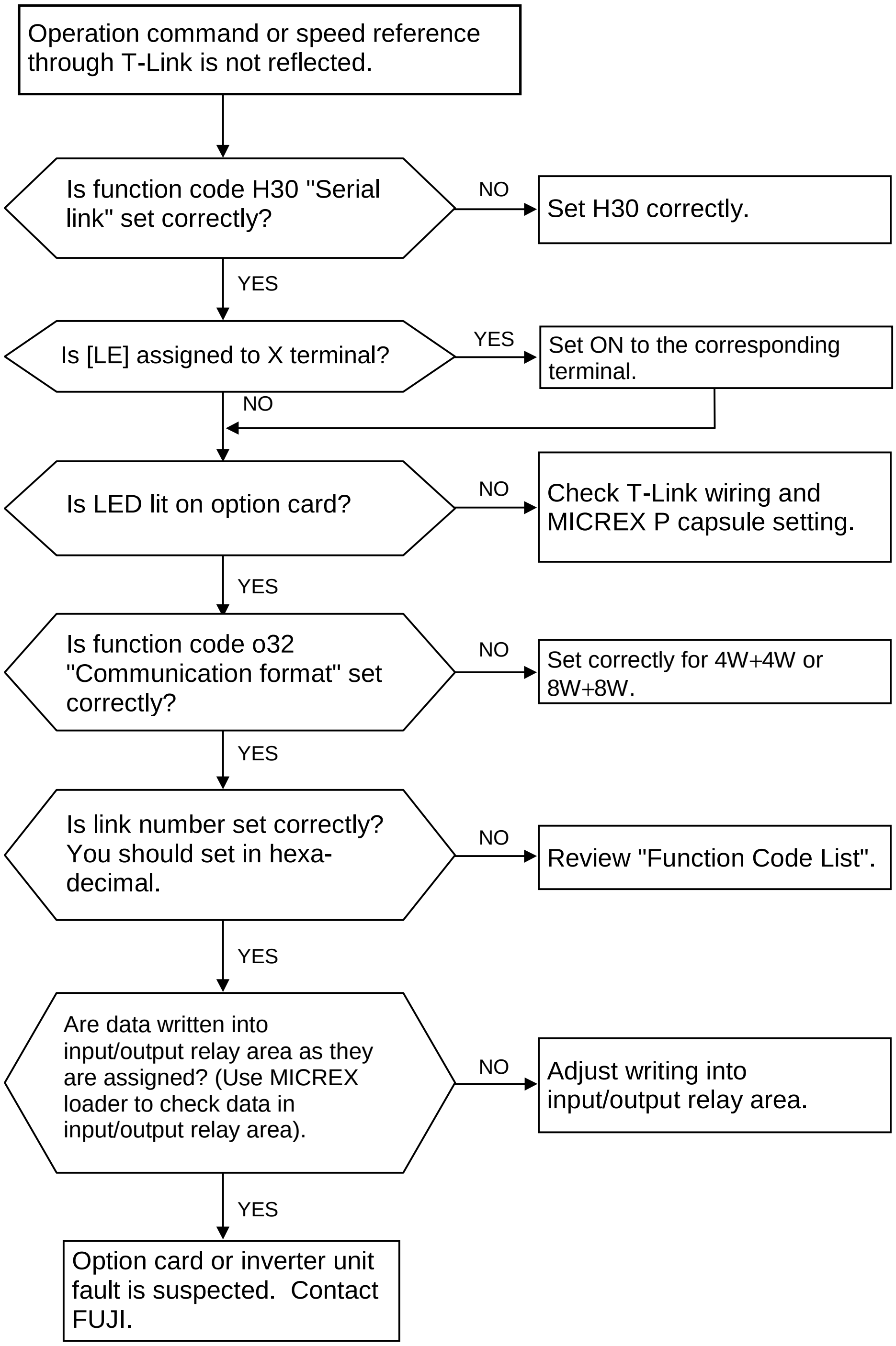
## 7.1.7 Troubleshooting

(1) T-Link error (Er4)

Refer to the RAS information of the MICREX P capsule to diagnose the cause of a failure when you have a T-Link error. Refer to the instruction manual of the MICREX for the RAS information.



(2) Operation command and speed reference setting




* You can use the "I/O Check" screen of the KEYPAD panel to view the description of the Er4.

| Code | T-Link option error type | How to reset |
|---|---|---|
| 1 | CRC check error<br>Flag error | Normal reception resets automatically |
| 2 | Transmission cycle time over<br>Frequent CRC error (16 times or more) | Power reset or reset key |
| 3 | Overrun or under run | Power reset or reset key |

# 7. Control Options

## 7.2 DI (DIA, DIB) Extension Card

### 7.2.1 Product Guide

#### 7.2.1.1 Product Overview

Overview

This option card (OPC-VG7-DI) is an inverter control option card installed on the FRENIC5000VG7S (VG7S hereafter).
You can use this card to specify a speed reference, a torque reference and a torque current reference in 16-bit digital data. You can also use this card to specify torque limiters during speed control.
There is a hardware switch on this card. This switch is set to "DIA" as factory setting and you do not have to change this setting when you use a single card. When you want use two DI cards for a speed reference and a torque reference, set them as "DIA" and "DIB" respectively and install both of them simultaneously.

**⚠WARNING**

- Turn off the circuit breaker on the power supply side of an inverter when you mount/dismount this option after you have turned on the inverter. You will get electric shock if you touch the live part since the smoothing capacitors are still charged after you turn off. Wait until the charge lamp (CHARGE) is off on the inverter and use a multimeter to check if the DC voltage of the inverter (between P and N terminals) has decreased to a safe level.

**You may get electric shock.**

- Improper wiring work may cause electric shock and a fire. Leave the wiring work to a specialist.

**You may cause fires.**

- Improper data specified to function codes may cause dangerous situations. Check your data again after you specify and write data.

**You may cause accidents.**

- An inverter starts if you reset an alarm while the operation command is set to ON after the protective function of the inverter was activated and you removed the cause of the alarm. Reset the alarm after you check the operation command is set to OFF.

**You may cause accidents or be injured.**

**⚠CAUTION**

- Avoid using a damaged product or a product with missing parts.

**You may be injured.**

- You may damage a product when you mount/dismount the product in improper manner.

**You may cause accidents.**

- After you turn off the main circuit power supply, the control circuit power supply and the auxiliary power supply, if the external control circuit has a separate power supply, the power is still applied to the 30A, 30B, 30C, RYA, and RYC. Turn off the external power supply to avoid electric shock.

**You may get electric shock.**

- Avoid to apply voltage over permissible levels to individual terminals. The voltage over the permissible level may damage this option.

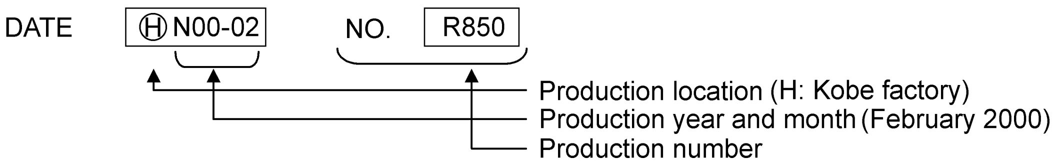
**You may cause accidents.**

## 7.2.1.2 Product Guarantee

The period of product guarantee is either twelve months after your purchase or eighteen months after production that comes first.
Note that the following cases will void the product guarantee.

- Improper operations, repairs or modifications
- Operation out of the standard specifications
- Drops or damages during transportation after your purchase
- Earthquakes, fires, winds, floods, lightning, abnormal voltages, and other natural disasters, or secondary disasters.

Production date and production number (displayed on the product)




## 7.2.1.3 Standard Product Specifications

Table 7-2-1 Standard Specifications

| Item | | Specification |
|---|---|---|
| Name | | Digital input option card |
| Type | | OPC-VG7-DI (switch to DIA or DIB) |
| Input | Number of contacts | 16 points |
| | Circuit | Isolated by photocouplers, sink type (Continuous current per circuit: 3mA) |

Note 1: This product is dedicated for the vector control inverter FRENIC5000VG7S. You cannot apply to other products.
Note 2: Avoid megger test on the terminals of this option.
Note 3: When the protective function is activated, refer to "4.4 If You Think Defective" and remove the cause of abnormality to restart.
Note 4: Items of maintenance and inspection are the same as those of the inverter. Refer to the instruction manual of the inverter.

## 7.2.2 Connections

**WARNING**

- Improper wiring work may cause electric shock and a fire. Leave the wiring work to a specialist. Turn off the circuit braker on the power supply side of an inverter to avoid electric shock when you work with connection after you have turned on the inverter. You will get electric shock if you touch the live part since the smoothing capacitors are still charged after you turn off.
- Wait until the charge lamp (CHARGE) is off on the inverter and use a mutimeter to check if the DC current of the inverter (between P and N terminals) has decreased to a safe level.

**You may get electric shock.**

**CAUTION**

- Avoid to apply voltage over permissible levels to individual terminals. The voltage over the permissible level may damage this option.
- After you turn off the main circuit power supply, the control circuit power supply and the auxiliary power supply, if the external control circuit has a separate power supply, the power is still applied to the 30A, 30B, 30C, RYA, and RYC.
- Turn off the external power supply to avoid electric shock.

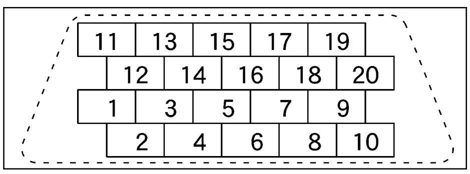
**You may get electric shock.**

### 7.2.2.1 Terminal Function Description

Connect wiring to the plug supplied with the option card and connect the plug to the connector CN2. The pin assignment is described below.

Table 7-2-2 Pin Numbers and Signals of CN2

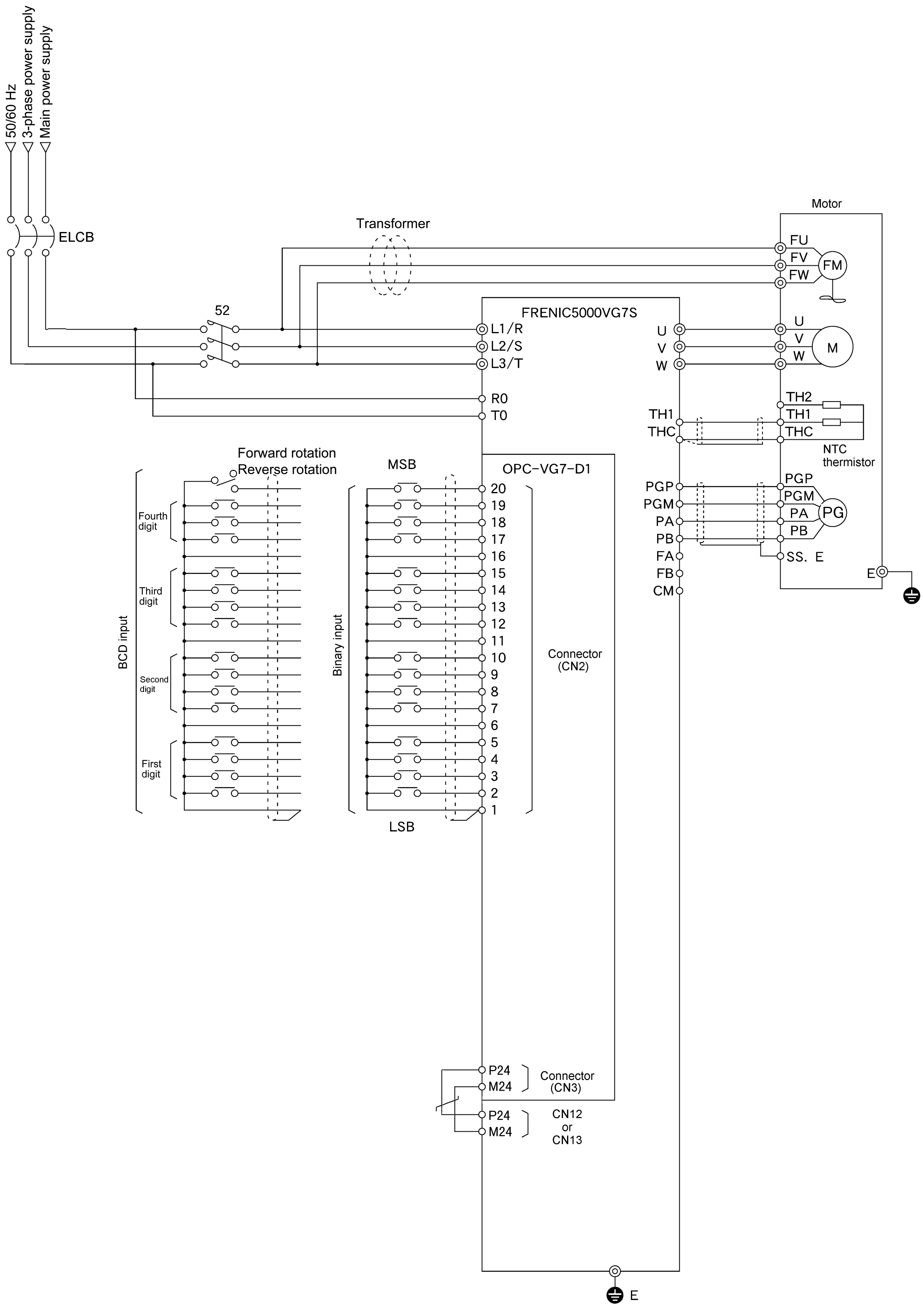
| Pin number | Name | Description | | Notes |
|---|---|---|---|---|
| | | In binary | In BCD | |
| 1 | CM | Common (M24) | | • Contact capacity: about 3mA, 24V DC |
| 2 | DI0 | $2^0$ = 1 | $1 \times 10^0$ | |
| 3 | DI1 | $2^1$ = 2 | $2 \times 10^0$ | • "1" when a signal terminal and the common terminal is connected. |
| 4 | DI2 | $2^2$ = 4 | $4 \times 10^0$ | |
| 5 | DI3 | $2^3$ = 8 | $8 \times 10^0$ | |
| 6 | CM | Common (M24) | | |
| 7 | DI4 | $2^4$ = 16 | $1 \times 10^1$ | • Use function code o01 and o02 to select between binary and BCD |
| 8 | DI5 | $2^5$ = 32 | $2 \times 10^1$ | |
| 9 | DI6 | $2^6$ = 64 | $4 \times 10^1$ | |
| 10 | DI7 | $2^7$ = 128 | $8 \times 10^1$ | |
| 11 | CM | Common (M24) | | • In BCD, pin 20 is used as sign and input range is –7,999 to 0 to +7,999 |
| 12 | DI8 | $2^8$ = 256 | $1 \times 10^2$ | |
| 13 | DI9 | $2^9$ = 512 | $2 \times 10^2$ | |
| 14 | DI10 | $2^{10}$ = 1024 | $4 \times 10^2$ | |
| 15 | DI11 | $2^{11}$ = 2048 | $8 \times 10^2$ | |
| 16 | CM | Common (M24) | | |
| 17 | DI12 | $2^{12}$ = 4096 | $1 \times 10^3$ | |
| 18 | DI13 | $2^{13}$ = 8192 | $2 \times 10^3$ | |
| 19 | DI14 | $2^{14}$ = 16384 | $4 \times 10^3$ | |
| 20 | DI15 | $2^{15}$ = 32768 | Sign (negative when closed) | |



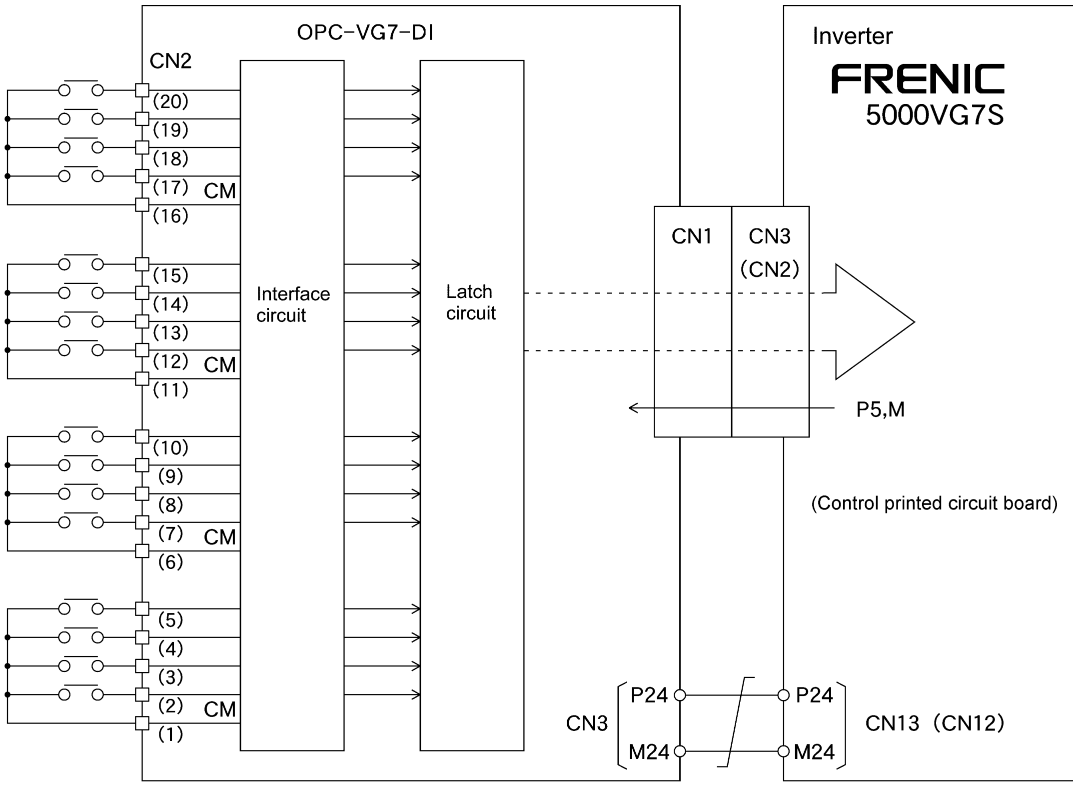

Viewed from the soldering terminal side of the plug

Pin assignment of plug (for CN2)

## 7.2.2.2 Basic Wiring Diagram

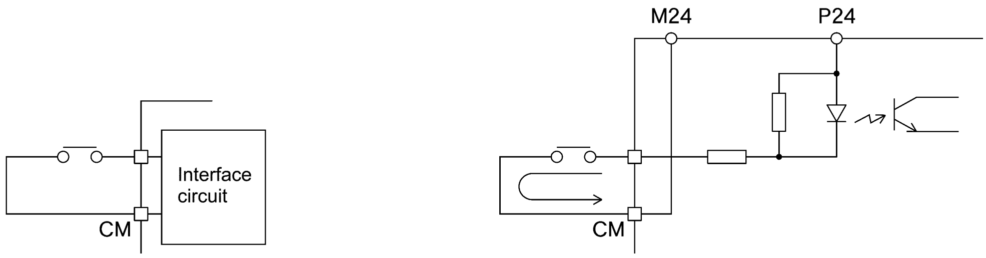


## 7.2.2.3 Block Diagram




Block diagram

Note: Interface circuit structure is described below.




Block diagram (one circuit)

Permissible contact capacity
24V DC,3mA

Equivalent circuit (one circuit)

## 7.2.3 Function Codes for this Option

| ⚠ WARNING |
|---|
| • Improper data specified to function codes may cause dangerous situations. Check your data again after you specify and write data.<br>**You may cause accidents.**<br>• An inverter starts if you reset an alarm while the operation command is set to ON after the protective function of the inverter was activated and you removed the cause of the alarm. Reset the alarm after you check the operation command is set to OFF.<br>**You may cause accidents or be injured.** |

### 7.2.3.1 DI Data Latch Function

You can enter a 16-bit parallel data into an inverter to reflect it at 1ms cycle.
You can use the data latch function to hold a data or to restrain the fluctuation of the lower bits of a data obtained by A/D conversion.

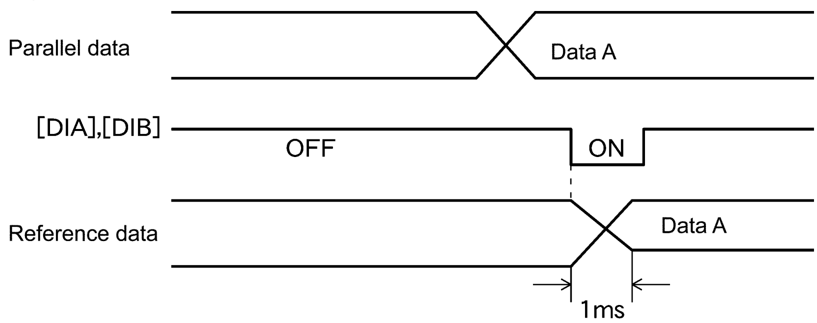
(1) Related Function Codes

| Function code | Name | Setting range |
|---|---|---|
| E01 to E13 | X1 to X14 function selection<br>(X11 to X14 are DIOA option) | 0 to 63[d] |

1) Assign functions to the control input terminals (X1 to X14).
57 [DIA] DIA data latch: For setting DIA (specified by a hardware switch)
57 [DIB] DIB data latch: For setting DIB (specified by a hardware switch)

| [DIA], [DIB] | Terminal signal | Parallel data to DI card |
|---|---|---|
| Not assigned | - | Reads always |
| Assigned | ON | |
| | OFF | Does not read<br>(Holds the last data before OFF) |

Assigned case



## 7.2.3.2 Selecting Binary or BCD

You can use the option function code o01 "DIA function selection" and o02 "DIB function selection" to select binary or BCD as a parallel input data.

Set data 0: Binary
1: BCD (Binary Coded Decimal)

### Examples of Binary Input

Valid range is –32768 to 32767

| (MSB) 20 | 19 | 18 | 17 | 15 | 14 | 13 | 12 | 10 | 9 | 8 | 7 | 5 | 4 | 3 | (LSB) 2 | Intended data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 20000 |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 32767 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | –32768 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | –32767 |
| 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | –20000 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | – 2 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | – 1 |

### Examples of BCD Input

Valid range is –799.9 to 799.9

| (MSB) 20 | 19 | 18 | 17 | 15 | 14 | 13 | 12 | 10 | 9 | 8 | 7 | 5 | 4 | 3 | (LSB) 2 | Intended data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.2 |
| 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 462.0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 799.9 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | –0.1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | –0.2 |
| 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | –462.0 |
| 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | –799.9 |

Digit for 100 (bits 20–17) | Digit for 10 (bits 15–12) | Digit for 1 (bits 10–7) | Digit for 0.1 (bits 5–2)

## 7.2.3.3 Control Reference Input

(1) Speed Reference Input

When you use the DI input as a speed reference, specify either the function code F01 or C25 that is effective according to the switch set to either DIA or DIB.
You can set the control input [N2/N1] to either ON or OFF to switch between F01 and C25. When you have not assigned the control input, F01 is effective.

1) Binary Input Setting

(a) When you specify 600r/min as a speed reference:
If the maximum speed setting is 1,500r/min,
you enter the following value into the DI card.

$$600 \times \frac{20{,}000}{1{,}500} = 8000\ [d]$$

$= 1F40\ [H]$
$= 0001\ 1111\ 0100\ 0000\ [B]$

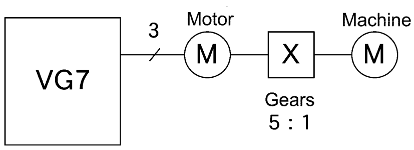
(b) When you specify –1,000r/min as a speed reference:
If the maximum speed setting is 1,500r/min,
you enter the following value into the DI card.

$$-1{,}000 \times \frac{20{,}000}{1{,}500} = -13333\ [d]$$

$= CBEB\ [H]$
$= 1100\ 1011\ 1100\ 1011\ [B]$

2) BCD Input Setting

You should specify the function code o03 and o04 "BCD input setting" according to the DIA and the DIB setting.
Set data: 99 to 7,999
Use this function to specify "the operation speed of a machine" in BCD.
For example, a machine connected to a motor through gears with ratio of 5:1, the machine runs at 300.0r/min while the motor runs at 1,500r/min.




When you use the BCD input to specify the operation speed of the machine directly, set "300" to the "BCD input setting". This setting drives the motor at 1,500r/min when the input to the DI card is 300.0. When you want to set the speed of the machine to 120.0r/min, enter 120.0 to the DI card.

$$\frac{120.0}{300} \times 1500 = 600\ \text{r/min(Motor speed)}$$

In this example, the motor runs at 600r/min.

3) Specified Resolution for BCD Input

Compare the setting 100 and 500 specified to the o03 or o04 "BCD input setting".
When the maximum motor speed is 1,500r/min,

For setting of 100: $\frac{\text{DI card input : 0.0 to 100.0}}{100} \times 1500 = 0$ to 1,500r/min (1.5r/min per step)

For setting of 500: $\frac{\text{DI card input : 0.0 to 500.0}}{500} \times 1500 = 0$ to 1,500r/min (0.3r/min per step)

As indicated above, the resolution changes according to the set value.

### (2) Torque, Torque Current and Torque Limiter Input

Specify DIA or DIB in the following function codes to use the DI input to specify the torque, the torque current and the torque limiter. Refer to the Control Block Diagram for more details.

| |
|---|
| H41 "Torque reference selection"<br>H42 "Torque current reference selection"<br>F42, F43 "Torque limiter value selection (Level 1, Level 2)" |

In all cases, 10,000 is assumed as 100%.

1) Binary Input Setting (∗BCD input is not available. o01 and o02 setting is not effective in this case)

(a) When you specify a torque reference of 70%:
You enter the following value into the DI card.

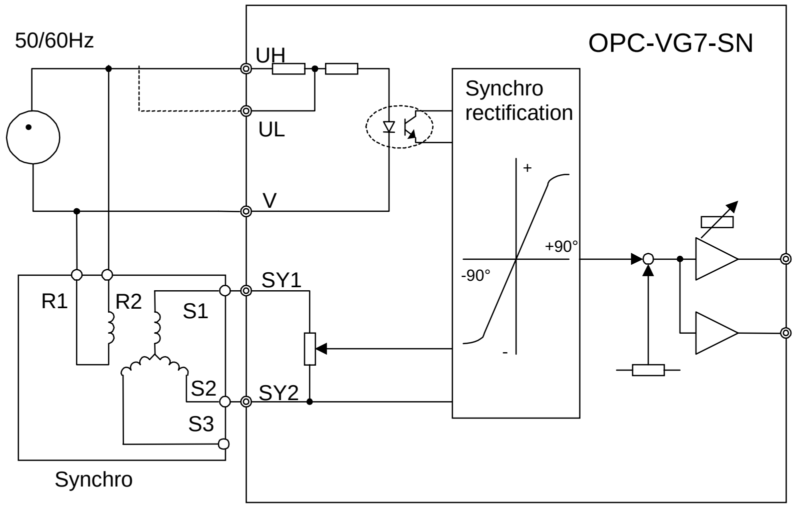
$$70 \times \frac{10000}{100} = 7000\ (d)$$
$$= 1B58\ [H]$$
$$= 0001\ 1011\ 0101\ 1000\ [B]$$

(b) When you specify a torque current reference of −25%:
You enter the following value into the DI card.

$$-25 \times \frac{10000}{100} = -2{,}500\ [d]$$
$$= F63C\ [H]$$
$$= 1111\ 0110\ 0011\ 1100\ [B]$$

## 7.3 Synchronized Interface Card/Unit

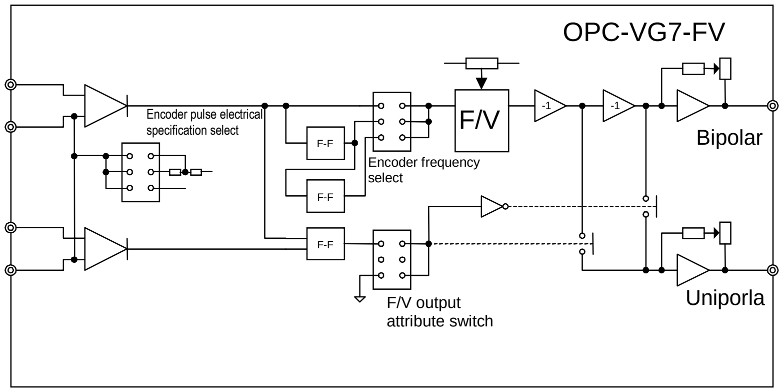
- Integrated type OPC-VG7-SN
- Separate type MCA-VG7-SN




This card/unit converts the AC voltage supplied from a synchrony-transmitter used for dancer control to a control signal in the range of 0 to ±10V.

## 7.4 F/V Converter

- Integrated type OPC-VG7-FV
- Separate type MCA-VG7-FV




You can use this card/unit to detect line speed.
This card/unit converts the frequency signal from a PG to a voltage signal.

# 7. Control Options

## 7.5 AIO Extension Card

● OPC-VG7-AIO

You can use this card when you need additional analog input/output points for a system construction using the UPAC or a control system utilizing the PID control integrated into the inverter.

This card adds 2 channels of Ai and 2 channels of Ao.
Ai specification: ±10V input, 12-bit resolution, conversion cycle 1ms
Ao specification: ±10V output, 12-bit resolution, conversion cycle 1ms

## 7.6 PG Interface Extension Card

● OPC-VG7-PG

- You can use this card to add a PG signal input of 5V line driver type, voltage output type, or open collector output type.
- You can install up to two of this card. You can set the switch on the printed circuit board to select a setting from the following four types.

1) PG (SD)
   For motor speed detection. You can use this setting to drive a motor with a 5V line driver type PG as used in the combination of a FALDIC-IM motor and a VG7S.

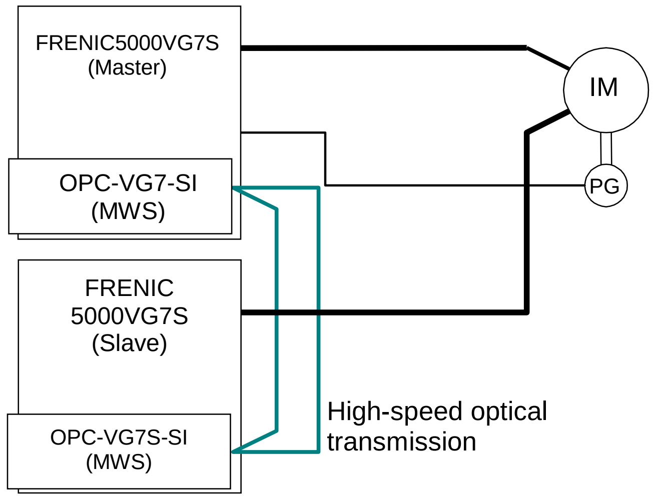
2) PG (LD)
   Use to detect line speed directly in digital data.
   Related function codes are o06, o07, and o08.

3) PG (PR)
   Use to specify the position reference in pulse train control.
   You can select from three pulse train types: 90 degrees of phase difference between A- and B-phases, A-phase: reference pulse and B-phase: reference sign, A-phase: forward rotation pulse and B-phase: reverse rotation pulse.

4) PG (PD)
   Use to detect the spindle position in pulse train control.
   You can use a motor PG to detect the position in pulse train control.
   (Related function code: o05)
   You can also use this setting to detect the spindle position in orientation control.

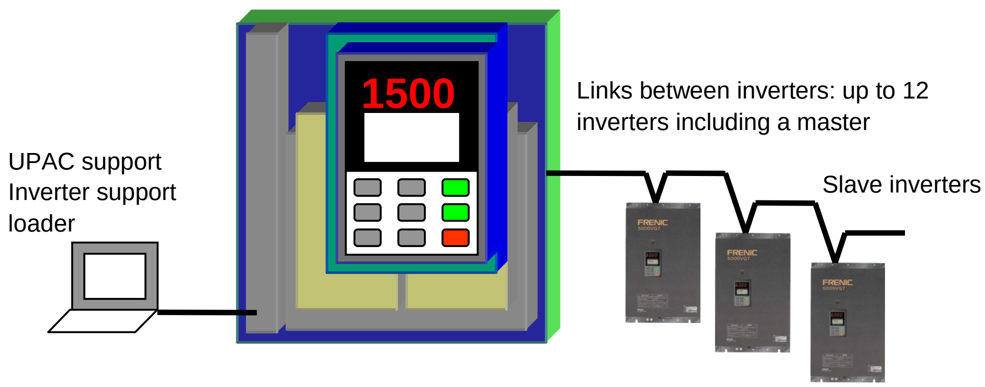
## 7.7 High-Speed Serial Card

● OPC-VG7-SI (MWS)




Multiplexing windings of a motor and preparing an inverter for each winding (up to four-way multiplexing) can increase the capacity of a drive system.
Though a master inverter conducts normal operation, slave inverters conduct only current control following the current control instruction from the master inverter.

● OPC-VG7-SI (UPAC)




A link system connecting inverters can be constructed by designating one inverter with a UPAC as a master.

50W input/output mode: Up to 5 slave inverters can be linked.
(1 to 3 slaves: 2ms, 4 to 5 slaves: 3ms)
22W input/output mode: Up to 11 slave inverters can be linked.
(1 to 6 slaves: 2ms, 7 to 11 slaves: 3ms)

## 7.8 RS485 Extension Card

- OPC-VG7-RS

1) Use to construct a low-cost inter-inverter link utilizing the UPAC system

A link system connecting inverters can be constructed by designating an inverter with a UPAC as a master
50W input/output mode: Up to 5 slave inverters can be linked.
(1 to 3 slaves: 200ms, 4 to 5 slaves: 300ms)
22W input/output mode: Up to 11 slave inverters can be linked.
(1 to 6 slaves: 200ms, 7 to 11 slaves: 300ms)

2) Use when you employ the POD as a remote controller

## 7.9 PG Card for Synchronous Motor Driving

- OPC-VG7-PMPG

- This PG interface card provides a magnetic pole position signal input.
  U, V, and W signals or multiple-bit Gray code are available as a magnetic pole position signal and this card can accept A- and B-phase signals and an up to 4 bits of magnetic pole position signal.

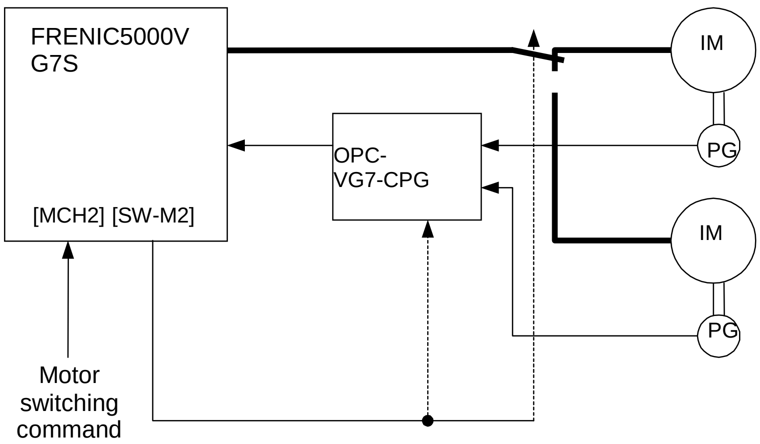
- Applicable PG signal is 5V line driver type.

- Use OPC-VG7-PG card for synchronous motor drive with an A-, B-, and Z-phase pulse generator.

## 7.10 PG Signal Switch

### ● MCA-VG7-CPG

- You can use this option for one inverter to switch between two motors to drive.
- This option can switch PG signals and NTC thermistor signals.
- The following example shows a connection when this option is combined with the second motor selection function of the VG7S.




## 7.11 Field Bus Interface Unit

- Comply with different types of field bus.
- Communication protocol meets each DRIVE Profile (except for MODBU-RTU).

1) For Profibus-DP: OPC-VG7-PDP
   (Drive profile: PROFIDRIVE)
2) For DeviceNet: OPC-VG7-DEV
   (Drive profile: AC Drive)
3) For Interbus-S: OPC-VG7-IBS
   (Drive profile: DRIVECOM Profile 21)
4) For CAN Open: OPC-VG7-COP
   (Drive profile: DRIVES & MOTION CONTROL)
5) For Modbus Plus: OPC-VG7-MBP
   (supports Global database)

- MEMO -

THE INVERTER

# Ⅷ. Peripheral Equipment

# 8. Peripheral Equipment

## 8.1 Inverter Input Current

• This section describes selecting peripheral devices and cables.

Table 8.1 Various Current Value Through Inverter

| Power supply voltage | Nominal applied motor [kW] | 50Hz, 200V (400V) | | | | | 60Hz, 220V (440V) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Input effective value current [A] | | DC link circuit current [A] | Braking resistor circuit current [A] | | Input effective value current [A] | | DC link circuit current [A] | Braking resistor circuit current [A] | |
| | | With DCR | Without reactor | | CT/HT | VT | With DCR | Without reactor | | CT/HT | VT |
| Three-phase 200V | 0.75 | 3.1 | 6.4 | 3.8 | 1.4 | – | 2.7 | 6.2 | 3.3 | 1.4 | – |
| | 1.5 | 5.7 | 11.1 | 7.0 | 1.9 | 1.4 | 5.1 | 10.6 | 6.2 | 1.9 | 1.4 |
| | 2.2 | 8.3 | 16.1 | 10 | 2.3 | 1.9 | 7.5 | 15.5 | 9.2 | 2.3 | 1.9 |
| | 3.7 | 14.0 | 25.5 | 17 | 3.4 | 2.3 | 12.5 | 24.2 | 15 | 3.4 | 2.3 |
| | 5.5 | 19.7 | 40.8 | 24 | 5.1 | 3.4 | 16.9 | 36.2 | 21 | 5.1 | 3.4 |
| | 7.5 | 26.9 | 52.6 | 33 | 6.8 | 5.1 | 24.0 | 46.6 | 29 | 6.8 | 5.1 |
| | 11 | 39.0 | 76.9 | 48 | 10.2 | 6.8 | 34.7 | 67.7 | 42 | 10.2 | 6.8 |
| | 15 | 54.0 | 98.5 | 66 | 13.7 | 10.2 | 48 | 87 | 59 | 13.7 | 10.2 |
| | 18.5 | 66.2 | 117 | 81 | 17.6 | 13.0 | 59 | 104 | 72 | 17.6 | 13.0 |
| | 22 | 78.8 | 136 | 96 | 20.3 | 16.4 | 70 | 123 | 86 | 20.3 | 16.4 |
| | 30 | 109 | 168 | 133 | 30.0 | 20.3 | 99 | 149 | 121 | 30.0 | 20.3 |
| | 37 | 135 | 204 | 165 | 35.1 | 28.5 | 122 | 181 | 149 | 35.1 | 28.5 |
| | 45 | 163 | 243 | 200 | 41.1 | 33.2 | 148 | 217 | 181 | 41.1 | 33.2 |
| | 55 | 199 | 291 | 244 | 50.8 | 38.9 | 182 | 262 | 223 | 50.8 | 38.9 |
| | 75 | 272 | | 333 | 68.5 | 50.8 | 247 | | 303 | 68.5 | 50.8 |
| | 90 | 327 | – | 400 | 83.0 | 64.2 | 296 | – | 363 | 83.0 | 64.2 |
| | 110 | 400 | | 490 | – | 78.6 | 364 | | 446 | – | 78.6 |
| Three-phase 400V | 3.7 | 7.1 | 14.9 | 8.7 | 1.7 | – | 6.3 | 14.2 | 7.7 | 1.7 | – |
| | 5.5 | 10.0 | 21.5 | 12 | 2.5 | 1.7 | 8.3 | 19.0 | 10 | 2.5 | 1.7 |
| | 7.5 | 13.5 | 27.9 | 17 | 3.4 | 2.5 | 12.1 | 24.6 | 15 | 3.4 | 2.5 |
| | 11 | 19.8 | 39.1 | 24 | 5.1 | 3.4 | 17.7 | 34.5 | 22 | 5.1 | 3.4 |
| | 15 | 26.8 | 50.3 | 32 | 6.8 | 5.1 | 24 | 44 | 29 | 6.8 | 5.1 |
| | 18.5 | 33.2 | 59.9 | 40 | 8.8 | 6.5 | 29 | 53 | 36 | 8.8 | 6.5 |
| | 22 | 39.3 | 69.3 | 48 | 10.2 | 8.2 | 35 | 62 | 43 | 10.2 | 8.2 |
| | 30 | 54 | 86 | 66 | 15.0 | 10.2 | 49 | 76 | 60 | 15.0 | 10.2 |
| | 37 | 67 | 104 | 82 | 17.6 | 14.3 | 61 | 92 | 75 | 17.6 | 14.3 |
| | 45 | 81 | 124 | 99 | 20.5 | 16.6 | 74 | 111 | 91 | 20.5 | 16.6 |
| | 55 | 100 | 150 | 122 | 25.2 | 19.4 | 91 | 134 | 111 | 25.2 | 19.4 |
| | 75 | 134 | | 164 | 34.6 | 25.2 | 122 | | 149 | 34.6 | 25.2 |
| | 90 | 160 | | 196 | 41.6 | 32.5 | 146 | | 179 | 41.6 | 32.5 |
| | 110 | 196 | | 240 | 50.8 | 39.4 | 178 | | 218 | 50.8 | 39.4 |
| | 132 | 232 | | 284 | 61.7 | 47.6 | 211 | | 258 | 61.7 | 47.6 |
| | 160 | 282 | | 345 | 73.9 | 58.2 | 256 | | 314 | 73.9 | 58.2 |
| | 200 | 352 | – | 431 | 92.6 | 70.7 | 320 | – | 392 | 92.6 | 70.7 |
| | 220 | 385 | | 472 | 102 | 83.2 | 350 | | 429 | 102 | 83.2 |
| | 280 | 491 | | 601 | 138 | 98.1 | 446 | | 546 | 138 | 98.1 |
| | 315 | 552 | | 676 | 147 | 125 | 502 | | 615 | 147 | 125 |
| | 355 | 624 | | 764 | 175 | 133 | 567 | | 694 | 175 | 133 |
| | 400 | 704 | | 962 | 186 | 159 | 640 | | 784 | 186 | 159 |
| | 500 | 880 | | 1078 | - | 178 | 800 | | 980 | – | 178 |

Note 1: The inverter efficiency is calculated using individual value by capacity. The input effective value current is obtained for following conditions:

**[22kW or smaller]**

**Power source capacity : 500kVA Power source impedance : 2.5%**

**[30kW or larger]**

**Power source capacity and impedance are calculated using values corresponding to Fuji's recommended capacity.**

Note 2: For different power voltages such as 230V or 380V, input current is in inverse proportion to the power voltage.

Note 3: The braking resistor circuit currents are obtained on condition that the standard braking resistor (10% ED) is used. Ask us for the data taken when the resistor of 20%ED, 40%ED, 100%ED, or continuous rating is used.

# 8.2 Circuit Breakers and Magnetic Contactors

Table 8.2 Circuit Breakers and Magnetic Contactors

| Power supply voltage | Nominal applied motor [kW] | Inverter type | | MCCB, ELCB Rated current [A] | | MC1 (for input circuit) | | MC2 (for output circuit) | |
|---|---|---|---|---|---|---|---|---|---|
| | | CT use, HT use | VT use | With DCR | Without reactor | With DCR | Without reactor | CT use, HT use | VT use |
| Three-phase 200V | 0.75 | FRN0.75VG7S-2 | – | 5 | 10 | SC-05 | SC-05 | SC-05 | – |
| | 1.5 | FRN1.5VG7S-2 | FRN0.75VG7S-2 | 10 | 15 | | | | SC-05 |
| | 2.2 | FRN2.2VG7S-2 | FRN1.5VG7S-2 | | 20 | | | | |
| | 3.7 | FRN3.7VG7S-2 | FRN2.2VG7S-2 | 20 | 30 | | SC-5-1 | | |
| | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | 30 | 50 | | SC-N1 | SC-N1 | |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | 40 | 75 | SC-5-1 | SC-N2 | | SC-N1 |
| | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | 50 | 100 | SC-N1 | SC-N2S | SC-N2 | |
| | 15 | FRN15VG7S-2 | FRN11PS11-2 | 75 | 125 | SC-N2 | SC-N3 | SC-N2S | SC-N2 |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | 100 | 150 | SC-N2S | SC-N4 | | SC-N2S |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | | 175 | | SC-N5 | SC-N3 | |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | 150 | 200 | SC-N4 | SC-N7 | SC-N4 | SC-N3 |
| | 37 | FRN37VG7S-2 | FRN30VG7S-2 | 175 | 250 | SC-N5 | SC-N8 | SC-N5 | SC-N4 |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | 200 | 300 | SC-N7 | | SC-N7 | SC-N5 |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | 250 | 350 | SC-N8 | SC-N11 | SC-N8 | SC-N7 |
| | 75 | FRN75VG7S-2 | FRN55VG7S-2 | 350 | – | SC-N11 | – | SC-N11 | SC-N8 |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | 400 | | | | | SC-N11 |
| | 110 | – | FRN90VG7S-2 | 500 | | SC-N12 | | – | |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | 10 | 20 | SC-05 | SC-05 | SC-05 | – |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | 15 | 30 | | SC-4-0 | | SC-05 |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | 20 | 40 | | SC-5-1 | SC-4-0 | |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | 30 | 50 | | SC-N1 | SC-5-1 | SC-4-0 |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | 40 | 60 | SC-5-1 | | SC-N1 | SC-5-1 |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | | 75 | SC-N1 | SC-N2 | | SC-N1 |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | 50 | 100 | | SC-N2S | SC-N2 | |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | 75 | 125 | SC-N2 | SC-N3 | SC-N2S | SC-N2 |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | 100 | | SC-N2S | SC-N4 | SC-N3 | SC-N2S |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | | 150 | SC-N3 | | SC-N4 | SC-N3 |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | 125 | 200 | | SC-N5 | SC-N5 | SC-N4 |
| | 75 | FRN75VG7S-4 | FRN55VG7S-4 | 175 | – | SC-N4 | – | SC-N7 | SC-N5 |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | 200 | | SC-N7 | | SC-N8 | SC-N7 |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | 250 | | | | | SC-N8 |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | 300 | | SC-N8 | | SC-N11 | |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | 350 | | SC-N11 | | SC-N12 | SC-N11 |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | 500 | | SC-N12 | | | SC-N12 |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | 500 | | | | SC-N14 | |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | 600 | | SC-N14 | | | SC-N14 |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | 800 | | | | | |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | 800 | | | | | |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | 1200 | | | | SC-N16 | |
| | 500 | – | FRN400VG7S-4 | 1600 | | SC-N16 | | – | SC-N16 |

Note 1: For the MCCB and ELCB types, the rated current values recommended for 50°C or lower panel inside temperature are shown. Select an actual type according to facility short-circuit interrupting capacity.

Note 2: The magnetic contactor is selected on assumption that **the contactor is connected with HIV cable (allowable temperature: 75°C).** When connecting with other cables, reselect a magnetic contactor that matches the terminal size and the cable size.

# 8. Peripheral Equipment

## 8.3 Wire Size

### 8.3.1 Recommended Wire Size

(1) Under the 50°C or lower panel inside temperature

Table 8.3.1(1) Wire Size (50°C)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | | Recommended wire size [mm²] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Input circuit [L1/R, L2/S, L3/T] | | | | | | | | Output circuit [U, V, W] | | | | | | | |
| | | | | With DCR | | | | Without reactor | | | | CT use, HT use | | | | VT use | | | |
| | | CT use, HT use | VT use | Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Current [A] |
| | | | | 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | |
| Three-phase 200V | 0.75 | FRN0.75VG7S-2 | – | 2.0 | 2.0 | 2.0 | 3.1 | 2.0 | 2.0 | 2.0 | 6.4 | 2.0 | 2.0 | 2.0 | 5.0 | – | | | |
| | 1.5 | FRN1.5VG7S-2 | FRN0.75VG7S-2 | | | | 5.7 | | | | 11.1 | | | | 8.0 | 2.0 | 2.0 | 2.0 | 8.0 |
| | 2.2 | FRN2.2VG7S-2 | FRN1.5VG7S-2 | | | | 8.3 | 3.5 | | | 16.1 | | | | 11 | | | | 11 |
| | 3.7 | FRN3.7VG7S-2 | FRN2.2VG7S-2 | | | | 14.0 | 5.5 | 3.5 | | 25.5 | 3.5 | | | 18 | 3.5 | | | 18 |
| | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | 3.5 | | | 19.7 | 14 | 5.5 | 3.5 | 40.8 | 5.5 | 3.5 | | 27 | 5.5 | 3.5 | | 27 |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | 5.5 | 3.5 | | 26.9 | 22 | 8.0 | 5.5 | 52.6 | 14 | 5.5 | 3.5 | 37 | 14 | 5.5 | 3.5 | 37 |
| | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | 14 | 5.5 | 3.5 | 39.0 | 38 | 14 | 14 | 76.9 | 14 | 8.0 | 5.5 | 49 | 14 | 8.0 | 5.5 | 49 |
| | 15 | FRN15VG7S-2 | FRN11VG7S-2 | 22 | 8.0 | 5.5 | 54.0 | 60 | 22 | 14 | 98.5 | 22 | 14 | 8.0 | 63 | 22 | 14 | 8.0 | 63 |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | 38 | 14 | 8.0 | 66.2 | 60 | 38 | 22 | 117 | 38 | 14 | 14 | 74 | 38 | 14 | 14 | 74 |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | 38 | 14 | 14 | 78.8 | – | 38 | 38 | 136 | 38 | 22 | 14 | 90 | 38 | 22 | 14 | 90 |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | 60 | 38 | 22 | 109 | – | 60 | 38 | 168 | 60 | 38 | 22 | 116 | 60 | 38 | 22 | 116 |
| | 37 | – | FRN30VG7S-2 | – | 38 | 38 | 135 | – | 60 | 60 | 204 | 100 | 38 | 38 | 145 | 100 | 38 | 38 | 145 |
| | | FRN37VG7S-2 | – | 100 | | | | | 100 | | | | | | | | | | |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | – | 60 | 38 | 163 | – | 100 | 60 | 243 | – | 60 | 38 | 180 | – | 60 | 38 | 180 |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | – | 100 | 60 | 199 | – | 100 | 100 | 291 | – | 100 | 60 | 215 | – | 100 | 60 | 215 |
| | 75 | FRN75VG7S-2 | FRN55VG7S-2 | – | 150 | 100 | 272 | – | | | | – | 150 | 100 | 283 | – | 150 | 100 | 283 |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | – | 150 | 150 | 327 | | | | | – | 150 | 150 | 346 | – | 150 | 150 | 346 |
| | 110 | – | FRN90VG7S-2 | – | 200 | 150 | 400 | | | | | – | | | | – | 200 | 150 | 415 |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | 2.0 | 2.0 | 2.0 | 7.1 | 2.0 | 2.0 | 2.0 | 14.9 | 2.0 | 2.0 | 2.0 | 9.0 | – | | | |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | | | | 10.0 | 5.5 | | | 21.5 | | | | 13.5 | 2.0 | 2.0 | 2.0 | 13.5 |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | | | | 13.5 | 5.5 | 3.5 | | 27.9 | 3.5 | | | 18.5 | 3.5 | | | 18.5 |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | 3.5 | | | 19.8 | 14 | 5.5 | 3.5 | 39.1 | 5.5 | 3.5 | | 24.5 | 5.5 | 3.5 | | 24.5 |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | 5.5 | 3.5 | | 26.8 | 14 | 8.0 | 5.5 | 50.3 | 8.0 | 3.5 | 3.5 | 32 | 8.0 | 3.5 | 3.5 | 32 |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | 8.0 | 5.5 | 3.5 | 33.2 | 22 | 14 | 8.0 | 59.9 | 14 | 5.5 | 3.5 | 39 | 14 | 5.5 | 3.5 | 39 |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | 14 | 5.5 | 3.5 | 39.3 | 38 | 14 | 8.0 | 69.3 | 14 | 8.0 | 5.5 | 45 | 14 | 8.0 | 5.5 | 45 |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | 22 | 8.0 | 5.5 | 54 | 38 | 22 | 14 | 86 | 22 | 14 | 8.0 | 60 | 22 | 14 | 8.0 | 60 |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | 38 | 14 | 8.0 | 67 | 60 | 22 | 22 | 104 | 38 | 14 | 14 | 75 | 38 | 14 | 14 | 75 |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | 38 | 22 | 14 | 81 | 60 | 38 | 22 | 124 | 38 | 22 | 14 | 91 | 38 | 22 | 14 | 91 |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | 60 | 22 | 14 | 100 | – | 60 | 38 | 150 | 60 | 38 | 22 | 112 | 60 | 38 | 22 | 112 |
| | 75 | – | FRN55VG7S-4 | – | 38 | 38 | 134 | – | | | | 100 | 60 | 38 | 150 | 100 | 60 | 38 | 150 |
| | | FRN75VG7S-4 | – | 100 | | | | | | | | | | | | | | | |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | 100 | 60 | 38 | 160 | | | | | – | 60 | 38 | 176 | – | 60 | 38 | 176 |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | – | 60 | 60 | 196 | | | | | – | 100 | 60 | 210 | – | 100 | 60 | 210 |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | – | 100 | 60 | 232 | | | | | – | 100 | 100 | 253 | – | 100 | 100 | 253 |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | – | 150 | 100 | 282 | | | | | – | 150 | 100 | 304 | – | 150 | 100 | 304 |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | – | 150 | 150 | 352 | | | | | – | 200 | 150 | 377 | – | 200 | 150 | 377 |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | – | 200 | 150 | 385 | | | | | – | 200 | 150 | 415 | – | 200 | 150 | 415 |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | – | 250 | 200 | 491 | | | | | – | 325 | 200 | 520 | – | 325 | 200 | 520 |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | – | 325 | 250 | 552 | | | | | – | 325 | 200 | 585 | – | 325 | 200 | 585 |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | – | 400 | 250 | 624 | | | | | – | 400 | 325 | 650 | – | 400 | 325 | 650 |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | – | 500 | 325 | 704 | | | | | – | 500 | 325 | 740 | – | 500 | 325 | 740 |
| | 500 | – | FRN400VG7S-4 | – | – | 500 | 880 | | | | | – | | | | – | – | 500 | 960 |

*1): Allowable temperature **60°C** means using **"IV wire"**; **75°C** means **"600V HIV insulation wire"**; and **90°C** means **"600V cross-linking polyethylene insulation wire"**.

- Select an appropriate wire size referring to **Table 8.1** and **Table 8.3.2** if conditions such as ambient temperature or power voltage are different.

Table 8.3.1(1) Wire Size (50°C) (cont'd)

| Recommended wire size [mm²] | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC link circuit [P1, P(+)] | | | | | | | | Braking circuit [P(+), DB, N(–)] | | | | | | | | Control circuit | | | Auxiliary control power supply [R0, T0] | | | Grounding [⏚G] | | |
| CT use, HT use | | | | VT use | | | | CT use, HT use | | | | VT use | | | | | | | | | | | | |
| Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Current [A] | Allowable temp. *1) | | | Allowable temp. *1) | | | Allowable temp. *1) | | |
| 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | | 60°C | 75°C | 90°C | 60°C | 75°C | 90°C | 60°C | 75°C | 90°C |
| | | | 3.8 | – | | | | | | | 1.4 | – | | | | | | | | | | | | |
| 2.0 | | | 7.0 | 2.0 | | | 7.0 | | | | 1.9 | | | | 1.4 | | | | | | | 2.0 | | |
| | 2.0 | 2.0 | 10 | | 2.0 | 2.0 | 10 | | | | 2.3 | | | | 1.9 | | | | | | | | 2.0 | 2.0 |
| 3.5 | | | 17 | 3.5 | | | 17 | 2.0 | | | 3.4 | | | | 2.3 | | | | | | | | | |
| 5.5 | | | 24 | 5.5 | | | 24 | | 2.0 | | 5.1 | 2.0 | | | 3.4 | | | | | | | 3.5 | | |
| 8.0 | 3.5 | 3.5 | 33 | 8.0 | 3.5 | 3.5 | 33 | | | 2.0 | 6.8 | | 2.0 | | 5.1 | | | | | | | 5.5 | 3.5 | |
| 14 | 8.0 | 5.5 | 48 | 14 | 8.0 | 5.5 | 48 | | | | 10.2 | | | 2.0 | 6.8 | | | | | | | 14 | 5.5 | 3.5 |
| 22 | 14 | 8.0 | 66 | 22 | 14 | 8.0 | 66 | | | | 13.7 | | | | 10.2 | | | | | | | 22 | 8.0 | 5.5 |
| 38 | 22 | 14 | 81 | 38 | 22 | 14 | 81 | 35 | | | 17.6 | | | | 13.0 | 1.25 | 1.25 | 1.25 | 2.0 | 2.0 | 2.0 | 38 | 14 | 8.0 |
| 60 | 22 | 14 | 96 | 60 | 22 | 14 | 96 | | | | 20.3 | 3.5 | | | 16.4 | | | | | | | 38 | 14 | 14 |
| – | 38 | 38 | 133 | – | 38 | 38 | 133 | 8.0 | 3.5 | | 30.0 | | | | 20.3 | | | | | | | 60 | 38 | 22 |
| – | 60 | 38 | 165 | – | 60 | 38 | 165 | 14 | 5.5 | 3.5 | 35.1 | 8.0 | 3.5 | | 28.5 | | | | | | | – 100 | 38 | 38 |
| – | 100 | 60 | 200 | - | 100 | 60 | 200 | 14 | 5.5 | 3.5 | 41.1 | 8.0 | 5.5 | 3.5 | 33.2 | | | | | | | – | 60 | 38 |
| – | 100 | 60 | 244 | - | 100 | 60 | 244 | 14 | 8.0 | 5.5 | 50.8 | 14 | | | 38.9 | | | | | | | – | 100 | 60 |
| – | 150 | 100 | 333 | - | 150 | 100 | 333 | 38 | 14 | 8.0 | 68.5 | 14 | 8.0 | 5.5 | 50.8 | | | | | | | – | 150 | 100 |
| – | 200 | 150 | 400 | - | 200 | 150 | 400 | 38 | 22 | 14 | 83.0 | 22 | 14 | 8.0 | 64.2 | | | | | | | – | 150 | 150 |
| – | | | | - | 250 | 200 | 490 | – | | | | 38 | 14 | 14 | 78.6 | | | | | | | – | 200 | 150 |
| 2.0 | | | 8.7 | – | | | | | | | 1.7 | – | | | | | | | | | | | | |
| | 2.0 | 2.0 | 12 | 20 | | | 12 | | | | 2.5 | | | | 1.7 | | | | | | | 2.0 | 2.0 | |
| 3.5 | | | 17 | 3.5 | 2.0 | 2.0 | 17 | | | | 3.4 | | | | 2.5 | | | | | | | | | 2.0 |
| 5.5 | | | 24 | 5.5 | | | 24 | 2.0 | | | 5.1 | | | | 3.4 | | | | | | | 3.5 | | |
| 8.0 | 3.5 | 3.5 | 32 | 8.0 | 3.5 | 3.5 | 32 | | 2.0 | | 6.8 | 2.0 | | | 5.1 | | | | | | | 5.5 | 3.5 | |
| 14 | 5.5 | 3.5 | 40 | 14 | 5.5 | 3.5 | 40 | | | 2.0 | 8.8 | | 2.0 | | 6.5 | | | | | | | 8.0 | 5.5 | 3.5 |
| 14 | 8.0 | 5.5 | 48 | 14 | 8.0 | 5.5 | 48 | | | | 10.2 | | | 2.0 | 8.2 | | | | | | | 14 | 5.5 | 3.5 |
| 22 | 14 | 8.0 | 66 | 22 | 14 | 8.0 | 66 | | | | 15.0 | | | | 10.2 | | | | | | | 22 | 8.0 | 5.5 |
| 38 | 22 | 14 | 82 | 38 | 22 | 14 | 82 | 3.5 | | | 17.6 | | | | 14.3 | | | | | | | 38 | 14 | 8.0 |
| 60 | 22 | 14 | 99 | 60 | 22 | 14 | 99 | 3.5 | | | 20.5 | 3.5 | | | 16.6 | 1.25 | 1.25 | 1.25 | 2.0 | 2.0 | 2.0 | 38 | 22 | 14 |
| 60 | 38 | 22 | 122 | 60 | 38 | 22 | 122 | 5.5 | 3.5 | | 25.2 | 3.5 | | | 19.4 | | | | | | | 60 | 22 | 14 |
| 100 | 60 | 38 | 164 | 100 | 60 | 38 | 164 | 8.0 | 5.5 | 3.5 | 34.6 | 5.5 | 3.5 | | 25.2 | | | | | | | – 100 | 38 | 38 |
| – | 60 | 60 | 196 | – | 60 | 60 | 196 | 14 | 5.5 | 3.5 | 41.6 | 8.0 | 3.5 | 3.5 | 32.5 | | | | | | | 100 | 60 | 38 |
| – | 100 | 60 | 240 | – | 100 | 60 | 240 | 14 | 8.0 | 5.5 | 50.8 | 14 | 5.5 | 3.5 | 39.4 | | | | | | | – | 60 | 60 |
| – | 150 | 100 | 284 | – | 150 | 100 | 284 | 22 | 14 | 8.0 | 61.7 | 14 | 8.0 | 5.5 | 47.6 | | | | | | | – | 100 | 60 |
| – | 150 | 150 | 345 | – | 150 | 150 | 345 | 38 | 14 | 14 | 73.9 | 22 | 14 | 8.0 | 58.2 | | | | | | | – | 150 | 100 |
| – | 250 | 150 | 431 | – | 250 | 150 | 431 | 38 | 22 | 14 | 92.6 | 38 | 14 | 14 | 70.7 | | | | | | | – | 150 | 150 |
| – | 250 | 200 | 472 | – | 250 | 200 | 472 | 60 | 22 | 22 | 102 | 38 | 22 | 14 | 83.2 | | | | | | | – | 200 | 150 |
| – | 400 | 250 | 601 | – | 400 | 250 | 601 | 100 | 38 | 38 | 138 | 60 | 22 | 14 | 98.1 | | | | | | | – | 250 | 200 |
| – | 400 | 325 | 676 | – | 400 | 325 | 676 | 100 | 38 | 38 | 147 | 60 | 38 | 22 | 125 | | | | | | | – | 325 | 250 |
| – | 500 | 400 | 764 | – | 500 | 400 | 764 | 150 | 60 | 38 | 175 | 100 | 38 | 38 | 133 | | | | | | | – | 400 | 250 |
| – | – | 500 | 862 | – | – | 500 | 862 | 150 | 60 | 38 | 186 | 100 | 60 | 38 | 159 | | | | | | | – | 500 | 325 |
| – | | | | – | – | – | 1078 | - | | | | 150 | 60 | 38 | 178 | | | | | | | – | – | 500 |

(2) Under the 40°C or lower panel inside temperature

Table 8.3.1(2) Wire Size (40°C)

| Power supply voltage | Nominal applied motor [kW] | Inverter type: CT use, HT use | Inverter type: VT use | Recommended wire size [mm²] Input circuit [L1/R, L2/S, L3/T] With DCR Allowable temp. *1) 60°C | 75°C | 90°C | Current [A] | Without reactor Allowable temp. *1) 60°C | 75°C | 90°C | Current [A] | Output circuit [U, V, W] CT use, HT use Allowable temp. *1) 60°C | 75°C | 90°C | Current [A] | VT use Allowable temp. *1) 60°C | 75°C | 90°C | Current [A] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Three-phase 200V | 0.75 | FRN0.75VG7S-2 | – | 2.0 | 2.0 | 2.0 | 3.1 | 2.0 | 2.0 | 2.0 | 6.4 | 2.0 | 2.0 | 2.0 | 5.0 | – | | | |
| | 1.5 | FRN1.5VG7S-2 | FRN0.75VG7S-2 | | | | 5.7 | | | | 11.1 | | | | 8.0 | 2.0 | 2.0 | 2.0 | 8.0 |
| | 2.2 | FRN2.2VG7S-2 | FRN1.5VG7S-2 | | | | 8.3 | | | | 16.1 | | | | 11 | | | | 11 |
| | 3.7 | FRN3.7VG7S-2 | FRN2.2VG7S-2 | | | | 14.0 | 3.5 | | | 25.5 | | | | 18 | | | | 18 |
| | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | | | | 19.7 | 8.0 | 5.5 | 3.5 | 40.8 | 3.5 | | | 27 | 3.5 | | | 27 |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | 3.5 | | | 26.9 | 14 | 8.0 | 5.5 | 52.6 | 5.5 | 3.5 | | 37 | 5.5 | 3.5 | | 37 |
| | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | 5.5 | 5.5 | 3.5 | 39.0 | 22 | 14 | 8.0 | 76.9 | 8.0 | 5.5 | 3.5 | 49 | 8.0 | 5.5 | 3.5 | 49 |
| | 15 | FRN15VG7S-2 | FRN11VG7S-2 | 14 | 8.0 | 5.5 | 54.0 | 38 | 22 | 14 | 98.5 | 14 | 8.0 | 5.5 | 63 | 14 | 8.0 | 5.5 | 63 |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | 14 | 14 | 8.0 | 66.2 | 38 | 22 | 22 | 117 | 22 | 14 | 8.0 | 74 | 22 | 14 | 8.0 | 74 |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | 22 | 14 | 14 | 78.8 | 60 | 38 | 22 | 136 | 22 | 14 | 14 | 90 | 22 | 14 | 14 | 90 |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | 38 | 22 | 14 | 109 | 60 | 38 | 38 | 168 | 38 | 22 | 22 | 116 | 38 | 22 | 22 | 116 |
| | 37 | – | FRN30VG7S-2 | 60 | 38 | 22 | 135 | 60 | 60 | 38 | 204 | 60 | 38 | 22 | 145 | 60 | 38 | 22 | 145 |
| | | FRN37VG7S-2 | – | | | | | 100 | | | | | | | | | | | |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | 60 | 38 | 38 | 163 | 100 | 100 | 60 | 243 | 100 | 60 | 38 | 180 | 100 | 60 | 38 | 180 |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | 100 | 60 | 38 | 199 | – | 100 | 100 | 291 | 100 | 60 | 60 | 215 | 100 | 60 | 60 | 215 |
| | 75 | – | FRN55VG7S-2 | – | 100 | 60 | 272 | – | | | | 150 | 100 | 100 | 283 | 150 | 100 | 100 | 283 |
| | | FRN75VG7S-2 | – | 150 | | | | | | | | | | | | | | | |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | 200 | 150 | 100 | 327 | | | | | 200 | 150 | 100 | 346 | 200 | 150 | 100 | 346 |
| | 110 | – | FRN90VG7S-2 | 250 | 150 | 150 | 400 | | | | | – | | | | 250 | 150 | 150 | 415 |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | 2.0 | 2.0 | 2.0 | 7.1 | 2.0 | 2.0 | 2.0 | 14.9 | 2.0 | 2.0 | 2.0 | 9.0 | – | | | |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | | | | 10.0 | | | | 21.5 | | | | 13.5 | 2.0 | 2.0 | 2.0 | 13.5 |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | | | | 13.5 | 3.5 | | | 27.9 | | | | 18.5 | | | | 18.5 |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | | | | 19.8 | 5.5 | 5.5 | 3.5 | 39.1 | 3.5 | | | 24.5 | 3.5 | | | 24.5 |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | 3.5 | | | 26.8 | 14 | 5.5 | 5.5 | 50.3 | 3.5 | 3.5 | | 32 | 3.5 | 3.5 | | 32 |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | 5.5 | 3.5 | | 33.2 | 14 | 8.0 | 5.5 | 59.9 | 5.5 | 3.5 | 3.5 | 39 | 5.5 | 3.5 | 3.5 | 39 |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | 5.5 | 5.5 | 3.5 | 39.3 | 14 | 14 | 8.0 | 69.3 | 8.0 | 5.5 | 3.5 | 45 | 8.0 | 5.5 | 3.5 | 45 |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | 14 | 8.0 | 5.5 | 54 | 22 | 14 | 14 | 86 | 14 | 8.0 | 5.5 | 60 | 14 | 8.0 | 5.5 | 60 |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | 14 | 14 | 8.0 | 67 | 38 | 22 | 14 | 104 | 22 | 14 | 8.0 | 75 | 22 | 14 | 8.0 | 75 |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | 22 | 14 | 14 | 81 | 38 | 38 | 22 | 124 | 22 | 14 | 14 | 91 | 22 | 14 | 14 | 91 |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | 38 | 22 | 14 | 100 | 60 | 38 | 38 | 150 | 38 | 22 | 14 | 112 | 38 | 22 | 14 | 112 |
| | 75 | FRN75VG7S-4 | FRN55VG7S-4 | 60 | 38 | 22 | 134 | – | | | | 60 | 38 | 38 | 150 | 60 | 38 | 38 | 150 |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | 60 | 38 | 38 | 160 | | | | | 60 | 60 | 38 | 176 | 60 | 60 | 38 | 176 |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | 100 | 60 | 38 | 196 | | | | | 100 | 60 | 60 | 210 | 100 | 60 | 60 | 210 |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | 100 | 60 | 60 | 232 | | | | | 150 | 100 | 60 | 253 | 150 | 100 | 60 | 253 |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | 150 | 100 | 100 | 282 | | | | | 150 | 100 | 100 | 304 | 150 | 100 | 100 | 304 |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | 200 | 150 | 100 | 352 | | | | | 200 | 150 | 100 | 377 | 200 | 150 | 100 | 377 |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | 250 | 150 | 150 | 385 | | | | | 250 | 150 | 150 | 415 | 250 | 150 | 150 | 415 |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | 325 | 200 | 150 | 491 | | | | | 325 | 250 | 200 | 520 | 325 | 250 | 200 | 520 |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | 400 | 250 | 200 | 552 | | | | | 400 | 250 | 200 | 585 | 400 | 250 | 200 | 585 |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | 500 | 325 | 250 | 624 | | | | | 500 | 325 | 250 | 650 | 500 | 325 | 250 | 650 |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | – | 400 | 250 | 704 | | | | | – | 400 | 325 | 740 | – | 400 | 325 | 740 |
| | 500 | – | FRN400VG7S-4 | – | 500 | 400 | 880 | | | | | – | | | | – | – | 400 | 960 |

* 1) Allowable temperature **60°C** means using **"IV wire"**; **75°C** means **"600V HIV insulation wire"**; and **90°C** means **"600V cross-linking polyethylene insulation wire"**.

- Select an appropriate wire size referring to **Table 8.1** and **Table 8.3.2** if conditions such as ambient temperature or power voltage are different.

Table 8.3.1(2) Wire Size (40°C) (cont'd)

| Recommended wire size [mm²] | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC link circuit current [P1, P(+)] | | | | | | | | Braking circuit [P(+), DB, N(–)] | | | | | | | | Control circuit | | | Auxiliary control power supply [R0, T0] | | | Grounding [⏚G] | | |
| CT use, HT use | | | | VT use | | | | CT use, HT use | | | | VT use | | | | | | | | | | | | |
| Allowable temp. *1) | | | Current | Allowable temp. *1) | | | Current | Allowable temp. *1) | | | Current | Allowable temp. *1) | | | Current | Allowable temp. *1) | | | Allowable temp. *1) | | | Allowable temp. *1) | | |
| 60°C | 75°C | 90°C | [A] | 60°C | 75°C | 90°C | [A] | 60°C | 75°C | 90°C | [A] | 60°C | 75°C | 90°C | [A] | 60°C | 75°C | 90°C | 60°C | 75°C | 90°C | 60°C | 75°C | 90°C |
| 2.0 | 2.0 | 2.0 | 3.8 | – | | | | 2.0 | 2.0 | 2.0 | 1.4 | – | | | | 1.25 | 1.25 | 1.25 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | | | 7.0 | 2.0 | 2.0 | 2.0 | 7.0 | | | | 1.9 | 2.0 | 2.0 | 2.0 | 1.4 | | | | | | | | | |
| | | | 10 | | | | 10 | | | | 2.3 | | | | 1.9 | | | | | | | | | |
| | | | 17 | | | | 17 | | | | 3.4 | | | | 2.3 | | | | | | | | | |
| | | | 24 | 3.5 | | | 24 | | | | 5.1 | | | | 3.4 | | | | | | | | | |
| 3.5 | | | 33 | 5.5 | 3.5 | | 33 | | | | 6.8 | | | | 5.1 | | | | | | | 3.5 | | |
| 8.0 | 5.5 | 3.5 | 48 | 8.0 | 8.0 | 5.5 | 48 | | | | 10.2 | | | | 6.8 | | | | | | | 5.5 | 5.5 | 3.5 |
| 14 | 8.0 | 5.5 | 60 | 14 | 14 | 8.0 | 66 | | | | 13.7 | | | | 10.2 | | | | | | | 14 | 8.0 | 5.5 |
| 14 | 14 | 8.0 | 81 | 22 | 14 | 14 | 81 | | | | 17.6 | | | | 13.0 | | | | | | | 14 | 14 | 8.0 |
| 22 | 14 | 8.0 | 96 | 38 | 22 | 14 | 96 | | | | 20.3 | | | | 16.4 | | | | | | | 22 | 14 | 14 |
| 38 | 22 | 22 | 133 | 60 | 38 | 22 | 133 | 3.5 | 3.5 | 2.0 | 30.0 | | | | 20.3 | | | | | | | 38 | 22 | 14 |
| 60 | 38 | 22 | 165 | 60 | 38 | 38 | 165 | 5.5 | 3.5 | 3.5 | 35.1 | 3.5 | | | 28.5 | | | | | | | 60 | 38 | 22 |
| 100 | 60 | 38 | 200 | 100 | 60 | 38 | 200 | 8.0 | 5.5 | 3.5 | 41.1 | 5.5 | 3.5 | | 33.2 | | | | | | | 60 | 38 | 38 |
| 100 | 60 | 60 | 244 | 100 | 100 | 60 | 244 | 14 | 5.5 | 5.5 | 50.8 | 5.5 | 3.5 | 3.5 | 38.9 | | | | | | | 100 | 60 | 38 |
| – | 100 | 100 | 333 | – | 150 | 100 | 333 | 14 | 14 | 8.0 | 68.5 | 14 | 5.5 | 5.5 | 50.8 | | | | | | | –<br>150 | 100 | 60 |
| – | 150 | 100 | 400 | – | 150 | 150 | 400 | 22 | 14 | 14 | 83.0 | 14 | 8.0 | 8.0 | 64.2 | | | | | | | 200 | 150 | 100 |
| – | | | | – | 200 | 150 | 490 | – | | | | 22 | 14 | 14 | 78.6 | | | | | | | 250 | 150 | 150 |
| 2.0 | 2.0 | 2.0 | 8.7 | – | | | | 2.0 | 2.0 | 2.0 | 1.7 | – | | | | 1.25 | 1.25 | 1.25 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| | | | 12 | 2.0 | 2.0 | 2.0 | 12 | | | | 2.5 | 2.0 | 2.0 | 2.0 | 1.7 | | | | | | | | | |
| | | | 27 | | | | 17 | | | | 3.4 | | | | 2.5 | | | | | | | | | |
| 3.5 | | | 24 | 3.5 | | | 24 | | | | 5.1 | | | | 3.4 | | | | | | | | | |
| 3.5 | 3.5 | | 32 | 5.5 | 3.5 | | 32 | | | | 6.8 | | | | 5.1 | | | | | | | 3.5 | | |
| 5.5 | 5.5 | 3.5 | 40 | 5.5 | 5.5 | 3.5 | 40 | | | | 8.8 | | | | 6.5 | | | | | | | 5.5 | 3.5 | |
| 8.0 | 5.5 | 5.5 | 48 | 8.0 | 5.5 | 5.5 | 48 | | | | 10.2 | | | | 8.2 | | | | | | | 5.5 | 5.5 | 3.5 |
| 14 | 14 | 8.0 | 66 | 14 | 14 | 8.0 | 66 | | | | 15.0 | | | | 10.2 | | | | | | | 14 | 8.0 | 5.5 |
| 22 | 14 | 14 | 82 | 22 | 14 | 14 | 82 | | | | 17.6 | | | | 14.3 | | | | | | | 14 | 14 | 8.0 |
| 22 | 22 | 14 | 99 | 38 | 22 | 14 | 99 | | | | 20.5 | | | | 16.6 | | | | | | | 22 | 14 | 14 |
| 38 | 22 | 22 | 122 | 38 | 22 | 22 | 122 | 3.5 | 2.0 | 2.0 | 25.2 | | | | 19.4 | | | | | | | 38 | 22 | 14 |
| 60 | 38 | 38 | 164 | 60 | 38 | 38 | 164 | 5.5 | 3.5 | 3.5 | 34.6 | 3.5 | 2.0 | 2.0 | 25.2 | | | | | | | 60 | 38 | 22 |
| 60 | 60 | 38 | 196 | – | 60 | 38 | 196 | 8.0 | 5.5 | 3.5 | 41.6 | 5.5 | 3.5 | 2.0 | 32.5 | | | | | | | 60 | 38 | 38 |
| 100 | 100 | 60 | 240 | – | 100 | 60 | 240 | 14 | 5.5 | 5.5 | 50.8 | 5.5 | 5.5 | 3.5 | 39.4 | | | | | | | 100 | 60 | 38 |
| – | 100 | 100 | 284 | – | 100 | 100 | 284 | 14 | 8.0 | 5.5 | 61.7 | 8.0 | 5.5 | 5.5 | 47.6 | | | | | | | 100 | 60 | 60 |
| – | 150 | 100 | 345 | – | 150 | 100 | 345 | 22 | 14 | 8.0 | 73.9 | 14 | 8.0 | 5.5 | 58.2 | | | | | | | 150 | 100 | 100 |
| – | 200 | 150 | 431 | – | 200 | 150 | 431 | 22 | 14 | 14 | 92.6 | 14 | 14 | 8.0 | 70.7 | | | | | | | 200 | 150 | 100 |
| – | 200 | 150 | 472 | – | 200 | 150 | 472 | 38 | 22 | 14 | 102 | 22 | 14 | 14 | 83.2 | | | | | | | 250 | 150 | 150 |
| – | 325 | 200 | 601 | – | 325 | 200 | 601 | 60 | 38 | 22 | 138 | 38 | 22 | 14 | 98.1 | | | | | | | 325 | 200 | 150 |
| – | 325 | 250 | 676 | – | 325 | 250 | 676 | 60 | 38 | 22 | 147 | 38 | 38 | 22 | 125 | | | | | | | 400 | 250 | 200 |
| – | 400 | 325 | 764 | – | 400 | 325 | 764 | 60 | 60 | 38 | 175 | 60 | 38 | 22 | 133 | | | | | | | 500 | 325 | 250 |
| – | 500 | 400 | 862 | – | 500 | 400 | 862 | 100 | 60 | 38 | 186 | 60 | 38 | 38 | 159 | | | | | | | – | 400 | 250 |
| – | | | | – | – | 500 | 1078 | – | | | | 100 | 60 | 38 | 178 | | | | | | | – | 500 | 400 |

# 8. Peripheral Equipment

## 8.3.2 Recommended Wire Size Classified by Power Supply Conditions

● IV wire (Maximum allowable temperature : 60°C)

Table 8.3.2(1) Allowable Current of Insulation Wire

| Wire size [mm$^2$] | Allowable current reference value (up to 30°C) Io [A] | Wiring outside duct | | | | | Wiring in the duct (Max. 3 wires in one duct) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 35°C (Iox0.91) [A] | 40°C (Iox0.82) [A] | 45°C (Iox0.71) [A] | 50°C (Iox0.58) [A] | 55°C (Iox0.41) [A] | 35°C (Iox0.63) [A] | 40°C (Iox0.57) [A] | 45°C (Iox0.49) [A] | 50°C (Iox0.40) [A] |
| 2.0 | 27 | 24 | 22 | 19 | 15 | 11 | 17 | 15 | 13 | 10 |
| 3.5 | 37 | 33 | 30 | 26 | 21 | 15 | 23 | 21 | 18 | 14 |
| 5.5 | 49 | 44 | 40 | 34 | 28 | 20 | 30 | 27 | 24 | 19 |
| 8.0 | 61 | 55 | 50 | 43 | 35 | 25 | 38 | 34 | 29 | 24 |
| 14 | 88 | 80 | 72 | 62 | 51 | 36 | 55 | 50 | 43 | 35 |
| 22 | 115 | 104 | 94 | 81 | 66 | 47 | 72 | 65 | 56 | 46 |
| 38 | 162 | 147 | 132 | 115 | 93 | 66 | 102 | 92 | 79 | 64 |
| 60 | 217 | 197 | 177 | 154 | 125 | 88 | 136 | 123 | 106 | 86 |
| 100 | 298 | 271 | 244 | 211 | 172 | 122 | 187 | 169 | 146 | 119 |
| 150 | 395 | 359 | 323 | 280 | 229 | 161 | 248 | 225 | 193 | 158 |
| 200 | 469 | 426 | 384 | 332 | 272 | 192 | 295 | 267 | 229 | 187 |
| 250 | 556 | 505 | 455 | 394 | 322 | 227 | 350 | 316 | 272 | 222 |
| 325 | 650 | 591 | 533 | 461 | 377 | 266 | 409 | 370 | 318 | 260 |
| 400 | 745 | 677 | 610 | 528 | 432 | 305 | 469 | 424 | 365 | 298 |
| 500 | 842 | 766 | 690 | 597 | 488 | 345 | 530 | 479 | 412 | 336 |
| 2 x 100 | 497 | 452 | 407 | 352 | 288 | 203 | 313 | 283 | 243 | 198 |
| 2 x 150 | 658 | 598 | 539 | 467 | 381 | 269 | 414 | 375 | 322 | 263 |
| 2 x 200 | 782 | 711 | 641 | 555 | 453 | 320 | 492 | 445 | 383 | 312 |
| 2 x 250 | 927 | 843 | 760 | 658 | 537 | 380 | 584 | 528 | 454 | 370 |
| 2 x 325 | 1083 | 985 | 888 | 768 | 628 | 444 | 682 | 617 | 530 | 433 |
| 2 x 400 | 1242 | 1130 | 1018 | 881 | 720 | 509 | 782 | 707 | 608 | 496 |
| 2 x 500 | 1403 | 1276 | 1150 | 996 | 813 | 575 | 883 | 799 | 687 | 561 |

● HIV wire (Maximum allowable temperature : 75°C)

Table 8.3.2(2) Allowable Current of Insulation Wire

| Wire size [mm$^2$] | Allowable current reference value (up to 30°C) Iox1.22 [A] | Wiring outside duct | | | | | Wiring in the duct (Max. 3 wires in one duct) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 35°C (Iox1.15) [A] | 40°C (Iox1.08) [A] | 45°C (Iox1.00) [A] | 50°C (Iox0.91) [A] | 55°C (Iox0.82) [A] | 35°C (Iox0.80) [A] | 40°C (Iox0.75) [A] | 45°C (Iox0.70) [A] | 50°C (Iox0.63) [A] |
| 2.0 | 32 | 31 | 29 | 27 | 24 | 22 | 21 | 20 | 18 | 17 |
| 3.5 | 45 | 42 | 39 | 37 | 33 | 30 | 29 | 27 | 25 | 23 |
| 5.5 | 59 | 56 | 52 | 49 | 44 | 40 | 39 | 36 | 34 | 30 |
| 8.0 | 74 | 70 | 65 | 61 | 55 | 50 | 48 | 45 | 42 | 38 |
| 14 | 107 | 101 | 95 | 88 | 80 | 72 | 70 | 66 | 61 | 55 |
| 22 | 140 | 132 | 124 | 115 | 104 | 94 | 92 | 86 | 80 | 72 |
| 38 | 197 | 186 | 174 | 162 | 147 | 132 | 129 | 121 | 113 | 102 |
| 60 | 264 | 249 | 234 | 217 | 197 | 177 | 173 | 162 | 151 | 136 |
| 100 | 363 | 342 | 321 | 298 | 271 | 244 | 238 | 223 | 208 | 187 |
| 150 | 481 | 454 | 426 | 395 | 359 | 323 | 316 | 296 | 276 | 248 |
| 200 | 572 | 539 | 506 | 469 | 426 | 384 | 375 | 351 | 328 | 295 |
| 250 | 678 | 639 | 600 | 556 | 505 | 455 | 444 | 417 | 389 | 350 |
| 325 | 793 | 747 | 702 | 650 | 591 | 533 | 520 | 487 | 455 | 409 |
| 400 | 908 | 856 | 804 | 745 | 677 | 610 | 596 | 558 | 521 | 469 |
| 500 | 1027 | 968 | 909 | 842 | 766 | 690 | 673 | 631 | 589 | 530 |
| 2 x 100 | 606 | 571 | 536 | 497 | 452 | 407 | 397 | 372 | 347 | 313 |
| 2 x 150 | 802 | 756 | 710 | 658 | 598 | 539 | 526 | 493 | 460 | 414 |
| 2 x 200 | 954 | 899 | 844 | 782 | 711 | 641 | 625 | 586 | 547 | 492 |
| 2 x 250 | 1130 | 1066 | 1001 | 927 | 843 | 760 | 741 | 695 | 648 | 584 |
| 2 x 325 | 1321 | 1245 | 1169 | 1083 | 985 | 888 | 866 | 812 | 758 | 682 |
| 2 x 400 | 1515 | 1428 | 1341 | 1242 | 1130 | 1018 | 993 | 931 | 869 | 782 |
| 2 x 500 | 1711 | 1613 | 1515 | 1403 | 1276 | 1150 | 1122 | 1052 | 982 | 883 |

● 600V cross-linking polyethylene insulation wire (Maximum allowable temperature : 90°C)

Table 8.3.2(3) Allowable Current of Insulation Wire

| Wire size [mm$^2$] | Allowable current reference value (up to 30°C) Iox1.41 [A] | Wiring outside duct | | | | | Wiring in the duct (Max. 3 wires in one duct) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 35°C (Iox1.35) [A] | 40°C (Iox1.29) [A] | 45°C (Iox1.22) [A] | 50°C (Iox1.15) [A] | 55°C (Iox1.08) [A] | 35°C (Iox0.94) [A] | 40°C (Iox0.90) [A] | 45°C (Iox0.85) [A] | 50°C (Iox0.80) [A] |
| 2.0 | 38 | 36 | 34 | 32 | 31 | 29 | 25 | 24 | 22 | 21 |
| 3.5 | 52 | 49 | 47 | 45 | 42 | 39 | 34 | 33 | 31 | 29 |
| 5.5 | 69 | 66 | 63 | 59 | 56 | 52 | 46 | 44 | 41 | 39 |
| 8.0 | 86 | 82 | 78 | 74 | 70 | 65 | 57 | 54 | 51 | 48 |
| 14 | 124 | 118 | 113 | 107 | 101 | 95 | 82 | 79 | 74 | 70 |
| 22 | 162 | 155 | 148 | 140 | 132 | 124 | 108 | 103 | 97 | 92 |
| 38 | 228 | 218 | 208 | 197 | 186 | 174 | 152 | 145 | 137 | 129 |
| 60 | 305 | 292 | 279 | 264 | 249 | 234 | 203 | 195 | 184 | 173 |
| 100 | 420 | 402 | 384 | 363 | 342 | 321 | 280 | 268 | 253 | 238 |
| 150 | 556 | 533 | 509 | 481 | 454 | 426 | 371 | 355 | 335 | 316 |
| 200 | 661 | 633 | 605 | 572 | 539 | 506 | 440 | 422 | 398 | 375 |
| 250 | 783 | 750 | 717 | 678 | 639 | 600 | 522 | 500 | 472 | 444 |
| 325 | 916 | 877 | 838 | 793 | 747 | 702 | 611 | 585 | 552 | 520 |
| 400 | 1050 | 1005 | 961 | 908 | 856 | 804 | 700 | 670 | 633 | 596 |
| 500 | 1187 | 1136 | 1086 | 1027 | 968 | 909 | 791 | 757 | 715 | 673 |
| 2 x 100 | 700 | 670 | 641 | 606 | 571 | 536 | 467 | 447 | 422 | 397 |
| 2 x 150 | 927 | 888 | 848 | 802 | 756 | 710 | 618 | 592 | 559 | 526 |
| 2 x 200 | 1102 | 1055 | 1008 | 954 | 899 | 844 | 735 | 703 | 664 | 625 |
| 2 x 250 | 1307 | 1251 | 1195 | 1130 | 1066 | 1001 | 871 | 834 | 787 | 741 |
| 2 x 325 | 1527 | 1462 | 1397 | 1321 | 1245 | 1169 | 1018 | 974 | 920 | 866 |
| 2 x 400 | 1751 | 1676 | 1602 | 1515 | 1428 | 1341 | 1167 | 1117 | 1055 | 993 |
| 2 x 500 | 1978 | 1894 | 1809 | 1711 | 1613 | 1515 | 1318 | 1262 | 1192 | 1122 |

# 8. Peripheral Equipment

## 8.4 Braking Unit and Braking Resistor

### 8.4.1 10%ED

● CT use

Table 8.4.1(1) Braking Unit and Braking Resistor (Standard)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | Option: Braking unit Type | Option: Braking unit Q'ty | Option: Braking resistor Type | Option: Braking resistor Q'ty | Option: Braking resistor Ohmic value | Maximum braking torque [%] | Torque [N·m] 50Hz | Torque [N·m] 60Hz | Cont. braking (150% torque conversion value) Braking time [s] | Cont. braking (150% torque conversion value) Discharging capability [kWs] | Repetitive braking (100s or less cycle) Duty cycle [%ED] | Repetitive braking (100s or less cycle) Average loss [kW] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.75 | FRN0.75VG7S-2 | | | DB2.2V-21B | 1 | 30 | 150 | 7.16 | 5.97 | 10 | 16.5 | 10 | 0.165 |
| | 1.5 | FRN1.5VG7S-2 | | | DB2.2V-21B | 1 | 30 | 150 | 14.3 | 11.9 | 10 | 16.5 | 10 | 0.165 |
| | 2.2 | FRN2.2VG7S-2 | | | DB2.2V-21B | 1 | 30 | 150 | 21.0 | 17.5 | 10 | 16.5 | 10 | 0.165 |
| | 3.7 | FRN3.7VG7S-2 | | | DB3.7V-21B | 1 | 24 | 150 | 35.3 | 29.4 | 10 | 27.8 | 10 | 0.278 |
| | 5.5 | FRN5.5VG7S-2 | | | DB5.5V-21B | 1 | 16 | 150 | 52.5 | 43.8 | 10 | 41.3 | 10 | 0.413 |
| | 7.5 | FRN7.5VG7S-2 | | | DB7.5V-21B | 1 | 12 | 150 | 71.6 | 59.7 | 10 | 56.3 | 10 | 0.563 |
| | 11 | FRN11VG7S-2 | – | – | DB11V-21B | 1 | 8.0 | 150 | 105 | 87.5 | 10 | 82.5 | 10 | 0.825 |
| Three-phase 200V | 15 | FRN15VG7S-2 | | | DB15V-21B | 1 | 6.0 | 150 | 143 | 119 | 10 | 113 | 10 | 1.13 |
| | 18.5 | FRN18.5VG7S-2 | | | DB18.5V-21B | 1 | 4.5 | 150 | 177 | 147 | 10 | 139 | 10 | 1.39 |
| | 22 | FRN22VG7S-2 | | | DB22V-21B | 1 | 4.0 | 150 | 210 | 175 | 10 | 165 | 10 | 1.65 |
| | 30 | FRN30VG7S-2 | | | DB30V-21B | 1 | 2.5 | 150 | 286 | 239 | 10 | 225 | 10 | 2.25 |
| | 37 | FRN37VG7S-2 | | | DB37V-21B | 1 | 2.25 | 150 | 353 | 294 | 10 | 278 | 10 | 2.78 |
| | 45 | FRN45VG7S-2 | | | DB45V-21B | 1 | 2.0 | 150 | 430 | 358 | 10 | 338 | 10 | 3.38 |
| | 55 | FRN55VG7S-2 | | | DB55V-21C | 1 | 1.6 | 150 | 525 | 438 | 10 | 413 | 10 | 4.13 |
| | 75 | FRN75VG7S-2 | BU55-2C | 2 | DB75V-21C | 1 | 1.2 | 150 | 716 | 597 | 10 | 563 | 10 | 5.63 |
| | 90 | FRN90VG7S-2 | BU90-2C | 2 | DB90V-21C | 1 | 1.0 | 150 | 859 | 716 | 10 | 675 | 10 | 6.75 |
| | 3.7 | FRN3.7VG7S-4 | | | DB3.7V-41B | 1 | 96 | 150 | 35.3 | 29.4 | 10 | 27.8 | 10 | 0.278 |
| | 5.5 | FRN5.5VG7S-4 | | | DB5.5V-41B | 1 | 64 | 150 | 52.5 | 43.8 | 10 | 41.3 | 10 | 0.413 |
| | 7.5 | FRN7.5VG7S-4 | | | DB7.5V-41B | 1 | 48 | 150 | 71.6 | 59.7 | 10 | 56.3 | 10 | 0.563 |
| | 11 | FRN11VG7S-4 | | | DB11V-41B | 1 | 32 | 150 | 105 | 87.5 | 10 | 82.5 | 10 | 0.825 |
| | 15 | FRN15VG7S-4 | | | DB15V-41B | 1 | 24 | 150 | 143 | 119 | 10 | 113 | 10 | 1.13 |
| | 18.5 | FRN18.5VG7S-4 | | | DB18.5V-41B | 1 | 18 | 150 | 177 | 147 | 10 | 139 | 10 | 1.39 |
| | 22 | FRN22VG7S-4 | – | – | DB22V-41B | 1 | 16 | 150 | 210 | 175 | 10 | 165 | 10 | 1.65 |
| | 30 | FRN30VG7S-4 | | | DB30V-41B | 1 | 10 | 150 | 286 | 239 | 10 | 225 | 10 | 2.25 |
| | 37 | FRN37VG7S-4 | | | DB37V-41B | 1 | 9.0 | 150 | 353 | 294 | 10 | 278 | 10 | 2.78 |
| | 45 | FRN45VG7S-4 | | | DB45V-41B | 1 | 8.0 | 150 | 430 | 358 | 10 | 338 | 10 | 3.38 |
| Three-phase 400V | 55 | FRN55VG7S-4 | | | DB55V-41C | 1 | 6.5 | 150 | 525 | 438 | 10 | 413 | 10 | 4.13 |
| | 75 | FRN75VG7S-4 | | | DB75V-41C | 1 | 4.7 | 150 | 716 | 597 | 10 | 563 | 10 | 5.63 |
| | 90 | FRN90VG7S-4 | | | DB90V-41C | 1 | 3.9 | 150 | 859 | 716 | 10 | 675 | 10 | 6.75 |
| | 110 | FRN110VG7S-4 | | | DB110V-41C | 1 | 3.2 | 150 | 1050 | 875 | 10 | 825 | 10 | 8.25 |
| | 132 | FRN132VG7S-4 | BU220-4C | 1 | DB132V-41C | 1 | 2.6 | 150 | 1261 | 1050 | 10 | 990 | 10 | 9.90 |
| | 160 | FRN160VG7S-4 | BU220-4C | 1 | DB160V-41C | 1 | 2.2 | 150 | 1528 | 1273 | 10 | 1200 | 10 | 12.0 |
| | 200 | FRN200VG7S-4 | BU220-4C | 2 | DB200V-41C | 1 | 1.75 | 150 | 1910 | 1592 | 10 | 1500 | 10 | 15.0 |
| | 220 | FRN220VG7S-4 | BU220-4C | 2 | DB220V-41C | 1 | 1.6 | 150 | 2101 | 1751 | 10 | 1650 | 10 | 16.5 |
| | 280 | FRN280VG7S-4 | BU220-4C | 2 | DB160V-41C | 2 | 1.1 | 150 | 2674 | 2228 | 10 | 2100 | 10 | 21.0 |
| | 315 | FRN315VG7S-4 | BU220-4C | 2 | DB160V-41C | 2 | 1.1 | 150 | 3008 | 2507 | 10 | 2363 | 10 | 23.6 |
| | 355 | FRN355VG7S-4 | BU220-4C | 3 | DB132V-41C | 3 | 0.867 | 150 | 3390 | 2825 | 10 | 2663 | 10 | 26.6 |
| | 400 | FRN400VG7S-4 | BU220-4C | 3 | DB132V-41C | 3 | 0.867 | 150 | 3820 | 3183 | 10 | 3000 | 10 | 30.0 |

Note 1: Refer to Selection procedure and Notes on Selection.

Note 2: Maximum braking torque is based on the rated torque run by a commercial power supply.

Note 3: The braking resistor types DB160V-41C to DB220V-41C use two braking resistors when their quantity is described as “1”.
(For example, if the quantity of DB160V-41C is “2”, four braking resistors are used. )

● VT use

Table 8.4.1(2) Braking Unit and Braking Resistor (Standard)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | Option: Braking unit Type | Option: Braking unit Q'ty | Option: Braking resistor Type | Option: Braking resistor Q'ty | Option: Braking resistor Ohmic value | Maximum braking torque [%] | Torque [N·m] 50Hz | Torque [N·m] 60Hz | Cont. braking (150% torque conversion value) Braking time [s] | Cont. braking (150% torque conversion value) Discharging capability [kWs] | Repetitive braking (100s or less cycle) Duty cycle [%ED] | Repetitive braking (100s or less cycle) Average loss [kW] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Three-phase 200V | 1.5 | FRN0.75VG7S-2 | | | DB2.2V-21B | 1 | 30 | 75 | 7.2 | 6.0 | 10 | 13.9 | 10 | 0.165 |
| | 2.2 | FRN1.5VG7S-2 | | | DB2.2V-21B | 1 | 30 | 102 | 14.3 | 11.9 | 10 | 18.9 | 10 | 0.165 |
| | 3.7 | FRN2.2VG7S-2 | | | DB2.2V-21B | 1 | 30 | 89 | 21.0 | 17.5 | 10 | 16.5 | 10 | 0.165 |
| | 5.5 | FRN3.7VG7S-2 | | | DB3.7V-21B | 1 | 24 | 101 | 35.4 | 29.5 | 10 | 27.8 | 10 | 0.278 |
| | 7.5 | FRN5.5VG7S-2 | | | DB5.5V-21B | 1 | 16 | 110 | 52.5 | 43.8 | 10 | 41.3 | 10 | 0.413 |
| | 11 | FRN7.5VG7S-2 | | | DB7.5V-21B | 1 | 12 | 102 | 71.4 | 59.5 | 10 | 56.1 | 10 | 0.563 |
| | 15 | FRN11VG7S-2 | – | – | DB11V-21B | 1 | 8.0 | 110 | 105 | 87.5 | 10 | 82.5 | 10 | 0.83 |
| | 18.5 | FRN15VG7S-2 | | | DB15V-21B | 1 | 6.0 | 110 | 130 | 108 | 10 | 102 | 10 | 1.13 |
| | 22 | FRN18.5VG7S-2 | | | DB18.5V-21B | 1 | 4.5 | 110 | 154 | 128 | 10 | 121 | 10 | 1.39 |
| | 30 | FRN22VG7S-2 | | | DB22V-21B | 1 | 4.0 | 110 | 210 | 175 | 10 | 165 | 10 | 1.65 |
| | 37 | FRN30VG7S-2 | | | DB30V-21B | 1 | 2.5 | 110 | 259 | 216 | 10 | 204 | 10 | 2.25 |
| | 45 | FRN37VG7S-2 | | | DB37V-21B | 1 | 2.25 | 110 | 315 | 263 | 10 | 248 | 10 | 2.78 |
| | 55 | FRN45VG7S-2 | | | DB45V-21B | 1 | 2.0 | 110 | 385 | 321 | 10 | 303 | 10 | 3.38 |
| | 75 | FRN55VG7S-2 | | | DB55V-21C | 1 | 1.6 | 110 | 525 | 438 | 10 | 413 | 10 | 4.13 |
| | 90 | FRN75VG7S-2 | BU55-2C | 2 | DB75V-21C | 1 | 1.2 | 110 | 630 | 525 | 10 | 495 | 10 | 5.63 |
| | 110 | FRN90VG7S-2 | BU90-2C | 2 | DB90V-21C | 1 | 1.0 | 110 | 770 | 642 | 10 | 605 | 10 | 6.75 |
| Three-phase 400V | 5.5 | FRN3.7VG7S-4 | | | DB3.7V-41B | 1 | 96 | 101 | 35.4 | 29.5 | 10 | 27.8 | 10 | 0.278 |
| | 7.5 | FRN5.5VG7S-4 | | | DB5.5V-41B | 1 | 64 | 110 | 52.5 | 43.8 | 10 | 41.3 | 10 | 0.413 |
| | 11 | FRN7.5VG7S-4 | | | DB7.5V-41B | 1 | 48 | 102 | 71.4 | 59.5 | 10 | 56.1 | 10 | 0.563 |
| | 15 | FRN11VG7S-4 | | | DB11V-41B | 1 | 32 | 110 | 105 | 87.5 | 10 | 82.5 | 10 | 0.825 |
| | 18.5 | FRN15VG7S-4 | | | DB15V-41B | 1 | 24 | 110 | 130 | 108 | 10 | 102 | 10 | 1.13 |
| | 22 | FRN18.5VG7S-4 | | | DB18.5V-41B | 1 | 18 | 110 | 154 | 128 | 10 | 121 | 10 | 1.39 |
| | 30 | FRN22VG7S-4 | – | – | DB22V-41B | 1 | 16 | 110 | 210 | 175 | 10 | 165 | 10 | 1.65 |
| | 37 | FRN30VG7S-4 | | | DB30V-41B | 1 | 10 | 110 | 259 | 216 | 10 | 204 | 10 | 2.25 |
| | 45 | FRN37VG7S-4 | | | DB37V-41B | 1 | 9.0 | 110 | 315 | 263 | 10 | 248 | 10 | 2.78 |
| | 55 | FRN45VG7S-4 | | | DB45V-41B | 1 | 8.0 | 110 | 385 | 321 | 10 | 303 | 10 | 3.38 |
| | 75 | FRN55VG7S-4 | | | DB55V-41C | 1 | 6.5 | 110 | 525 | 438 | 10 | 413 | 10 | 4.13 |
| | 90 | FRN75VG7S-4 | | | DB75V-41C | 1 | 4.7 | 110 | 630 | 525 | 10 | 495 | 10 | 5.63 |
| | 110 | FRN90VG7S-4 | | | DB90V-41C | 1 | 3.9 | 110 | 770 | 642 | 10 | 605 | 10 | 6.75 |
| | 132 | FRN110VG7S-4 | | | DB110V-41C | 1 | 3.2 | 110 | 924 | 770 | 10 | 726 | 10 | 8.25 |
| | 160 | FRN132VG7S-4 | BU220-4C | 1 | DB132V-41C | 1 | 2.6 | 110 | 1120 | 934 | 10 | 880 | 10 | 9.9 |
| | 200 | FRN160VG7S-4 | BU220-4C | 1 | DB160V-41C | 1 | 2.2 | 110 | 1401 | 1167 | 10 | 1100 | 10 | 12.0 |
| | 220 | FRN200VG7S-4 | BU220-4C | 2 | DB200V-41C | 1 | 1.75 | 110 | 1541 | 1284 | 10 | 1210 | 10 | 15.0 |
| | 280 | FRN220VG7S-4 | BU220-4C | 2 | DB220V-41C | 1 | 1.6 | 110 | 1961 | 1634 | 10 | 1540 | 10 | 16.5 |
| | 315 | FRN280VG7S-4 | BU220-4C | 2 | DB160V-41C | 2 | 1.1 | 110 | 2206 | 1838 | 10 | 1733 | 10 | 21.0 |
| | 355 | FRN315VG7S-4 | BU220-4C | 2 | DB160V-41C | 2 | 1.1 | 110 | 2486 | 2072 | 10 | 1953 | 10 | 23.6 |
| | 400 | FRN355VG7S-4 | BU220-4C | 3 | DB132V-41C | 3 | 0.867 | 110 | 2801 | 2334 | 10 | 2200 | 10 | 26.6 |
| | 500 | FRN400VG7S-4 | BU220-4C | 3 | DB132V-41C | 3 | 0.867 | 110 | 3501 | 2918 | 10 | 2750 | 10 | 30.0 |

Note 1: Refer to Selection procedure and Notes on Selection.

Note 2: Maximum braking torque is based on the rated torque run by a commercial power supply.

Note 3: The braking resistor types DB160V-41C to DB220V-41C use two braking resistors when their quantity is described as “1”.
(For example, if the quantity of DB160V-41C is “2”, four braking resistors are used.)

● HT use

Table 8.4.1(3) Braking Unit and Braking Resistor (Standard)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | Option | | | | | Maximum braking torque [%] | | | Cont. braking (150% torque conversion value) | | Repetitive braking (100s or less cycle) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Braking unit | | Braking resistor | | | | Torque [N·m] | | | | | |
| | | | Type | Q'ty | Type | Q'ty | Ohmic value | | 50Hz | 60Hz | Braking time [s] | Discharging capability [kWs] | Duty cycle [%ED] | Average loss [kW] |
| | 3.7 | FRN3.7VG7S-2 | | | DB3.7V-21B | 1 | 24 | 150 | 35.3 | 29.4 | 10 | 27.8 | 10 | 0.278 |
| | 5.5 | FRN5.5VG7S-2 | | | DB5.5V-21B | 1 | 16 | 150 | 52.5 | 43.8 | 10 | 41.3 | 10 | 0.413 |
| | 7.5 | FRN7.5VG7S-2 | | | DB7.5V-21B | 1 | 12 | 150 | 71.6 | 59.7 | 10 | 56.3 | 10 | 0.563 |
| | 11 | FRN11VG7S-2 | | | DB11V-21B | 1 | 8.0 | 150 | 105 | 87.5 | 10 | 82.5 | 10 | 0.825 |
| | 15 | FRN15VG7S-2 | | | DB15V-21B | 1 | 6.0 | 150 | 143 | 119 | 10 | 113 | 10 | 1.13 |
| Three-phase 200V | 18.5 | FRN18.5VG7S-2 | – | – | DB18.5V-21B | 1 | 4.5 | 150 | 177 | 147 | 10 | 139 | 10 | 1.39 |
| | 22 | FRN22VG7S-2 | | | DB22V-21B | 1 | 4.0 | 150 | 210 | 175 | 10 | 165 | 10 | 1.65 |
| | 30 | FRN30VG7S-2 | | | DB30V-21B | 1 | 2.5 | 150 | 286 | 239 | 10 | 225 | 10 | 2.25 |
| | 37 | FRN37VG7S-2 | | | DB37V-21B | 1 | 2.25 | 150 | 353 | 294 | 10 | 278 | 10 | 2.78 |
| | 45 | FRN45VG7S-2 | | | DB45V-21B | 1 | 2.0 | 150 | 430 | 358 | 10 | 338 | 10 | 3.38 |
| | 55 | FRN55VG7S-2 | | | DB55V-21C | 1 | 1.6 | 150 | 525 | 438 | 10 | 413 | 10 | 4.13 |
| | 3.7 | FRN3.7VG7S-4 | | | DB3.7V-41B | 1 | 96 | 150 | 35.3 | 29.4 | 10 | 27.8 | 10 | 0.278 |
| | 5.5 | FRN5.5VG7S-4 | | | DB5.5V-41B | 1 | 64 | 150 | 52.5 | 43.8 | 10 | 41.3 | 10 | 0.413 |
| | 7.5 | FRN7.5VG7S-4 | | | DB7.5V-41B | 1 | 48 | 150 | 71.6 | 59.7 | 10 | 56.3 | 10 | 0.563 |
| | 11 | FRN11VG7S-4 | | | DB11V-41B | 1 | 32 | 150 | 105 | 87.5 | 10 | 82.5 | 10 | 0.825 |
| | 15 | FRN15VG7S-4 | | | DB15V-41B | 1 | 24 | 150 | 143 | 119 | 10 | 113 | 10 | 1.13 |
| Three-phase 400V | 18.5 | FRN18.5VG7S-4 | – | – | DB18.5V-41B | 1 | 18 | 150 | 177 | 147 | 10 | 139 | 10 | 1.39 |
| | 22 | FRN22VG7S-4 | | | DB22V-41B | 1 | 16 | 150 | 210 | 175 | 10 | 165 | 10 | 1.65 |
| | 30 | FRN30VG7S-4 | | | DB30V-41B | 1 | 10 | 150 | 286 | 239 | 10 | 225 | 10 | 2.25 |
| | 37 | FRN37VG7S-4 | | | DB37V-41B | 1 | 9.0 | 150 | 353 | 294 | 10 | 278 | 10 | 2.78 |
| | 45 | FRN45VG7S-4 | | | DB45V-41B | 1 | 8.0 | 150 | 430 | 358 | 10 | 338 | 10 | 3.38 |
| | 55 | FRN55VG7S-4 | | | DB55V-41C | 1 | 6.5 | 150 | 525 | 438 | 10 | 413 | 10 | 4.13 |

Note 1: Refer to Selection procedure and Notes on Selection.
Note 2: Maximum braking torque is based on the rated torque run by a commercial power supply.
Note 3: When the motor speed is reduced to 75%, the maximum braking torque reaches the following rates.
(1) Up to 22kW: 200%, 10s
(2) 30 to 55kW: 170%, 10s

## 8.4.2 20%ED

● CT use

Table 8.4.2(1) Braking Unit and Braking Resistor (20%ED)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | Option | | | | | Maximum braking torque [%] | Torque [N·m] | | Cont. braking (150% torque conversion value) | | Repetitive braking (100s or less cycle) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Braking unit | | Braking resistor | | | | | | | | | |
| | | | Type | Q'ty | Type | Q'ty | Ohmic value | | 50Hz | 60Hz | Braking time [s] | Discharging capability [kWs] | Duty cycle [%ED] | Average loss [kW] |
| Three-phase 200V | 0.75 | FRN0.75VG7S-2 | – | – | DB2.2V-22B | 1 | 32 | 150 | 7.16 | 5.97 | 20 | 33.0 | 20 | 0.330 |
| | 1.5 | FRN1.5VG7S-2 | | | DB2.2V-22B | 1 | 32 | 150 | 14.3 | 11.9 | 20 | 33.0 | 20 | 0.330 |
| | 2.2 | FRN2.2VG7S-2 | | | DB2.2V-22B | 1 | 32 | 150 | 21.0 | 17.5 | 20 | 33.0 | 20 | 0.330 |
| | 3.7 | FRN3.7VG7S-2 | | | DB3.7V-22B | 1 | 24 | 150 | 35.3 | 29.4 | 20 | 55.5 | 20 | 0.555 |
| | 5.5 | FRN5.5VG7S-2 | | | DB5.5V-22B | 1 | 16 | 150 | 52.5 | 43.8 | 20 | 82.5 | 20 | 0.825 |
| | 7.5 | FRN7.5VG7S-2 | | | DB7.5V-22B | 1 | 12 | 150 | 71.6 | 59.7 | 20 | 113 | 20 | 1.13 |
| | 11 | FRN11VG7S-2 | | | DB11V-22B | 1 | 8.0 | 150 | 105 | 87.5 | 20 | 165 | 20 | 1.65 |
| | 15 | FRN15VG7S-2 | | | DB15V-22B | 1 | 6.0 | 150 | 143 | 119 | 20 | 225 | 20 | 2.25 |
| | 18.5 | FRN18.5VG7S-2 | | | DB18.5V-22B | 1 | 4.5 | 150 | 177 | 147 | 20 | 278 | 20 | 2.78 |
| | 22 | FRN22VG7S-2 | | | DB22V-22B | 1 | 4.0 | 150 | 210 | 175 | 20 | 330 | 20 | 3.30 |
| | 30 | FRN30VG7S-2 | | | DB30V-22C | 1 | 3.0 | 150 | 286 | 239 | 20 | 450 | 20 | 4.50 |
| | 37 | FRN37VG7S-2 | | | DB37V-22C | 1 | 2.4 | 150 | 353 | 294 | 20 | 555 | 20 | 5.55 |
| | 45 | FRN45VG7S-2 | | | DB45V-22C | 1 | 2.0 | 150 | 430 | 358 | 20 | 675 | 20 | 6.75 |
| | 55 | FRN55VG7S-2 | | | DB55V-22C | 1 | 1.6 | 150 | 525 | 438 | 20 | 825 | 20 | 8.25 |
| | 75 | FRN75VG7S-2 | BU55-2C | 2 | DB37V-22C | 2 | 1.2 | 150 | 716 | 597 | 20 | 1125 | 20 | 11.3 |
| | 90 | FRN90VG7S-2 | BU90-2C | 2 | DB45V-22C | 2 | 1.0 | 150 | 859 | 716 | 20 | 1350 | 20 | 13.5 |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | – | DB3.7V-42B | 1 | 96 | 150 | 35.3 | 29.4 | 20 | 55.5 | 20 | 0.555 |
| | 5.5 | FRN5.5VG7S-4 | | | DB5.5V-42B | 1 | 64 | 150 | 52.5 | 43.8 | 20 | 82.5 | 20 | 0.825 |
| | 7.5 | FRN7.5VG7S-4 | | | DB7.5V-42B | 1 | 48 | 150 | 71.6 | 59.7 | 20 | 113 | 20 | 1.13 |
| | 11 | FRN11VG7S-4 | | | DB11V-42B | 1 | 32 | 150 | 105 | 87.5 | 20 | 165 | 20 | 1.65 |
| | 15 | FRN15VG7S-4 | | | DB15V-42B | 1 | 24 | 150 | 143 | 119 | 20 | 225 | 20 | 2.25 |
| | 18.5 | FRN18.5VG7S-4 | | | DB18.5V-42B | 1 | 18 | 150 | 177 | 147 | 20 | 278 | 20 | 2.78 |
| | 22 | FRN22VG7S-4 | | | DB22V-42B | 1 | 16 | 150 | 210 | 175 | 20 | 330 | 20 | 3.30 |
| | 30 | FRN30VG7S-4 | | | DB30V-42C | 1 | 12 | 150 | 286 | 239 | 20 | 450 | 20 | 4.50 |
| | 37 | FRN37VG7S-4 | | | DB37V-42C | 1 | 9.0 | 150 | 353 | 294 | 20 | 555 | 20 | 5.55 |
| | 45 | FRN45VG7S-4 | | | DB45V-42C | 1 | 8.0 | 150 | 430 | 358 | 20 | 675 | 20 | 6.75 |
| | 55 | FRN55VG7S-4 | | | DB55V-42C | 1 | 6.5 | 150 | 525 | 438 | 20 | 825 | 20 | 8.25 |
| | 75 | FRN75VG7S-4 | | | DB75V-42C | 1 | 4.7 | 150 | 716 | 597 | 20 | 1125 | 20 | 11.3 |
| | 90 | FRN90VG7S-4 | | | DB90V-42C | 1 | 3.9 | 150 | 859 | 716 | 20 | 1350 | 20 | 13.5 |
| | 110 | FRN110VG7S-4 | | | DB110V-42C | 1 | 3.2 | 150 | 1050 | 875 | 20 | 1650 | 20 | 16.5 |
| | 132 | FRN132VG7S-4 | BU220-4C | 1 | DB132V-42C | 1 | 2.6 | 150 | 1261 | 1050 | 20 | 1980 | 20 | 19.8 |
| | 160 | FRN160VG7S-4 | BU220-4C | 1 | DB160V-42C | 1 | 2.2 | 150 | 1528 | 1273 | 20 | 2400 | 20 | 24.0 |
| | 200 | FRN200VG7S-4 | BU220-4C | 2 | DB200V-42C | 1 | 1.75 | 150 | 1910 | 1592 | 20 | 3000 | 20 | 30.0 |
| | 220 | FRN220VG7S-4 | BU220-4C | 2 | DB220V-42C | 1 | 1.6 | 150 | 2101 | 1751 | 20 | 3300 | 20 | 33.0 |
| | 280 | FRN280VG7S-4 | BU220-4C | 2 | DB160V-42C | 2 | 1.1 | 150 | 2674 | 2228 | 20 | 4200 | 20 | 42.0 |
| | 315 | FRN315VG7S-4 | BU220-4C | 2 | DB160V-42C | 2 | 1.1 | 150 | 3008 | 2507 | 20 | 4725 | 20 | 47.3 |
| | 355 | FRN355VG7S-4 | BU220-4C | 3 | DB132V-42C | 3 | 0.867 | 150 | 3390 | 2825 | 20 | 5325 | 20 | 53.3 |
| | 400 | FRN400VG7S-4 | BU220-4C | 3 | DB132V-42C | 3 | 0.867 | 150 | 3820 | 3183 | 20 | 6000 | 20 | 60.0 |

Note 1: This option is manufactured on order.

Note 2: The braking unit requires a fan unit (BU-F).

Note 3: Maximum braking torque is based on the rated torque run by a commercial power supply.

Note 4: The braking resistor types DB200V-42C to DB220V-42C use two braking resistors when their quantity is described as "1".
(For example, if the quantity of DB200V-42C is "2", four braking resistors are used.)

# 8. Peripheral Equipment

● VT use

Table 8.4.2(2) Braking Unit and Braking Resistor (20%ED)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | Option: Braking unit Type | Option: Braking unit Q'ty | Option: Braking resistor Type | Option: Braking resistor Q'ty | Option: Braking resistor Ohmic value | Maximum braking torque [%] | Maximum braking torque: Torque [N·m] 50Hz | Maximum braking torque: Torque [N·m] 60Hz | Cont. braking (150% torque conversion value): Braking time [s] | Cont. braking (150% torque conversion value): Discharging capability [kWs] | Repetitive braking (100s or less cycle): Duty cycle [%ED] | Repetitive braking (100s or less cycle): Average loss [kW] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Three-phase 200V | 1.5 | FRN0.75VG7S-2 | | | DB2.2V-22B | 1 | 32 | 75 | 7.2 | 6.0 | 20 | 27.8 | 20 | 0.330 |
| | 2.2 | FRN1.5VG7S-2 | | | DB2.2V-22B | 1 | 32 | 102 | 14.3 | 11.9 | 20 | 37.7 | 20 | 0.330 |
| | 3.7 | FRN2.2VG7S-2 | | | DB2.2V-22B | 1 | 32 | 89 | 21.0 | 17.5 | 20 | 32.9 | 20 | 0.330 |
| | 5.5 | FRN3.7VG7S-2 | | | DB3.7V-22B | 1 | 24 | 101 | 35.4 | 29.5 | 20 | 55.6 | 20 | 0.555 |
| | 7.5 | FRN5.5VG7S-2 | | | DB5.5V-22B | 1 | 16 | 110 | 52.5 | 43.8 | 20 | 82.5 | 20 | 0.825 |
| | 11 | FRN7.5VG7S-2 | | | DB7.5V-22B | 1 | 12 | 102 | 71.4 | 59.5 | 20 | 112 | 20 | 1.13 |
| | 15 | FRN11VG7S-2 | – | – | DB11V-22B | 1 | 8.0 | 110 | 105 | 87.5 | 20 | 165 | 20 | 1.65 |
| | 18.5 | FRN15VG7S-2 | | | DB15V-22B | 1 | 6.0 | 110 | 130 | 108 | 20 | 204 | 20 | 2.25 |
| | 22 | FRN18.5VG7S-2 | | | DB18.5V-22B | 1 | 4.5 | 110 | 154 | 128 | 20 | 242 | 20 | 2.78 |
| | 30 | FRN22VG7S-2 | | | DB22V-22B | 1 | 4.0 | 110 | 210 | 175 | 20 | 330 | 20 | 3.30 |
| | 37 | FRN30VG7S-2 | | | DB30V-22C | 1 | 3.0 | 110 | 259 | 216 | 20 | 407 | 20 | 4.50 |
| | 45 | FRN37VG7S-2 | | | DB37V-22C | 1 | 2.4 | 110 | 315 | 263 | 20 | 495 | 20 | 5.55 |
| | 55 | FRN45VG7S-2 | | | DB45V-22C | 1 | 2.0 | 110 | 385 | 321 | 20 | 605 | 20 | 6.75 |
| | 75 | FRN55VG7S-2 | | | DB55V-22C | 1 | 1.6 | 110 | 525 | 438 | 20 | 825 | 20 | 8.25 |
| | 90 | FRN75VG7S-2 | BU55-2C | 2 | DB37V-22C | 2 | 1.2 | 110 | 630 | 525 | 20 | 990 | 20 | 11.3 |
| | 110 | FRN90VG7S-2 | BU90-2C | 2 | DB45V-22C | 2 | 1.0 | 110 | 770 | 642 | 20 | 1210 | 20 | 13.5 |
| Three-phase 400V | 5.5 | FRN3.7VG7S-4 | | | DB3.7V-42B | 1 | 96 | 101 | 35.4 | 29.5 | 20 | 55.6 | 20 | 0.555 |
| | 7.5 | FRN5.5VG7S-4 | | | DB5.5V-42B | 1 | 64 | 110 | 52.5 | 43.8 | 20 | 82.5 | 20 | 0.825 |
| | 11 | FRN7.5VG7S-4 | | | DB7.5V-42B | 1 | 48 | 102 | 71.4 | 59.5 | 20 | 112 | 20 | 1.13 |
| | 15 | FRN11VG7S-4 | | | DB11V-42B | 1 | 32 | 110 | 105 | 87.5 | 20 | 165 | 20 | 1.65 |
| | 18.5 | FRN15VG7S-4 | | | DB15V-42B | 1 | 24 | 110 | 130 | 108 | 20 | 204 | 20 | 2.25 |
| | 22 | FRN18.5VG7S-4 | | | DB18.5V-42B | 1 | 18 | 110 | 154 | 128 | 20 | 242 | 20 | 2.78 |
| | 30 | FRN22VG7S-4 | – | – | DB22V-42B | 1 | 16 | 110 | 210 | 175 | 20 | 330 | 20 | 3.30 |
| | 37 | FRN30VG7S-4 | | | DB30V-42C | 1 | 12 | 110 | 259 | 216 | 20 | 407 | 20 | 4.50 |
| | 45 | FRN37VG7S-4 | | | DB37V-42C | 1 | 9.0 | 110 | 315 | 263 | 20 | 495 | 20 | 5.55 |
| | 55 | FRN45VG7S-4 | | | DB45V-42C | 1 | 8.0 | 110 | 385 | 321 | 20 | 605 | 20 | 6.75 |
| | 75 | FRN55VG7S-4 | | | DB55V-42C | 1 | 6.5 | 110 | 525 | 438 | 20 | 825 | 20 | 8.25 |
| | 90 | FRN75VG7S-4 | | | DB75V-42C | 1 | 4.7 | 110 | 630 | 525 | 20 | 990 | 20 | 11.3 |
| | 110 | FRN90VG7S-4 | | | DB90V-42C | 1 | 3.9 | 110 | 770 | 642 | 20 | 1210 | 20 | 13.5 |
| | 132 | FRN110VG7S-4 | | | DB110V-42C | 1 | 3.2 | 110 | 924 | 770 | 20 | 1452 | 20 | 16.5 |
| | 160 | FRN132VG7S-4 | BU220-4C | 1 | DB132V-42C | 1 | 2.6 | 110 | 1120 | 934 | 20 | 1760 | 20 | 19.8 |
| | 200 | FRN160VG7S-4 | BU220-4C | 1 | DB160V-42C | 1 | 2.2 | 110 | 1401 | 1167 | 20 | 2200 | 20 | 24.0 |
| | 220 | FRN200VG7S-4 | BU220-4C | 2 | DB200V-42C | 1 | 1.75 | 110 | 1541 | 1284 | 20 | 2420 | 20 | 30.0 |
| | 280 | FRN220VG7S-4 | BU220-4C | 2 | DB220V-42C | 1 | 1.6 | 110 | 1961 | 1634 | 20 | 3080 | 20 | 33.0 |
| | 315 | FRN280VG7S-4 | BU220-4C | 2 | DB160V-42C | 2 | 1.1 | 110 | 2206 | 1838 | 20 | 3465 | 20 | 42.0 |
| | 355 | FRN315VG7S-4 | BU220-4C | 2 | DB160V-42C | 2 | 1.1 | 110 | 2486 | 2072 | 20 | 3905 | 20 | 47.3 |
| | 400 | FRN355VG7S-4 | BU220-4C | 3 | DB132V-42C | 3 | 0.867 | 110 | 2801 | 2334 | 20 | 4400 | 20 | 53.3 |
| | 500 | FRN400VG7S-4 | BU220-4C | 3 | DB132V-42C | 3 | 0.867 | 110 | 3501 | 2918 | 20 | 5500 | 20 | 60.0 |

Note 1: This option is manufactured on order.

Note 2: The braking unit requires a fan unit (BU-F).

Note 3: Maximum braking torque is based on the rated torque run by a commercial power supply.

Note 4: The braking resistor types DB200V-42C to DB220V-42C use two braking resistors when their quantity is described as "1".
(For example, if the quantity of DB200V-42C is "2", four braking resistors are used.)

● HT use

Table 8.4.2(3) Braking Unit and Braking Resistor (20%ED)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | Option | | | | | Maximum braking torque [%] | | | Cont. braking (150% torque conversion value) | | Repetitive braking (100s or less cycle) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Braking unit | | Braking resistor | | | | Torque [N·m] | | | | | |
| | | | Type | Q'ty | Type | Q'ty | Ohmic value | | 50Hz | 60Hz | Braking time [s] | Discharging capability [kWs] | Duty cycle [%ED] | Average loss [kW] |
| Three-phase 200V | 3.7 | FRN3.7VG7S-2 | – | – | DB3.7V-22B | 1 | 24 | 150 | 35.3 | 29.4 | 20 | 55.5 | 20 | 0.555 |
| | 5.5 | FRN5.5VG7S-2 | | | DB5.5V-22B | 1 | 16 | 150 | 52.5 | 43.8 | 20 | 82.5 | 20 | 0.825 |
| | 7.5 | FRN7.5VG7S-2 | | | DB7.5V-22B | 1 | 12 | 150 | 71.6 | 59.7 | 20 | 113 | 20 | 1.13 |
| | 11 | FRN11VG7S-2 | | | DB11V-22B | 1 | 8.0 | 150 | 105 | 87.5 | 20 | 165 | 20 | 1.65 |
| | 15 | FRN15VG7S-2 | | | DB15V-22B | 1 | 6.0 | 150 | 143 | 119 | 20 | 225 | 20 | 2.25 |
| | 18.5 | FRN18.5VG7S-2 | | | DB18.5V-22B | 1 | 4.5 | 150 | 177 | 147 | 20 | 278 | 20 | 2.78 |
| | 22 | FRN22VG7S-2 | | | DB22V-22B | 1 | 4.0 | 150 | 210 | 175 | 20 | 330 | 20 | 3.30 |
| | 30 | FRN30VG7S-2 | | | DB30V-22C | 1 | 3.0 | 150 | 286 | 239 | 20 | 450 | 20 | 4.50 |
| | 37 | FRN37VG7S-2 | | | DB37V-22C | 1 | 2.4 | 150 | 353 | 294 | 20 | 555 | 20 | 5.55 |
| | 45 | FRN45VG7S-2 | | | DB45V-22C | 1 | 2.0 | 150 | 430 | 358 | 20 | 675 | 20 | 6.75 |
| | 55 | FRN55VG7S-2 | | | DB55V-22C | 1 | 1.6 | 150 | 525 | 438 | 20 | 825 | 20 | 8.25 |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | – | DB3.7V-42B | 1 | 96 | 150 | 35.3 | 29.4 | 20 | 55.5 | 20 | 0.555 |
| | 5.5 | FRN5.5VG7S-4 | | | DB5.5V-42B | 1 | 64 | 150 | 52.5 | 43.8 | 20 | 82.5 | 20 | 0.825 |
| | 7.5 | FRN7.5VG7S-4 | | | DB7.5V-42B | 1 | 48 | 150 | 71.6 | 59.7 | 20 | 113 | 20 | 1.13 |
| | 11 | FRN11VG7S-4 | | | DB11V-42B | 1 | 32 | 150 | 105 | 87.5 | 20 | 165 | 20 | 1.65 |
| | 15 | FRN15VG7S-4 | | | DB15V-42B | 1 | 24 | 150 | 143 | 119 | 20 | 225 | 20 | 2.25 |
| | 18.5 | FRN18.5VG7S-4 | | | DB18.5V-42B | 1 | 18 | 150 | 177 | 147 | 20 | 278 | 20 | 2.78 |
| | 22 | FRN22VG7S-4 | | | DB22V-42B | 1 | 16 | 150 | 210 | 175 | 20 | 330 | 20 | 3.30 |
| | 30 | FRN30VG7S-4 | | | DB30V-42C | 1 | 12 | 150 | 286 | 239 | 20 | 450 | 20 | 4.50 |
| | 37 | FRN37VG7S-4 | | | DB37V-42C | 1 | 9.0 | 150 | 353 | 294 | 20 | 555 | 20 | 5.55 |
| | 45 | FRN45VG7S-4 | | | DB45V-42C | 1 | 8.0 | 150 | 430 | 358 | 20 | 675 | 20 | 6.75 |
| | 55 | FRN55VG7S-4 | | | DB55V-42C | 1 | 6.5 | 150 | 525 | 438 | 20 | 825 | 20 | 8.25 |

Note 1: This option is manufactured on order.
Note 2: The braking unit requires a fan unit (BU-F).
Note 3: Maximum braking torque is based on the rated torque run by a commercial power supply.
Note 4: When the motor speed is reduced to 75%, the maximum braking torque reaches the following rates.
(1) Up to 22kW: 200%, 10s
(2) 30 to 55kW: 170%, 10s

## 8.4.3 Explanation of %ED

In developing FRENIC5000VG7S series, we changed the definition (calculation method) of %ED value, which is used to measure the braking resistor capacity.
Since the definition applied to VG7 differs from that applied to VG5 series (also all the VG series), be sure to read the following when selecting a braking resistor.

- FRENIC5000VG7S series

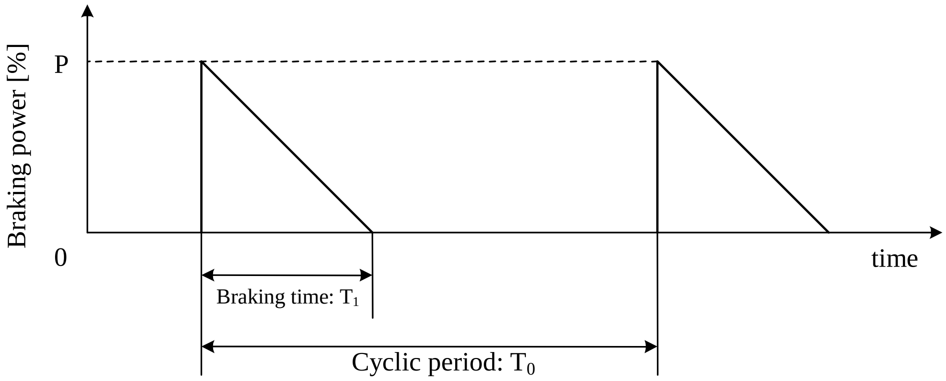



Figure 8.4.3 (a) Definition of %ED (Applied to FRENIC5000VG7S Series)

Duty cycle %ED = $\dfrac{T_1}{T_0}$ x 100

- FRENIC5000VG5 series

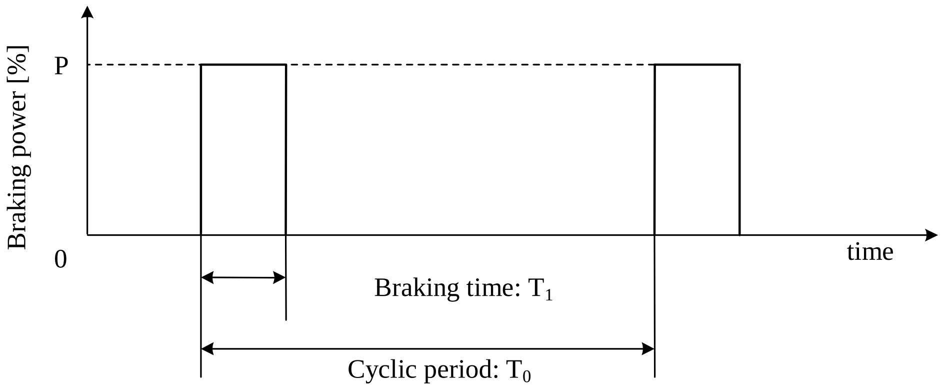



Figure 8.4.3 (b) Definition of %ED (Applied to FRENIC5000VG5 Series)

Duty cycle %ED = $\dfrac{T_1}{T_0}$ x 100

As illustrated in the above graphs, the duty cycle of FRENIC5000VG7S series is calculated by regarding that the braking power reduces as the time elapses whereas the conventional calculation method is based on the concept that the braking force is constant during braking time. As a result, the duty cycle (%ED) of VG7 has doubled compared with that of VG5 series.
The right table shows the comparison in braking capacity.

Table 8.4.3 Braking Power Comparison Table

| Series | FRENIC5000VG7S | FRENIC5000VG5 |
|---|---|---|
| Braking power | Standard (10%ED) | 5%ED |
| | 20%ED | 10%ED |

We are ready to deliver FRENIC5000VG7S series with a braking capacity of 40%ED, 100%ED, or continuous rating on receiving order.

# 8.5 Rated Sensitive Current of ELCB

Table 8.5 Rated Sensitive Current of ELCB

| Power supply voltage | Nominal applied motor [kW] | Inverter type | | Rated current of nominal applied motor [A] | Wiring length and sensitive current | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | CT series, HT series | VT series | | 10m | 30m | 50m | 100m | 200m | 300m |
| | 0.75 | FRN0.75VG7S-2 | – | 3.6 | | | | | | |
| | 1.5 | FRN1.5VG7S-2 | FRN0.75VG7S-2 | 6.5 | | | | | | |
| | 2.2 | FRN2.2VG7S-2 | FRN1.5VG7S-2 | 9.2 | | | | | | |
| | 3.7 | FRN3.7VG7S-2 | FRN2.2VG7S-2 | 15 | | 30mA | | | | |
| | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | 22 | | | | | | |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | 29 | | | | | | |
| Three-phase 200V | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | 42 | | | | 100mA | | |
| | 15 | FRN15VG7S-2 | FRN11VG7S-2 | 55 | | | | | | |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | 67 | | | | | 200mA | |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | 78 | | | | | | |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | 107 | | | | | | |
| | 37 | FRN37VG7S-2 | FRN30VG7S-2 | 130 | | | | | | |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | 156 | | | | | | |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | 198 | | | | | | |
| | 75 | FRN75VG7S-2 | FRN55VG7S-2 | 271 | | | | | | 500mA |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | 315 | | | | | | |
| | 110 | – | FRN90VG7S-2 | 383 | | | | | | |
| | 3.7 | FRN3.7VG7S-4 | – | 7.5 | | | | | | |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | 11 | | | | | | |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | 14.5 | 30mA | | | | | |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | 21 | | | | | | |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | 27.5 | | | | | | |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | 34 | | | 100mA | | | |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | 39 | | | | | | |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | 54 | | | | 200mA | | |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | 65 | | | | | | |
| Three-phase | 45 | FRN45VG7S-4 | FRN37VG7S-4 | 78 | | | | | 500mA | |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | 99 | | | | | | |
| 400V | 75 | FRN75VG7S-4 | FRN55VG7S-4 | 135 | | | | | | |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | 160 | | | | | | |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | 192 | | | | | | |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | 226 | | | | | | 1000mA |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | 265 | | | | | | (Special) |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | 336 | | | | | | |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | 396 | | | | | | |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | 500 | | | | | | |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | | | | | | | |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | | | | | | | |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | | | | | | | |
| | 500 | – | FRN400VG7S-4 | | | | | | | |

Note: Rated current of nominal applied motor is based on the value of Fuji standard motor (4 pole, 200V, 50Hz).

## 8.6 Options

### 8.6.1 Output Circuit Noise Filter (OFL)

● 400V Series

Table 8.6.1 Output Circuit Noise Filter (OFL)

| Power supply voltage | Nominal applied motor [kW] | Inverter type: CT use, HT use | Inverter type: VT use | Filter type | Rated current [A] | Overload capability | Inverter power input voltage | Carrier frequency allowable range [kHz] | Maximum output frequency [Hz] |
|---|---|---|---|---|---|---|---|---|---|
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | OFL-3.7-4A | 9 | "150%-1min" "200%-0.5s" | Three-phase 380 to 460[V] 50/60[Hz] | 0.75 to 15 | 400 |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | OFL-7.5-4A | 18 | | | | |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | | | | | | |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | OFL-15-4A | 30 | | | | |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | | | | | | |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | OFL-22-4A | 45 | | | | |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | | | | | | |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | OFL-30-4A | 60 | "150%-1min" "180%-0.5s" | | 0.75 to 10 | |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | OFL-37-4A | 75 | | | | |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | OFL-45-4A | 91 | | | | |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | OFL-55-4A | 112 | | | | |
| | 75 | FRN75VG7S-4 | FRN55VG7S-4 | OFL-75-4A | 150 | | | | |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | OFL-90-4A | 176 | | | | |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | OFL-110-4A | 210 | | | | |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | OFL-132-4A | 253 | | | | |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | OFL-160-4A | 304 | | | | |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | OFL-200-4A | 377 | | | | |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | OFL-220-4A | 415 | | | | |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | OFL-280-4A | 520 | | | | |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | | | | | | |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | | | | | | |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | | | | | | |
| | 500 | – | FRN400VG7S-4 | | | | | | |

## 8.6.2 EMC Compliance Filter

● 400V series

Table 8.6.2 EMC Compliance Filter (EFL)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor [kW]</th><th colspan="2">Inverter type</th><th colspan="4">Filter</th></tr>
<tr><th>CT use, HTuse</th><th>VT use</th><th>Type</th><th>Rated voltage [V]</th><th>Rated current [A]</th><th>Leakage current [mA]</th></tr>
<tr><td rowspan="22">Three-phase 400V</td><td>3.7</td><td>FRN3.7VG7S-4</td><td>–</td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td><td rowspan="7"></td></tr>
<tr><td>5.5</td><td>FRN5.5VG7S-4</td><td>FRN3.7VG7S-4</td></tr>
<tr><td>7.5</td><td>FRN7.5VG7S-4</td><td>FRN5.5VG7S-4</td></tr>
<tr><td>11</td><td>FRN11VG7S-4</td><td>FRN7.5VG7S-4</td></tr>
<tr><td>15</td><td>FRN15VG7S-4</td><td>FRN11VG7S-4</td></tr>
<tr><td>18.5</td><td>FRN18.5VG7S-4</td><td>FRN15VG7S-4</td></tr>
<tr><td>22</td><td>FRN22VG7S-4</td><td>FRN18.5VG7S-4</td></tr>
<tr><td>30</td><td>FRN30VG7S-4</td><td>FRN22VG7S-4</td><td>RF3100-F11</td><td rowspan="11">480</td><td>100</td><td rowspan="10">130</td></tr>
<tr><td>37</td><td>FRN37VG7S-4</td><td>FRN30VG7S-4</td><td rowspan="5">RF3180-F11</td><td rowspan="5">180</td></tr>
<tr><td>45</td><td>FRN45VG7S-4</td><td>FRN37VG7S-4</td></tr>
<tr><td>55</td><td>FRN55VG7S-4</td><td>FRN45VG7S-4</td></tr>
<tr><td>75</td><td>FRN75VG7S-4</td><td>FRN55VG7S-4</td></tr>
<tr><td>90</td><td>FRN90VG7S-4</td><td>FRN75VG7S-4</td></tr>
<tr><td>110</td><td>FRN110VG7S-4</td><td>FRN90VG7S-4</td><td rowspan="2">RF3280-F11</td><td rowspan="2">280</td></tr>
<tr><td>132</td><td>FRN132VG7S-4</td><td>FRN110VG7S-4</td></tr>
<tr><td>160</td><td>FRN160VG7S-4</td><td>FRN132VG7S-4</td><td rowspan="3">RF3400-F11</td><td rowspan="3">400</td></tr>
<tr><td>200</td><td>FRN200VG7S-4</td><td>FRN160VG7S-4</td></tr>
<tr><td>220</td><td>FRN220VG7S-4</td><td>FRN200VG7S-4</td></tr>
<tr><td>280</td><td>FRN280VG7S-4</td><td>FRN220VG7S-4</td><td>RF3880-F11</td><td>880</td><td>180</td></tr>
<tr><td>315</td><td>FRN315VG7S-4</td><td>FRN280VG7S-4</td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td><td rowspan="4"></td></tr>
<tr><td>355</td><td>FRN355VG7S-4</td><td>FRN315VG7S-4</td></tr>
<tr><td>400</td><td>FRN400VG7S-4</td><td>FRN355VG7S-4</td></tr>
<tr><td>500</td><td>–</td><td>FRN400VG7S-4</td></tr>
</table>

## 8.6.3 DC Reactor (DCR)

• This Reactor is mainly used for normalizing **the power supply or improving power-factor (reducing harmonics)**

Table 8.6.3 DC Reactor (DCR)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | | DC Reactor (DCR) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | CT use, HT use | VT use | Type | Rated current [A] | Inductance [mH] | Coil resistance [mΩ] | Generated loss [W] |
| Three-phase 200V | 0.75 | FRN0.75VG7S-2 | – | DCR2-0.75 | 5.0 | 7.0 | 123 | 2.8 |
| | 1.5 | FRN1.5VG7S-2 | FRN0.75VG7S-2 | DCR2-1.5 | 8.0 | 4.0 | 57.5 | 4.6 |
| | 2.2 | FRN2.2VG7S-2 | FRN1.5VG7S-2 | DCR2-2.2 | 11 | 3.0 | 43 | 6.7 |
| | 3.7 | FRN3.7VG7S-2 | FRN2.2VG7S-2 | DCR2-3.7 | 18 | 1.7 | 21 | 8.8 |
| | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | DCR2-5.5 | 25 | 1.2 | 16 | 14 |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | DCR2-7.5 | 34 | 0.8 | 9.7 | 16 |
| | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | DCR2-11 | 50 | 0.6 | 7.0 | 27 |
| | 15 | FRN15VG7S-2 | FRN11VG7S-2 | DCR2-15 | 67 | 0.4 | 4.3 | 27 |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | DCR2-18.5 | 81 | 0.35 | 3.1 | 29 |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | DCR2-22A | 98 | 0.3 | 2.7 | 38 |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | DCR2-30B | 136 | 0.23 | 1.10 | 37 |
| | 37 | FRN37VG7S-2 | FRN30VG7S-2 | DCR2-37B | 167 | 0.19 | 0.82 | 47 |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | DCR2-45B | 203 | 0.16 | 0.62 | 52 |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | DCR2-55B | 244 | 0.13 | 0.79 | 55 |
| | 75 | FRN75VG7S-2 | FRN55VG7S-2 | DCR2-75B | 341 | 0.080 | 0.46 | 55 |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | DCR2-90B | 410 | 0.067 | 0.28 | 57 |
| | 110 | – | FRN90VG7S-2 | DCR2-110B | 526 | 0.055 | 0.22 | 67 |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | DCR4-3.7 | 9.0 | 7.0 | 74.5 | 8.1 |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | DCR4-5.5 | 13 | 4.0 | 43 | 10 |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | DCR4-7.5 | 18 | 3.5 | 35.5 | 15 |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | DCR4-11 | 25 | 2.2 | 23.2 | 21 |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | DCR4-15 | 34 | 1.8 | 18.1 | 28 |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | DCR4-18.5 | 41 | 1.4 | 12.1 | 29 |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | DCR4-22A | 49 | 1.2 | 10.0 | 35 |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | DCR4-30B | 71 | 0.86 | 4.00 | 35 |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | DCR4-37B | 88 | 0.70 | 2.80 | 40 |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | DCR4-45B | 107 | 0.58 | 1.90 | 44 |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | DCR4-55B | 131 | 0.47 | 1.70 | 55 |
| | 75 | FRN75VG7S-4 | FRN55VG7S-4 | DCR4-75B | 178 | 0.335 | 1.40 | 58 |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | DCR4-90B | 214 | 0.29 | 1.20 | 64 |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | DCR4-110B | 261 | 0.24 | 0.91 | 73 |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | DCR4-132B | 313 | 0.215 | 0.64 | 84 |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | DCR4-160B | 380 | 0.177 | 0.52 | 90 |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | DCR4-200B | 475 | 0.142 | 0.52 | 126 |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | DCR4-220B | 524 | 0.126 | 0.41 | 131 |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | DCR4-280B | 649 | 0.100 | 0.32 | 150 |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | DCR4-315B | 739 | 0.089 | 0.33 | 190 |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | DCR4-355B | 833 | 0.079 | 0.28 | 205 |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | DCR4-400B | 938 | 0.070 | 0.23 | 215 |
| | 500 | – | FRN400VG7S-4 | DCR4-500B | 1173 | 0.057 | 0.20 | 292 |

Note: The generated loss is an approximate value calculated by the following conditions:

- Power supply voltage is 200V or 400V, 50Hz. Voltage unbalance is 0(zero)%.
- Power transformer capacity is 500kVA, or 10 times of inverter rated capacity; which is larger one is adopted.
- The load motor is 4 pole standard motor with 100% load.
- No AC Reactor (ACR) is connected.

## 8.6.4 AC Reactor (ACR)

- This reactor is unnecessary unless an especially stable power supply as DC-bus connection operation (PN-connection operation) is required. Use a DC Reactor (DCR) for reducing harmonics.
- Use this reactor if the power supply voltage fluctuates excessively (for reason such as excessive voltage unbalance between phases).

Table 8.6.4 AC Reactor (ACR)

| Power supply voltage | Nominal appplied motor [kW] | Inverter type | | AC Reactor (ACR) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | CT use, HT use | VT use | Type | Rated current [A] | Reactance [mΩ/phase] 50[Hz] | Reactance [mΩ/phase] 60[Hz] | Coil resistance [mΩ] | Generated loss [W] |
| Three-phase 200V | 0.75 | FRN0.75VG7S-2 | – | ACR2-0.75A | 5 | 493 | 592 | – | 12 |
| | 1.5 | FRN1.5VG7S-2 | FRN0.75VG7S-2 | ACR2-1.5A | 8 | 295 | 354 | | 14 |
| | 2.2 | FRN2.2VG7S-2 | FRN1.5VG7S-2 | ACR2-2.2A | 11 | 213 | 256 | | 16 |
| | 3.7 | FRN3.7VG7S-2 | FRN2.2VG7S-2 | ACR2-3.7A | 17 | 218 | 153 | | 23 |
| | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | ACR2-5.5A | 25 | 87.7 | 105 | | 27 |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | ACR2-7.5A | 33 | 65.0 | 78.0 | | 30 |
| | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | ACR2-11A | 46 | 45.5 | 54.7 | | 37 |
| | 15 | FRN15VG7S-2 | FRN11VG7S-2 | ACR2-15A | 59 | 34.8 | 41.8 | | 43 |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | ACR2-18.5A | 74 | 28.6 | 34.3 | | 51 |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | ACR2-22A | 87 | 24.0 | 28.8 | | 57 |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | ACR2-37 | 200 | 10.8 | 13.0 | 0.5 | 28.6 |
| | 37 | FRN37VG7S-2 | FRN30VG7S-2 | | | | | | 40.8 |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | ACR2-55 | 270 | 7.50 | 9.00 | 0.375 | 47.1 |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | | | | | | 66.1 |
| | 75 | FRN75VG7S-2 | FRN55VG7S-2 | ACR2-75 | 390 | 5.45 | 6.54 | 0.250 | 55.1 |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | ACR2-90 | 450 | 4.73 | 5.67 | 0.198 | 61.5 |
| | 110 | – | FRN90VG7S-2 | ACR2-110 | 500 | 4.25 | 5.10 | 0.180 | 83.4 |
| Three-phase 400V | 3.7 | FRN3.7VG7S-4 | – | ACR4-3.7A | 9 | 512 | 615 | – | 17 |
| | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | ACR4-5.5A | 13 | 349 | 418 | | 22 |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | ACR4-7.5A | 18 | 256 | 307 | | 27 |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | ACR4-11A | 24 | 183 | 219 | | 40 |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | ACR4-15A | 30 | 139 | 167 | | 46 |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | ACR4-18.5A | 39 | 114 | 137 | | 57 |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | ACR4-22A | 45 | 95.8 | 115 | | 62 |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | ACR4-37 | 100 | 41.7 | 50 | 2.73 | 38.9 |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | | | | | | 55.7 |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | ACR4-55 | 135 | 30.8 | 37 | 1.61 | 50.2 |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | | | | | | 70.7 |
| | 75 | FRN75VG7S-4 | FRN55VG7S-4 | ACR4-75 *1 | 160 | 25.8 | 31 | 1.16 | 65.3 |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | ACR4-110 | 250 | 16.7 | 20 | 0.523 | 42.2 |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | | | | | | 60.3 |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | ACR4-132 | 270 | 20.8 | 25 | 0.741 | 119 |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | ACR4-220 *1 | 561 | 10.0 | 12 | 0.236 | 56.4 |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | | | | | | 90.4 |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | | | | | | 107 |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | ACR4-280 | 825 | 6.67 | 8 | 0.144 | 108 |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | | | | | | |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | | | | | | |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | | | | | | |
| | 500 | – | FRN400VG7S-4 | | | | | | |

*1) Fan cooling is required (3m/s or over).

*2) The generated loss is an approximate value calculated by the following conditions:

- Power supply voltage is 200V or 400V, 50Hz. Voltage unbalance is 0 (zero)%.
- Power transformer capacity is 500kVA, or 10 times of inverter rated capacity; which is larger one is adopted.
- The load motor is 4 pole standard motor with 100% load.
- The inverters standard-equipped with DC power reactor (DCR) of 75kW or over are indicated as the value with DCR.

## 8.6.5 Ferrite Ring for Reducing Radio Noise (ACL)

- The applicable wire size depends **on the inner diameter and installation condition** of ferrite ring for reducing radio noise (ACL).

Table 8.6.5 Ferrite Ring for Reducing Radio Noise (ACL)

| Type of Ferrite Ring for Reducing Radio Noise | Setting condition | | Recommended wire size [mm$^2$] |
|---|---|---|---|
| | Q'ty [pcs] | No. of turns [time] | |
| ACL-40B | 1 | 4 | 2.0 |
| | | | 3.5 |
| | | | 5.5 |
| | 2 | 2 | 8.0 |
| | | | 14 |

| Type of Ferrite Ring for Reducing Radio Noise | Setting condition | | Recommended wire size [mm$^2$] |
|---|---|---|---|
| | Q'ty [pcs] | No. of turns [time] | |
| ACL-74B | 1 | 4 | 8.0 |
| | | | 14 |
| | 2 | 2 | 22 |
| | | | 38 |
| | | | 60 |
| | | | 5.5×2 |
| | | | 8.0×2 |
| | | | 14×2 |
| | | | 22×2 |
| | 4 | 1 | 100 |
| | | | 150 |
| | | | 200 |
| | | | 250 |
| | | | 325 |
| | | | 38×2 |
| | | | 60×2 |
| | | | 100×2 |
| | | | 150×2 |

Note: Selected wire is supposed to be for three-phase.

# 8.6.6 Power Regenerative PWM Converter (RHC)

• For the actual connection method, refer to the instruction manual for the power regenerative PWM converter (RHC).

Table 8.6.6 Power Regenerative PWM Converter (RHC)

| Power supply voltage | Nominal applied motor [kW] | Inverter type | | PWM converter main unit type | Exclusive reactor type | Exclusive filter | | |
|---|---|---|---|---|---|---|---|---|
| | | CT use, HT use | VT use | | | Filter (Reactor type) | Filter (Capacitor type) | Filter (Resistor type) |
| Three-phase 200V | 5.5 | FRN5.5VG7S-2 | FRN3.7VG7S-2 | RHC7.5-2A | LR2-7.5 | LFC2-7.5 | CF2-7.5 | RF2-7.5 |
| | 7.5 | FRN7.5VG7S-2 | FRN5.5VG7S-2 | | | | | |
| | 11 | FRN11VG7S-2 | FRN7.5VG7S-2 | RHC15-2A | LR2-15 | LFC2-15 | CF2-15 | RF2-15 |
| | 15 | FRN15VG7S-2 | FRN11VG7S-2 | | | | | |
| | 18.5 | FRN18.5VG7S-2 | FRN15VG7S-2 | RHC22-2A | LR2-22 | LFC2-22 | CF2-22 | RF2-22 |
| | 22 | FRN22VG7S-2 | FRN18.5VG7S-2 | | | | | |
| | 30 | FRN30VG7S-2 | FRN22VG7S-2 | RHC37-2A | LR2-37L | LFC2-37 | CF2-37 | GRZG400-1Ω |
| | 37 | FRN37VG7S-2 | FRN30VG7S-2 | | | | | |
| | 45 | FRN45VG7S-2 | FRN37VG7S-2 | RHC55-2A | LR2-55L | LFC2-55 | CF2-55 | GRZG400-0.6Ω |
| | 55 | FRN55VG7S-2 | FRN45VG7S-2 | | | | | |
| | 75 | FRN75VG7S-2 | FRN55VG7S-2 | * | * | * | * | * |
| | 90 | FRN90VG7S-2 | FRN75VG7S-2 | | | | | |
| | 110 | – | FRN90VG7S-2 | | | | | |
| Three-phase 400V | 5.5 | FRN5.5VG7S-4 | FRN3.7VG7S-4 | RHC7.5-4A | LR4-7.5 | LFC4-7.5 | CF4-7.5 | RF4-7.5 |
| | 7.5 | FRN7.5VG7S-4 | FRN5.5VG7S-4 | | | | | |
| | 11 | FRN11VG7S-4 | FRN7.5VG7S-4 | RHC15-4A | LR4-15 | LFC4-15 | CF4-15 | RF4-15 |
| | 15 | FRN15VG7S-4 | FRN11VG7S-4 | | | | | |
| | 18.5 | FRN18.5VG7S-4 | FRN15VG7S-4 | RHC22-4A | LR4-22 | LFC4-22 | CF4-22 | RF4-22 |
| | 22 | FRN22VG7S-4 | FRN18.5VG7S-4 | | | | | |
| | 30 | FRN30VG7S-4 | FRN22VG7S-4 | RHC37-4A | LR4-37L | LFC4-37 | CF4-37 | GRZG400-4Ω |
| | 37 | FRN37VG7S-4 | FRN30VG7S-4 | | | | | |
| | 45 | FRN45VG7S-4 | FRN37VG7S-4 | RHC55-4A | LR4-55L | LFC4-55 | CF4-55 | GRZG400-2.4Ω |
| | 55 | FRN55VG7S-4 | FRN45VG7S-4 | | | | | |
| | 75 | FRN75VG7S-4 | FRN55VG7S-4 | RHC75-4A | LR4-75L | LFC4-75 | CF4-75 | RF4-75 |
| | 90 | FRN90VG7S-4 | FRN75VG7S-4 | RHC110-4A | LR4-110L | LFC4-110 | CF4-110 | RF4-110 |
| | 110 | FRN110VG7S-4 | FRN90VG7S-4 | | | | | |
| | 132 | FRN132VG7S-4 | FRN110VG7S-4 | RHC160-4A | LR4-160L | LFC4-160 | CF4-160 | RF4-160 |
| | 160 | FRN160VG7S-4 | FRN132VG7S-4 | | | | | |
| | 200 | FRN200VG7S-4 | FRN160VG7S-4 | RHC220-4A | LR4-220L | LFC4-220 | CF4-220 | RF4-220 |
| | 220 | FRN220VG7S-4 | FRN200VG7S-4 | | | | | |
| | 280 | FRN280VG7S-4 | FRN220VG7S-4 | * | * | * | * | * |
| | 315 | FRN315VG7S-4 | FRN280VG7S-4 | | | | | |
| | 355 | FRN355VG7S-4 | FRN315VG7S-4 | | | | | |
| | 400 | FRN400VG7S-4 | FRN355VG7S-4 | | | | | |
| | 500 | – | FRN400VG7S-4 | | | | | |

Ask us for the converter data marked with *.

# 8. Peripheral Equipment

## 8.6.7 Inverter Generating Loss

| Power supply voltage | Inverter type | Inverter generating loss [W] | | | | | |
|---|---|---|---|---|---|---|---|
| | | CT use | | VT use | | HT use | |
| | | Low carrier *1 | High carrier *2 | Low carrier *1 | High carrier *3 | Low carrier *1 | High carrier *2 |
| Three-phase 200V | FRN0.75VG7S-2 | 95 | 110 | 125 | 140 | – | – |
| | FRN1.5VG7S-2 | 125 | 150 | 160 | 180 | | |
| | FRN2.2VG7S-2 | 160 | 195 | 250 | 280 | | |
| | FRN3.7VG7S-2 | 210 | 280 | 320 | 370 | 180 | 230 |
| | FRN5.5VG7S-2 | 310 | 400 | 440 | 510 | 240 | 320 |
| | FRN7.5VG7S-2 | 380 | 490 | 560 | 640 | 300 | 390 |
| | FRN11VG7S-2 | 500 | 650 | 700 | 810 | 390 | 520 |
| | FRN15VG7S-2 | 630 | 840 | 780 | 920 | 490 | 670 |
| | FRN18.5VG7S-2 | 840 | 1000 | 1000 | 1100 | 710 | 850 |
| | FRN22VG7S-2 | 1000 | 1200 | 1300 | 1400 | 850 | 1000 |
| | FRN30VG7S-2 | 1150 | 1400 | 1550 | 1700 | 950 | 1150 |
| | FRN37VG7S-2 | 1400 | 1750 | 1800 | 2050 | 1150 | 1450 |
| | FRN45VG7S-2 | 1700 | 2050 | 2100 | 2350 | 1450 | 1800 |
| | FRN55VG7S-2 | 1950 | 2400 | 2800 | 3100 | 1750 | 2150 |
| | FRN75VG7S-2 | 2750 | *4 3100 | 3350 | *5 3500 | – | – |
| | FRN90VG7S-2 | 3250 | *4 3650 | 3950 | *5 4150 | | |
| Three-phase 400V | FRN3.7VG7S-4 | 160 | 240 | 210 | 280 | 140 | 210 |
| | FRN5.5VG7S-4 | 210 | 330 | 280 | 370 | 180 | 280 |
| | FRN7.5VG7S-4 | 270 | 430 | 380 | 500 | 220 | 360 |
| | FRN11VG7S-4 | 330 | 530 | 430 | 590 | 270 | 430 |
| | FRN15VG7S-4 | 420 | 690 | 520 | 710 | 340 | 560 |
| | FRN18.5VG7S-4 | 650 | 850 | 700 | 850 | 540 | 730 |
| | FRN22VG7S-4 | 750 | 1050 | 950 | 1250 | 650 | 1000 |
| | FRN30VG7S-4 | 900 | 1400 | 1300 | 1600 | 750 | 1200 |
| | FRN37VG7S-4 | 1000 | 1700 | 1450 | 1900 | 850 | 1450 |
| | FRN45VG7S-4 | 1150 | 1950 | 1700 | 2200 | 1000 | 1650 |
| | FRN55VG7S-4 | 1400 | 2300 | 2050 | 2700 | 1150 | 1900 |
| | FRN75VG7S-4 | 2000 | *4 2800 | 2650 | *5 2950 | – | – |
| | FRN90VG7S-4 | 2350 | *4 3250 | 2950 | *5 3300 | | |
| | FRN110VG7S-4 | 2600 | *4 3600 | 3300 | *5 3750 | | |
| | FRN132VG7S-4 | 2950 | *4 4150 | 3900 | *5 4450 | | |
| | FRN160VG7S-4 | 3450 | *4 4900 | 4450 | *5 5150 | | |
| | FRN200VG7S-4 | 3950 | *4 5750 | 4950 | *5 5700 | | |
| | FRN220VG7S-4 | 4400 | *4 6350 | 5800 | *5 6700 | | |
| | FRN280VG7S-4 | 5550 | *4 8050 | 6500 | *5 7550 | | |
| | FRN315VG7S-4 | 6250 | *4 9000 | 7250 | *5 8450 | | |
| | FRN355VG7S-4 | 6950 | *4 10200 | 8250 | *5 9550 | | |
| | FRN400VG7S-4 | 7850 | *4 11400 | 10400 | *5 12100 | | |

Note: Carrier frequencies are as follows
*1: 2 kHz, *2: 15 kHz, *3: 10 kHz, *4: 10 kHz, *5: 6 kHz

THE INVERTER

# IX. Selecting Inverter Capacity

9.1 Inverter and Motor Selection

9.2 Braking Unit and Braking Resistor Selection

# 9. Selecting Inverter Capacity

## 9.1 Inverter and Motor Selection

### 9.1.1 Characteristics of Output Torque

Figure 9.1 shows the output torque characteristics. The output torque is classified into the following quadrants by speed and torque-applied direction.

| | (Speed) | (Torque) | |
|---|---|---|---|
| • Quadrant I : | + | + | … Driving in forward rotation |
| • Quadrant II : | − | + | … Braking in reverse rotation |
| • Quadrant III : | − | − | … Driving in reverse rotation |
| • Quadrant IV : | + | − | … Braking in forward rotation |

In the figure below, **the speed rate (%) is expressed by regarding the base speed as 100%**, and **the torque rate (%) is expressed by regarding the continuous rated torque as 100%**.

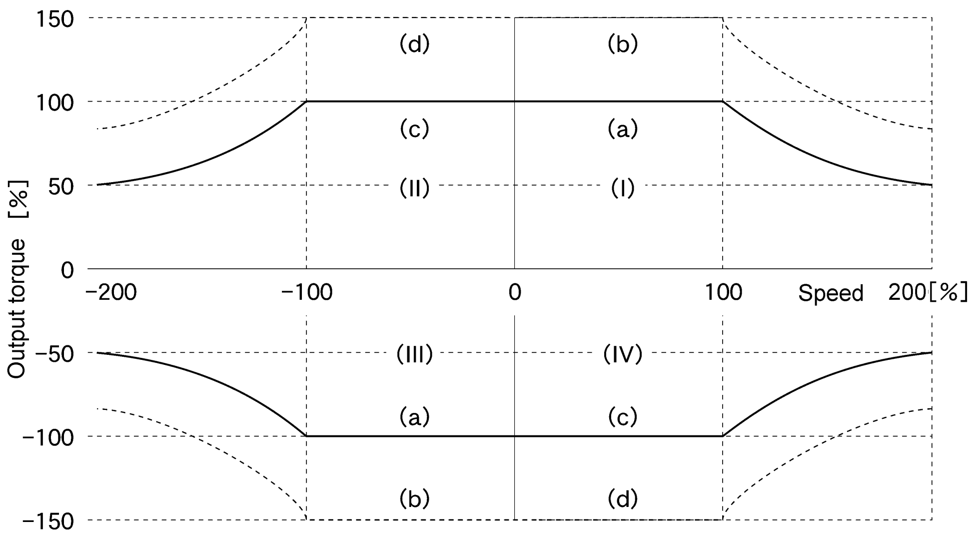



Figure 9-1 Characteristics of the Output Torque (CT Specification)

(1) Allowable continuous driving torque (curve (a) in the 1st and 3rd quadrants)
Curve (a) shows the torque that is available continuously in driving mode.
In the area below the base speed (100%) in the speed control range (0 to 200%), the rated torque is obtained. In the area above the base speed, the constant output is obtained, and the output torque is in inverse to proportion to the speed.
At very low speeds below the speed control range, the allowable torque drops to 80% for less than 0.5Hz converted into inverter output frequency. The motor can be operated continuously considering motor slip in practice.

(2) Max. driving torque in a short-time (curve (b) in the 1st and 3rd quadrants)
Curve (b) shows the torque that is allowed for a short-time (60 seconds) in driving mode.
In general, this torque is 150% of rated torque, and used for acceleration or deceleration.
At very low speeds below the speed control range, due to the restriction of inverter internal temperature, the allowable torque drops to 100% for less than 0.5Hz converted into inverter output frequency.

(3) Starting torque (around speed zero (0) in the 1st and 3rd quadrants)
The starting torque is the torque at speeds around 0 in the 1st and 3rd quadrants.
Although the continuous torque is 80%, the starting torque becomes as high as 150% because the curve passes the very low speed range in quite a short period (30 seconds or less).

(4) Braking torque (the 2nd and 4th quadrants)

The 2nd and 4th quadrants are the braking mode range. Curve (c) shows the braking torque that is available in the continuous rated current range of the inverter; curve (d) is the braking torque that is available for 60-second rated current. In the very low speed range, the torque drops to 80% similar to that in the driving mode.

The time rating of the braking torque is limited by the braking resistor and braking unit capacity, because the energy of the machine system is regenerated.

## 9.1.2 Selection Procedure

Figure 9-5 shows the general selection procedure for optimal inverter selection. Inverter capacity can be easily selected if there are no limitation regarding acceleration and deceleration time.
The cases such as “Lifting or lowering a load”, “Acceleration and deceleration time is restricted”, or “Highly frequent acceleration and deceleration” make the selection procedure a little bit complex.

(1) Calculation of load torque during constant speed running
(For detailed calculation, see Section 9.1.3.1)
This step is necessary for capacity selection for all loads. Determine the rated torque of the motor during constant speed running higher than that of the load torque, and select a tentative capacity. To perform capacity selection efficiently, it is necessary to match the rated speeds (base speeds) of the motor and load.
To do this, select an appropriate reduction-gear (mechanical transmission) ratio and number of motor poles. If acceleration/deceleration time is not limited and the system is not a lifting machine, capacity selection is completed as it is.

(2) Acceleration time
(For detailed calculation, see Section 9.1.3.2)
When there are specified requirements for the acceleration time, calculate it using the following procedure:

1) Calculate moment of inertia for the load and motor.
Calculate moment of inertia for the load by referring to Section 9.1.3.2. The moment of inertia of motor is shown in Section 2.2.3.
2) Calculate minimum acceleration torque. (See Figure 9-2)
The acceleration torque is the difference between motor short time output torque (60s rating) explained in Section 9.1.1(2) and load torque ($\tau_L/\eta_G$) during constant speed running calculated in the above (1). Calculate minimum acceleration torque for the whole range of speed.
3) Calculate the acceleration time.
Assign the value calculated above to the expression (3.15) in Section 9.1.3.2 to calculate the acceleration time.
If the calculated acceleration time is longer than the requested time, select one size larger capacity inverter and motor and calculate it again.

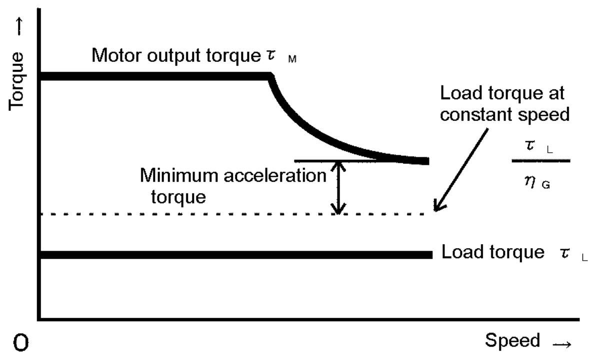


Figure 9-2 Example Study of Minimum Acceleration

(3) Deceleration time

(For detailed calculation, see Section 9.1.3.2)

To calculate the deceleration time, check the motor deceleration torque characteristics for the whole range of speed in the same way as for the acceleration time.

1) Calculate moment of inertia for the load and motor.
   * Same as for acceleration time.
2) Calculate minimum deceleration torque. (See Figure 9-3)
   * Same as for acceleration time.
3) Calculate the deceleration time.
   Assign the value calculated above to the expression (3.16) in Section 9.1.3.2 to calculate the deceleration time.
   If the calculated deceleration time is longer than the requested time, select one size larger capacity and calculate it again.

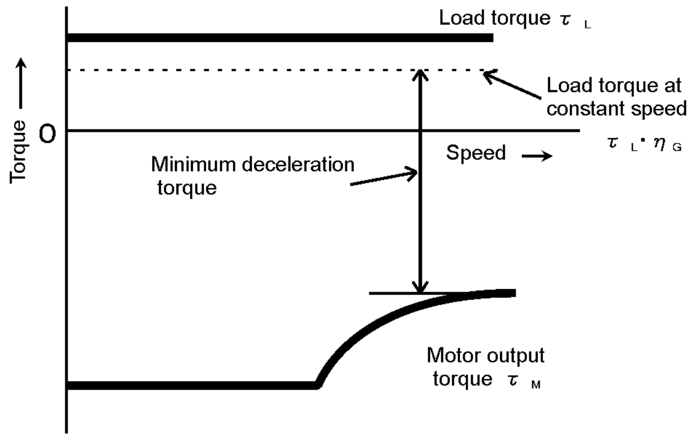



Figure 9-3  Example Study of Minimum Deceleration Torque (1)

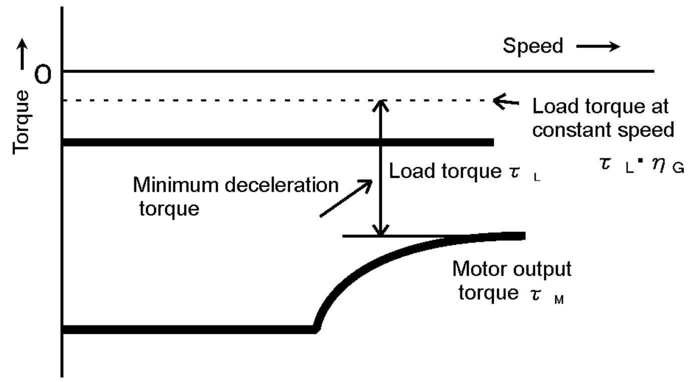



Figure 9-4  Example Study of Minimum Deceleration Torque (2)

However, note that minimum deceleration torque becomes smaller due to regenerative operation when lifting or lowering a load. (See Figure 9-4)

# 9. Selecting Inverter Capacity

(4) Braking resistor rating

(For detailed calculation, see Section 9.1.3.3)

Braking resistor rating is divided into two types according to the braking periodic duty cycle:

1) When periodic duty cycle is 100s or less:
   - Calculate average loss to determine rated values.

2) When periodic duty cycle is 100s or more:
   - Allowable braking energy depends on maximum braking power. The actual value for the maximum braking energy is indicated by the characteristics curve.

(5) Motor RMS current

(For detailed calculation, see Section 9.1.3.4)

In metal processing machine and carriage machinery requiring positioning control, highly frequent running with short time rating is performed. In this case, calculate an equivalent RMS current value not to exceed the allowable value for the motor.

(6) Notes for examining inverter capacity

- When selecting an inverter for driving a Fiji's inverter-dedicated motor, ensure that the root mean square of the motor torque is lower than the inverter rated torque (80% of the rated torque for HT use).
- When selecting a general-purpose motor, ensure that the root mean square of the motor current is lower than the motor rated current for effective motor cooling. In this case, select an inverter so that the root mean square of the current is lower than the inverter rated current (80% of the rated current for HT use).

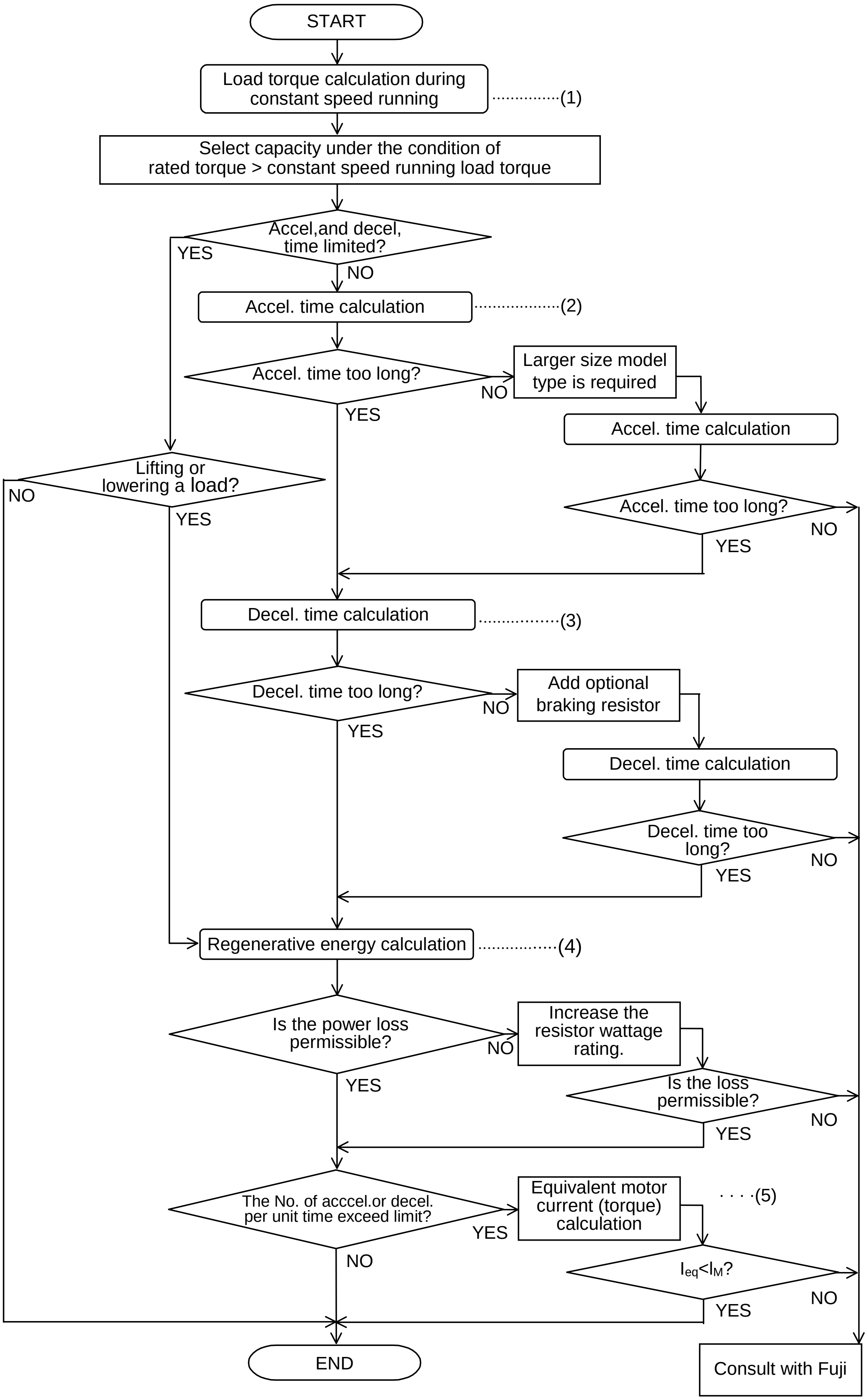


Figure 9-5 Selection Procedure

## 9.1.3 Calculations for Selecting Capacity

### 9.1.3.1 Load Torque during Constant Speed Running

(1) General expression

The frictional force acting on a horizontally moved load must be calculated. For loads lifted or lowered vertically or along a slope, the gravity acting on the load must be calculated. Calculation for driving a load along a straight line with the motor is shown below.
Where the force to move a load linearly at constant speed $\upsilon$ [m/s] is F[N] and the motor speed for driving this is $N_M$ [r/min], the required motor output torque $\tau_M$ [N·m] is as follows:

$$\tau_M = \frac{60\cdot\upsilon}{2\pi\cdot N_M}\cdot\frac{F}{\eta_G}\ [\mathrm{N\cdot m}] \quad \cdots\cdots (3.1)$$

Where, $\eta_G$: Reduction-gear efficiency

When the motor is in braking mode, efficiency works inversely, so the required motor torque should be calculated as follows:

$$\tau_M = \frac{60\cdot\upsilon}{2\pi\cdot N_M}\cdot F\cdot\eta_G\ [\mathrm{N\cdot m}] \quad \cdots\cdots (3.2)$$

$(60\ \upsilon)/(2\ \pi\cdot N_M)$ in the above expression is an equivalent rotation radius corresponding to speed $\upsilon$ around the motor shaft.
The value F in the above expressions changes according to the load type.

(2) Moving a load horizontally

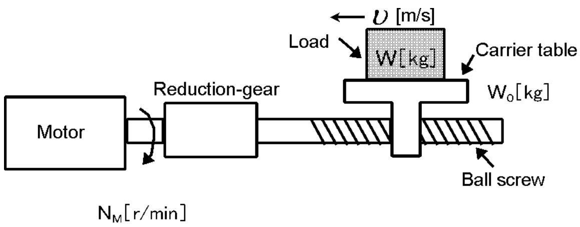



Figure 9-6 Moving a Load Horizontally

As shown in Figure 9-6, where the carrier table weight is $W_0$ [kg], load is W [kg], and friction coefficient of the ball screw is $\mu$, friction force F [N] is expressed as follows:

$$F = (W_o + W)\cdot g\cdot\mu\ [\mathrm{N}] \quad \cdots\cdots (3.3)$$

Where, g : Gravity acceleration ($\approx$ 9.8 m/s$^2$)

Then, required driving torque around the motor shaft is expressed as follows:

$$\tau_M = \frac{60\cdot\upsilon}{2\pi\cdot N_M}\cdot\frac{(W_o + W)\cdot g\cdot\mu}{\eta_G}\ [\mathrm{N\cdot m}] \quad \cdots\cdots (3.4)$$

(3) Moving a load vertically

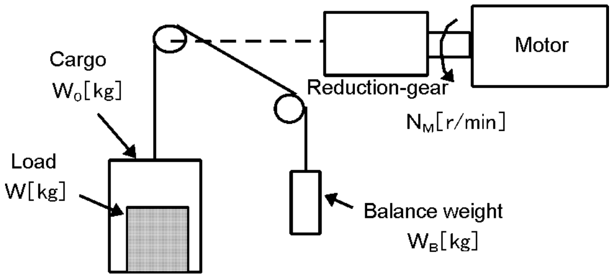



Figure 9-7 Moving a Load

As shown in Figure 9-7, where a cage weight, load weight, and balance-mass weight are $W_0$, W, and $W_B$ [kg], the force of gravity F [N] is as follows:

(Lifting)

$$F = (W_O + W - W_B) \cdot g \text{ [N]} \qquad (3.5)$$

(Lowering)

$$F = (W_B + W - W_O) \cdot g \text{ [N]} \qquad (3.6)$$

Where maximum load is $W_{max}$, generally $W_B$ equals to $(W_o + W_{max}) / 2$. So, F may become a negative force to brake both lifting and lowering movements depending on the load weight.
Calculate the required torque τ around the motor shaft in the driving mode by expression (3.1) and that in the braking mode by expression (3.2). That is, if F is positive, use expression (3.1); if it is negative, use expression (3.2).

(4) Moving a load along a slope

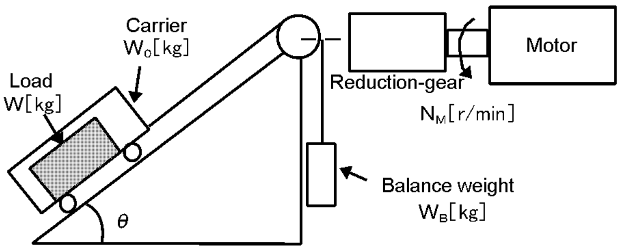



Figure 9-8 Moving a Load Along a Slope

Lifting and lowering a load along a slope may seem to be like lifting and lowering a load vertically, but friction force between the load and the slope cannot be ignored. Therefore, the expression for lifting a load is a little different from that for lowering a load. Where slope angle is θ and friction coefficient is μ, as shown in Figure 9-8, driving force F [N] is as follows:

(Lifting)

$$F = (W_O + W)(\sin\theta + \mu \cdot \cos\theta) - W_B \cdot g \text{ [N]} \qquad (3.7)$$

(Lowering)

$$F = (W_B - (W_O + W)(\sin\theta + \mu \cdot \cos\theta) \cdot g \text{ [N]} \qquad (3.8)$$

The force of gravity F may become a negative force to brake both lifting and lowering movements, depending on the load weight. This is the same as for vertical lifting and lowering. Required torque around the motor shaft can be also calculated similarly.
That is, when F is positive, use expression (3.1); when it is negative, use expression (3.2).

## 9.1.3.2 Acceleration and Deceleration Time Calculation

When an object whose moment of inertia is J [kg·m$^2$] rotates at the speed N [r/min], it has the following kinetic energy:

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N}{60}\right)^2 \quad [J] \quad \cdots\cdots (3.9)$$

To accelerate the above rotation, kinetic energy will be increased; to decelerate, kinetic energy must be dis-charged.
The torque required for acceleration and deceleration can be expressed as follows:

$$\tau = J \cdot \frac{2\pi}{60} \left(\frac{dN}{dt}\right) \quad [N \cdot m] \quad \cdots\cdots (3.10)$$

In this way, the mechanical moment of inertia is an important element in acceleration and deceleration. First, calculation method of moment of inertia is described, then that for acceleration and deceleration time are explained.

(1) Calculation of moment of inertia

For an object that rotates around the rotation axis, vertually divide the object into small segments and square the distance from the rotation axis to each segment. Then, sum the squares of the distances and the masses of the segments to calculate the moment of inertia.

Moment of inertia $J = \sum (W_i \cdot r_i^2)$ [kg · m$^2$] $\cdots\cdots$ (3.11)

1) Hollow cylinder and solid cylinder

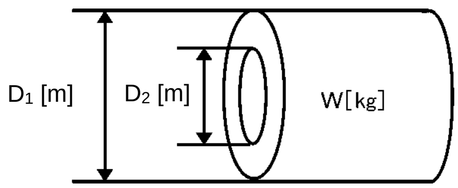



Figure 9-9 Hollow

The common shape of a rotating body is hollow cylinder. The moment of inertia J [J] around the hollow cylinder center axis can be calculated as follows, where the outer and inner diameters are $D_1$ and $D_2$ [m] and total weight is W [kg] in Figure 9-9.

$$J = \frac{W \cdot (D_1^2 + D_2^2)}{60} \quad [J] \quad \cdots\cdots (3.12)$$

For a similar shape, a solid cylinder, calculate the moment of inertia as $D_2$ is 0.

2) For a general rotating body

Table 9-1 lists the calculation expressions of moment of inertia of various rotating bodies including the above cylindrical rotating body.

3) For a load running horizontally

As shown in Figure 9-6, a carrier table can be driven by a motor. If the table speed is $\upsilon$ [m/s] when the motor rotation speed is $N_M$ [r/min], an equivalent distance from the rotation axis is $60\,\upsilon/(2\pi \cdot N_M)$ [m]. Then, the moment of inertia of table and load to the rotation axis is calculated as follows:

$$J = \left(\frac{60\upsilon}{2\pi \cdot N_M}\right)^2 \cdot (W_O + W) \quad [kg \cdot m^2] \quad \cdots\cdots (3.13)$$

4) For lifting and lowering load

As shown in Figures 9-7 and 9-8, two loads tied with the rope move in different directions. The moment of inertia can be calculated by obtaining the sum of the moving objects weight as follows:

$$J = \left(\frac{60\upsilon}{2\pi \cdot N_M}\right)^2 \cdot (W_O + W + W_B) \quad [kg \cdot m^2] \quad \cdots\cdots (3.14)$$

(2) Calculation of the acceleration time

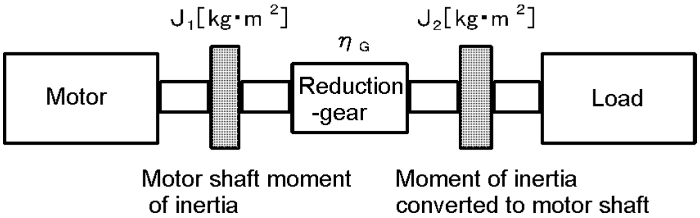



Figure 9-10 Load Model Including Reduction-gear

Figure 9-10 shows a general load model. Here, the load is tied via a reduction-gear with efficiency $\eta_G$. The time required to accelerate this load to a speed of $N_M$ [r/min] is calculated with the following expression:

$$t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M - \tau_L / \eta_G} \cdot \frac{2\pi \cdot (N_M - 0)}{60} \quad [s] \quad \cdots\cdots (3.15)$$

Where,

$J_1$ : Motor shaft moment of inertia [kg·m²]
$J_2$ : Load shaft moment of inertia converted to motor shaft [kg·m²]
$\tau_M$ : Minimum motor output torque in driving mode [N·m]
$\tau_L$ : Maximum load torque converted to motor shaft [N·m]
$\eta_G$ : Reduction-gear efficiency

As clarified in the above expression, equivalent moment of inertia becomes ($J_1$+$J_2$/$\eta_G$) considering the reduction gear efficiency.

(3) Calculation of the deceleration time

In Figure 9-10, the time required to stop the motor rotating at a speed of $N_M$ [r/min] is calculated with the following expression:

$$t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot (0 - N_M)}{60} \quad [s] \quad \cdots\cdots (3.16)$$

Where,

$J_1$ : Motor shaft moment of inertia [kg·m²]
$J_2$ : Load shaft moment of inertia converted to motor shaft [kg·m²]
$\tau_M$ : Minimum motor output torque in braking (deceleration) mode [N·m]
$\tau_L$ : Maximum load torque converted to motor shaft [N·m]
$\eta_G$ : Reduction-gear efficiency

In the above expression, generally output torque $\tau_M$ is negative and load torque $\tau_L$ is positive. So, deceleration time becomes shorter. However, in a lifted and lowered load, $\tau_L$ may become a negative value in braking mode. In this case, the deceleration time becomes longer.

* For lifting or lowering load
In inverter and motor capacity selection for lifted and lowered load, the deceleration time must be calculated by using the maximum value that makes the load torque negative.

(4) Non-linear (S-curve) accel./decel. time

For loads that are frequently accelerated and decelerated, it is often necessary to minimize the accel. and decel. time by using accel. and decel. torques. Vector control inverters are ideal for such operations.

Selecting Inverter Capacity

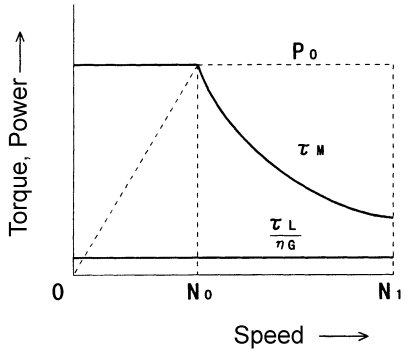



Figure 9-11 Sample of Driving Device which Includes the Constant Power Characteristic

In this operation, the accel. and decel. characteristic becomes non-linear, so the time required to accel. or decel. cannot be expressed by a simple formula.

Therefore, in general, the method employed divides speed N into small sections ($\Delta N$) to calculate the partial accel./decel. time and sums these until accel. or decel. ends.
The smaller the divisions, the higher the calculation accuracy.
The above figure shows a sample torque-speed characteristic of a driving system: the curve shows a constant-torque in the range below $N_0$ and constant-output in the range from $N_0$ to $N_1$.
The accel. time is expressed as follows:

$$\Delta t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M + \tau_L / \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad [s] \quad \cdots\cdots (3.17)$$

Obtaining in advance the moment of inertia of the motor shaft ($J_1$) and of the load shaft (after conversion into motor shaft) ($J_2$) and load torque $\tau_L$ (after conversion into motor shaft) as well as the efficiency of the reduction speed device ($\eta_G$), the maximum motor torque ($\tau_M$) is calculated using one of the following formulas depending on the speed range:

- $\tau_M$ when $N \le N_0$: constant-torque range

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N_O} \quad [N \cdot m] \quad \cdots\cdots (3.18)$$

- $\tau_M$ when $N_0 \le N \le N_1$: constant-output range (torque is inversely proportional to speed)

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N} \quad [N \cdot m] \quad \cdots\cdots (3.19)$$

If the result of the above calculation differs from the expected result, select a drive system by one frame larger.

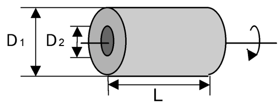
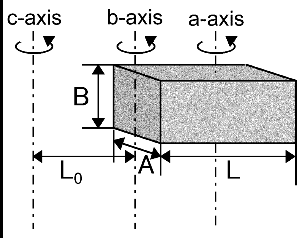
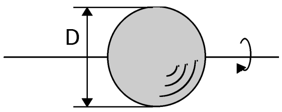
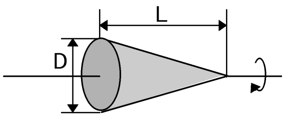
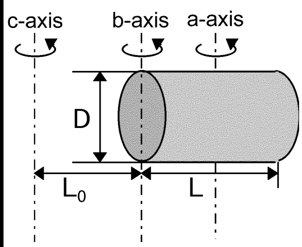
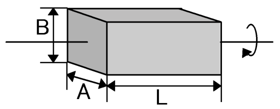
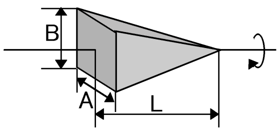
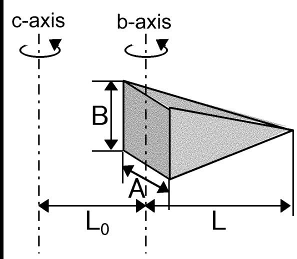
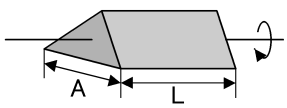
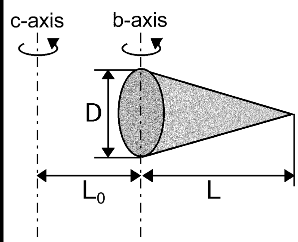
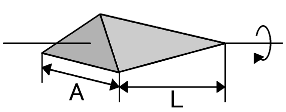
(5) Calculation for nonlinear decelerating time

Decelerating time can be calculated by the same formula as used for calculating accelerating time.

$$\Delta t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \quad [s] \quad \cdots\cdots (3.20)$$

In this formula, because both $\tau_M$ and $\Delta_N$ are negative value, load torque $\tau_L$ generally promotes deceleration. However, lift load has a mode in which $\tau_L$ becomes negative. In this mode, the polarity differs between $\tau_M$ and $\tau_L$, which blocks deceleration.

Table 9.1  Moment of Inertia of Various Rotating Bodies

| Shape | Mass: W [kg]<br>Moment of inertia: J [kg·m²] | Shape | Mass: W [kg]<br>Moment of inertia: J [kg·m²] |
|---|---|---|---|
| Hollow cylinder<br> | $W=\frac{\pi}{4}\cdot(D_1^2-D_2^2)\cdot L\cdot\rho$<br>$J=\frac{1}{8}\cdot W\cdot(D_1^2+D_2^2)$ |  | $W=A\cdot B\cdot L\cdot\rho$<br>$J_a=\frac{1}{12}\cdot W\cdot(L^2+A^2)$<br>$J_b=\frac{1}{12}\cdot W\cdot(L^2+\frac{1}{4}\cdot A^2)$<br>$J_c\approx W\cdot(L_0^2+L_0\cdot L+\frac{1}{3}\cdot L^2)$ |
| Sphere<br> | $W=\frac{\pi}{6}\cdot D^3\cdot\rho$<br>$J=\frac{1}{10}\cdot W\cdot D^2$ | | |
| Cone<br> | $W=\frac{\pi}{12}\cdot D^2\cdot L\cdot\rho$<br>$J=\frac{3}{40}\cdot W\cdot D^2$ |  | $W=\frac{\pi}{4}\cdot D^2\cdot L\cdot\rho$<br>$J_a=\frac{1}{12}\cdot W\cdot(L^2+\frac{3}{4}\cdot D^2)$<br>$J_b=\frac{1}{3}\cdot W\cdot(L^2+\frac{3}{16}\cdot D^2)$<br>$J_c\approx W\cdot(L_0^2+L_0\cdot L+\frac{1}{3}\cdot L^2)$ |
| Rectangular prism<br> | $W=A\cdot B\cdot L\cdot\rho$<br>$J=\frac{1}{12}\cdot W\cdot(A^2+B^2)$ | | |
| Square cone<br>(pyramid, rectangular base)<br> | $W=\frac{1}{3}\cdot A\cdot B\cdot L\cdot\rho$<br>$J=\frac{1}{20}\cdot W\cdot(A^2+B^2)$ |  | $W=\frac{1}{3}\cdot A\cdot B\cdot L\cdot\rho$<br>$J_b=\frac{1}{10}\cdot W\cdot(L^2+\frac{1}{4}\cdot A^2)$<br>$J_c\approx W\cdot(L_0^2+\frac{3}{2}\cdot L_0\cdot L+\frac{3}{5}\cdot L^2)$ |
| Triangular prism<br> | $W=\frac{\sqrt{3}}{4}\cdot A^2\cdot L\cdot\rho$<br>$J=\frac{1}{3}\cdot W\cdot A^2$ |  | $W=\frac{\pi}{12}\cdot D^2\cdot L\cdot\rho$<br>$J_b=\frac{1}{10}\cdot W\cdot(L^2+\frac{3}{8}\cdot D^2)$<br>$J_c\approx W\cdot(L_0^2+\frac{3}{2}\cdot L_0\cdot L+\frac{3}{5}\cdot L^2)$ |
| Triangle cone<br>(tetrahedron with equilateral triangular base)<br> | $W=\frac{\sqrt{3}}{12}\cdot A^2\cdot L\cdot\rho$<br>$J=\frac{1}{5}\cdot W\cdot A^2$ | | |

Main metal density (at 20°C)  $\rho$[kg/m³]
Carbon steel: 7860, Stainless steel: 7910, Aluminum: 2700

## 9.1.3.3 Heat Energy Calculation of Braking Resistor

Braking by an inverter causes mechanical energy to be regenerated in the inverter circuit.
This regenerative energy is often discharged to the resistor. In this section, braking resistor rating is explained.

(1) Calculation of regenerative energy

Regenerative energy generated in the inverter operation consists of kinetic energy of a moving object and its potential energy.

1) Kinetic energy of a moving object

When an object with moment of inertia J [kg· m$^2$] rotates at a speed $N_2$ [r/min], its kinetic energy is as follows:

$$E = \frac{J}{2} \cdot \left(\frac{2\pi \cdot N_2}{60}\right)^2 \text{ [J]} \quad \cdots\cdots (3.21)$$

$$\approx \frac{1}{182.4} \cdot J \cdot N_2^2 \text{ [J]} \quad \cdots\cdots (3.21)'$$

The output energy when this object is decelerated to a speed $N_1$ [r/min] is as follows:

$$E = \frac{J}{2} \cdot \left[\left(\frac{2\pi \cdot N_2}{60}\right)^2 - \left(\frac{2\pi \cdot N_1}{60}\right)^2\right] \text{ [J]} \quad \cdots\cdots (3.22)$$

$$\approx \frac{1}{182.4} \cdot J \cdot (N_2^2 - N_2^2) \text{ [J]} \quad \cdots\cdots (3.22)'$$

The energy regenerated to the inverter as shown in Figure 9-10 is calculated by considering the reduction-gear efficiency $\eta_G$ and motor efficiency $\eta_M$ as follows:

$$E \approx \frac{1}{182.4} \cdot (J_1 + J_2 \cdot \eta_G) \cdot \eta_M \cdot (N_2^2 - N_1^2) \text{ [J]} \quad \cdots\cdots (3.23)$$

2) Potential energy of an object

When an object of W [kg] is lowered from height $h_2$ [m] to $h_1$ [m], the output potential energy is expressed as follows:

$$E = W \cdot g \cdot (h_2 - h_1) \text{ [J]} \quad \cdots\cdots (3.24)$$

Where, $g \approx 9.8065$ [m/s$^2$]

Regenerative energy to the inverter circuit is calculated by considering the reduction-gear efficiency $\eta_G$ and motor efficiency $\eta_M$ as follows:

$$E = W \cdot g \cdot (h_2 - h_1) \cdot \eta_G \cdot \eta_M \text{ [J]} \quad \cdots\cdots (3.25)$$

(2) Braking power loss

The allowable loss changes with the periodic duty cycle T [s] of braking and power limit during braking.

1) When T ≤ 100 [s]

- Average loss is calculated to select capacity.
- From braking energy E [J] per cycle and T, average power loss $P_R$ [kW] is calculated using the following formula:

$$P_R = \frac{E}{T} \times 10^3 \quad [kW] \quad \cdots\cdots (3.26)$$

Select the capacity such that the above $P_R$[kW] does not over the continuous rating of the braking resistor.

- The details of the continuous rating of the braking resistor[kW] is mentioned in the “option” edition. This rating can be calculated by the following formula.

$$\text{Allowable power loss [kW]} = \frac{\text{Rated\%ED}(*) \times 1.5}{100} \times \text{Rated output of motor [kW]} \cdots (3.27)$$

(*)For the braking resistor with 5%ED, an average power loss equivalent to 7.5% the motor rating is allowed; for the braking resistor with 10%ED, an average power loss equivalent to 15% the moter rating is allowed.

- For braking resistors, two types of rated %ED are available: 5%ED and 10%ED. For rated %ED greater than 10%, consult with Fuji.

2) When T > 100 [s]

Permissible braking energy can be obtained with Figure 9-12.

<1> When 150% of braking power is required.

| Rated %ED of resistor | 5 | 10 |
|---|---|---|
| Permissible braking energy [%·s] | 750 | 1500 |

<2> In the following conditions, the permissible braking energy can be obtained by the graph:

- Conditions: Resistor with 5%ED, 300s duty cycle, 150% braking power
- Braking energy:
  From duty cycle 300s, braking energy is 1750%·s
  From braking power 150%, braking energy is 750%·s

according to this result, 750%·s of braking energy is permissible value.

<3> In the following conditions, the permissible braking energy can be obtained by the graph:

- Conditions: Resistor with 5%ED, 300s duty cycle, 40% braking power
- Braking energy:
  From duty cycle 300s, braking energy is 1750%·s
  From braking power 40%, braking energy is 2000%·s

according to this result, 1750%·s of braking energy is permissible value.

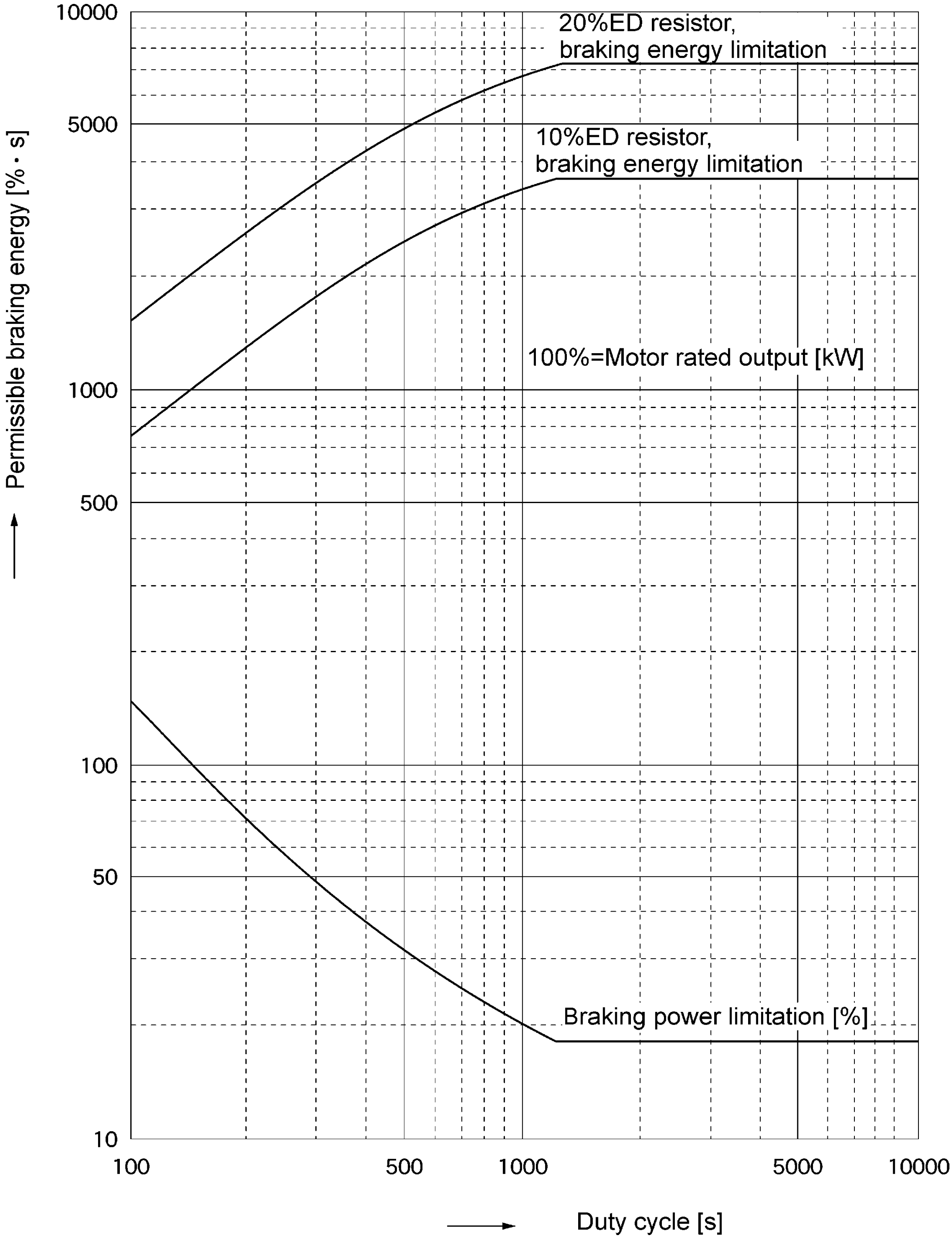



Figure 9-12 Permissible Braking Energy

## 9.1.3.4 Calculating RMS Rating of Motor

In case of the load which repeats the operation very frequently, the load current fluctuates largely and enters into the short-time rating range of the motor repeatedly. It is, therefore, required to review the thermal allowable value. The exothermicity is approximately considered to be in proportion to the square of the load current. In case of the dedicated motor of VG7S which utilizes the forced cooling fan method, the temperature will increase in proportion to the exothermicity itself.
When the operation is repeated in such an interval as to be short enough compared with the thermal time constant of the motor, calculate the "equivalent RMS current" as mentioned below, and select the unit such that this RMS current does not over the rated current of the motor.

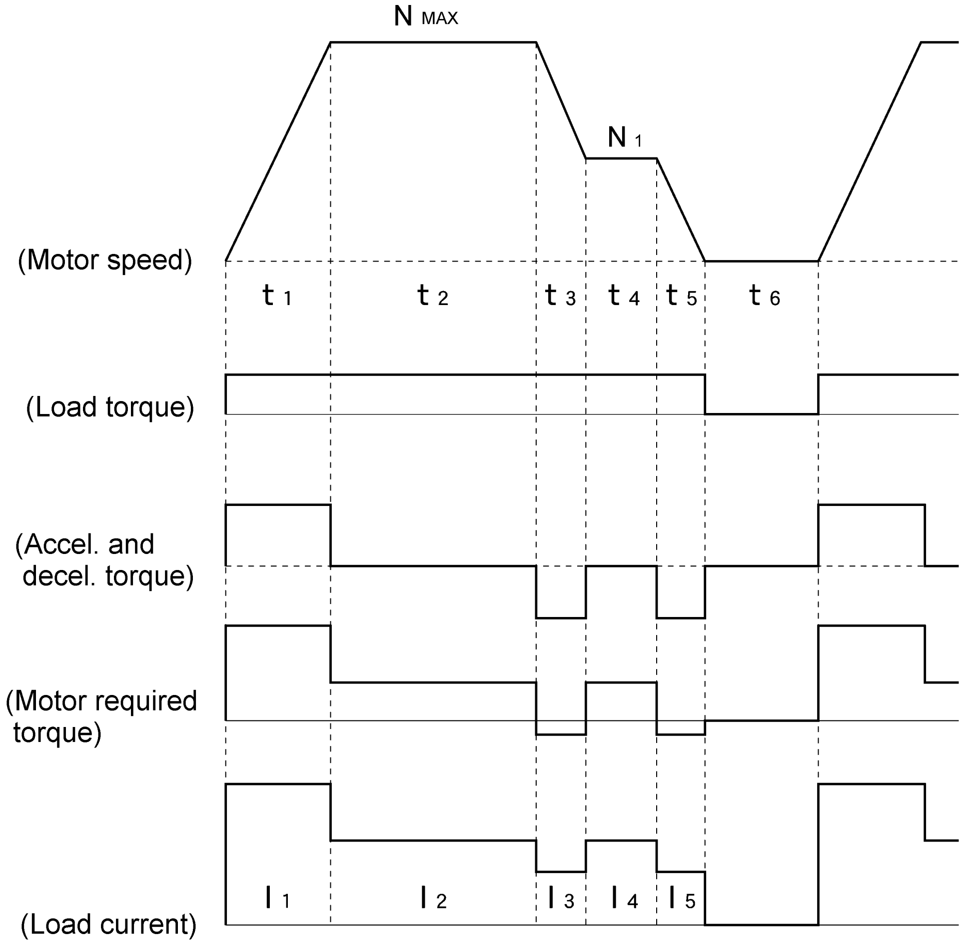



Figure 9-13 Sample of the Repetitive Operation

Firstly, calculate the required torque of each part based on the speed pattern. Then using the torque-current curve of motor, convert this torque to the pattern of the load current. The "equivalent RMS current, I eq" can be finally calculated by the following formula.

$$I_{eq} = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + I_3^2 \cdot t_3 + I_4^2 \cdot t_4 + I_5^2 \cdot t_5}{t_1 + t_2 + t_3 + t_4 + t_5 + t_6}} \text{ [A]} \quad \cdots\cdots (3.28)$$

The torque-current curve for the dedicated motor is not available for actual calculation. So, calculate the load current I from the load torque $\tau_1$ using the following formula (3.29). Then, calculates the equivalent current Ieq.

$$I = \sqrt{\left(\frac{\tau_1}{100} \times It_{100}\right) + Im_{100}^{\ 2}} \quad \text{[A]} \quad \cdots\cdots (3.29)$$

Here, $\tau_1$: load torque [%], $It_{100}$ = torque current (P09; M1 torque current), $Im_{100}$ = (exciting current) (P08; M1 exciting current)

- For the function code data of P08 and P09, refer to Chapter 14 Replacement data.
- When using the second motor, refer to the torque current and exciting current of A code instead of those of P code.

## 9.1.3.5 Appendix (Calculation for Other than in SI Unit)

All the expressions in this document are based on SI units (International System of Units). In this section, how to convert expressions to other units is explained.

(1) Conversion of unit

1) Force

$1\ [kgf] \approx 9.8\ [N]$

$1\ [N] \approx 0.102\ [kgf]$

2) Torque

$1\ [kgf \cdot m] \approx 9.8\ [N \cdot m]$

$1\ [N \cdot m] \approx 0.102\ [kgf \cdot m]$

3) Work and energy

$1\ [kgf \cdot m] \approx 9.8\ [N \cdot m] = 9.8\ [J] = 9.8\ [W \cdot s]$

4) Power

$1\ [kgf \cdot m/s] \approx 9.8\ [N \cdot m/s] = 9.8\ [J/s] = 9.8\ [W]$

$1\ [N \cdot m/s] \approx 1\ [J/s] = 1\ [W] \approx 0.102\ [kgf \cdot m/s]$

5) Rotation speed

$$1\ [r/min] = \frac{2\pi}{60}\ [rad/s] \approx 0.1047\ [rad/s]$$

$$1\ [rad/s] = \frac{60}{2\pi}\ [r/min] \approx 9.549\ [r/min]$$

6) Inertia constant

$J\ [kg \cdot m^2]$ : Moment of inertia

$GD^2\ [kg \cdot m^2]$ : Flywheel effect

$GD^2 = 4J$

$$J = \frac{GD^2}{4}$$

7) Pressure and stress

$1\ [mmAq] \approx 9.8\ [Pa] \approx 9.8\ [N/m^2]$

$1\ [Pa] \approx 1\ [N/m^2] \approx 0.102\ [mmAq]$

$1\ [bar] \approx 100000\ [Pa] \approx 1.02\ [kg \cdot cm^2]$

$1\ [kg \cdot cm^2] \approx 98000\ [Pa] \approx 980 [mbar]$

1 atmospheric pressure

$= 1013\ [mbar] = 760\ [mmHg]$

$= 101300\ [Pa] \approx 1.033\ [kg \cdot cm^2]$

(2) Calculation formula

1) Torque, power and rotation speed

$$P\ [W] \approx \frac{2\pi}{60} \cdot N\ [r/min] \cdot \tau\ [N \cdot m]$$

$$P\ [W] \approx 1.026 \cdot N\ [r/min] \approx T\ [kgf \cdot m]$$

$$\tau\ [N \cdot m] \approx 9.55 \cdot \frac{P\ [W]}{N\ [r/min]}$$

$$T\ [kgf \cdot m] \approx 0.974 \cdot \frac{P\ [W]}{N\ [r/min]}$$

2) Kinetic energy

$$E\ [J] \approx \frac{1}{182.4} \cdot J\ [kg \cdot m^2] \cdot N^2\ [(r/min)^2]$$

$$E\ [J] \approx \frac{1}{730} \cdot GD^2\ [kg \cdot m^2] \cdot N^2\ [(r/min)^2]$$

3) Torque of linear moving load

[Driving mode]

$$\tau\ [N \cdot m] \approx 0.159 \frac{V\ [m/min]}{N_M\ [r/min] \cdot \eta_G} \cdot F\ [N]$$

$$T\ [kgf \cdot m] \approx 0.159 \frac{V\ [m/min]}{N_M\ [r/min] \cdot \eta_G} \cdot F\ [kgf]$$

[Braking mode]

$$\tau\ [N \cdot m] \approx 0.159 \frac{V\ [m/min]}{N_M\ [r/min] \cdot \eta_G} \cdot F\ [N]$$

$$T\ [kgf \cdot m] \approx 0.159 \frac{V\ [m/min]}{N_M\ [r/min] \cdot \eta_G} \cdot F\ [kgf]$$

4) Acceleration torque

[Driving mode]

$$\tau\ [N \cdot m] \approx \frac{J\ [kg \cdot m^2]}{9.55} \cdot \frac{\Delta N\ [r/min] \cdot \eta_G}{\Delta t\ [s]}$$

$$T\ [kgf \cdot m] \approx \frac{GD^2\ [kg \cdot m^2]}{375} \cdot \frac{\Delta N\ [r/min] \cdot \eta_G}{\Delta t\ [s]}$$

[Braking mode]

$$\tau\ [N \cdot m] \approx \frac{J\ [kg \cdot m^2]}{9.55} \cdot \frac{\Delta N\ [r/min] \cdot \eta_G}{\Delta t\ [s]}$$

$$T\ [kgf \cdot m] \approx \frac{GD^2\ [kg \cdot m^2]}{375} \cdot \frac{\Delta N\ [r/min] \cdot \eta_G}{\Delta t\ [s]}$$

5) Acceleration time

$$t_{ACC}\ [s]\ \frac{J_1 + J_2/\eta_G\ [kg \cdot m^2]}{\tau_M - \tau_L/\eta_G\ [N \cdot m^2]} \cdot \frac{\Delta N\ [r/min]}{9.55}$$

$$t_{ACC}\ [s]\ \frac{GD_1^2 + GD_2^2/\eta_G\ [kg \cdot m^2]}{T_M - T_L/\eta_G\ [kgf \cdot m]} \cdot \frac{\Delta N\ [r/min]}{375}$$

6) Deceleration time

$$t_{DEC}\ [s]\ \frac{J_1 + J_2 \cdot \eta_G\ [kg \cdot m^2]}{\tau_M - \tau_L \cdot \eta_G\ [N \cdot m^2]} \cdot \frac{\Delta N\ [r/min]}{9.55}$$

$$t_{DEC}\ [s]\ \frac{GD_1^2 + GD_2^2/\eta_G\ [kg \cdot m^2]}{T_M - T_L/\eta_G\ [kgf \cdot m]} \cdot \frac{\Delta N\ [r/min]}{375}$$

# 9.2 Braking Unit and Braking Resistor Selection

## 9.2.1 Selection Procedure

- The following three requirements must be satisfied simultaneously:

(1) Maximum braking torque must not exceed values listed in Tables 8.4.1(1) to 8.4.5(2)in Chapter 8.
To use maximum braking torque exceeding values in the above tables, select one size larger capacity braking unit and resistor.

(2) Discharge energy for a single braking action must not exceed discharging capability [kWs] listed in the Tables 8.4.1 (1) to 8.4.5 (2) in Chapter 8.
For detailed calculation, see Section 9.1.3.3 Heat energy calculation of braking resistor.

(3) Average loss obtained by dividing discharge energy by cyclic period must not exceed the average loss [kW] listed in the Table.

The selecting conditions depend on the periodic duty cycle as described follows:

1) If the periodic duty cycle is 100s or shorter, the above conditions 1) and 3) must be satisfied.
2) If the periodic duty cycle is longer than 100s, the above conditions 1) and 2) must be satisfied.

## 9.2.2 Notes on Selection

- Braking time and duty cycle (%ED) are converted under deceleration braking conditions based on the rated torque as shown below. However, these value need not be considered when selecting braking unit and resistor capacity.

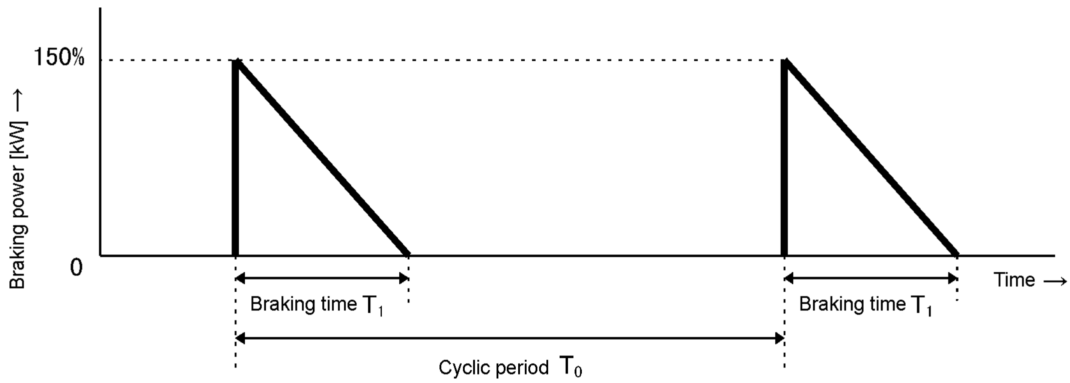



Figure 9-14 Duty Cycle

$$\text{Duty cycle (\%ED)} = \frac{T_1}{T_0} \times 100$$

- MEMO -

THE INVERTER

# Ⅹ. About Motors

# 10. About Motors

## 10.1 Vibration and Noise

* Please refer to the “2-2-3 Dedicated Motor Specifications” for the specifications and the external dimensions of the dedicated motors.

<table>
<tr><th rowspan="2">Dedicated applicable motor<br><br>[kW]</th><th rowspan="2">No. of poles</th><th>Motor type</th><th colspan="2">Vibration level [ µm ]</th><th colspan="2">Noise level [ dB ] *3)</th></tr>
<tr><th>MVK__A-C</th><th>At base speed 1500[r/min]</th><th>At max. speed *2) 3600[r/min]</th><th>At base speed 1500[r/min]</th><th>At max. speed 3600[r/min]</th></tr>
<tr><td>0.75</td><td rowspan="21">4</td><td>6096</td><td rowspan="12">less than 5</td><td rowspan="10">less than 7</td><td rowspan="3">56</td><td rowspan="3">60</td></tr>
<tr><td>1.5</td><td>6097</td></tr>
<tr><td>2.2</td><td>6107</td></tr>
<tr><td>3.7</td><td>6115</td><td>58</td><td>62</td></tr>
<tr><td>5.5</td><td>6133</td><td rowspan="2">60</td><td rowspan="2">64</td></tr>
<tr><td>7.5</td><td>6135</td></tr>
<tr><td>11</td><td>6165</td><td rowspan="2">68</td><td rowspan="2">72</td></tr>
<tr><td>15</td><td>6167</td></tr>
<tr><td>18.5</td><td>6184</td><td rowspan="4">71</td><td rowspan="2">73</td></tr>
<tr><td>22</td><td>6185</td></tr>
<tr><td>30</td><td>6206</td><td rowspan="2">less than 7</td><td rowspan="2">73</td></tr>
<tr><td>37</td><td>6207</td></tr>
<tr><td>45</td><td>9221<br>(6208)</td><td>*1)<br>(less than 5)</td><td>less than 15 *2)<br>(less than 7 *2))</td><td>*1)<br>(71)</td><td>88<br>(73)</td></tr>
<tr><td>55</td><td>9250</td><td rowspan="8">*1)</td><td rowspan="8">less than 15</td><td rowspan="8">*1)</td><td rowspan="8">88</td></tr>
<tr><td>75</td><td>9252</td></tr>
<tr><td>90</td><td>9280</td></tr>
<tr><td>110</td><td>9282</td></tr>
<tr><td>132</td><td>9310</td></tr>
<tr><td>160</td><td>9312</td></tr>
<tr><td>200</td><td>9316</td></tr>
<tr><td>220</td><td>9318</td></tr>
</table>

*1) Please contact Fuji for the individual figures.

*2) The maximum speed (max. speed) for 30 to 37[kW] is 3000[r/min], for 45 to 75[kW], 2400[r/min], and for 90 to 220[kW] max. speed is 2000[r/min].

*3) This noise level was measured at the point which is 1[m] away to the direction of the terminal box from the motor.

## 10.2 Acceleration Vibration Value

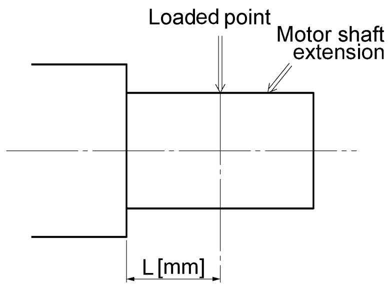
| Dedicated applicable motor [kw] | No.of poles | Motor type MVK__A-C | Acceleration vibration value, acceptable [m/s$^2$] |
|---|---|---|---|
| 0.75 | 4 | 6096 | less than 6.4 |
| 1.5 | | 6097 | |
| 2.2 | | 6107 | |
| 3.7 | | 6115 | |
| 5.5 | | 6133 | |
| 7.5 | | 6135 | |
| 11 | | 6165 | |
| 15 | | 6167 | |
| 18.5 | | 6184 | |
| 22 | | 6185 | |
| 30 | | 6206 | |
| 37 | | 6207 | |
| 45 | | 9221 (6208) | less than 1.0 (less than 6.4) |
| 55 | | 9250 | less than 1.0 |
| 75 | | 9252 | |
| 90 | | 9280 | |
| 110 | | 9282 | |
| 132 | | 9310 | less than 6.4 |
| 160 | | 9312 | |
| 200 | | 9316 | |
| 220 | | 9318 | |

Note: If the actual vibration is over the figure on this table, other countermeasure is required.

# 10. About Motors

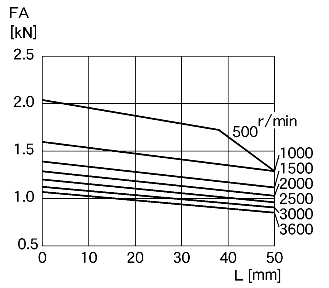
## 10.3 Allowable Radial Load at Motor Shaft Extension

[Loaded point]

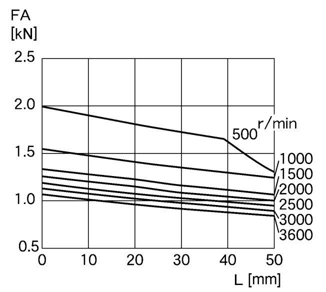



The maximum allowable value of radial load applied by the belt is shown in the figures below. The data is classified by the frame number and the rotation speed.
If the point which is decided by the radial load FA[kN] acting on the motor shaft and the length L[mm] from the stepped joint at shaft end to the center of the pulley (the distance to the FA load points) is within a curve, the motor can be operated by that pulley.
Please refer to the technical leaflet of the induction motor for the details.

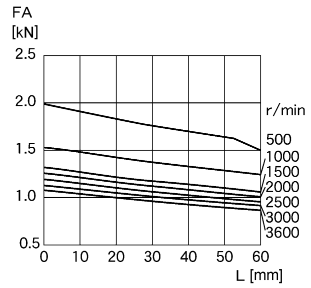
Frame number 90L MVK6096A-C[0.75kW]



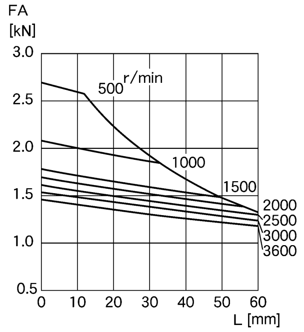

Frame number 90L MVK6097A-C[1.5kW]



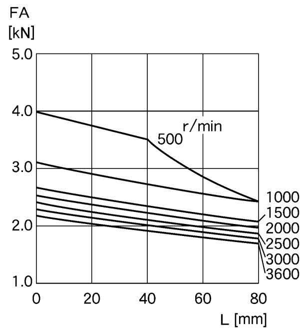

Frame number 100L MVK6107A-C[2.2kW]



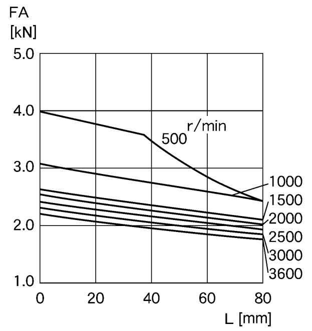

Frame number 112M MVK6115A-C[3.7kW]



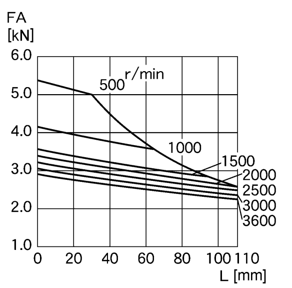

Frame number 132S MVK6133A-C[5.5kW]



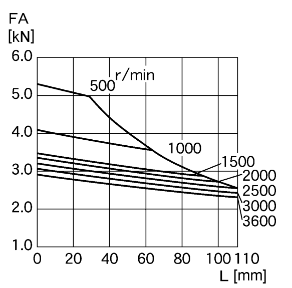

Frame number 132M MVK6135A-C[7.5kW]



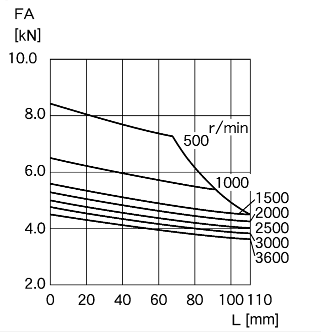

Frame number 160M MVK6165A-C[11kW]

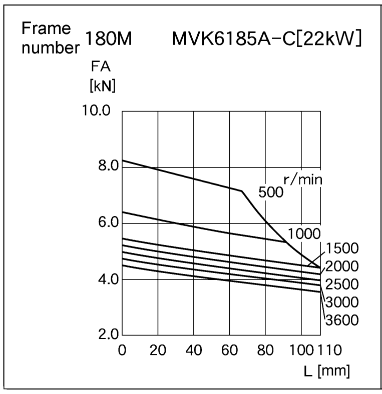


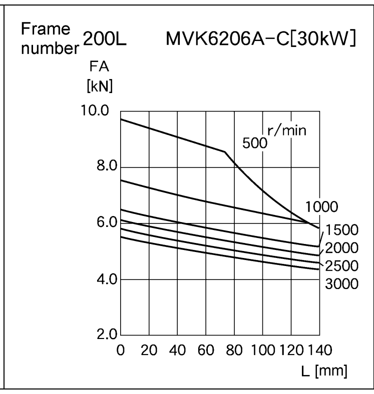

Frame number 160L MVK6167A-C[15kW]

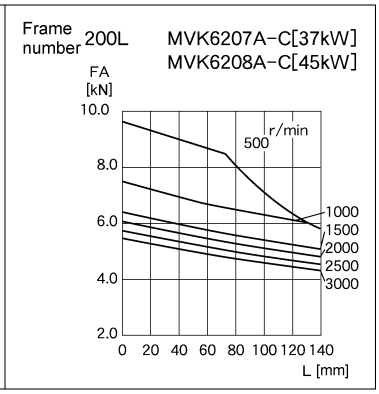



Frame number 180M MVK6184A-C[18.5kW]





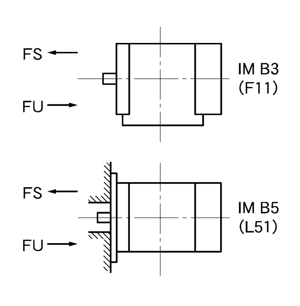
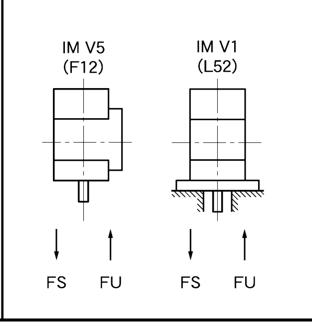
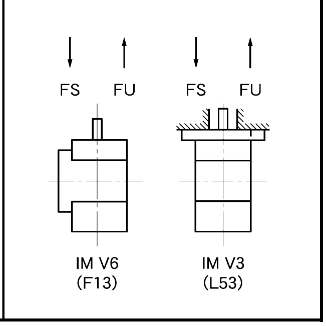




Note: Please contact Fuji individually for the motors whose frame number is over 200L (more than 55kW).

## 10.4 Allowable Thrust Load

(Unit:k·N)

| Frame number | Type MVK__A-C | Horizontal use IM B3(F11), IM B5(L51) | | | | | | Vertical use IM V5(F12), IM V1(L52) | | | | | | Vertical use IM V6(F13), IM V3(L53) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Direction of thrust: FS | | | Direction of thrust: FU | | | Direction of thrust: FS | | | Direction of thrust: FU | | | Direction of thrust: FS | | | Direction of thrust: FU | | |
| | | 2 Poles | 4 Poles | 6 Poles | 2 Poles | 4 Poles | 6 Poles | 2 Poles | 4 Poles | 6 Poles | 2 Poles | 4 Poles | 6 Poles | 2 Poles | 4 Poles | 6 Poles | 2 Poles | 4 Poles | 6 Poles |
| 90L | 6096<br>6097 | 0.3 | 0.45 | 0.55 | 0.4 | 0.6 | 0.7 | 0.25 | 0.4 | 0.5 | 0.45 | 0.65 | 0.75 | 0.4 | 0.55 | 0.65 | 0.3 | 0.5 | 0.6 |
| 100L | 6107 | – | 0.65 | 0.8 | – | 0.55 | 0.65 | – | 0.6 | 0.7 | – | 0.6 | 0.6 | – | 0.5 | 0.6 | – | 0.75 | 0.85 |
| 112M | 6115 | 0.65 | 0.9 | 1.1 | 0.6 | 0.75 | 0.95 | 0.6 | 0.8 | 1 | 0.65 | 0.85 | 1 | 0.55 | 0.7 | 0.85 | 0.75 | 1 | 1.2 |
| 132S | 6133 | 1 | 1.4 | 1.7 | 0.75 | 1 | 1.2 | 1 | 1.3 | 1.7 | 0.9 | 1.1 | 1.4 | 0.65 | 0.9 | 1.1 | 1.2 | 1.5 | 1.9 |
| 132M | 6135 | – | | | – | | | – | | 1.6 | – | | | – | | 1 | – | | |
| 160M | 6165 | 1.3 | 1.8 | 2.2 | 1.2 | 1.5 | 1.9 | 1.1 | 1.6 | 2 | 1.5 | 1.8 | 2.2 | 1 | 1.4 | 1.7 | 1.6 | 2.1 | 2.5 |
| 160L | 6167 | | 1.7 | 2.1 | | | 1.8 | | 1.5 | 1.8 | | | | | 1.3 | 1.5 | | | |
| 180M | 6184<br>6185 | 2 | 2.7 | 3.3 | 1.9 | 2.3 | 2.8 | 1.8 | 2.3 | 2.9 | 2.2 | 2.7 | 3.4 | 1.6 | 2 | 2.6 | 2.4 | 3.2 | 3.9 |
| 200L | 6206<br>6207 | 1.9 | 3.8 | 4.5 | 2 | 3.2 | 3.7 | 1.5 | 3.2 | 3.8 | 2.6 | 4 | 4.8 | | 2.7 | 3 | 2.5 | 4.6 | 5.6 |
| 225S<br>(200L) | 9221<br>(6208) | 1.2 | 5.4 | 6.5 | 1.2 | 5.4 | 6.5 | 0.4 | 4.4 | 5.3 | 2.3 | 6.9 | 8.2 | 0.4 | 4.4 | 5.3 | 2.3 | 6.9 | 8.2 |
| 250S | 9250 | 1.1 | 5.2 | 6.2 | 1.1 | 5.2 | 6.2 | 0.3 | 4.1 | 4.8 | | | | 0.3 | 4.1 | 4.8 | | | |
| 250M | 9252 | 1 | 6.4 | 7.6 | 1 | 6.4 | 7.6 | – | 4.9 | 5.6 | – | 8.4 | 10.3 | – | 4.9 | 5.6 | – | 8.4 | 10.3 |
| 280S | 9280 | 0.9 | 6.2 | 7.3 | 0.9 | 6.2 | 7.3 | – | 4.5 | 5.1 | – | 8.5 | 10.4 | – | 4.5 | 5.1 | – | 8.5 | 10.4 |
| 280M | 9282 | 0.8 | 5.9 | 6.9 | 0.8 | 5.9 | 6.9 | – | 3.7 | 4.2 | – | 9.2 | 10.8 | – | 3.7 | 4.2 | – | 9.2 | 10.8 |
| 315S | 9310 | 0.7 | 5.7 | 6.7 | 0.7 | 5.7 | 6.7 | – | 3.1 | 3.8 | – | 9.3 | 10.9 | – | 3.1 | 3.8 | – | 9.3 | 10.9 |
| 315M | 9312<br>9316 | * Contact Fuji individually | | | | | | * Contact Fuji individually | | | | | | * Contact Fuji individually | | | | | |
| – | 9318 | | | | | | | | | | | | | | | | | | |
| Mounting method and the direction of thrust | |  | | | | | |  | | | | | |  | | | | | |



Note 1: The above-mentioned figures whose frame number are more than 250S are the allowable thrust (axial) load of the motor for direct connection

Note 2: The above-mentioned allowable thrust (axial) load is calculated on the assumption that the motor would bear the radial load through the normal sized half-coupling.

Note 3: For the motor with shielded type ball bearing, if the thrust load to the anti-driving direction is bigger than the pre-load spring pressure on the anti-driving side, the runout of shaft end shown in the following table will occur on the anti-driving side.

| Frame number | | 90L, 100L | 112M | 132S, 132M | 160M, 160L | 180M to 225S | 250S to 315M |
|---|---|---|---|---|---|---|---|
| Preload [N] | | 166 | 235 | 294 | 343 | 568 | *Contact Fuji individually. |
| Runout of shaft end [mm] | *Std | 0.6 | | | 1.2 | | |
| | Max. | 1.4 | | | 2.0 | | |

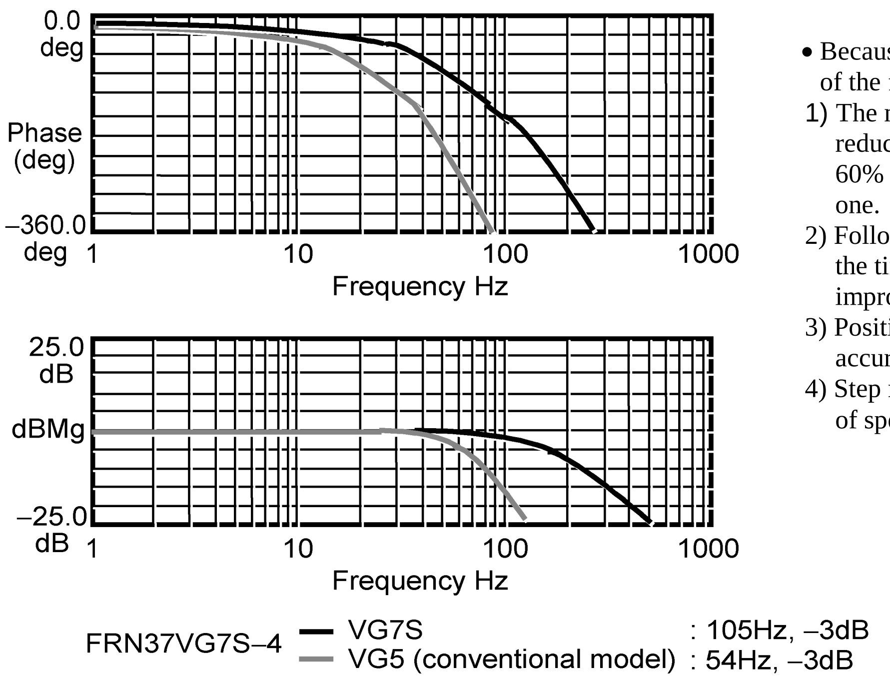
*Std.: Standard

XI

# XI. Operation Data

# 11. Operation Data

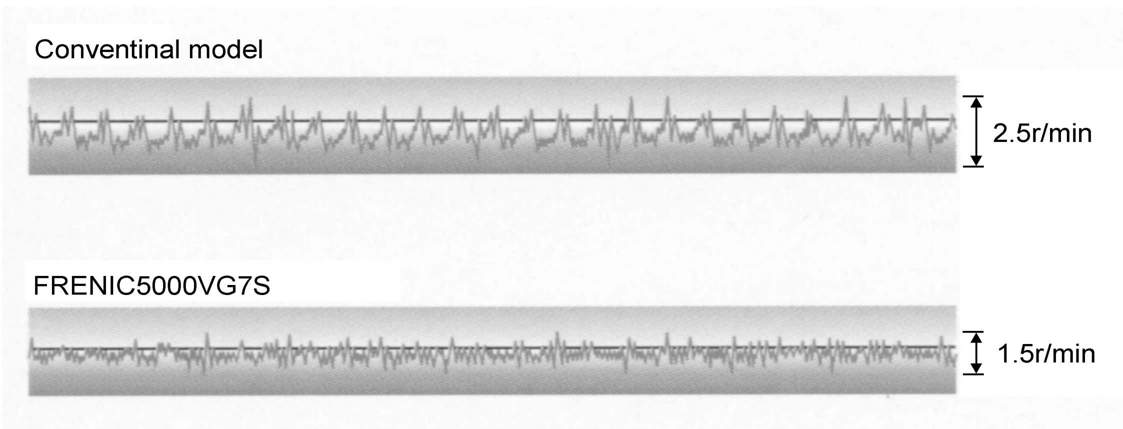
## 11.1 Frequency Response Characteristics




- Because of the improvement of the frequency response,
  1) The motor wow was reduced to approximately 60% of the conventional one.
  2) Follow-up characteristics at the time of load fluctuation improved.
  3) Position synchronizing accuracy improved.
  4) Step response characteristics of speed improved.

| | |
|---|---|
| Inverter | ; FRN37VG7S-4 |
| Motor | ; MVK6207A-C, 37kW, 1500/3600r/min |
| Test condition | ; Motor only |

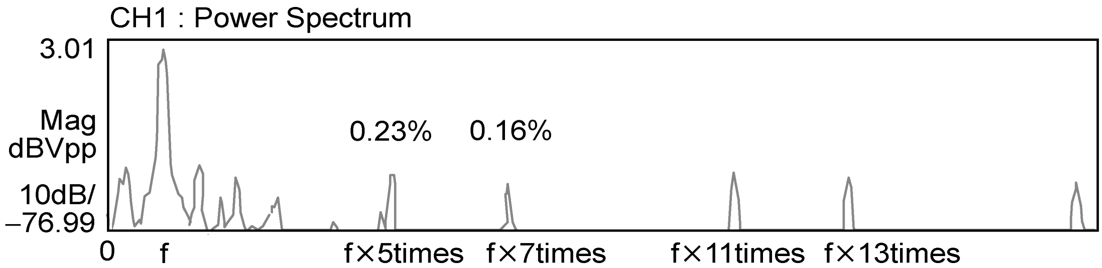
## 11.2 Sample Measurement of Motor Wow




| | |
|---|---|
| Inverter | ; FRN37VG7S-4 |
| Motor | ; MVK6207A-C, 37kW, 1500/3600r/min |
| Test condition | ; Motor only |

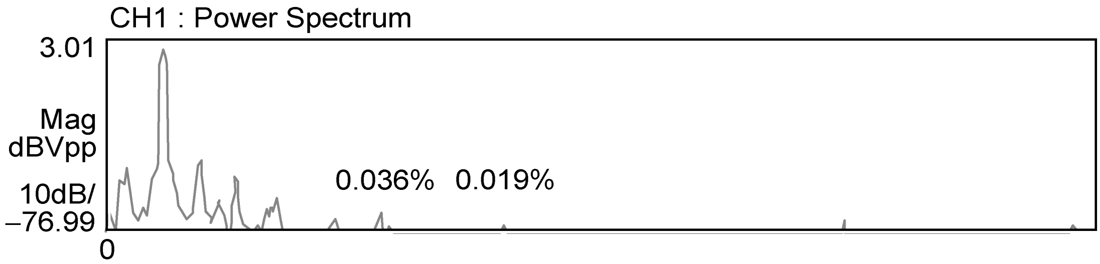
## 11.3 Current Response Characteristics

FRENIC5000VG5




f: Frequency of output current [Hz]

FRENIC5000VG7S

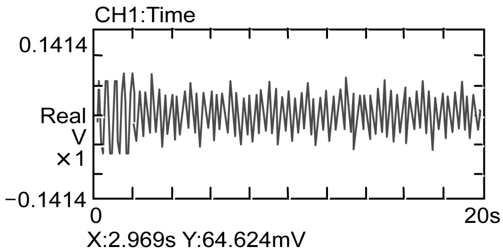



- By realizing the current response of 800Hz, the waveform distortion of output current was reduced.
- The harmonic of 5,7,11,13 times caused from PWM control was reduced. This leads to the reduction of torque ripple.

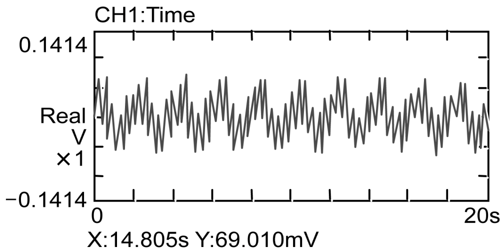
| | |
|---|---|
| Inverter | ; FRN37VG7S-4 |
| Motor | ; MVK6207A-C, 37kW, 1500/3600r/min |
| Test condition | ; 100% load |

## 11.4 Torque Ripple

VG7S




VG5

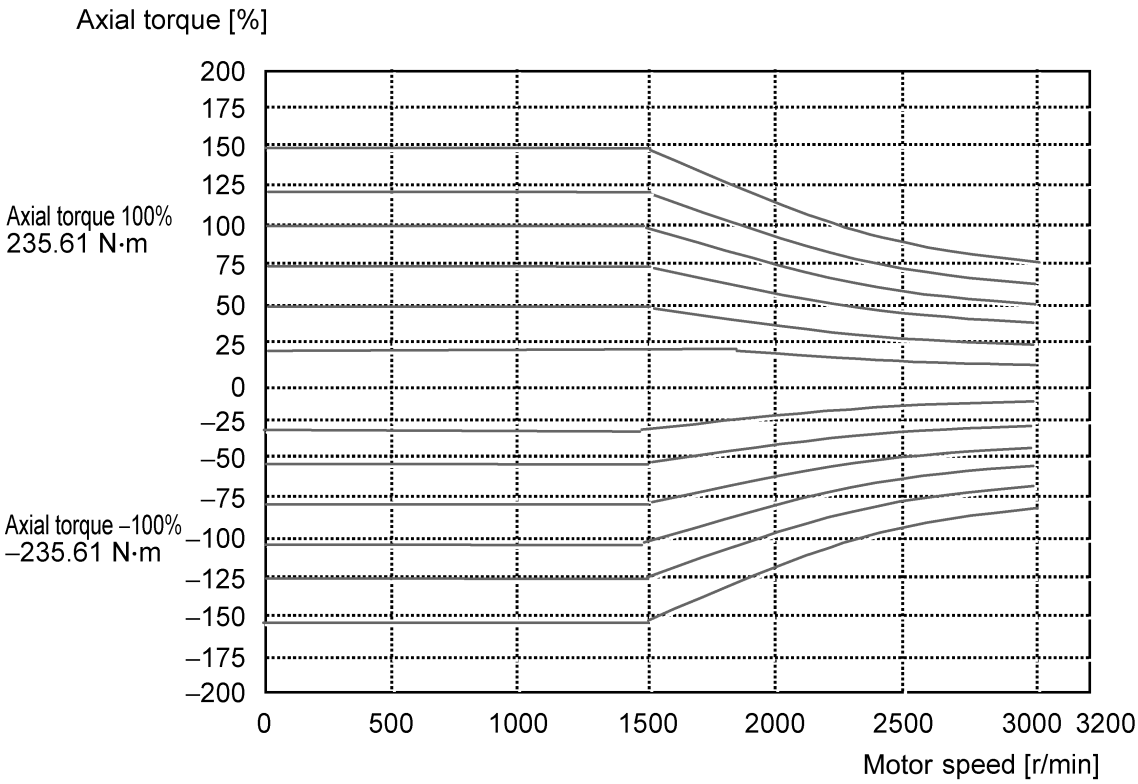



| | Torque ripple P–P 100%:Rated torque | | | |
|---|---|---|---|---|
| | 1 time | 2 times | 4 times | 6 times |
| VG7S | 0.23% | 0.22% | 0.10% | 1.49% |
| VG5 | 0.70% | 0.20% | 0.09% | 1.60% |

| | |
|---|---|
| Inverter | ; FRN37VG7S-4 |
| Motor | ; MVK6207A-C, 37kW, 1500/3600r/min |
| Test condition | ; Motor constraint |

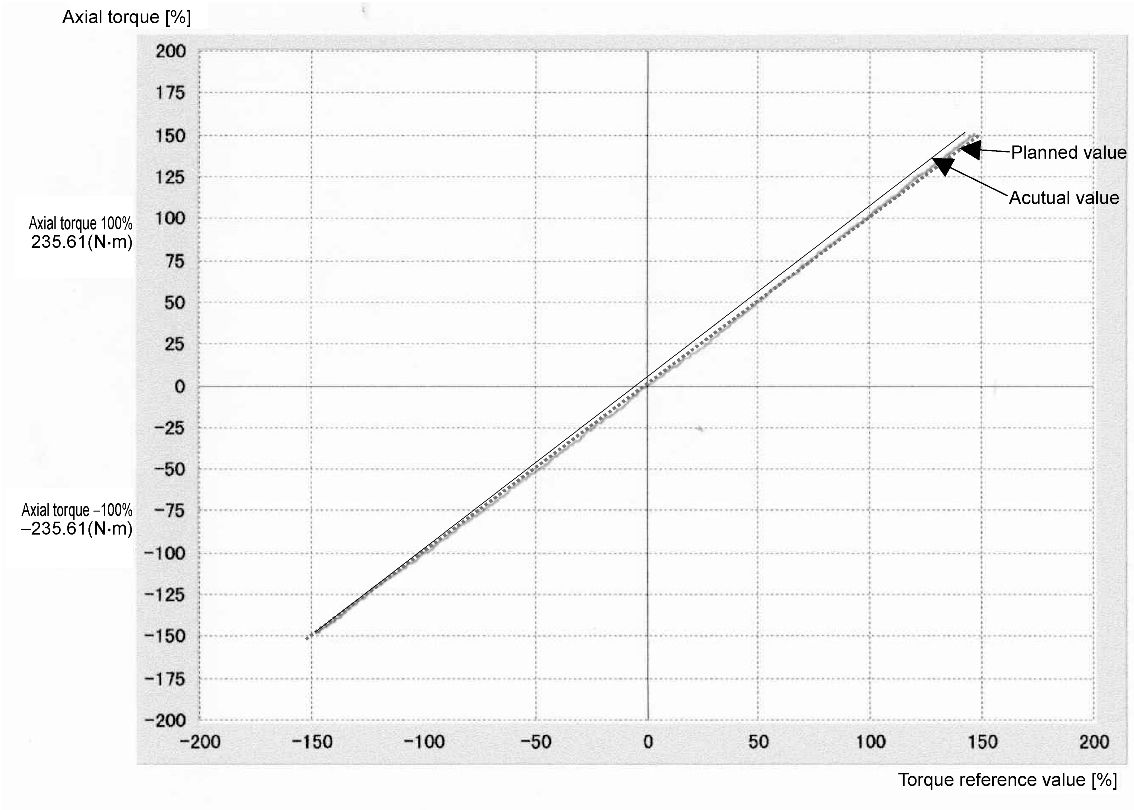
# 11. Operation Data

## 11.5 Speed-torque Characteristics (PG Vector Control)




Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

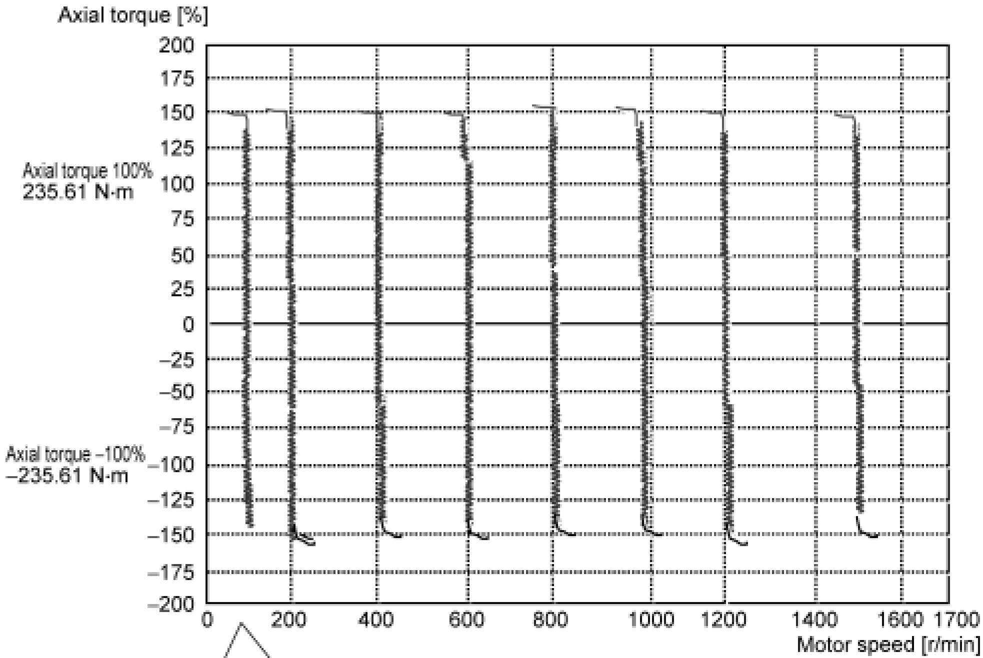
# 11.6 Torque Control Accuracy (PG Vector Control)



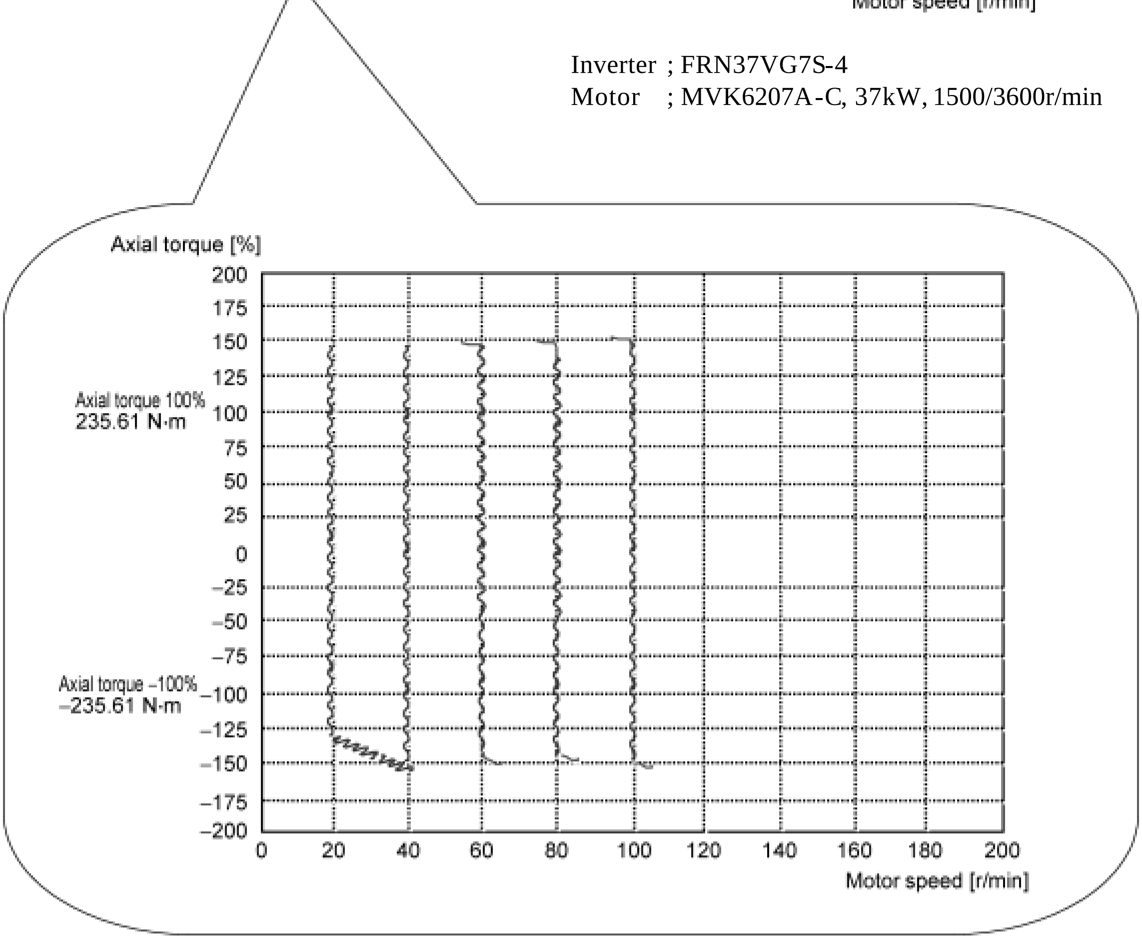

Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

# 11. Operation Data

## 11.7 Speed-torque Characteristics (Sensorless Vector Control)

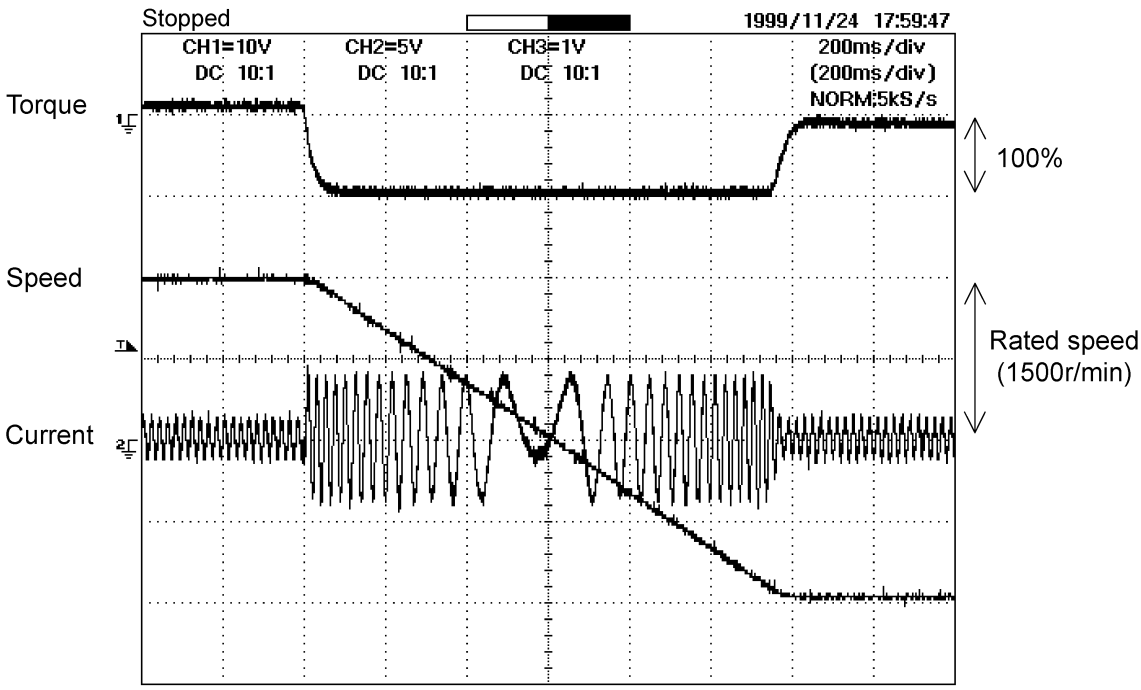



Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min



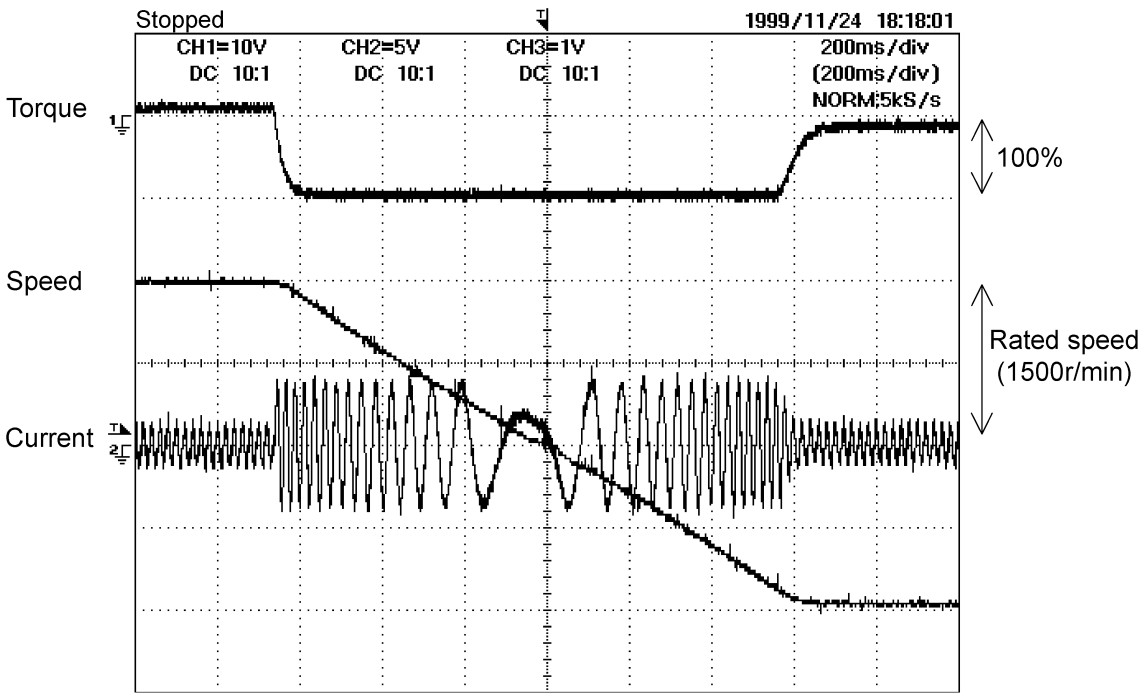

Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

## 11.8 Deceleration and Acceleration via Zero Speed (PG Vector Control)




Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

## 11.9 Deceleration and Acceleration via Zero Speed (Sensorless Vector Control)




Inverter ; FRN37VG7S-4
Motor ; MVK6207A-C, 37kW, 1500/3600r/min

Operation Data

# 11. Operation Data

## 11.10 Comparison of Radiation Noise


1. Motor speed : 1000r/min
2. Measurement distance : 1.0m
3. Motor capacity : 5.5kW-200V
4. Carrier frequency : 10kHz

XII

# Ⅻ. Function Code List

# 12. Function Code List

## 12.1 Function Code Configuration

### 12.1.1 Identification Code Displayed on KEYPAD Panel

F 0 0

Code number

Identification code

| Function code | | Function | | Notes |
|---|---|---|---|---|
| Fundamental functions | F00 to F80 | Fundamental function | | Displayed on KEYPAD panel always |
| Extensional terminal functions | E01 to E84 | Terminal function | | Some codes are displayed only when options are installed |
| | | | E10 to E13 | Function codes for OPC-VG7-DIOA option |
| | | | E20 to E27 | Function codes for OPC-VG7-DIOA option |
| | | | E51, 52 | Function codes for OPC-VG7-AIO option |
| | | | E55, 56 | Function codes for OPC-VG7-AIO option |
| | | | E59, 60 | Function codes for OPC-VG7-AIO option |
| | | | E63, 64 | Function codes for OPC-VG7-AIO option |
| | | | E67, 68 | Function codes for OPC-VG7-AIO option |
| | | | E72, 73 | Function codes for OPC-VG7-AIO option |
| | | | E77, 78 | Function codes for OPC-VG7-AIO option |
| | | | E82, 83 | Function codes for OPC-VG7-AIO option |
| Control functions of frequency | C01 to C73 | Control function | | Displayed on KEYPAD panel always |
| Motor Parameters | P01 to P30 | Motor parameter function for M1 | | |
| High performance functions | H01 to H73 | High performance function | | |
| Alternative motor parameters | A01 to A50 | Motor parameters for M2 and M3 | | |
| Optional functions | o01 to o41 | Option function | | Displayed when options are installed.<br>PG (PR) option codes are displayed always. |
| | | | o01 to o04 | Function codes for OPC-VG7-DIA and DIB options |
| | | | o05 | Function codes for OPC-VG7-PG (PD) option |
| | | | o06 to o08 | Function codes for OPC-VG7-PG (LD) digital line speed detection option |
| | | | o09 to o11 | Function codes for OPC-VG7-PMPG synchronous motor PG option |
| | | | o12 to o19 | Function codes for OPC-VG7-PG (PR) pulse train input option |
| | | | o30 to o32 | Function codes for OPC-VG7-TL field bus option |
| | | | o33, o34 | Function code for OPC-VG7-SI (MWS) multi-winding system option |
| | | | o35 to o37 | Function codes for OPC-VG7-SI (UPAC) option |
| | | | o38 to o41 | Function codes for OPC-VG7-UPAC option |
| Lift functions | L01 to L14 | Lift functions | | |
| User functions | U01 to U64 | User functions (UPAC, OM) | | You can use for UPAC option.<br>Displayed on KEYPAD panel always. |
| Serial communication functions | S01 to S12 | Command functions | | You cannot refer to or change in LOC mode (KEYPAD panel).<br>You can use in COM mode (T-Link, RS485, UPAC, optical communication, SX, and field bus). |
| Monitoring functions | M01 to M60 | Data monitor functions | | |

# 12.2 Function Code List

## 12.2.1 Function Code List Description

| Item | Description |
|---|---|
| Fcode | Identification codes for function codes. |
| Communication address<br>485 number | Address used with integrated RS485 or UPAC option (OPC-VG7-UPAC) to refer to or change function codes. |
| Communication address<br>Link number | Address used with field bus options (OPC-VG7-TL, OPC-VG7-SX and field bus options) to refer to or change function codes. You cannot use a filed bus option for a function code without a communication address Link number. |
| Function name | Name assigned to a group of function codes with a similar nature. |
| Function directory name | Name of an individual function of a function code. |
| Setting range | Indicates the setting range and the data definition. |
| Factory setting | Data specified by FUJI before delivery. Modified data are displayed with ∗ (asterisk) on the KEYPAD panel. You can use the initialization function code to reset them to the factory setting. |
| Type | Indicates a format type used to refer to or change data through communication system (such as 485 and filed bus).<br>See 12.3 "Function Code List Dedicated for Communication" for more information. |
| Copy | Indicates whether to be copied or not to another inverter when you use the copy function of the KEYPAD panel to copy entire data stored in the KEYPAD panel. |
| Initialization | Indicates whether to be initialized (reset to the factory setting) or not by the function code H03 "Data initializing". 1: Initialized, 2: Not initialized. |
| Control type: Available/ Not available | Indicates whether available or not in individual control types (PG: Vector control with PG, LES: Sensorless vector control, VF: V/f control, SM: Vector control to drive synchronous motor). |

## 12.2.2 List

### F: Fundamental Functions

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| F00 | 0h | 80( 50 h) | Data protection | | 0 to 1<br>0 : Data change enable<br>1 : Data protection<br>This is a function to protect writing from the Keypad panel.<br>The protection of writing from the link (T-Link, RS485, etc.) is defined with H29 "Link function protection". | 40 | x | 1 | o | o | o | o |
| F01 | 1h | ( h) | Speed setting N1 | | 0 to 7<br>0 : KEYPAD operation ( ∧ and ∨ key)<br>1 : Analog input (0 to ±10VDC)<br>2 : Analog input (0 to +10VDC)<br>3 : UP/DOWN control 1 (initial speed = 0 r/min)<br>4 : UP/DOWN control 2 (initial speed = last value)<br>5 : UP/DOWN control 3 (initial speed = Creep speed 1 or 2)<br>6 : DIA card input<br>7 : DIB card input | 41 | o | 1 | o | o | o | o |
| F02 | 2h | ( h) | Operation method | | 0 to 1<br>The method of operation is set.<br>0 : KEYPAD operation (FWD or REV or STOP key) (LOCAL)<br>1 : FWD or REV signal input (REMOTE)<br>The change of REMOTE/LOCAL is possible also by RST+STOP key to the keypad panel. This operation corresponds to writing data of F02. | 42 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| F03 | 3h | 81( 51 h) | M1 Maximum speed | M1 Maximum speed | 50 to 1500 to 24000 r/min | 0 | o | 2 | o | o | o | o |
| F04 | 4h | 82( 52 h) | | M1-Rated speed | 50 to 24000 r/min | 0 | o | 2 | o | o | o | o |
| F05 | 5h | 83( 53 h) | | M1-Rated voltage | 80 to 999 V | 0 | o | 2 | o | o | o | o |
| F07 | 7h | 84( 54 h) | Acceleration time 1 | | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| F08 | 8h | 85( 55 h) | Deceleration time 1 | | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| F10 | Ah | 86( 56 h) | M1 Electronic thermal overload relay | M1 Electronic thermal overload relay (Select) | 0 to 2<br>The motor overheating protection operates by using NTC thermistor with the motor only for VG. In this case, please make setting F10 Electronic thermal "Inactive".<br>0 : Inactive (When you use the motor only for VG)<br>1 : Active (for 4-pole standard motor, with self-cooling fan)<br>2 : Active (for Inverter motor, with separate cooling fan) | 85 | o | 2 | o | o | o | o |
| F11 | Bh | 87( 57 h) | | M1 Electronic thermal overload relay (Level) | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | o | o |
| F12 | Ch | 88( 58 h) | | M1 Electronic thermal overload relay (Thermal time constant) | 0.5 to 75.0 min | 2 | o | 2 | o | o | o | o |
| F14 | Eh | (　　h) | Restart mode after momentary power failure | | 0 to 5<br>0 : Inactive (Trip and alarm when power failure occurs.)<br>1 : Inactive (Trip, and alarm when power recovers.)<br>2 : Inactive (Deceleration to stop, and trip and alarm.)<br>3 : Active (Smooth recovery by continuous operation mode)<br>4 : Active (Momentarily stops and restarts at speed on power failure)<br>5 : Active (Momentarily stops and restarts at starting speed) | 0 | o | 1 | o | o | o | o |
| F17 | 11h | (　　h) | Gain (terminal 12 input) | | 0.0 to 100 to 200.0 % | 2 | o | 1 | o | o | o | o |
| F18 | 12h | (　　h) | Bias (terminal 12 input) | | -24000 to 0 to 24000 r/min | 5 | o | 1 | o | o | o | o |
| F20 | 14h | 89( 59 h) | DC brake (Starting speed) | DC brake (Starting speed) | 0 to 3600 r/min | 0 | o | 1 | o | o | o | o |
| F21 | 15h | 90( 5A h) | | DC brake (Braking level) | 0 to 100 % | 16 | o | 1 | o | o | o | o |
| F22 | 16h | 91( 5B h) | | DC brake (Braking time) | 0.0 to 30.0 s<br>0.0 : (Inactive)<br>0.1 to 30.0 s | 2 | o | 1 | o | o | o | o |
| F23 | 17h | 92( 5C h) | Starting speed (Speed) | | 0.0 to 150.0 r/min<br>(The frequency is limited so as not to become 0.1Hz or less. (When using sensoless or V/F control)) | 2 | o | 1 | o | o | o | o |
| F24 | 18h | 93( 5D h) | Starting speed (Holding time) | | 0.00 to 10.00 s | 3 | o | 1 | o | o | o | o |
| F26 | 1Ah | 94( 5E h) | Motor sound (Carrier Freq.) | | 0.75 to 7 to 15 kHz<br>A factory setting value of 75kW or more is 10kHz. | 10 | o | 1 | o | o | o | o |
| F27 | 1Bh | 95( 5F h) | Motor sound (Sound tone) | | 0 to 3<br>0 : level 0<br>1 : level 1<br>2 : level 2<br>3 : level 3 | 0 | o | 1 | o | o | o | o |
| F36 | 24h | (　　h) | 30RY operation mode | | 0 to 1<br>0 : The relay(30) exites on alarm mode.<br>1 : The relay(30) exites on normal mode. | 43 | o | 1 | o | o | o | o |
| F37 | 25h | 96( 60 h) | Stop speed (Level) | Stop speed (Level) | 0.0 to 10.0 to 150.0 r/min<br>(The frequency is limited so as not to become 0.1Hz or less. (When using sensoless or VF control)) | 2 | o | 1 | o | o | o | o |
| F38 | 26h | 97( 61 h) | | Stop speed (Detection method) | 0 to 1<br>0 : Reference value<br>1 : Detected value<br>It is fixed 0 to use the V/F control. | 90 | o | 1 | o | o | x | o |

You can change the setting of a function indicated by during operation.
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Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| F39 | 27h | 98( 62 h) | | Stop speed (Zerospeed holding time) | 0.00 to 0.50 to 10.00 s | 3 | o | 1 | o | o | o | o |
| F40 | 28h | 99( 63 h) | Torque limiter | Torque limiting mode 1 | 0 to 3<br>0 : Torque limiting invalid<br>1 : Torque limiting<br>2 : Power limiting<br>3 : Torque current limiting | 44 | o | 1 | o | o | x | o |
| F41 | 29h | 100( 64 h) | | Torque limiting mode 2 | 0 to 3<br>0 : Same limiting level (level 1) for 4 quadrants<br>1 : Drive torque limiting (level 1),<br>and Brake torque limiting (level 2)<br>2 : Upper torque limiting (level 1),<br>and Lower torque limiting (level 2)<br>3 : Same limiting level for 4 quadrants<br>(level 1 and level 2 changeover)<br>Level 1 and 2 is the data setting of the definition by F42, 43 ahead. | 45 | o | 1 | o | o | x | o |
| F42 | 2Ah | 101( 65 h) | | Level 1 selection | 0 to 5<br>0 : Internal preset value by F44<br>1 : Ai terminal input value [TL-REF1]<br>2 : DIA card input<br>3 : DIB card input<br>4 : Link enabled<br>5 : PID output | 46 | o | 1 | o | o | x | o |
| F43 | 2Bh | 102( 66 h) | | Level 2 selection | 0 to 5<br>0 : Internal preset value by F45<br>1 : Ai terminal input value [TL-REF2]<br>2 : DIA card input<br>3 : DIB card input<br>4 : Link enabled<br>5 : PID output | 47 | o | 1 | o | o | x | o |
| F44 | 2Ch | 103( 67 h) | | Internal set 1 | -300 to 150 to 300 % | 5 | o | 1 | o | o | x | o |
| F45 | 2Dh | 104( 68 h) | | Internal set 2 | -300 to 10 to 300 % | 5 | o | 1 | o | o | x | o |
| F46 | 2Eh | 105( 69 h) | | Mechanical loss compensation | -300.00 to 0.00 to 300.00 %<br>This is used when mechanical loss of the load makes amends. | 7 | o | 1 | o | o | x | o |
| F47 | 2Fh | 106( 6A h) | | Torque bias set 1 | -300.00 to 0.00 to 300.00 %<br>This set value can be added to the torque reference value.<br>TB1, 2 and 3 are switched by DI and are used. | 7 | o | 1 | o | o | x | o |
| F48 | 30h | ( h) | | Torque bias set 2 | -300.00 to 0.00 to 300.00 %<br>This set value can be added to the torque reference value.<br>TB1, 2 and 3 are switched by DI and are used. | 7 | o | 1 | o | o | x | o |
| F49 | 31h | ( h) | | Torque bias set 3 | -300.00 to 0.00 to 300.00 %<br>This set value can be added to the torque reference value.<br>TB1, 2 and 3 are switched by DI and are used. | 7 | o | 1 | o | o | x | o |
| F50 | 32h | ( h) | | Torque bias activation timer | 0.00 to 1.00 s<br>( 300% / 1.00s )<br>Time up to 300% is set. | 3 | o | 1 | o | o | x | o |
| F51 | 33h | 251( FB h) | | Torque reference monitor (polarity) | 0 to 1<br>Polarity selection of the data output related to torque (AO, Keypad panel,code M)<br>0 : Display with torque polarity<br>1 : (+) for driving mode, and (-) for braking mode | 48 | o | 1 | o | o | o | o |
| F52 | 34h | ( h) | LED monitor coefficient | Display coefficient A | -999.00 to 1.00 to 999.00<br>The conversion coefficient to decide load axis rotation speed and the display value at the line speed displayed in LED are set.<br>Display value = Motor speed × (0.01 to 200.00)<br>The set data is effective only by 0.01 to 200.00 and outside the range is invalid. | 12 | o | 1 | o | o | o | o |
| F53 | 35h | ( h) | | Display coefficient B | -999.00 to 1.00 to 999.00<br>The conversion coefficient to decide the reference value of the PID adjustment machine and the display value (amount of the process) of the amount of feedback is set by using display coefficient A and B.<br>Display coefficient A ; Maximum value<br>Display coefficient B ; Minimum value<br>Display value = (Reference value or feedback value)<br>* (Display coefficient A - B) + B | 12 | o | 1 | o | o | o | o |

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You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| F54 | 36h | ( h) | | LED display filter | 0.0 to 0.2 to 5.0 s<br>Filter to prevent LED from flickering by change of the display data.<br>The filter is effective in all the data selected with F55. | 2 | o | 1 | o | o | o | o |
| F55 | 37h | ( h) | | LED (Selection) | 0 to 28<br>0 : Detected speed 1 or reference speed (r/min) (depending on F56 while motor is stopped)<br>1 : Speed reference value 4 (ASR input) (r/min)<br>2 : Output frequency after slip compensation (Hz)<br>3 : Torque current reference (%)<br>4 : Torque reference value (%)<br>5 : Torque (calculated value) (%)<br>6 : Inverter input power (kW or HP) (depending on F60)<br>7 : Output current (A)<br>8 : Output voltage (V)<br>9 : DC link circuit voltage (V)<br>10 : Magnetic flux reference (%)<br>11 : Magnetic flux (calculated value) (%)<br>12 : Motor temperature (°C) ("---" is displayed when NTC thermistor unused.)<br>13 : Load shaft speed (r/min) (depending on F56)<br>14 : Line speed (m/min) (depending on F56)<br>15 : Ai adjusted value (12) (%)<br>16 : Ai adjusted value (Ai1) (%)<br>17 : Ai adjusted value (Ai2) (%)<br>18 : Ai adjusted value (Ai3) (%)<br>19 : Ai adjusted value (Ai4) (%)<br>The following data becomes non-display by the mode on the option.<br>20 : PID reference (%) (Display at the PID mode)<br>21 : PID feedback value (%) (Display at the PID mode)<br>22 : PID output value (%) (Display at the PID mode)<br>23 : Option monitor 1 (HEX) (Displayed with use of option)<br>24 : Option monitor 2 (HEX) (Displayed with use of option)<br>25 : Option monitor 3 (DEC) (Displayed with use of option)<br>26 : Option monitor 4 (DEC) (Displayed with use of option)<br>27 : Option monitor 5 (DEC) (Displayed with use of option)<br>28 : Option monitor 6 (DEC) (Displayed with use of option) | 49 | o | 1 | o | o | o | o |
| F56 | 38h | ( h) | | LED (Display at stop mode) | 0 to 1<br>Change of the display on F55 when the motor is stopping.<br>The corresponding data is speed (0), load shaft rotation speed (13), and line speed (14).<br>0 : Speed reference (r/min)<br>1 : Speed feedback (r/min) | 50 | o | 1 | o | o | o | o |
| F57 | 39h | ( h) | LCD monitor | LCD (Selection) | 0 to 1<br>Change of operation mode display on Keypad panel<br>0 : Operation guide (State of operation, Direction of rotation)<br>1 : Bar graph monitor (Speed, Current, Torque) | 51 | o | 1 | o | o | o | o |
| F58 | 3Ah | ( h) | | LCD (Language) | 0 to 6<br>0 : Japanese<br>1 : English<br>2 : German<br>3 : French<br>4 : Spanish<br>5 : Italian<br>6 : Chinese | 52 | o | 1 | o | o | o | o |
| F59 | 3Bh | ( h) | | LCD (Contrast) | 0 to 5 to 10<br>0 (Soft) to 10 (Hard) | 0 | o | 1 | o | o | o | o |
| F60 | 3Ch | ( h) | Output unit selection (kW or HP) | | 0 to 1<br>The unit of inverter power consumption and motor (M1,2,3) of the function setting is defined.<br>0 : kW<br>1 : HP | 53 | o | 1 | o | o | o | o |
| F61 | 3Dh | 107( 6B h) | ASR1 | P-gain | 0.1 to 10.0 to 200.0 (times) | 2 | o | 1 | o | o | x | o |
| F62 | 3Eh | 108( 6C h) | | I-gain | 0.010 to 0.200 to 1.000 s<br>P control when setting 1.000 | 4 | o | 1 | o | o | x | o |

You can change the setting of a function indicated by [grey box] during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

| Fcode | Communication address: 485 number | Communication address: Link number | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available: PG | LES | VF | SM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F63 | 3Fh | 109( 6D h) | | Feed forward gain | 0.000 to 9.999 s | 4 | o | 1 | o | o | x | o |
| F64 | 40h | 110( 6E h) | | Input filter | 0.000 to 0.040 to 5.000 s | 4 | o | 1 | o | o | o | o |
| F65 | 41h | 111( 6F h) | | Detection filter | 0.000 to 0.005 to 0.100 s | 4 | o | 1 | o | o | x | o |
| F66 | 42h | 112( 70 h) | | Output filter | 0.000 to 0.002 to 0.100 s | 4 | o | 1 | o | o | x | o |
| F67 | 43h | 113( 71 h) | | S-curve (Acc start side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| F68 | 44h | 114( 72 h) | | S-curve (Acc end side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| F69 | 45h | 115( 73 h) | | S-curve (Dec start side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| F70 | 46h | 116( 74 h) | | S-curve (Dec end side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| F73 | 49h | ( h) | Magnetic flux at light leal | Magnetic flux at light leal | 10 to 100 % | 16 | o | 1 | o | o | x | x |
| F74 | 4Ah | 117( 75 h) | | Pre-exiting time | 0.0 to 10.0 s | 2 | o | 1 | o | o | x | x |
| F75 | 4Bh | 118( 76 h) | | Pre-excitation initial Level | 100 to 400 % | 0 | o | 1 | o | o | x | x |
| F76 | 4Ch | ( h) | Speed limitier | Speed limiter (Mode select) | 0 to 3<br>0 : Limiting level 1 for forward rotation, and limiting level 2 for reverse rotation<br>1 : Limiting level 1 for both side rotation<br>2 : Limiting level 1 for upper limit, and limiting level 2 for lower limit<br>3 : Forword (Level 1) and reverse (Level 2). Add the [12] input as a bias. | 91 | o | 1 | o | o | o | o |
| F77 | 4Dh | ( h) | | Speed limiting (Level 1) | -110.0 to 100.0 to 110.0 % | 6 | o | 1 | o | o | o | o |
| F78 | 4Eh | ( h) | | Speed limiting (Level 2) | -110.0 to 100.0 to 110.0 % | 6 | o | 1 | o | o | o | o |
| F79 | 4Fh | 119( 77 h) | Motor selection (M1, M2, M3) | | 0 to 2<br>An effective motor (M1, 2 or 3) is selected by the function or terminal.<br>0 : M1 select<br>The signal input by the terminal is given to priority.<br>M1 select ; (MCH2,MCH3)=(OFF,OFF) (If there is no allocation)<br>M2 select ; (MCH2,MCH3)=(ON ,OFF)(ON,ON)<br>1 : M2 select (x function inactive)<br>2 : M3 select (x function inactive) | 54 | o | 2 | o | o | o | o |
| F80 | 50h | ( h) | Current rating switching | | 0 to 2<br>0 : CT (Overload current 150%)<br>1 : VT (Overload current 110%)<br>2 : HT (Overload torque 200/170%) | 56 | o | 2 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
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Underline indicates a factory setting.

# 12. Function Code List

## E: Extension Terminal Functions

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| E01 | 101h | 120( 78 h) | X1 terminal function | X1 terminal function | 0 to 63<br>0 to 3 : Multistep speed selection (1 to 15 steps)<br>(0 : SS1, 1 : SS2, 2 : SS4, 3 : SS8)<br>4, 5 : ASR and ACC/DEC time selection (4 steps)<br>(4 : RT1, 5 : RT2)<br>6 : 3 wire operation stop command (HLD)<br>7 : Coast-to-stop command (BX)<br>8 : Alarm reset (RST)<br>9 : Trip command (External fault) (THR)<br>10 : Jogging operation (JOG)<br>11 : Speed setting 2 / Speed setting 1 (N2/N1)<br>12 : Motor M2 selection (M-CH2)<br>13 : Motor M3 selection (M-CH3)<br>14 : DC brake command (DCBRK)<br>15 : ACC/DEC cleared to zero (CLR)<br>16 : Creep speed switching in UP/DOWN control (CRP-N2/N1)<br>17 : UP command (UP)<br>18 : DOWN command (DOWN)<br>19 : Write enable for KEYPAD (WE-KP)<br>20 : PID control cancel (N/PID)<br>21 : Inverse mode changeover (IVS)<br>22 : Interlock signal for 52-2 (IL)<br>23 : Write enable through link (WE-LK)<br>24 : Operation selection through link (LE)<br>25 : Universal DI (U-DI)<br>26 : Pick up start mode (STM)<br>27 : Synchronization command (PG (PR) optional function) (SYC)<br>28 : Zero speed locking command (LOCK)<br>29 : Pre-exiting command (EXITE)<br>30 : Speed reference limiter cancel (N-LIM)<br>(Related function : F76, F77, F78)<br><br>31 : H41 [torque reference] cancel (H41-CCL)<br>32 : H42 [torque current reference] cancel (H42-CCL)<br>33 : H43 [magnetic flux reference] cancel (H43-CCL)<br>34 : F40 [torque limiter mode 1] cancel (F40-CCL)<br>35 : Torque limiter 2 / Torque limiter 1 (TL2/TL1)<br>36 : Bypass from ramp function generator (BPS)<br>37, 38 : Torque bias reference 1/2<br>(37 : TB1, 38 : TB2)<br>39 : DROOP selection (DROOP)<br>40 : Zero hold command for Ai1 (ZH-AI1)<br>41 : Zero hold command for Ai2 (ZH-AI2)<br>42 : Zero hold command for Ai3 (option) (ZH-AI3)<br>43 : Zero hold command for Ai4 (option) (ZH-AI4)<br>44 : Ai1 polarity change (REV-AI1)<br>45 : Ai2 polarity change (REV-AI2)<br>46 : Ai3 polarity change (option) (REV-AI3)<br>47 : Ai4 polarity change (option) (REV-AI4)<br>48 : Inverse mode of PID output (PID-INV)<br>49 : PG alarm cancel (PG-CCL)<br>50 : Undervoltage cancel (LU-CCL)<br>51 : Ai torque bias hold [H-TB]<br>52 : STOP1 (The motor stops with normal deceleration time.) (STOP1)<br>53 : STOP2 (The motor stops with deceleratime 4) (STOP2)<br>54 : STOP3 (The motor stops with max, torque.) (STOP3)<br>55 : DIA data latch (DIA option) (DIA)<br>56 : DIB data latch (DIB option) (DIB)<br>57 : Mulitiwinding motor cancel (SI (MWS) option) (MT-CCL)<br>58 to 63 : Option Di 1/2/3/4/5/6 (O-DI1 to 6) | 57 | o | 1 | o | o | o | o |
| E02 | 102h | 121( 79 h) | | X2 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E03 | 103h | 122( 7A h) | | X3 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E04 | 104h | 123( 7B h) | | X4 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E05 | 105h | 124( 7C h) | | X5 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E06 | 106h | 125( 7D h) | | X6 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E07 | 107h | 126( 7E h) | | X7 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |

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Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| E08 | 108h | 127( 7F h) | | X8 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E09 | 109h | 128( 80 h) | | X9 terminal function | * Same as ( E01 ) | 57 | o | 1 | o | o | o | o |
| E10 | 10Ah | 129( 81 h) | | X11 terminal function | * Same as ( E01 )<br>(When the DIO option is installed, this is displayed.) | 57 | o | 1 | o | o | o | o |
| E11 | 10Bh | 130( 82 h) | | X12 terminal function | * Same as ( E01 )<br>(When the DIO option is installed, this is displayed.) | 57 | o | 1 | o | o | o | o |
| E12 | 10Ch | 131( 83 h) | | X13 terminal function | * Same as ( E01 )<br>(When the DIO option is installed, this is displayed.) | 57 | o | 1 | o | o | o | o |
| E13 | 10Dh | 132( 84 h) | | X14 terminal function | * Same as ( E01 )<br>(When the DIO option is installed, this is displayed.) | 57 | o | 1 | o | o | o | o |
| E14 | 10Eh | ( h) | X terminal function normal open/close | | 0000 to 01FF<br>Setting of normal state of X1-X9.<br>0 : Normally open<br>1 : Normally closed | 35 | o | 1 | o | o | o | o |
| E15 | 10Fh | 133( 85 h) | Y1 terminal function | Y1 terminal function | 0 to 1 to 47<br>0 : Inverter running (RUN)<br>1 : Speed existence signal (N-EX)<br>2 : Speed agreement signal (N-AG)<br>3 : Speed egilivarent signal (N-AR)<br>4 : Speed level detection 1 (N-DT1)<br>5 : Speed level detection 2 (N-DT2)<br>6 : Speed level detection 3 (N-DT3)<br>7 : Stopping on undervoltage (LU)<br>8 : Detected torque polarity (Braking/Driving) (B/D)<br>9 : Torque limiting (TL)<br>10 : Torque detection 1 (T-DT1)<br>11 : Torque detection 2 (T-DT2)<br>12 : KEYPAD operation mode (KP)<br>13 : Inverter stopping (STP)<br>14 : Operation ready output (RDY)<br>15 : Magnetic flux detection signal (MF-DT)<br>16 : Motor M2 selection status (SW-M2)<br>17 : Motor M3 selection status (SW-M3)<br>18 : Mechanical brake release signal (BRK)<br>19 : Alarm indication signal 1 (AL1)<br>20 : Alarm indication signal 2 (AL2)<br>21 : Alarm indication signal 4 (AL4)<br>22 : Alarm indication signal 8 (AL8)<br>23 : Fan operation signal (FAN)<br>24 : Auto-resetting (TRY)<br>25 : Universal DO (U-DO)<br>26 : Heat sink overheat early warning (INV-OH)<br>27 : Synchronization completion signal (SY-C)<br>28 : Lifetime alarm (LIFE)<br>29 : Under acceleration (U-ACC)<br>30 : Under deceleration (U-DEC)<br>31 : Inverter overload early warning (INV-OL)<br>32 : Motor overheat early warning (M-OH)<br>33 : Motor overload early warning (M-OL)<br>34 : DB overload early warning (DB-OL)<br>35 : Link transmission error (LK-ERR)<br>36 : Load adaptive control under limiting (ANL)<br>37 : Load adaptive control under calculation (ANC)<br>38 : Analog torque bias hold (TBH)<br>39 to 47 : Option DO1 to 9 (O-DO1 to O-DO9) | 58 | o | 1 | o | o | o | o |
| E16 | 110h | 134( 86 h) | | Y2 terminal function | * Same as ( E15 ) | 58 | o | 1 | o | o | o | o |
| E17 | 111h | 135( 87 h) | | Y3 terminal function | * Same as ( E15 ) | 58 | o | 1 | o | o | o | o |
| E18 | 112h | 136( 88 h) | | Y4 terminal function | * Same as ( E15 ) | 58 | o | 1 | o | o | o | o |
| E19 | 113h | 137( 89 h) | | Y5 terminal function | * Same as ( E15 ) | 58 | o | 1 | o | o | o | o |
| E20 | 114h | 138( 8A h) | | Y11 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E21 | 115h | 139( 8B h) | | Y12 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E22 | 116h | 140( 8C h) | | Y13 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E23 | 117h | 141( 8D h) | | Y14 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |

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You should stop operation to change the setting of other functions.

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# 12. Function Code List

| Fcode | Communication address: 485 number | Communication address: Link number | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/Not available: PG | LES | VF | SM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E24 | 118h | 142( 8E h) | | Y15 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E25 | 119h | 143( 8F h) | | Y16 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E26 | 11Ah | 144( 90 h) | | Y17 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E27 | 11Bh | 145( 91 h) | | Y18 terminal function | * Same as ( E15 )<br>(When the DIOA option is installed, this is displayed.) | 58 | o | 1 | o | o | o | o |
| E28 | 11Ch | ( h) | Y terminal function normally open/closed | | 0000 to 001F<br>Setting of normal state of Y1 to Y4,RY.<br>0 : Normally open<br>1 : Normally closed | 36 | o | 1 | o | o | o | o |
| E29 | 11Dh | 146( 92 h) | PG pulse output selection | | 0 to 9<br>0 : No dividing<br>1 : 1/2<br>2 : 1/4<br>3 : 1/8<br>4 : 1/16<br>5 : 1/32<br>6 : 1/64<br>0 to 6: Internal PG inputs are output after being divided.<br>7 : Pulse oscillation mode (A/B 90° phase difference signal)<br>Internal speed reference is output after pulse conversion.<br>8 : PG (PD)<br>Pulse inputs for position encoder are directly output.<br>9 : PG (PR)<br>Pulse inputs for position command are directly output. | 92 | o | 1 | o | x | x | o |
| E30 | 11Eh | ( h) | Motor OH protection | Motor OH protection (temperature) | 100 to 150 to 200 °C<br>It is effective when NTC thermistor is used with selected motor (M1,M2). | 0 | o | 1 | o | o | o | o |
| E31 | 11Fh | ( h) | | M-OH early warning (temperature) | 50 to 75 to 200 °C<br>It is effective when NTC thermistor is used with selected motor (M1,M2). | 0 | o | 1 | o | o | o | o |
| E32 | 120h | 205( CD h) | | M1-M3 (operation level PTC) | 0.00 to 1.60 to 5.00 V | 3 | o | 1 | o | o | x | o |
| E33 | 121h | ( h) | | INV-OL early warning | 25 to 90 to 100 % | 0 | o | 1 | o | o | o | o |
| E34 | 122h | ( h) | | M-OL early warning | 25 to 90 to 100 % | 0 | o | 1 | o | o | o | o |
| E35 | 123h | ( h) | | DB overload protection | 0 to 10 to 100 % | 0 | o | 1 | o | o | o | o |
| E36 | 124h | ( h) | | DB-OL early warning | 0 to 80 to 100 % | 0 | o | 1 | o | o | o | o |
| E37 | 125h | ( h) | | DB thermal time constant | 0 to 100 to 1000 s | 0 | o | 1 | o | o | o | o |
| E38 | 126h | 147( 93 h) | Speed detection method | Speed detection method | 000 to 111<br>(N-DT1) (N-DT2) (N-DT3)<br>0 : Detected speed<br>1 : Speed reference<br>Only reference values are effective under VF control. | 9 | o | 1 | o | o | x | o |
| E39 | 127h | 148( 94 h) | | N-DT1 Level | 0 to 1500 to 24000 r/min | 0 | o | 1 | o | o | o | o |
| E40 | 128h | 149( 95 h) | | N-DT2 Level | -24000 to 1500 to 24000 r/min | 5 | o | 1 | o | o | o | o |
| E41 | 129h | 150( 96 h) | | N-DT3 Level | -24000 to 1500 to 24000 r/min | 5 | o | 1 | o | o | o | o |
| E42 | 12Ah | 151( 97 h) | | N-AR detection width | 1.0 to 3.0 to 20.0 % | 2 | o | 1 | o | o | o | o |
| E43 | 12Bh | 152( 98 h) | | N-AG detection width | 1.0 to 3.0 to 20.0 % | 2 | o | 1 | o | o | x | o |
| E44 | 12Ch | 153( 99 h) | | N-AG off-delay timer | 0.000 to 0.100 to 1.000 s | 4 | o | 1 | o | o | x | o |
| E45 | 12Dh | 154( 9A h) | | Speed disagreement alarm | 0 to 1<br>0 : Inactive<br>1 : Active | 0 | o | 1 | o | x | x | o |
| E46 | 12Eh | 155( 9B h) | | Torque detection level 1 | 0 to 30 to 300 %<br>When the V/F control is used, the calculation value is set. | 16 | o | 1 | o | o | o | o |
| E47 | 12Fh | 156( 9C h) | | Torque detection level 2 | 0 to 30 to 300 %<br>When the V/F control is used, the calculation value is set. | 16 | o | 1 | o | o | o | o |
| E48 | 130h | 157( 9D h) | | Magnetic flux detection level | 10 to 100 % | 16 | o | 1 | o | o | x | x |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| E49 | 131h | (    h) | Ai function selection | Ai1 function selection | <u>0</u> to 18<br>0 : Input signal off (OFF)<br>1 : Auxiliary speed setting 1 (before ramp function) (±10 V / ±Nmax) (AUX-N1)<br>2 : Auxiliary speed setting 2 (after ramp function) (± 10 V / ±Nmax) (AUX-N2)<br>3 : Torque limiter level 1 (±10 V / ±150 %) (TL-REF1)<br>4 : Torque limiter level 2 (±10 V / ±150 %) (TL-REF2)<br>5 : Torque bias reference (±10 V / ±150 %) (TB-REF)<br>6 : Torque reference (before limit function) (±10 V / ± 150 %) (T-REF)<br>7 : Torque current reference (±10 V / ±150 %) (IT-REF)<br>8 : Creep speed 1 for UP/DOWN control (±10 V / ± Nmax) (CRP-N1)<br>9 : Creep speed 2 for UP/DOWN control (±10 V / ± Nmax) (CRP-N2)<br>10 : Magnetic flux reference (+10 V / +100 %) (MF-REF)<br>11 : Detected line speed (±10 V / ±Nmax) (LINE-N)<br>12 : Motor temperature (+10 V / 200 °C) (M-TMP)<br>13 : Speed override (±10 V / ±50 %) (N-OR)<br>14 : Universal Ai (±10 V / ±4000 (h)) (U-AI)<br>15 : PID feedback (±10 V / ±20000 (d)) (PID-FB)<br>16 : PID reference (±10 V / ±20000 (d)) (PID-REF)<br>17 : PID correction gain (±10 V / ±4000 (h)) (PID-G)<br>18 : Option Ai (±10 V / ±7FFF (h)) (O-AI) | 59 | o | 1 | o | o | o | o |
| E50 | 132h | (    h) | | Ai2 function selection | * Same as ( E49 ) | 59 | o | 1 | o | o | o | o |
| E51 | 133h | (    h) | | Ai3 function selection | * Same as ( E49 )<br>(When the AIO option is installed, this is displayed.) | 59 | o | 1 | o | o | o | o |
| E52 | 134h | (    h) | | Ai4 function selection | * Same as ( E49 )<br>(When the AIO option is installed, this is displayed.) | 59 | o | 1 | o | o | o | o |
| E53 | 135h | (    h) | Gain adjustment for analog input | Gain (Ai1) | -10.000 to <u>1.000</u> to 10.000 (times)<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory. | 8 | o | 1 | o | o | o | o |
| E54 | 136h | (    h) | | Gain (Ai2) | -10.000 to <u>1.000</u> to 10.000 (times)<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory. | 8 | o | 1 | o | o | o | o |
| E55 | 137h | (    h) | | Gain (Ai3) | -10.000 to <u>1.000</u> to 10.000 (times)<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory.<br>(When the AIO option is installed, this is displayed.) | 8 | o | 1 | o | o | o | o |
| E56 | 138h | (    h) | | Gain (Ai4) | -10.000 to <u>1.000</u> to 10.000 (times)<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory.<br>(When the AIO option is installed, this is displayed.) | 8 | o | 1 | o | o | o | o |
| E57 | 139h | (    h) | Bias adjustment for analog input | Bias (Ai1) | -100.0 to <u>0.0</u> to 100.0 %<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory. | 6 | o | 1 | o | o | o | o |
| E58 | 13Ah | (    h) | | Bias (Ai2) | -100.0 to <u>0.0</u> to 100.0 %<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory. | 6 | o | 1 | o | o | o | o |
| E59 | 13Bh | (    h) | | Bias (Ai3) | -100.0 to <u>0.0</u> to 100.0 %<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory.<br>(When the AIO option is installed, this is displayed.) | 6 | o | 1 | o | o | o | o |
| E60 | 13Ch | (    h) | | Bias (Ai4) | -100.0 to <u>0.0</u> to 100.0 %<br>Use ∧ or ∨ key to write data onto RAM during editing with KEYPAD panel.<br>Using F/D key causes data writing onto nonvolatile memory.<br>(When the AIO option is installed, this is displayed.) | 6 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▒ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| E61 | 13Dh | ( h) | Filter adjustment for analog input | Filter (Ai1) | 0.000 to 0.010 to 0.500 s | 4 | o | 1 | o | o | o | o |
| E62 | 13Eh | ( h) | | Filter (Ai2) | 0.000 to 0.010 to 0.500 s | 4 | o | 1 | o | o | o | o |
| E63 | 13Fh | ( h) | | Filter (Ai3) | 0.000 to 0.010 to 0.500 s<br>(When the AIO option is installed, this is displayed.) | 4 | o | 1 | o | o | o | o |
| E64 | 140h | ( h) | | Filter (Ai4) | 0.000 to 0.010 to 0.500 s<br>(When the AIO option is installed, this is displayed.) | 4 | o | 1 | o | o | o | o |
| E65 | 141h | ( h) | Increment/decremrnt limiter | Inc/dec limiter (Ai1) | 0.00 to 60.00 s | 3 | o | 1 | o | o | o | o |
| E66 | 142h | ( h) | | Inc/dec limiter (Ai2) | 0.00 to 60.00 s | 3 | o | 1 | o | o | o | o |
| E67 | 143h | ( h) | | Inc/dec limiter (Ai3) | 0.00 to 60.00 s<br>(When the AIO option is installed, this is displayed.) | 3 | o | 1 | o | o | o | o |
| E68 | 144h | ( h) | | Inc/dec limiter (Ai4) | 0.00 to 60.00 s<br>(When the AIO option is installed, this is displayed.) | 3 | o | 1 | o | o | o | o |
| E69 | 145h | ( h) | AO function selection | AO1 function selection | 0 to 1 to 15, 30, 31<br>0 : Detected speed 1 (0 to 10 Vdc / 0 to ±Nmax speed) (N-FB1+)<br>1 : Detected speed 1 (0 to ±10 Vdc / 0 to ±Nmax speed) (N-FB1±)<br>2 : Speed settig 2 (before ACC/DEC calculating) (0 to ±10 Vdc / 0 to ±Nmax) (N-REF2)<br>3 : Speed settig 4 (ASR input) (0 to ±10 Vdc / 0 to ±Nmax) (N-REF4)<br>4 : Detected speed 2 (ASR input) (0 to ±10 Vdc / 0 to ±Nmax) (N-FB2±)<br>5 : Detected line speed (0 to ±10 Vdc / 0 to ±Nmax) (LINE-N±)<br>6 : Torque current reference (0 to ±10 Vdc / 0 to ±150 %) (IT-REF±)<br>7 : Torque current reference (0 to 10 Vdc / 0 to ±150 %) (IT-REF+)<br>8 : Torque reference (0 to ±10 Vdc / 0 to ±150 %) (T-REF±)<br>9 : Torque reference (0 to 10 Vdc / 0 to ±150 %) (T-REF+)<br>10 : Motor current (0 to 10 Vdc / 0 to 200 %) (I-AC)<br>11 : Motor voltage (0 to 10 Vdc / 0 to 200 %) (V-AC)<br>12 : Input power (0 to 10 Vdc / 0 to 200 %) (PWR)<br>13 : DC link circuit voltage (0 to 10 Vdc / 0 to 800 V) (V-DC)<br>14 : Test voltage output (+10 Vdc) (P10)<br>15 : Test voltage output (-10 Vdc) (N10)<br>30 : Universal analog output (U-AO)<br>31 : Option AO (O-AO) | 60 | o | 1 | o | o | o | o |
| E70 | 146h | ( h) | | AO2 function selection | * Same as ( E69 ) | 60 | o | 1 | o | o | o | o |
| E71 | 147h | ( h) | | AO3 function selection | * Same as ( E69 ) | 60 | o | 1 | o | o | o | o |
| E72 | 148h | ( h) | | AO4 function selection | * Same as ( E69 )<br>(When the AIO option is installed, this is displayed.) | 60 | o | 1 | o | o | o | o |
| E73 | 149h | ( h) | | AO5 function selection | * Same as ( E69 )<br>(When the AIO option is installed, this is displayed.) | 60 | o | 1 | o | o | o | o |
| E74 | 14Ah | ( h) | Gain adjustment for analog output | Gain (AO1) | -100.00 to 1.00 to 100.00 (times) | 7 | o | 1 | o | o | o | o |
| E75 | 14Bh | ( h) | | Gain (AO2) | -100.00 to 1.00 to 100.00 (times) | 7 | o | 1 | o | o | o | o |
| E76 | 14Ch | ( h) | | Gain (AO3) | -100.00 to 1.00 to 100.00 (times) | 7 | o | 1 | o | o | o | o |
| E77 | 14Dh | ( h) | | Gain (AO4) | -100.00 to 1.00 to 100.00 (times)<br>(When the AIO option is installed, this is displayed.) | 7 | o | 1 | o | o | o | o |
| E78 | 14Eh | ( h) | | Gain (AO5) | -100.00 to 1.00 to 100.00 (times)<br>(When the AIO option is installed, this is displayed.) | 7 | o | 1 | o | o | o | o |
| E79 | 14Fh | ( h) | Bias adjustment for analog output | Bias (AO1) | -100.0 to 0.0 to 100.0 % | 6 | o | 1 | o | o | o | o |
| E80 | 150h | ( h) | | Bias (AO2) | -100.0 to 0.0 to 100.0 % | 6 | o | 1 | o | o | o | o |
| E81 | 151h | ( h) | | Bias (AO3) | -100.0 to 0.0 to 100.0 % | 6 | o | 1 | o | o | o | o |
| E82 | 152h | ( h) | | Bias (AO4) | -100.0 to 0.0 to 100.0 %<br>(When the AIO option is installed, this is displayed.) | 6 | o | 1 | o | o | o | o |
| E83 | 153h | ( h) | | Bias (AO5) | -100.0 to 0.0 to 100.0 %<br>(When the AIO option is installed, this is displayed.) | 6 | o | 1 | o | o | o | o |
| E84 | 154h | ( h) | Filter adjustment for analog output (AO1-5) | | 0.000 to 0.010 to 0.500 s | 4 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# C: Control Functions of Frequency

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| C01 | 201h | ( h) | Jump speed control | Jump speed (Speed 1) | 0 to 24000 r/min | 0 | o | 1 | o | o | o | o |
| C02 | 202h | ( h) | | Jump speed (Speed 2) | 0 to 24000 r/min | 0 | o | 1 | o | o | o | o |
| C03 | 203h | ( h) | | Jump speed (Speed 3) | 0 to 24000 r/min | 0 | o | 1 | o | o | o | o |
| C04 | 204h | ( h) | | Jump speed (Hysteresis) | 0 to 1000 r/min | 0 | o | 1 | o | o | o | o |
| C05 | 205h | 158( 9E h) | Multistep speed setting | Multistep speed 1 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C06 | 206h | 159( 9F h) | | Multistep speed 2 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C07 | 207h | 160( A0 h) | | Multistep speed 3 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C08 | 208h | 161( A1 h) | | Multistep speed 4 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C09 | 209h | 162( A2 h) | | Multistep speed 5 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C10 | 20Ah | 163( A3 h) | | Multistep speed 6 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C11 | 20Bh | 164( A4 h) | | Multistep speed 7 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C12 | 20Ch | ( h) | | Multistep speed 8 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C13 | 20Dh | ( h) | | Multistep speed 9 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C14 | 20Eh | ( h) | | Multistep speed 10 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C15 | 20Fh | ( h) | | Multistep speed 11 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C16 | 210h | ( h) | | Multistep speed 12 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C17 | 211h | ( h) | | Multistep speed 13 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C18 | 212h | ( h) | | Multistep speed 14 /Creep speed 1 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C19 | 213h | ( h) | | Multistep speed 15 /Creep speed 2 | 0 to 24000 r/min / 0.00 to 100.00 % / 0.0 to 999.9 m/m (Change by C21) | 0 | o | 1 | o | o | o | o |
| C20 | 214h | ( h) | | Multistep speed agreement timer | 0.000 to 0.100 s | 4 | o | 1 | o | o | o | o |
| C21 | 215h | ( h) | | Multistep speed setting definition | 0 to 2<br>0 : 0 to 24000 r/min<br>1 : 0.00 to 100.00%<br>2 : 0.0 to 999.9 m/m<br>Defines setting methods of C05 to C19. With selection of "1", the setting range applies to the max speeds (F03, A06, A40) of selected motor. Refer to F79 for motor selection. | 93 | o | 1 | o | o | o | o |
| C25 | 219h | ( h) | Speed setting N2 | | 0 to 7<br>* Same as ( F01 ) | 41 | o | 1 | o | o | o | o |
| C29 | 21Dh | ( h) | Jogging speed | | 0 to 50 to 24000 r/min | 0 | o | 1 | o | o | o | o |
| C30 | 21Eh | ( h) | ASR-JOG | P-gain | 0.1 to 10.0 to 200.0 (times) | 2 | o | 1 | o | o | x | o |
| C31 | 21Fh | ( h) | | I-gain | 0.010 to 0.200 to 1.000 s<br>P control when setting 1.000 | 4 | o | 1 | o | o | x | o |
| C32 | 220h | ( h) | | Input filter | 0.000 to 0.040 to 5.000 s | 4 | o | 1 | o | o | o | o |
| C33 | 221h | ( h) | | Detection filter | 0.000 to 0.005 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C34 | 222h | ( h) | | Output filter | 0.000 to 0.002 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C35 | 223h | ( h) | | Acceleration time JOG | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C36 | 224h | ( h) | | Deceleration time JOG | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C37 | 225h | ( h) | | S-curve JOG (Start side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C38 | 226h | ( h) | | S-curve JOG (End side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address: 485 number | Communication address: Link number | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/Not available: PG | LES | VF | SM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C40 | 228h | ( h) | ASR2 | P-gain | 0.1 to 10.0 to 200.0 (times) | 2 | o | 1 | o | o | x | o |
| C41 | 229h | ( h) | | I-gain | 0.010 to 0.200 to 1.000 s<br>P control when setting 1.000 | 4 | o | 1 | o | o | x | o |
| C42 | 22Ah | ( h) | | F/F-gain | 0.000 to 9.999 s | 4 | o | 1 | o | o | x | o |
| C43 | 22Bh | ( h) | | Input filter | 0.000 to 0.040 to 5.000 s | 4 | o | 1 | o | o | o | o |
| C44 | 22Ch | ( h) | | Detection filter | 0.000 to 0.005 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C45 | 22Dh | ( h) | | Output filter | 0.000 to 0.002 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C46 | 22Eh | ( h) | | Acceleration time 2 | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C47 | 22Fh | ( h) | | Deceleration time 2 | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C48 | 230h | ( h) | | S-curve 2 (Start side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C49 | 231h | ( h) | | S-curve 2 (End side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C50 | 232h | ( h) | ASR3 | P-gain | 0.1 to 10.0 to 200.0 (times) | 2 | o | 1 | o | o | x | o |
| C51 | 233h | ( h) | | I-gain | 0.010 to 0.200 to 1.000 s<br>P control when setting 1.000 | 4 | o | 1 | o | o | x | o |
| C52 | 234h | ( h) | | F/F-gain | 0.000 to 9.999 s | 4 | o | 1 | o | o | x | o |
| C53 | 235h | ( h) | | Input filter | 0.000 to 0.040 to 5.000 s | 4 | o | 1 | o | o | o | o |
| C54 | 236h | ( h) | | Detection filter | 0.000 to 0.005 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C55 | 237h | ( h) | | Output filter | 0.000 to 0.002 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C56 | 238h | ( h) | | Acceleration time 3 | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C57 | 239h | ( h) | | Deceleration time 3 | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C58 | 23Ah | ( h) | | S-curve 3 (Start side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C59 | 23Bh | ( h) | | S-curve 3 (End side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C60 | 23Ch | ( h) | ASR4 | P-gain | 0.1 to 10.0 to 200.0 (times) | 2 | o | 1 | o | o | x | o |
| C61 | 23Dh | ( h) | | I-gain | 0.010 to 0.200 to 1.000 s<br>P control when setting 1.000 | 4 | o | 1 | o | o | x | o |
| C62 | 23Eh | ( h) | | F/F-gain | 0.000 to 9.999 s | 4 | o | 1 | o | o | x | o |
| C63 | 23Fh | ( h) | | Input filter | 0.000 to 0.040 to 5.000 s | 4 | o | 1 | o | o | o | o |
| C64 | 240h | ( h) | | Detection filter | 0.000 to 0.005 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C65 | 241h | ( h) | | Output filter | 0.000 to 0.002 to 0.100 s | 4 | o | 1 | o | o | x | o |
| C66 | 242h | ( h) | | Acceleration time 4 | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C67 | 243h | ( h) | | Deceleration time 4 | 0.01 to 5.00 to 99.99s<br>100.0 to 999.9s<br>1000 to 3600s | 13 | o | 1 | o | o | o | o |
| C68 | 244h | ( h) | | S-curve 4 (Start side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C69 | 245h | ( h) | | S-curve 4 (End side) | 0 to 50 % | 0 | o | 1 | o | o | o | o |
| C70 | 246h | ( h) | ASR switching time | | 0.00 to 1.00 to 2.55 s | 3 | o | 1 | o | o | x | o |
| C71 | 247h | 165( A5 h) | ACC/DEC switching speed | | 0.00 to 100.00 % | 3 | o | 1 | o | o | o | o |
| C72 | 248h | 166( A6 h) | ASR switching time | | 0.00 to 100.00 % | 3 | o | 1 | o | o | x | o |
| C73 | 249h | ( h) | Creep speed select (at UP/DOWN mode) | | 00 to 11<br>(Creep Speed 1)(Creep Speed 2)<br>0:Function setting (C18,19)<br>1:Analog input (CRP-N1, CRP-N2) | 9 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

## P: Motor Parameters

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| P01 | 301h | (  h) | M1 Control method | | 0 to 3<br>0 : Vector control<br>1 : Sensorless vector control<br>2 : Simulation operation mode<br>3 : Vector control (Synchronous motors) | 55 | o | 2 | o | o | o | o |
| P02 | 302h | (  h) | M1 selection | M1 selection (for Motor parameter setting) | 0 to 37<br>Display (kW,HP) changes by setting F60.<br>0 to 35: Settings for motors dedicated for VG7<br>Data at F04, F05, and P03 to P27are automatically set and write-protected.<br>36: P-OTHER<br>Data at F04, F05, and P03 to P27 are write-protected and cannot be overwritten.<br>37: OTHER<br>Data at F04, F05, and P03 to P27 are write-protected and cannot be overwritten. | 82 | o | 2 | o | o | x | o |
| P03 | 303h | 167( A7 h) | | M1-Rated capacity | 0.00 to 500.00kW at F60=0<br>0.00 to 600.00HP at F60=1 | 3 | o | 2 | o | o | x | o |
| P04 | 304h | 168( A8 h) | | M1-Rated current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | o |
| P05 | 305h | 169( A9 h) | | M1-Poles | 2 to 4 to 20 (poles) | 1 | o | 2 | o | o | x | o |
| P06 | 306h | 170( AA h) | | M1-%R1 | 0.00 to 30.00 % | 3 | o | 2 | o | o | x | o |
| P07 | 307h | 171( AB h) | | M1-%X | 0.00 to 30.00 % | 3 | o | 2 | o | o | x | o |
| P08 | 308h | 172( AC h) | | M1-Exciting current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | o |
| P09 | 309h | 173( AD h) | | M1-Torque current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | o |
| P10 | 30Ah | 174( AE h) | | M1-Slip (Driving) | 0.001 to 10.000 Hz | 4 | o | 2 | o | o | x | x |
| P11 | 30Bh | 175( AF h) | | M1-Slip (Braking) | 0.001 to 10.000 Hz | 4 | o | 2 | o | o | x | x |
| P12 | 30Ch | 176( B0 h) | | M1-Iron loss coefficient 1 | 0.00 to 10.00 % | 3 | o | 2 | o | o | x | o |
| P13 | 30Dh | 177( B1 h) | | M1-Iron loss coefficient 2 | 0.00 to 10.00 % | 3 | o | 2 | o | o | x | o |
| P14 | 30Eh | 178( B2 h) | | M1-Iron loss coefficient 3 | 0.00 to 10.00 % | 3 | o | 2 | o | o | x | o |
| P15 | 30Fh | 179( B3 h) | | M1-Magnetic sataration coefficient 1 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| P16 | 310h | 180( B4 h) | | M1-Magnetic sataration coefficient 2 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| P17 | 311h | 181( B5 h) | | M1-Magnetic sataration coefficient 3 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| P18 | 312h | 182( B6 h) | | M1-Magnetic sataration coefficient 4 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| P19 | 313h | 183( B7 h) | | M1-Magnetic sataration coefficient 5 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| P20 | 314h | 184( B8 h) | | M1-Secondary time constant | 0.001 to 9.999 s | 4 | o | 2 | o | o | x | x |
| P21 | 315h | 185( B9 h) | | M1-Induced voltagge coefficient | 0 to 999 V | 0 | o | 2 | o | o | x | o |
| P22 | 316h | 186( BA h) | | M1-R2 correction coefficient 1 | 0.500 to 5.000 | 4 | o | 2 | o | o | x | x |
| P23 | 317h | 187( BB h) | | M1-R2 correction coefficient 2 | 0.500 to 5.000 | 4 | o | 2 | o | o | x | x |
| P24 | 318h | 188( BC h) | | M1-R2 correction coefficient 3 | 0.010 to 5.000 | 4 | o | 2 | o | o | x | x |
| P25 | 319h | 189( BD h) | | M1-Exciting current correction coefficient. | 0.000 to 5.000 | 4 | o | 2 | o | o | x | x |
| P26 | 31Ah | 190( BE h) | | M1-ACR-P gain | 0.1 to 20.0 | 2 | o | 2 | o | o | x | o |
| P27 | 31Bh | 191( BF h) | | M1-ACR-I gain | 0.5 to 100.0 ms | 2 | o | 2 | o | o | x | o |
| P28 | 31Ch | 192( C0 h) | M1-PG pulses | | 100 to 1024 to 60000 | 0 | o | 2 | o | o | x | o |
| P29 | 31Dh | 214( D6 h) | M1-External PG correction coefficient | | 0000 to 4000 to 7FFF | 9 | o | 2 | o | x | x | o |
| P30 | 31Eh | 193( C1 h) | M1-thermistor selection | | 0 to 1 to 3<br>0 : No use thermistor<br>1 : NTC thermistor<br>2 : PTC thermistor<br>3 : Ai (M-TMP)<br>Please do the protection level setting of the motor at E30-E32. | 84 | o | 2 | o | o | x | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

## H: High Performance Functions

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| H01 | 401h | ( h) | Tuning operation selection | | 0 to 4<br>After writing the data, this function's data code automatically returns to 0.<br>0 : Inactive<br>1 : ASR system tuning<br>2 : R1,Lσ tuning<br>3 : Motor parameters tuning at stopping mode<br>4 : Motor parameters tuning at runing mode<br>The data after the tuning goes out when the power supply is turned off.<br>H02 “All save function" must operate when the maintenance (preservation) of the data is necessary. | 61 | x | 0 | o | o | o | x |
| H02 | 402h | 14( E h) | All Save Function | | 0 to 1<br>When tuning is executed at H01 and the internal data is written, or when the data is written by way of the link system (T-Link, field bus, and RS458, etc.), the data goes out when the power supply of the inverter is turned off. This function must operate when preservation is necessary.<br>After writing the data, this function's data code automatically returns to 0. | 11 | x | 0 | o | o | o | o |
| H03 | 403h | ( h) | Data initializing (Data reset) | | 0 to 1<br>The data which the customer rewrote is returned to the state of the factory setting value. Target functions for initialization are all fields of F, E, C, H, o, L, and U except motor parameter field (P,A).<br>After writing the data, this function's data code automatically returns to 0. | 11 | x | 0 | o | o | o | o |
| H04 | 404h | ( h) | Auto-reset (Times) | | 0 to 10<br>0 : (Inactive)<br>1 to 10 times<br>The auto-resetting signal can be output to the output terminal. | 0 | o | 1 | o | o | o | o |
| H05 | 405h | ( h) | Auto-reset (Reset interval) | | 0.01 to 5.00 to20.00 s | 3 | o | 1 | o | o | o | o |
| H06 | 406h | ( h) | Fan stop operation | | 0 to 1<br>The temperature of the cooling fan in the inverter is detected and it is a function to control the cooling fan automatically ON/OFF.<br>It always rotates when inactive is selected.<br>0 : Inactive<br>1 : Active<br>The signal indicating the cooling fan operation can be output by synchronizing with this function. | 68 | o | 1 | o | o | o | o |
| H08 | 408h | ( h) | Rev.phase sequence lock | | 0 to 1<br>0 : Inactive<br>1 : Active | 68 | o | 1 | o | o | x | o |
| H09 | 409h | 194( C2 h) | Start mode (rotating motor pick up ) | | 0 to 2<br>0 : Inactive<br>1 : Active (at after momentary power failure)<br>2 : Active (at all start mode) | 0 | o | 1 | o | o | o | o |
| H10 | 40Ah | 195( C3 h) | Energy-saving operation | | 0 to 1<br>0 : Inactive<br>1 : Active | 68 | o | 1 | o | o | x | o |
| H11 | 40Bh | ( h) | Automatic operation OFF function | | 0 to 2<br>It is a function when becoming following the stop speed setting to turn off the inverter automatically.<br>0 : Deceleration stop with FWD or REV shorted to CM between FWD-CM and REV-CM.<br>1 : The inverter is turned off below the stop speed even for ON between FWD-CM and REV-CM.<br>2: Coast-to-stop with FWD or REV shorted to CM | 0 | o | 1 | o | o | o | o |
| H13 | 40Dh | 196( C4 h) | Restart after momentary power failure | Restart waiting time | 0.1 to 0.5 to 5.0 s | 2 | o | 1 | o | o | o | o |
| H14 | 40Eh | ( h) | | Fall rate | 1 to 500 to 3600 ( r/min/s) | 0 | o | 1 | o | o | o | o |
| H15 | 40Fh | ( h) | | Holding voltage on continuous operation | 3ph 200V : 200 to 235 to 300V<br>3ph 400V : 400 to 470 to 600V | 0 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| H16 | 410h | ( h) | | Operation command selfhold setting | 0 to 1<br>0 : Set at H17<br>1 : Maximum time (The inverter judges that it is a power failure momentarily and self-maintains the operation command while the control power supply in the inverter establishes or until the main circuit DC voltage becomes almost 0.) | 94 | o | 1 | o | o | o | o |
| H17 | 411h | ( h) | | Operation command selfhold time | 0.0 to 30.0 s | 2 | o | 1 | o | o | o | o |
| H19 | 413h | 197( C5 h) | Active Drive | | 0 to 1<br>0 : Inactive<br>1 : Active | 68 | o | 1 | o | o | x | o |
| H20 | 414h | 198( C6 h) | PID control | PID control (Mode select) | 0 to 2<br>0 : Inactive<br>1 : Active (normal mode output)<br>2 : Active (inverse mode output) | 69 | o | 1 | o | o | x | o |
| H21 | 415h | 199( C7 h) | | Command select | 0 to 1<br>0 : Keypad panel or 12 input<br>1 : Analog input (PIDS) | 70 | o | 1 | o | o | x | o |
| H22 | 416h | 201( C9 h) | | P-gain | 0.000 to 1.000 to 10.000 (times) | 4 | o | 1 | o | o | x | o |
| H23 | 417h | 202( CA h) | | I-gain | 0.00 to 1.00 to 100.00 s | 3 | o | 1 | o | o | x | o |
| H24 | 418h | 203( CB h) | | D-gain | 0.000 to 10.000 s | 4 | o | 1 | o | o | x | o |
| H25 | 419h | 200( C8 h) | | PID control (Upper limit) | -300 to 100 to 300 % | 5 | o | 1 | o | o | x | o |
| H26 | 41Ah | 204( CC h) | | PID control (Lower limit) | -300 to -100 to 300 % | 5 | o | 1 | o | o | x | o |
| H27 | 41Bh | 206( CE h) | | PID control (Speed reference) | 0 to 2<br>0 : Inactive<br>1 : PID select<br>2 : Auxiliary speed | 95 | o | 1 | o | o | x | o |
| H28 | 41Ch | 207( CF h) | Droop control | | 0.0 to 25.0 % | 2 | o | 1 | o | o | x | o |
| H29 | 41Dh | ( h) | Link function | Data protect via serial link | 0 to 1<br>Function not to write data from link (T-Link, RS485, etc.) by mistake.<br>0 : Non-protect<br>1 : Protect via serial link<br>There are two writing from the link about usual function field and serial data field. This S field is defined at H30. | 40 | o | 1 | o | o | o | o |
| H30 | 41Eh | 208( D0 h) | | Serial link (Function select) | 0 to 3<br>(Monitor) (Speed reference) (Operation command)<br>0 : o x x<br>1 : o o x<br>2 : o x o<br>3 : o o o | 72 | o | 1 | o | o | o | o |
| H31 | 41Fh | ( h) | RS485 | RS485 (Address) | 0 to 1 to 255<br>Setting of the station address of RS485.<br>broadcast : (0 : RTU) , (99 : Fuji)<br>address : 1 to 255 | 0 | o | 2 | o | o | o | o |
| H32 | 420h | ( h) | | RS485 (Mode select on no response error) | 0 to 3<br>0 : Trip and alarm (Er5)<br>1 : Operation for H33 timer , and alarm (Er5)<br>2 : Operation for H33 timer , and retry to communicate.<br>* If the retry fails, then the inverter trips. ("Er5")<br>3 : Continuous operation | 73 | o | 1 | o | o | o | o |
| H33 | 421h | ( h) | | RS485 (Timer) | 0.01 to 2.00 to 20.00 s | 3 | o | 1 | o | o | o | o |
| H34 | 422h | ( h) | | RS485 (Baud rate) | 0 to 4<br>0 : 38400 bps<br>1 : 19200 bps<br>2 : 9600 bps<br>3 : 4800 bps<br>4 : 2400 bps | 74 | o | 2 | o | o | o | o |
| H35 | 423h | ( h) | | RS485 (Data length) | 0 to 1<br>0 : 8 bits<br>1 : 7 bits | 75 | o | 2 | o | o | o | o |
| H36 | 424h | ( h) | | RS485 (Parity check) | 0 to 1 to 2<br>0 : No checking<br>1 : Even parity<br>2 : Odd parity | 76 | o | 2 | o | o | o | o |
| H37 | 425h | ( h) | | RS485 (Stop bits) | 0 to 1<br>0 : 2 bits<br>1 : 1 bit | 77 | o | 2 | o | o | o | o |

You can change the setting of a function indicated by during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| H38 | 426h | ( h) | | RS485 (No response error detection time) | 0.0 to 60.0 s<br>0.0 : Detection of communication break invalid<br>0.1 to 60.0s : Detection of communication break valid<br>It is a function to do Er5 trip detecting the access disappearing for each station which includes an own station in the set time due to some abnormality (no response etc.) from operation via RS485. | 2 | o | 1 | o | o | o | o |
| H39 | 427h | ( h) | | RS485 (Response interval) | 0.00 to 0.05 to 1.00 s<br>The time to return the response is set to the demand by a host device. | 3 | o | 1 | o | o | o | o |
| H40 | 428h | ( h) | | RS485 (Protocol) | 0 to 1 to 2<br>0 : FUJI inverter protocol<br>1 : SX bus (FUJI private link) protocol<br>2 : Modbus RTU protocol<br>Please set 1 (SX bus protocol) when you use the PC loader of the VG7 exclusive use. | 78 | o | 2 | o | o | o | o |
| H41 | 429h | 209( D1 h) | Torque reference selection | Torque reference selection | 0 to 5<br>0 : Internal ASR output<br>1 : AI terminal input (T-REF)<br>2 : DIA card input<br>3 : DIB card input<br>4 : Link input<br>5 : PID | 64 | o | 1 | o | o | x | o |
| H42 | 42Ah | 210( D2 h) | | Torque current reference selection | 0 to 4<br>0 : Internal ASR output<br>1 : AI terminal input (IT-REF)<br>2 : DIA card input<br>3 : DIB card input<br>4 : Link input | 65 | o | 1 | o | o | x | o |
| H43 | 42Bh | 211( D3 h) | | Magnetic flux reference selection | 0 to 3<br>0 : Internal calculation value<br>1 : AI terminal input (MF-REF)<br>2 : Function setting value (H44)<br>3 : Link input | 66 | o | 1 | o | o | x | x |
| H44 | 42Ch | 212( D4 h) | | Magnetic flux reference value | 10 to 100 % | 16 | o | 1 | o | o | x | x |
| H46 | 42Eh | 215( D7 h) | Observer (Mode select) | Observer (Mode select) | 0 to 2<br>0 : Inactive<br>1 : Active (load disturbance observer)<br>2 : Active (oscillation suppressing observer) | 79 | o | 1 | o | o | x | o |
| H47 | 42Fh | 216( D8 h) | | (P-gain 1)(M1) | 0.00 to 1.00 (times) | 3 | o | 1 | o | o | x | o |
| H48 | 430h | ( h) | | (P-gain 2)(M2) | 0.00 to 1.00 (times) | 3 | o | 1 | o | o | x | o |
| H49 | 431h | 217( D9 h) | | (I-gain 1)(M1) | 0.005 to 0.100 to 1.000 s | 4 | o | 1 | o | o | x | o |
| H50 | 432h | ( h) | | (I-gain 2)(M2) | 0.005 to 0.100 to 1.000 s | 4 | o | 1 | o | o | x | o |
| H51 | 433h | 218( DA h) | | Load inertia M1 | 0.001 to 50.000 (kg.m$^2$ ) | 4 | o | 2 | o | o | x | o |
| H52 | 434h | ( h) | | Load inertia M2 | 0.001 to 50.000 (kg.m$^2$ ) | 4 | o | 2 | o | o | x | o |
| H53 | 435h | 213( D5 h) | Line speed feedback selection | | 0 to 3<br>0 : Line speed disabled<br>1 : Line speed (analog input) (AI-LINE)<br>2 : Line speed (digital input) (PG(LD))<br>3 : High level selected signal | 67 | o | 1 | o | x | x | o |
| H55 | 437h | ( h) | Zero speed control | Gain | 0 to 5 to 100 (times) | 0 | o | 1 | o | x | x | o |
| H56 | 438h | ( h) | | Completion range | 0 to 100 (pulse) | 0 | o | 1 | o | x | x | o |
| H57 | 439h | ( h) | OU trip prevention | OU trip prevention | 0 to 1<br>0 : Inactive<br>1 : Active | 68 | o | 1 | o | o | o | o |
| H58 | 43Ah | ( h) | | OC trip prevention | 0 to 1<br>0 : Inactive<br>1 : Active | 68 | o | 1 | o | o | o | o |
| H60 | 43Ch | ( h) | Load adaptive control function 1 | Load adaptive control function 1 | 0 to 3<br>0 : Inactive<br>1 : Method 1<br>2 : Method 2<br>3 : Method 3 | 80 | o | 1 | o | x | x | o |
| H61 | 43Dh | ( h) | | Load adaptive control function 2 | 0 to 1<br>0 : Winding up on forward rotation<br>1 : Winding down on forward rotation | 81 | o | 1 | o | x | x | o |
| H62 | 43Eh | ( h) | | Winding up speed | 0.0 to 999.9 m/min | 2 | o | 1 | o | x | x | o |
| H63 | 43Fh | ( h) | | Counter weight | 0.00 to 600.00 (t) | 3 | o | 1 | o | x | x | o |

You can change the setting of a function indicated by [shaded box] during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| H64 | 440h | ( h) | | Safety coefficient (for rated torque) | 0.50 to 1.00 to 1.20 | 3 | o | 1 | o | x | x | o |
| H65 | 441h | ( h) | | Machine efficiency | 0.500 to 1.000 | 4 | o | 1 | o | x | x | o |
| H66 | 442h | ( h) | | Rated loading | 0.00 to 600.00 (t) | 3 | o | 1 | o | x | x | o |
| H68 | 444h | ( h) | Alarm data delete | | 0 to 1<br>If these tuning are finished, this data code returns to 0. | 11 | x | 0 | o | o | o | o |
| H70 | 446h | ( h) | Reserved | Reserved 1 | 0 to 9999<br>0 : Standard<br>1 : Lift<br>2 to 9999 : Undecided | 0 | o | 2 | o | o | x | o |
| H71 | 447h | ( h) | | Reserved 2 | 0 to 6<br>It is not necessary to set usually.<br>If these tuning are finished, this data code returns to 0.<br>0 : Inactive<br>1 : ACR system tuning<br>2 : Voltage gain tuning (execution without connecting motor)<br>3 : Voltage sensor offset tuning<br>4 : Current sensor balance tuning<br>5 : Magnet pole position tuning (for SM driving)<br>6 : Shunt resistor gain tuning | 62 | x | 0 | o | o | o | o |
| H72 | 448h | ( h) | | Reserved 3 | 0 to 9999<br>0 : standard<br>1 to 9999 : Undecided<br>(Displayed when n-code can be displayed or the display mask function is cancelled (N40=2)). | 0 | x | 2 | o | o | o | o |
| H73 | 449h | ( h) | | Reserved 4 | 0 to 9999<br>0 : standard<br>1 to 9999 : Undecided<br>(Displayed when n-code can be displayed or the display mask function is cancelled (N40=2)). | 0 | x | 2 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

## A: Alternative Motor Parameters

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| A01 | 501h | ( h) | Setting M2 parameter | M2-Control method | 0 to 1<br>M2 is an induction motor only for the vector control.<br>0 : Vector control with PG<br>1 : Vector control without PG | 55 | o | 2 | o | o | x | x |
| A02 | 502h | ( h) | | M2-Rated capacity | 0.00 to 500.00kW at F60=0<br>0.00 to 600.00HP at F60=1 | 3 | o | 2 | o | o | x | x |
| A03 | 503h | ( h) | | M2-Rated current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | x |
| A04 | 504h | ( h) | | M2-Rated voltage | 80 to 999 V | 0 | o | 2 | o | o | x | x |
| A05 | 505h | ( h) | | M2-Rated speed | 50 to 1500 to 24000 r/min | 0 | o | 2 | o | o | x | x |
| A06 | 506h | ( h) | | M2-Maximum speed | 50 to 1500 to 24000 r/min | 0 | o | 2 | o | o | x | x |
| A07 | 507h | ( h) | | M2-Poles | 2 to 4 to 12 (poles) | 1 | o | 2 | o | o | x | x |
| A08 | 508h | ( h) | | M2-%R1 | 0.00 to 30.00 % | 3 | o | 2 | o | o | x | x |
| A09 | 509h | ( h) | | M2-%X | 0.00 to 30.00 % | 3 | o | 2 | o | o | x | x |
| A10 | 50Ah | ( h) | | M2-Exciting current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | x |
| A11 | 50Bh | ( h) | | M2-Torque current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | x |
| A12 | 50Ch | ( h) | | M2-Slip (Driving) | 0.001 to 10.000 Hz | 4 | o | 2 | o | o | x | x |
| A13 | 50Dh | ( h) | | M2-Slip (Braking) | 0.001 to 10.000 Hz | 4 | o | 2 | o | o | x | x |
| A14 | 50Eh | ( h) | | M2-Iron loss coefficient 1 | 0.00 to 10.00 % | 3 | o | 2 | o | o | x | x |
| A15 | 50Fh | ( h) | | M2-Iron loss coefficient 2 | 0.00 to 10.00 % | 3 | o | 2 | o | o | x | x |
| A16 | 510h | ( h) | | M2-Iron loss coefficient 3 | 0.00 to 10.00 % | 3 | o | 2 | o | o | x | x |
| A17 | 511h | ( h) | | M2-Magnetic saturation coefficient 1 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| A18 | 512h | ( h) | | M2-Magnetic saturation coefficient 2 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| A19 | 513h | ( h) | | M2-Magnetic saturation coefficient 3 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| A20 | 514h | ( h) | | M2-Magnetic saturation coefficient 4 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| A21 | 515h | ( h) | | M2-Magnetic saturation coefficient 5 | 0.0 to 100.0 % | 2 | o | 2 | o | o | x | x |
| A22 | 516h | ( h) | | M2-Secondary time constant | 0.001 to 9.999 s | 4 | o | 2 | o | o | x | x |
| A23 | 517h | ( h) | | M2-Induced voltage coefficient | 0 to 999 V | 0 | o | 2 | o | o | x | x |
| A24 | 518h | ( h) | | M2-R2 correction coefficient 1 | 0.000 to 5.000 | 4 | o | 2 | o | o | x | x |
| A25 | 519h | ( h) | | M2-R2 correction coefficient 2 | 0.000 to 5.000 | 4 | o | 2 | o | o | x | x |
| A26 | 51Ah | ( h) | | M2-R2 correction coefficient 3 | 0.010 to 5.000 | 4 | o | 2 | o | o | x | x |
| A27 | 51Bh | ( h) | | M2-Exciting current correction coefficient | 0.000 to 5.000 | 4 | o | 2 | o | o | x | x |
| A28 | 51Ch | ( h) | | M2-ACR-P gain | 0.1 to 1.0 to 20.0 | 2 | o | 2 | o | o | x | x |
| A29 | 51Dh | ( h) | | M2-ACR-I gain | 0.5 to 1.0 to 100.0 ms | 2 | o | 2 | o | o | x | x |
| A30 | 51Eh | ( h) | M2-PG pulses | | 100 to 1024 to 60000 | 0 | o | 2 | o | x | x | x |
| A31 | 51Fh | ( h) | M2-thermistor selection | | 0 to 1 to 3<br>0 : No use thermistor<br>1 : NTC thermistor<br>2 : PTC thermistor<br>3 : Ai (M-TMP)<br>Please do the protection level setting of the motor at E30-E32. | 84 | o | 2 | o | o | x | x |
| A32 | 520h | ( h) | M2-Electronic thermal overload relay (selection) | M2-Electronic thermal overload relay (Selection) | 0 to 2<br>The motor overheating protection operates by using NTC thermistor with the motor only for VG. In this case, please make setting a Electronic thermal "Inactive".<br>0 : Inactive<br>1 : Active (for standard motor, self-cooling fan)<br>2 : Active (for inverter motor, separate cooling fan) | 85 | o | 2 | o | o | x | x |
| A33 | 521h | ( h) | | M2-Electronic thermal overload relay (Level) | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | o | o | x | x |
| A34 | 522h | ( h) | | M2-Electronic thermal overload relay (Thermal time constant) | 0.5 to 75.0 min | 2 | o | 2 | o | o | x | x |
| A35 | 523h | 229( E5 h) | Setting M3 parameter for V/F control motor | M3-Rated capacity | 0.00 to 500.00kW at F60=0<br>0.00 to 600.00HP at F60=1 | 3 | o | 2 | x | x | o | x |
| A36 | 524h | 230( E6 h) | | M3-Rated current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | x | x | o | x |
| A37 | 525h | 231( E7 h) | | M3-Rated voltage | 80 to 999 V | 0 | o | 2 | x | x | o | x |
| A38 | 526h | 232( E8 h) | | M3-Maximum voltage | 80 to 999 V | 0 | o | 2 | x | x | o | x |
| A39 | 527h | 233( E9 h) | | M3-Rated speed | 50 to 1500 to 24000 r/min | 0 | o | 2 | x | x | o | x |
| A40 | 528h | 234( EA h) | | M3-Maximum speed | 50 to 1500 to 24000 r/min | 0 | o | 2 | x | x | o | x |
| A41 | 529h | 235( EB h) | | M3-Poles | 2 to 4 to 12 (poles) | 1 | o | 2 | x | x | o | x |
| A42 | 52Ah | 236( EC h) | | M3-%R1 | 0.00 to 30.00 % | 3 | o | 2 | x | x | o | x |
| A43 | 52Bh | 237( ED h) | | M3-%X | 0.00 to 30.00 % | 3 | o | 2 | x | x | o | x |
| A44 | 52Ch | 238( EE h) | | M3-Exciting current | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | x | x | o | x |
| A45 | 52Dh | 239( EF h) | | M3-Slip compensation control | -20.000 to 0.000 to 5.000 Hz | 8 | o | 2 | x | x | o | x |
| A46 | 52Eh | 240( F0 h) | M3-Torque boost | | 0.0 to 20.0<br>0.0 : Automatic torque boost (for CT load)<br>0.1 to 0.9 : Manual torque boost (for Square torque load)<br>1.0 to 1.9 : Manual torque boost (for VT load)<br>2.0 to 20.0 : Manual torque boost (for CT load) | 2 | o | 2 | x | x | o | x |
| A47 | 52Fh | 241( F1 h) | M3-Thermistor selection | | 0 to 1 to 3<br>0 : No use thermistor<br>1 : NTC thermistor<br>2 : PTC thermistor<br>3 : Ai (M-TMP)<br>Please do the protection level setting of the motor at E30-E37. | 84 | o | 2 | x | x | o | x |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| A48 | 530h | 242( F2 h) | M3-Electronic thermal overload relay (selection) | M3-Electronic thermal overload relay (Selection) | 0 to 2<br>0 : Inactive (when using PTC thermistor)<br>1 : Active (for standard motor, self-cooling fan)<br>2 : Active (for inverter motor, separate-cooling fan) | 85 | o | 2 | x | x | o | x |
| A49 | 531h | 243( F3 h) | | M3-Electronic thermal overload relay (Level) | 0.01 to 99.99A<br>100.0 to 999.9A<br>1000 to 2000A | 13 | o | 2 | x | x | o | x |
| A50 | 532h | 244( F4 h) | | M3-Electronic thermal overload relay (Thermal time constant) | 0.5 to 75.0 min | 2 | o | 2 | x | x | o | x |

You can change the setting of a function indicated by ▒ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

## O: Optional Functions

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| o01 | 601h | 245( F5 h) | DIA , DIB option setting | DIA function select | 0 to 1<br>0 : Binary<br>1 : BCD | 86 | o | 1 | o | o | o | o |
| o02 | 602h | 246( F6 h) | | DIB function select | 0 to 1<br>0 : Binary<br>1 : BCD | 86 | o | 1 | o | o | o | o |
| o03 | 603h | ( h) | | DIA BCD input speed setting | 99 to 1000 to 7999 | 0 | o | 1 | o | o | o | o |
| o04 | 604h | ( h) | | DIB BCD input speed setting | 99 to 1000 to 7999 | 0 | o | 1 | o | o | o | o |
| o05 | 605h | ( h) | PG (PD) option setting | Pulse feedback select | 0 to 1<br>0 : Build-in PG<br>1 : PG(PD) option | 96 | o | 1 | o | x | x | o |
| o06 | 606h | ( h) | PG (LD) option setting | Line speed detection (digital) (PG pulses) | 100 to 1024 to 60000 (P/R) | 0 | o | 1 | o | o | x | o |
| o07 | 607h | ( h) | | Line speed detection (digital) (Pulse correction function 1) | 0 to 1000 to 9999 | 0 | o | 1 | o | o | x | o |
| o08 | 608h | ( h) | | Line speed detection (digital) (Pulse correction function 2) | 0 to 1000 to 9999 | 0 | o | 1 | o | o | x | o |
| o09 | 609h | ( h) | PMPG option setting | Definition of absolute PG signal input | 0 to 16 | 0 | o | 1 | x | x | x | o |
| o10 | 60Ah | ( h) | | Magnetic pole position offset | 0000 to 03FF | 9 | o | 1 | x | x | x | o |
| o11 | 60Bh | ( h) | | Salient pole ratio | 1.000 to 3.000 | 4 | o | 1 | x | x | x | o |
| o12 | 60Ch | ( h) | PG (PR) pulse-string option setting | Pulse reference select | 0 to 1<br>0 : PG(PR) option<br>1 : Internal input | 97 | o | 1 | o | x | x | o |
| o13 | 60Dh | ( h) | | Pulse train input form selection | 0 to 2<br>0 : Phase difference 90° between A-phase and B-phase<br>1 : A-phase : Reference pulse, B-phase : Reference sign<br>2 : A-phase : Forward pulse, B-phase : Reverse pulse | 98 | o | 1 | o | x | x | o |
| o14 | 60Eh | 247( F7 h) | | Reference pulse correction 1 | 0 to 1000 to 9999 | 0 | o | 1 | o | x | x | o |
| o15 | 60Fh | 248( F8 h) | | Reference pulse correction 2 | 0 to 1000 to 9999 | 0 | o | 1 | o | x | x | o |
| o16 | 610h | 249( F9 h) | | APR P-gain | 0.0 to 10.0 to 999.9 (times) | 2 | o | 1 | o | x | x | o |
| o17 | 611h | 250( FA h) | | Feed forward gain | 0.0 to 1.5 (times) | 2 | o | 1 | o | x | x | o |
| o18 | 612h | ( h) | | Deviation over width | 0 to 65535 (pulse) | 0 | o | 1 | o | x | x | o |
| o19 | 613h | ( h) | | Deviation zero width | 0 to 20 to 1000 (pulse) | 0 | o | 1 | o | x | x | o |
| o30 | 61Eh | ( h) | Field option setting | Action on communication error | 0 to 3<br>0: Forced stop<br>1: Stops after preset operation time.<br>2: Stops if transmission error continues longer than the operation time.<br>3 : Continuous operation. | 73 | o | 1 | o | o | o | o |
| o31 | 61Fh | ( h) | | LINK error (Timer) | 0.01 to 0.10 to 20.00 s | 3 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▒ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12. Function Code List

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| o32 | 620h | ( h) | | LINK format select | 0 to 1<br>0 : 4W + 4W<br>1 : 8W + 8W | 87 | o | 2 | o | o | o | o |
| o33 | 621h | 253( FD h) | SI (MWS) option setting | Multi-winding motor system (mode) | 0 to 1<br>0 : Inactive<br>1 : Active | 68 | o | 1 | o | o | x | o |
| o34 | 622h | ( h) | | Multi-winding motor system (Slave station number) | 1 to 5<br>The numbers of slave units except master unit are set when multi-winding motor system is effective. | 0 | o | 1 | o | o | x | o |
| o35 | 623h | ( h) | SI (UPAC) option setting | SI PARA1 | 0000 to FFFF | 9 | o | 1 | o | o | o | o |
| o36 | 624h | ( h) | | SI PARA2 | 0000 to FFFF | 9 | o | 1 | o | o | o | o |
| o37 | 625h | ( h) | | SI PARA3 | 0000 to FFFF | 9 | o | 1 | o | o | o | o |
| o38 | 626h | ( h) | UPAC (Mode) | UPAC (Start/stop) | 0 to 2<br>0 : Stop UPAC<br>1 : Start UPAC<br>2 : Start UPAC (Intialized start)<br>Definition whether the instruction data from UPAC option is made active or inactive. | 68 | o | 1 | o | o | o | o |
| o39 | 627h | ( h) | | UPAC memory | 0000 to 001F<br>When the UPAC stop is changed, a pertinent field is set.<br>0 : Hold<br>1 : zero clear<br>1bit : IQ field<br>2bit : M field<br>3bit : RM field<br>4bit : FM field<br>5bit : SFM field | 9 | o | 1 | o | o | o | o |
| o40 | 628h | ( h) | | UPAC address | 100 to 255<br>Setting of UPAC address number in which RS485 communication is used when personal-computer accesses UPAC application. | 0 | o | 2 | o | o | o | o |
| o41 | 629h | ( h) | | UPAC slave station number | 0 to 11<br>Number of slave station inverters when two or more inverters are driven by using SI option communication as master inverter equipped with UPAC option. | 0 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

## L: Lift Functions

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| L01 | 901h | ( h) | Password data 1 | | 0 to 9999 | 0 | o | 2 | o | o | x | o |
| L02 | 902h | ( h) | Password data 2 | | 0 to 9999 | 0 | o | 2 | o | o | x | o |
| L03 | 903h | ( h) | Lift rated speed | | 0.0 to 100.0 to 999.9 m/min | 2 | o | 1 | o | o | x | o |
| L04 | 904h | ( h) | Preset S-curve (selection) | Preset S-curve | 0 to 2<br>0 : Inactive<br><Normal accel/decel, S-curve (15 steps, S-curve 5)><br>1 : Method 1<br>For VG3/VG5. accel/decel can be controlled via terminal 12 with SS1, SS2, and SS4 all OFF.<br>2 : Method 2<br>For VG7. zero speed is selected with SS1, SS2, and SS4 all OFF. | 80 | o | 1 | o | o | x | o |
| L05 | 905h | ( h) | | S-curve 1 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L06 | 906h | ( h) | | S-curve 2 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L07 | 907h | ( h) | | S-curve 3 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L08 | 908h | ( h) | | S-curve 4 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L09 | 909h | ( h) | | S-curve 5 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L10 | 90Ah | ( h) | | S-curve 6 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L11 | 90Bh | ( h) | | S-curve 7 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L12 | 90Ch | ( h) | | S-curve 8 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L13 | 90Dh | ( h) | | S-curve 9 | 0 to 50 % | 0 | o | 1 | o | o | x | o |
| L14 | 90Eh | ( h) | | S-curve 10 | 0 to 50 % | 0 | o | 1 | o | o | x | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

## U: User Functions

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| U01 | B01h | 219( DB h) | USER P1 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U02 | B02h | 220( DC h) | USER P2 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U03 | B03h | 221( DD h) | USER P3 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U04 | B04h | 222( DE h) | USER P4 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U05 | B05h | 223( DF h) | USER P5 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U06 | B06h | 224( E0 h) | USER P6 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U07 | B07h | 225( E1 h) | USER P7 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U08 | B08h | 226( E2 h) | USER P8 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U09 | B09h | 227( E3 h) | USER P9 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U10 | B0Ah | 228( E4 h) | USER P10 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U11 | B0Bh | ( h) | USER P11 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U12 | B0Ch | ( h) | USER P12 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U13 | B0Dh | ( h) | USER P13 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U14 | B0Eh | ( h) | USER P14 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U15 | B0Fh | ( h) | USER P15 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U16 | B10h | ( h) | USER P16 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U17 | B11h | ( h) | USER P17 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U18 | B12h | ( h) | USER P18 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U19 | B13h | ( h) | USER P19 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U20 | B14h | ( h) | USER P20 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U21 | B15h | ( h) | USER P21 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U22 | B16h | ( h) | USER P22 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U23 | B17h | ( h) | USER P23 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U24 | B18h | ( h) | USER P24 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U25 | B19h | ( h) | USER P25 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U26 | B1Ah | ( h) | USER P26 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U27 | B1Bh | ( h) | USER P27 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U28 | B1Ch | ( h) | USER P28 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U29 | B1Dh | ( h) | USER P29 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U30 | B1Eh | ( h) | USER P30 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U31 | B1Fh | ( h) | USER P31 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U32 | B20h | ( h) | USER P32 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U33 | B21h | ( h) | USER P33 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U34 | B22h | ( h) | USER P34 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U35 | B23h | ( h) | USER P35 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U36 | B24h | ( h) | USER P36 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U37 | B25h | ( h) | USER P37 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U38 | B26h | ( h) | USER P38 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U39 | B27h | ( h) | USER P39 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U40 | B28h | ( h) | USER P40 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U41 | B29h | ( h) | USER P41 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U42 | B2Ah | ( h) | USER P42 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U43 | B2Bh | ( h) | USER P43 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U44 | B2Ch | ( h) | USER P44 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U45 | B2Dh | ( h) | USER P45 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

| Fcode | Communication address | | Function name | Function directory name | Setting range | Type | Copy | Initialization | Control type: Available/ Not available | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | | | PG | LES | VF | SM |
| U46 | B2Eh | ( h) | USER P46 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U47 | B2Fh | ( h) | USER P47 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U48 | B30h | ( h) | USER P48 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U49 | B31h | ( h) | USER P49 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U50 | B32h | ( h) | USER P50 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U51 | B33h | ( h) | USER P51 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U52 | B34h | ( h) | USER P52 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U53 | B35h | ( h) | USER P53 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U54 | B36h | ( h) | USER P54 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U55 | B37h | ( h) | USER P55 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U56 | B38h | ( h) | USER P56 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U57 | B39h | ( h) | USER P57 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U58 | B3Ah | ( h) | USER P58 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U59 | B3Bh | ( h) | USER P59 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U60 | B3Ch | ( h) | USER P60 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U61 | B3Dh | ( h) | USER P61 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U62 | B3Eh | ( h) | USER P62 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U63 | B3Fh | ( h) | USER P63 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |
| U64 | B40h | ( h) | USER P64 | | -32768 to 32767 | 5 | o | 1 | o | o | o | o |

You can change the setting of a function indicated by ▭ during operation.
You should stop operation to change the setting of other functions.

Underline indicates a factory setting.

# 12.3 Function Code List Dedicated for Communication

You can refer to or change the following functions only through the integrated RS485 or the field bus options (T-Link, SX, field bus). The S area is write-only and the M area is read-only. The S and the M areas are common to FUJI inverters. Any FUJI inverters that you can link to communication system can use these areas.
See 12.4 "Data Format List" to refer to or change a function code after you check the "Type" column of the function code in the list.

## 12.3.1 S Function Code

This is a write-only area. You should use the function code H30 "Serial link" to initialize. See the function description of H30 for more details.

| Fcode | Communication address | | Function code name | Setting range | Min increment | Unit | Type |
|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | |
| S01 | 701h | 1( 1 h) | Frequency/speed reference (Setting 1) | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| S02 | 702h | 2( 2 h) | Torque reference | 0.01% / 1d | 0.01 | % | 7 |
| S03 | 703h | 3( 3 h) | Torque current reference | 0.01% / 1d | 0.01 | % | 7 |
| S04 | 704h | 4( 4 h) | Magnetic-flux reference | 0.01% / 1d | 0.01 | % | 7 |
| S05 | 705h | 5( 5 h) | Orientation position reference | 0000 to FFFF | 1 | - | 9 |
| S06 | 706h | 6( 6 h) | Operation method 1 | 0000 to FFFF | 1 | - | 32 |
| S07 | 707h | 7( 7 h) | Universal Do | 0000 to FFFF | 1 | - | 33 |
| S08 | 708h | 8( 8 h) | Acceleration time | 0.0 to 3600.0 s | 0.1 | s | 2 |
| S09 | 709h | 9( 9 h) | Deceleration time | 0.0 to 3600.0 s | 0.1 | s | 2 |
| S10 | 70Ah | 10( A h) | Torque limiter level 1 | 0.01% / 1d | 0.01 | % | 7 |
| S11 | 70Bh | 11( B h) | Torque limiter level 2 | 0.01% / 1d | 0.01 | % | 7 |
| S12 | 70Ch | 12( C h) | Operation method 2 | 0000 to FFFF | 1 | - | 9 |

## 12.3.2 M Function Code

This is a read-only area. You can always access this area without any restrictions.

| Fcode | Communication address | | Function code name | Setting range | Min increment | Unit | Type |
|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | |
| M01 | 801h | 15( F h) | Speed setting 4 (ASR input) | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M02 | 802h | 16( 10 h) | Torque reference | 0.01% / 1d | 0.01 | % | 7 |
| M03 | 803h | 17( 11 h) | Toque current reference | 0.01% / 1d | 0.01 | % | 7 |
| M04 | 804h | 18( 12 h) | Magnetic-flux reference | 0.01% / 1d | 0.01 | % | 7 |
| M05 | 805h | 19( 13 h) | Output frequency reference | 0.1Hz / 1d | 0.1 | Hz | 2 |
| M06 | 806h | 20( 14 h) | Detected speed value | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M07 | 807h | 21( 15 h) | Calculated torque value | 0.01% / 1d | 0.01 | % | 7 |
| M08 | 808h | 22( 16 h) | Calculated torque current value | 0.01% / 1d | 0.01 | % | 7 |
| M09 | 809h | 23( 17 h) | Output frequency | 0.1Hz / 1d | 0.1 | Hz | 2 |
| M10 | 80Ah | 24( 18 h) | Motor output | 0.1kW / 1d | 0.1 | kW | 2 |
| M11 | 80Bh | 25( 19 h) | Output current rms value | 0.1A / 1d | 0.1 | A | 2 |
| M12 | 80Ch | 26( 1A h) | Output voltage rms value | 0.1V / 1d | 0.1 | V | 2 |

# 12. Function Code List

| Fcode | Communication address | | Function code name | Setting range | Min increment | Unit | Type |
|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | |
| M13 | 80Dh | 27( 1B h) | Operation method (final command) | 0000 to FFFF | 1 | - | 32 |
| M14 | 80Eh | 28( 1C h) | Operation status | 0000 to FFFF | 1 | - | 21 |
| M15 | 80Fh | 29( 1D h) | Output terminals Y1 - Y18 | 0000 to FFFF | 1 | - | 33 |
| M16 | 810h | 30( 1E h) | Latest alarm data | 0 to 48 | 1 | - | 14 |
| M17 | 811h | 31( 1F h) | Last alarm data | 0 to 48 | 1 | - | 15 |
| M18 | 812h | 32( 20 h) | Second last alarm data | 0 to 48 | 1 | - | 15 |
| M19 | 813h | 33( 21 h) | Third last alarm data | 0 to 48 | 1 | - | 15 |
| M20 | 814h | 34( 22 h) | Accumulated operation time | 0 to 65535 h | 1 | h | 0 |
| M21 | 815h | 35( 23 h) | DC link circuit voltage | 1V / 1d | 1 | V | 0 |
| M22 | 816h | 36( 24 h) | Motor temperature | 1°C / 1d | 1 | °C | 5 |
| M23 | 817h | 37( 25 h) | Type code | 0000 to FFFF | 1 | - | 29 |
| M24 | 818h | 38( 26 h) | Capacity code | 0 to 29 | 1 | - | 28 |
| M25 | 819h | 39( 27 h) | Inverter ROM (main control) version | 0000 to FFFF | 1 | - | 9 |
| M26 | 81Ah | 40( 28 h) | Communication error code | 0 to 65535 | 1 | - | 34 |
| M27 | 81Bh | 41( 29 h) | Speed setting on alarm | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M28 | 81Ch | 42( 2A h) | Torque reterence on alarm | 0.01% / 1d | 0.01 | % | 7 |
| M29 | 81Dh | 43( 2B h) | Torque current reference on alarm | 0.01% / 1d | 0.01 | % | 7 |
| M30 | 81Eh | 44( 2C h) | Magnetic-flux reference on alarm | 0.01% / 1d | 0.01 | % | 3 |
| M31 | 81Fh | 45( 2D h) | Output frequency reference on alarm | 0.1Hz / 1d | 0.1 | Hz | 2 |
| M32 | 820h | 46( 2E h) | Detected speed on alarm | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M33 | 821h | 47( 2F h) | Calculated torque on alarm | 0.01% / 1d | 0.01 | % | 7 |
| M34 | 822h | 48( 30 h) | Calculated torque current on alarm | 0.01% / 1d | 0.01 | % | 7 |
| M35 | 823h | 49( 31 h) | Output frequency on alarm | 0.1Hz / 1d | 0.1 | Hz | 2 |
| M36 | 824h | 50( 32 h) | Motor output on alarm | 0.1kW / 1d | 0.1 | kW | 2 |
| M37 | 825h | 51( 33 h) | Output current rms value on alarm | 0.1A / 1d | 0.1 | A | 2 |
| M38 | 826h | 52( 34 h) | Output voltage rms value on alarm | 0.1V / 1d | 0.1 | V | 2 |
| M39 | 827h | 53( 35 h) | Operation method on alarm | 0000 to FFFF | 1 | - | 32 |
| M40 | 828h | 54( 36 h) | Operation status on alarm | 0000 to FFFF | 1 | - | 21 |
| M41 | 829h | 55( 37 h) | Output terminal on alarm | 0000 to FFFF | 1 | - | 33 |
| M42 | 82Ah | 56( 38 h) | Accumulated operation time on alarm | 0 to 65535 h | 1 | h | 0 |
| M43 | 82Bh | 57( 39 h) | DC link circuit voltage on alarm | 0.1V / 1d | 0.1 | V | 2 |
| M44 | 82Ch | 58( 3A h) | Inverter intemal temperature on alarm | 1°C / 1d | 1 | °C | 6 |
| M45 | 82Dh | 59( 3B h) | Heat sink temperature on alarm | 1°C / 1d | 1 | °C | 6 |
| M46 | 82Eh | 60( 3C h) | Main circuit capacitor capacity | 0 to 100 % | 1 | % | 0 |

| Fcode | Communication address | | Function code name | Setting range | Min increment | Unit | Type |
|---|---|---|---|---|---|---|---|
| | 485 number | Link number | | | | | |
| M47 | 82Fh | 61( 3D h) | PC board capacitor life on alarm | 0 to 65535 h | 1 | h | 0 |
| M48 | 830h | 62( 3E h) | Cooling fan life | 0 to 65535 h | 1 | h | 0 |
| M49 | 831h | 63( 3F h) | Speed setting 1 (before multistep speed | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M50 | 832h | 64( 40 h) | Speed setting 2 (before calculation of accel/decel.) | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M51 | 833h | 65( 41 h) | Speed setting 3 (after speed limit) | -24000 to 24000 r/min : (data)*Nmax/20000 | 1 | r/min | 31 |
| M52 | 834h | 66( 42 h) | Control output 1 | 0000 to FFFF | 1 | - | 125 |
| M53 | 835h | 67( 43 h) | Control output 2 | 0000 to FFFF | 1 | - | 126 |
| M54 | 836h | 68( 44 h) | Control output 3 | 0000 to FFFF | 1 | - | 127 |
| M55 | 837h | 69( 45 h) | Option monitor 1 | 0000 to FFFF | 1 | - | 9 |
| M56 | 838h | 70( 46 h) | Option monitor 2 | 0000 to FFFF | 1 | - | 9 |
| M57 | 839h | 71( 47 h) | Option monitor 3 | 0 to 65535 | 1 | - | 0 |
| M58 | 83Ah | 72( 48 h) | Option monitor 4 | 0 to 65535 | 1 | - | 0 |
| M59 | 83Bh | 73( 49 h) | Option monitor 5 | -32768 to 32767 | 1 | - | 5 |
| M60 | 83Ch | 74( 4A h) | Option monitor 6 | -32768 to 32767 | 1 | - | 5 |

## 12.4 Data Format List

You can use the following formats to access function codes through the link and these formats are common to the FRENICS500VG7S models.

### 12.4.1 Data Type 0 to 13

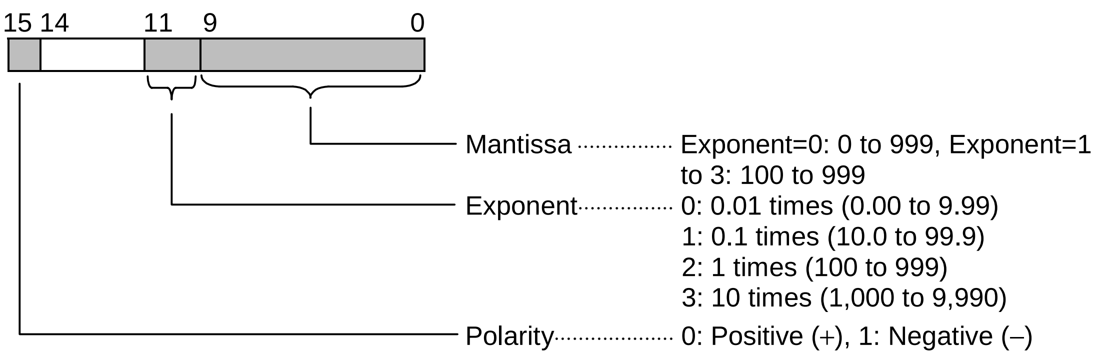
You can basically exchange data in the data types from 0 to 13.

| Code | Description | Display/setting | Resolution | Notes |
|---|---|---|---|---|
| 0 | Integer | 0, 1, 2, 3, …… | 1 | |
| 1 | Integer | 0, 2, 4, 6, …… | 2 | Only for pole number of motor |
| 2 | Fixed point | 0.0, 0.1, 0.2, …… | 0.1 | |
| 3 | | 0.00, 0.01, 0.02, …… | 0.01 | |
| 4 | | 0.001, 0.002, 0.003, …… | 0.001 | |
| 5 | Integer (signed) | -2, -1, 0, 1, 2, …… | 1 | |
| 6 | Fixed point (signed) | -0.1, 0.0, 0.1, …… | 0.1 | |
| 7 | | -0.01, 0.00, 0,01, …… | 0.01 | |
| 8 | | -0.001, 0.000, 0.001, …… | 0.001 | |
| 9 | Hexadecimal | 1A8E | 1h | Initial cursor position is left end. Cursor does not move automatically. When setting range is from 00 to 11, you should specify individual digits to set only 00, 01, 10, or 11. |
| 10 | Special data 3 | 0.75, 1, 2, …… 14, 15 | | Carrier frequency setting |
| 11 | Operation data | | 1 | Reset to 0 after writing |
| 12 | Exponent/mantissa 1 | | 0.01 | See 12.4.2 "Data Type 12 to 34" |
| 13 | Exponent/mantissa 2 | | 0.01 | |

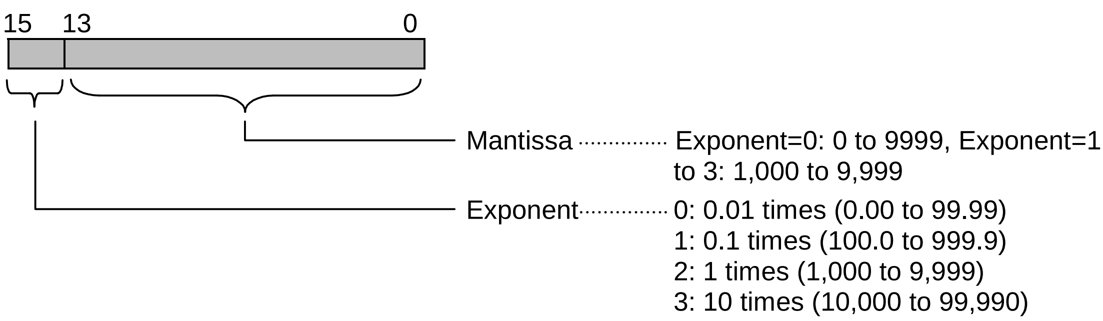
### 12.4.2 Data Type 12 to 34

The following data have special formats.

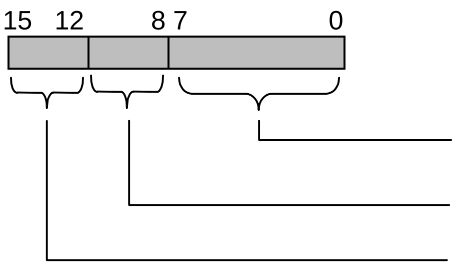
(1) Type [12]: Time, current, power, PID process values




(2) Type [13]: Current and others



(3) Type [14]: Cause of alarm




Alarm code·····································0 to 48

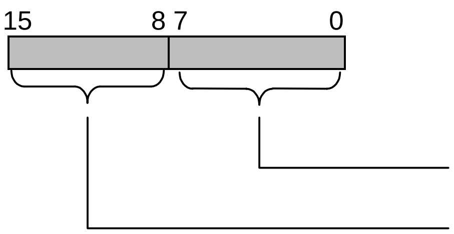
Order of alarm occurrence ············1st to 5th

Number of alarms····························1 to 5

Alarm codes

| Code | Display | Description | Code | Display | Description | Code | Display | Description |
|---|---|---|---|---|---|---|---|---|
| 0 | --- | No alarm | 17 | Lin | Input phase loss | 34 | Ar1 | Error code 1 for specific user application |
| 1 | CnU | Converter error | 18 | LU | Undervoltage | 35 | Ar2 | Error code 2 for specific user application |
| 2 | dbH | DB resistor overheating | 19 | nrb | NTC thermistor disconnection | 36 | Ar3 | Error code 3 for specific user application |
| 3 | dCF | DC fuse blown | 20 | OC | Overcurrent | 37 | Ar4 | Error code 4 for specific user application |
| 4 | dO | Excessive position deviation | 21 | OH1 | Overheating at heat sink | 38 | Ar5 | Error code 5 for specific user application |
| 5 | EF | Ground fault | 22 | OH2 | External alarm | 39 | Ar6 | Error code 6 for specific user application |
| 6 | Er1 | Memory error | 23 | OH3 | Inverter internal overheat | 40 | Ar7 | Error code 7 for specific user application |
| 7 | Er2 | KEYPAD panel communication error | 24 | OH4 | Motor overheat | 41 | Ar8 | Error code 8 for specific user application |
| 8 | Er3 | CPU error | 25 | OL1 | Motor 1 overload | 42 | Ar9 | Error code 9 for specific user application |
| 9 | Er4 | Network error | 26 | OL2 | Motor 2 overload | 43 | ArA | Error code A for specific user application |
| 10 | Er5 | RS485 communication error | 27 | OL3 | Motor 3 overload | 44 | ArB | Error code B for specific user application |
| 11 | Er6 | Operation procedure error | 28 | OLU | Inverter unit overload | 45 | ArC | Error code C for specific user application |
| 12 | Er7 | Output wiring error | 29 | OS | Overspeed | 46 | ArD | Error code D for specific user application |
| 13 | Er8 | A/D converter error | 30 | OU | Overvoltage | 47 | ArE | Error code E for specific user application |
| 14 | Er9 | Speed disagreement | 31 | PbF | Charging circuit error | 48 | ArF | Error code F for specific user application |
| 15 | ErA | UPAC error | 32 | P9 | PG error | | | |
| 16 | Erb | Inter-inverter communication error | 33 | Ar0 | Error code 0 for specific user application | | | |

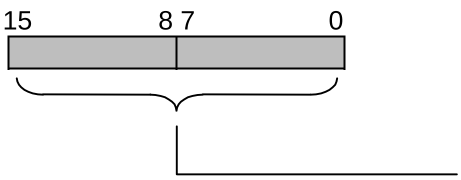
(4) Type [15]: Alarm history




Alarm code···························0 to 32 (See "Type [14]")

Number of the occurrence of the same alarm
················0 to 255

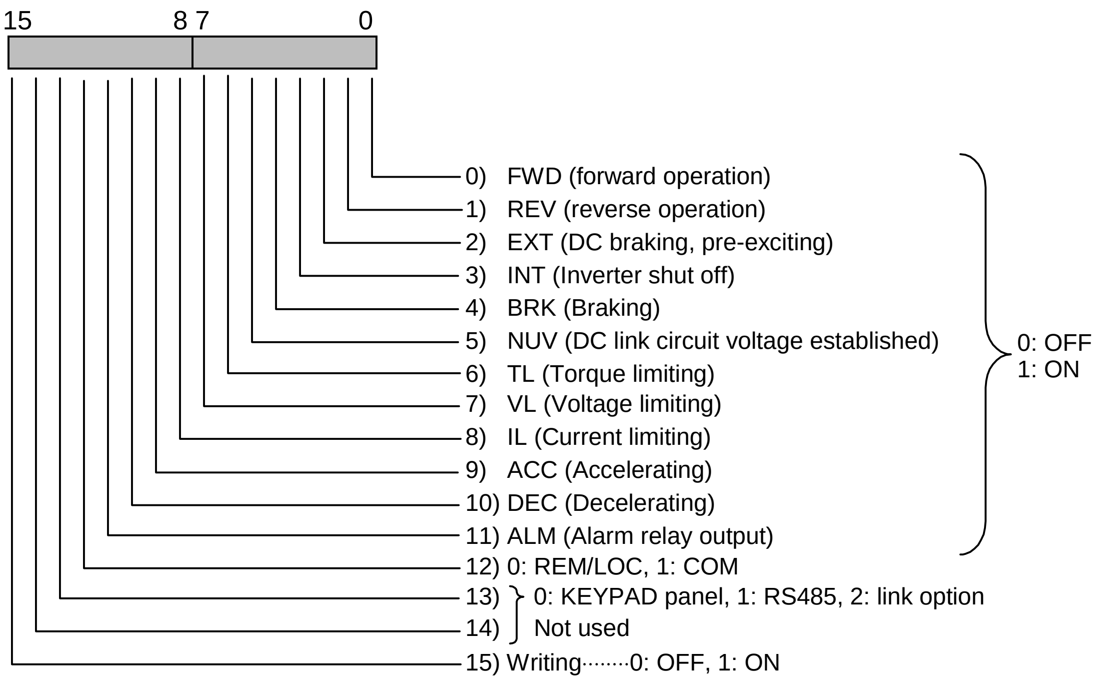
(5) Type [16]: Percentage



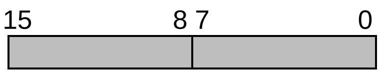

Percentage·········–300% to 300% (–30,000 to 30,000)
Decimal places are not displayed.

# 12. Function Code List

(6) Type [21]: Operation status




(7) Type [22]: DIA, DIB input information




16-bit terminal input information: 0000 to FFFF

- Option installation information is available from the option information.

(8) Type [28]: Inverter capacity

| Code | Inverter capacity | Code | Inverter capacity | Code | Inverter capacity | Code | Inverter capacity |
|---|---|---|---|---|---|---|---|
| 0 | 0.05 | 8 | 5.5 | 16 | 45 | 24 | 220 |
| 1 | 0.1 | 9 | 7.5 | 17 | 55 | 25 | 250 |
| 2 | 0.2 | 10 | 11 | 18 | 75 | 26 | 280 |
| 3 | 0.4 | 11 | 15 | 19 | 90 | 27 | 315 |
| 4 | 0.75 | 12 | 18.5 | 20 | 110 | 28 | 355 |
| 5 | 1.5 | 13 | 22 | 21 | 132 | 29 | 400 |
| 6 | 2.2 | 14 | 30 | 22 | 160 | | |
| 7 | 3.7 | 15 | 37 | 23 | 200 | | |

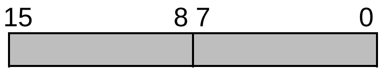
(9) Type [29]: Inverter model (common to entire FUJI inverter system)

The number is fixed to 1213h or 1214h for the VG inverters.

200V system: fixed to 1213h
400V system: fixed to 1214h

| Code | Model | | Development code | | Series | | Voltage | |
|---|---|---|---|---|---|---|---|---|
| | Division | Display | Division | Display | Division | Display | Division | Display |
| 0 | - | | - | | - | | - | |
| 1 | VG | VG | 11 series | 11 | Standard for domestic | | Single-phase 100V | 6 |
| 2 | G | G | 7 series | 7 | Standard for Asia | | Single-phase 200V | 7 |
| 3 | P | P | | | Standard for China | | Three-phase 200V | 2 |
| 4 | E | E | | | Standard for Europe | | Three-phase 400V | 4 |
| 5 | C | C | | | Standard for USA | | Three-phase 575V | 5 |
| 6 | S | S | | | | | | |

(10) Type [31]: Speed




Data (0 to ±20,000) → (0 to ±12,000 × r/min) : (Data) × Nmax/20,000 conversion

(Example) When the maximum speed is Nmax=1,500r/min,

- If you want to direct a speed reference of 1,000r/min,

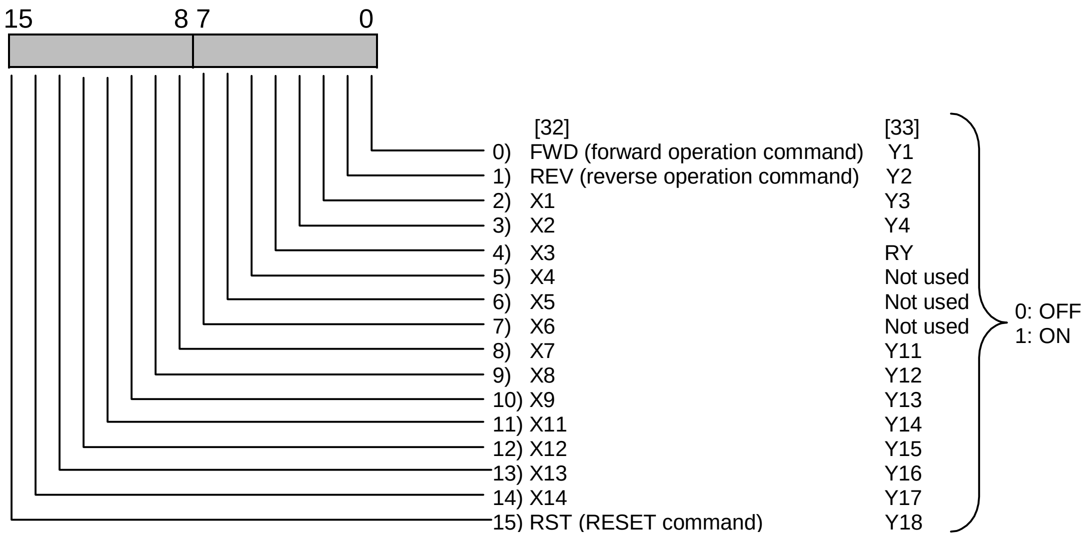
  Specify a data of $\frac{1,000}{1,500} \times 20,000 \rightarrow 13,333$.

- If the read out data is 3,500,

  You can determine the speed is $\frac{1,500}{20,000} \times 3,500 \rightarrow 262.5$r/min.

(11) Type [32]: Operation commands, [33]: Y1 to Y18

This type is the same as S06 and S07.



# 12. Function Code List

(12) Type [34]: Communication error codes

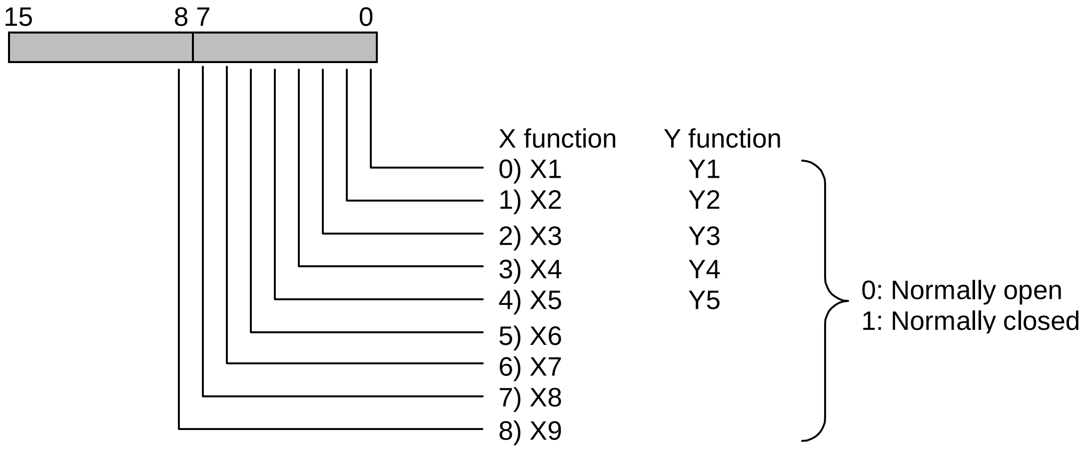
| 15 | 8 | 7 | 0 |
|---|---|---|---|
| | | | |

Description of alarms in the communication through the link (RS485, T-Link, field bus). The following data is set to the monitor data M26 according to the communication status. The codes listed in the column "KEYPAD panel display" is displayed on the KEYPAD panel as a communication error .

| Code | KEYPAD panel display | Communication error name | Description | |
|---|---|---|---|---|
| 0 | - | No communication error | 1 Normal communication<br>2 A data is written to an unused address of the function code (writing to address out of the specified range is defined separately).<br>3 A data is read from an unused address. The data will be "0000".<br>4 Writing to the S area while link operation is disabled. The data will not be reflected and cause no error.<br>5 A data out of range is written to the S area. The data is written after adjusted to the upper or the lower limit.<br>6 Access from another link or the KEYPAD panel occurs during data writing (EEPROM other than the S area is accessed).<br>7 Writing to operation data (such as tuning or initialization) during multiple function codes are being written once through the link. The inverter decides that the procedure is canceled and continues the writing.<br>8 Writing to/reading from option function codes that are not displayed on the KEYPAD panel. | |
| 1 to 32 | - | Alarm codes specific to the VG7S | Alarm codes specific to models other than communication errors. | |
| 33 to 70 | - | Not used | | |
| 71 | - | Checksum error, CRC error | Software error | Checksum value or CRC value does not match. |
| 72 | - | Parity error | Hardware error | Parity does not match. |
| 73 | - | Others (such as overrun, framing) | | Physical (reception) errors other than above. |
| 74 | 01 | Format error | Incorrect format.<br>Characters requesting transmission are incorrect. Characters terminating transmission are not in the specified order. | |
| 75 | 01 | Command error | Codes other than the specified commands are transmitted. | |
| 76 | 07 | Link priority error | 1 Writing to the S area through RS485 while a link option is installed.<br>2 Writing to the S area through a link with lower priority while multiple link options are installed. | |
| 77 | 07 | No right to write function code data | Not used for VG7S | |
| 78 | 02 | Function code error | 1 Access to a data out of the address range of the function codes (such as access to a data over F80).<br>2 Writing data over 16 words. | |
| 79 | 07 | Error on writing to write-disabled data | 1 Write-disabled function codes (Read-only data or the M area).<br>2 Function codes write-disabled during operation.<br>3 Writing through the link to data out of the S area in "write-disabled through link" mode. Note that F00 or "Write enable for KEYPAD" cannot protect from writing through the link.<br>4 Function codes that cannot be written through the link (link function codes: H31 to 40, o5x, o6x, and o8x).<br>5 Writing to M1 function code (P) area when motor parameters are protected.<br>6 Writing through the link in the copy mode operation of the KEYPAD panel. | |
| 80 | 03 | Data error | Written data is out of the setting range in the area other than the S area. | |
| 81 | 07 | Error during writing | Another writing request comes from the same source while writing function code data (EEPROM other than the S area is accessed). | |

Note: The alarm codes 1 to 32 constitute a code system specific to the VG7S different from the assignment for the general-purpose inverters.
The communication error codes 71 to 81 are common to the different models. Note that some causes of alarm are specific to models.
The KEYPAD panel does not display raw communication error codes but the values in the "KEYPAD panel display" column in the table above.
The KEYPAD panel displays "**" when it receives data that does not have a corresponding "KEYPAD panel display" in the table above.

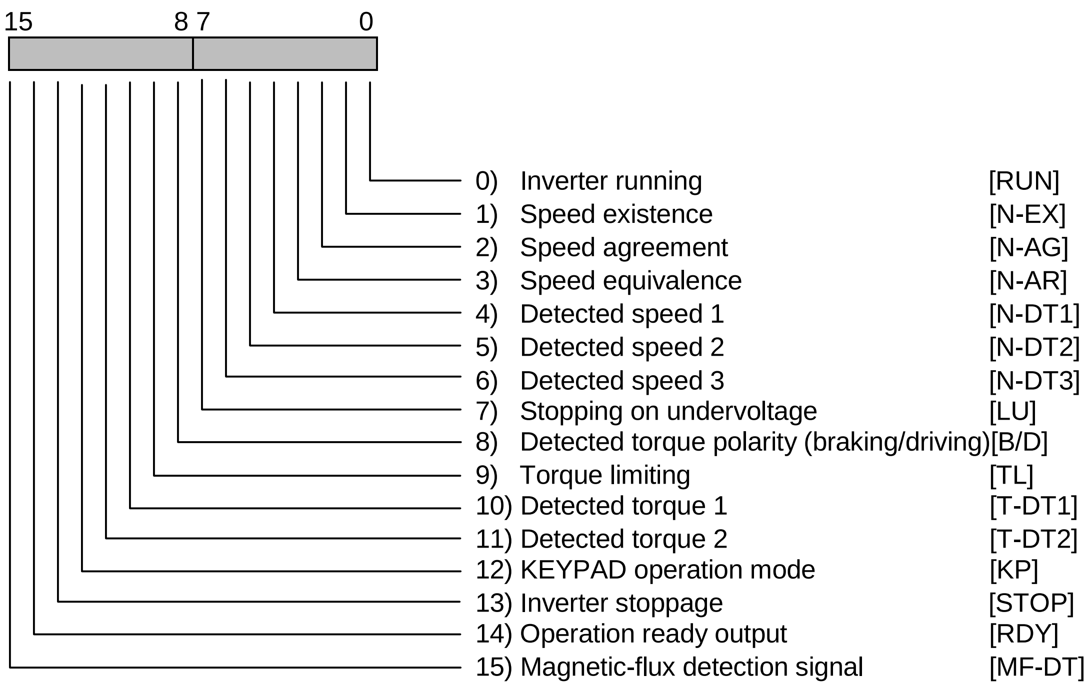
(13) Type [35]: X function normally open/closed
(14) Type [36]: Y function normally open/closed




(15) Type [40] to [99]

These types are reserved for the manufacturer.  Users can considers these types as type [0] to use.

(16) Type [125]: Control output 1



# 12. Function Code List

(17) Type [126]: Control output 2

15 8 7 0

| Bit | Description | Code |
|---|---|---|
| 0) | Motor M2 selection status | [SW-M2] |
| 1) | Motor M3 selection status | [SW-M3] |
| 2) | Brake release signal | [BRK] |
| 3) | Alarm indication | [AL1] |
| 4) | Alarm indication | [AL2] |
| 5) | Alarm indication | [AL4] |
| 6) | Alarm indication | [AL8] |
| 7) | Fan operation signal | [FAN] |
| 8) | Auto-resetting | [TRY] |
| 9) | Universal DO | [U-DO] |
| 10) | Heat sink overheat early warning | [INV-OH] |
| 11) | Synchronization completion signal | [SY-C] |
| 12) | Lifetime alarm | [LIFE] |
| 13) | Under accelerating | [U-ACC] |
| 14) | Under decelerating | [U-DEC] |
| 15) | Inverter overload early warning | [INV-OL] |

(18) Type [127]: Control output 3

15 8 7 0

| Bit | Description | Code |
|---|---|---|
| 0) | Motor temperature early warning | [M-OH] |
| 1) | Motor overload early warning | [M-OL] |
| 2) | DB overload early warning | [DB-OL] |
| 3) | Link transmission error | [LK-ERR] |
| 4) | Load adaptive control under limiting | [ANL] |
| 5) | Load adaptive control under calculation | [ANC] |
| 6) | Analog torque bias hold | [TBH] |
| 7) | Optional Do 1 | [O-DI1] |
| 8) | Optional Do 2 | [O-DI2] |
| 9) | Optional Do 3 | [O-DI3] |
| 10) | Optional Do 4 | [O-DI4] |
| 11) | Optional Do 5 | [O-DI5] |
| 12) | Optional Do 6 | [O-DI6] |
| 13) | Optional Do 7 | [O-DI7] |
| 14) | Optional Do 8 | [O-DI8] |
| 15) | Optional Do 9 | [O-DI9] |

THE INVERTER

XIII

# XIII. Replacement Data

# 13. Replacement Data

When replacing the former inverters (VG, VG3, VG5) with VG7, please refer to this section.

## 13.1 Classification of Replacement

| | Inverter | Motor | Possibility |
|---|---|---|---|
| A: Both inverter and motor are replaced. | VG5 ⇒ VG7S | VG ⇒ VG7 | Possible |
| | VG3/VG3N ⇒ VG7S | VG3 ⇒ VG7 | Possible |
| | VG5S/VG5N ⇒ VG7S | VG5 ⇒ VG7<br>(Same product) | Possible |
| B: Only the inverter is replaced. | VG5 ⇒ VG7S | VG | Possible (Note1) |
| | VG3/VG3N ⇒ VG7S | VG3 | Possible (Note1) |
| | VG5S/VG5N ⇒ VG7S | VG5 | Possible |
| C: Only the motor is replaced. | VG | VG ⇒ VG7 | Impossible (Note2) |
| | VG3 | VG3 ⇒ VG7 | Impossible (Note2) |
| | VG5 | VG5 ⇒ VG7<br>(Same product) | Possible |

Note 1: The rated current of VG and VG3 is bigger than that of VG5,VG7. For this reason, the inverter in one-rank upper grade is required if only the inverter is changed from VG or VG3.

Note 2: For VG and VG3, the maximum output voltage, to which the stable current control is possible, is lower than that of VG5 and VG7. Therefore, if these inverters are combined with VG5 or VG7 motors, the characteristics (torque accuracy or motor wow) at around the base speed or at higher speed will deteriorate.

# 13.2 External Dimensions Comparison

## 13.2.1 Replacing VG5S

● 200V series

| | FRENIC5000 VG5S | | | | | | | FRENIC5000 VG7S | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | External Dimensions | | | Installation dimensions | | Mounting Method | Mass (kg) | External dimensions | | | Installation dimensions | | Mounting method | Mass (kg) |
| Ca-pac-ity (kW) | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | |
| 0.75 | | | | | | | | | | | | | | |
| 1.5 | 205 | 350 | 245 | 183 | 328 | | 10 | 205 | 300 | 245 | 181 | 278 | | 7 |
| 2.2 | | | | | | | | | | | | | | |
| 3.7 | | | | | | | | | | | | | | |
| 5.5 | 205 | 350 | 245 | 183 | 328 | | 11 | 205 | 300 | 245 | 181 | 278 | | 8 |
| 7.5 | | | | | | | | | | | | | | |
| 11 | 255 | 440 | 255 | 233 | 418 | | 17 | 250 | 380 | 245 | 226 | 358 | | 12.5 |
| 15 | 320 | 480 | | 298 | 458 | Wall type | 25 | | | | | | Wall type | |
| 18.5 | 320 | 480 | 255 | 298 | 458 | | 25 | 340 | 480 | 255 | 240 | 460 | | 25 |
| 22 | | | | | | | | | | | | | | |
| 30 | 340 | 550 | | 326 | 530 | | 36 | 340 | 550 | 255 | 240 | 530 | | 30 |
| 37 | 375 | 615 | 255 | 275 | 595 | | 45 | 375 | 615 | 270 | 275 | 595 | | 37 |
| 45 | | | | | 730 | | 58 | | 740 | | | | | 46 |
| 55 | 530 | 750 | 270 | 430 | 720 | | 60 | 375 | | 270 | 275 | 720 | | 48 |
| 75 | | | 285 | | | | 76 | 530 | 750 | 285 | 430 | | | 70 |
| 90 | 680 | 880 | 360 | 580 | 860 | Floor type | 141 | 680 | 880 | 360 | 580 | 850 | | 115 |

● 400V series

| | FRENIC5000 VG5S | | | | | | | FRENIC5000 VG7S | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | External dimensions | | | Installation dimensions | | Mounting Method | Mass (kg) | External dimensions | | | Installation dimensions | | Mounting method | Mass (kg) |
| Ca-pac-ity (kW) | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | |
| 3.7 | 205 | 350 | 245 | 183 | 328 | | 10 | 205 | 300 | 245 | 181 | 278 | | 7 |
| 5.5 | 205 | 350 | 245 | 183 | 328 | | 11 | 205 | 300 | 245 | 181 | 278 | | 8.5 |
| 7.5 | | | | | | | | | | | | | | |
| 11 | 255 | 440 | 255 | 233 | 418 | | 17 | 250 | 380 | 245 | 226 | 358 | | 12.5 |
| 15 | | | | | | | | | | | | | | |
| 18.5 | 320 | 480 | 255 | 298 | 458 | | 25 | 340 | 480 | 255 | 240 | 460 | | 25 |
| 22 | | | | | | | | | | | | | | |
| 30 | 340 | 550 | | 240 | 530 | Wall type | 35 | 340 | 550 | 255 | 240 | 530 | | 30 |
| 37 | 375 | | 255 | 275 | | | 36 | 375 | | | 275 | | Wall type | 35 |
| 45 | | 675 | | | 655 | | 42 | | 675 | 270 | | 655 | | 40 |
| 55 | | | | | 645 | | 53 | 375 | | | 275 | 655 | | 41 |
| 75 | | | 270 | | | | 60 | | | 270 | | | | 49 |
| 90 | 530 | 740 | 315 | 430 | 710 | | 86 | | 740 | 315 | | 720 | | 72 |
| 110 | | | | | | | | 530 | | | 430 | | | |
| 132 | | | | | 970 | | 116 | | | | | 970 | | 100 |
| 160 | | 1000 | 360 | | | | 121 | | 1000 | 360 | | | | |
| 200 | 680 | | | 580 | 980 | Floor type | 173 | 680 | | | 580 | 970 | | 140 |
| 220 | | | | | | | | | | | | | | |

Larger than VG5.

An adapter is required for replacement.

The control panel containing VG5S should be modified.

Replacement Data

# 13. Replacement Data

## 13.2.2 Replacing VG3

● 200V series

| Capacity (Kw) | FRENIC5000 VG3 External dimensions W (mm) | H (mm) | D (mm) | Installation dimensions W1 (mm) | H1 (mm) | Mounting method | Mass (kg) | FRENIC5000 VG7S External dimensions W (mm) | H (mm) | D (mm) | Installation dimensions W1 (mm) | H1 (mm) | Mounting method | Mass (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.75 | | | | | | | | | | | | | | |
| 1.5 | | | | | | | 14 | 205 | 300 | 245 | 181 | 278 | | 7 |
| 2.2 | 255 | 440 | 252 | 155 | 425 | | | | | | | | | |
| 3.7 | | | | | | | | | | | | | | |
| 5.5 | | | | | | | 16 | 205 | 300 | 245 | 181 | 278 | | 8 |
| 7.5 | 280 | 480 | 252 | 180 | 465 | | 20 | | | | | | | |
| 11 | 320 | 480 | 252 | 220 | 460 | Wall type | 24 | 250 | 380 | 245 | 226 | 358 | | 12.5 |
| 15 | | 520 | | | 500 | | 27 | | | | | | Wall type | |
| 18.5 | 340 | 550 | 252 | 240 | 530 | | 30 | 340 | 480 | 255 | 240 | 460 | | 25 |
| 22 | | | | | | | | | | | | | | |
| 30 | 375 | 615 | | 275 | 596 | | 40 | 340 | 550 | 255 | 240 | 530 | | 30 |
| 37 | 390 | 800 | 252 | 290 | 775 | | 53 | 375 | 615 | 270 | 275 | 595 | | 37 |
| 45 | | | | | | | | | 740 | | | | | 46 |
| 55 | 540 | 750 | 267 | 440 | 720 | | 70 | 375 | | 270 | 275 | 720 | | 48 |
| 75 | 850 | 880 | – | 750 | 855 | Floor type | 130 | 530 | 750 | 285 | 430 | | | 70 |
| 90 | | | | | | | | 680 | 880 | 360 | 580 | 850 | | 115 |

● 400V series

| Capacity (kW) | FRENIC5000 VG3 External dimensions W (mm) | H (mm) | D (mm) | Installation dimensions W1 (mm) | H1 (mm) | Mounting method | Mass (kg) | FRENIC5000 VG7S External dimensions W (mm) | H (mm) | D (mm) | Installation dimensions W1 (mm) | H1 (mm) | Mounting method | Mass (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.7 | 280 | 440 | 252 | 180 | 425 | | 20 | 205 | 300 | 245 | 181 | 278 | | 7 |
| 5.5 | | | | | | | | 205 | 300 | 245 | 181 | 278 | | 8.5 |
| 7.5 | 280 | 480 | 252 | 180 | 465 | | 22 | | | | | | | |
| 11 | | | | | | | | 250 | 380 | 245 | 226 | 358 | | 12.5 |
| 15 | 320 | 520 | 252 | 220 | 500 | | 27 | | | | | | | |
| 18.5 | | | | | | | | 340 | 480 | 255 | 240 | 460 | | 25 |
| 22 | 340 | 550 | 252 | 240 | 530 | Wall type | 30 | | | | | | | |
| 30 | | 615 | | | 596 | | 35 | 340 | 550 | 255 | 240 | 530 | | 30 |
| 37 | 375 | 675 | 252 | 275 | 656 | | 43 | 375 | | | 275 | | Wall type | 35 |
| 45 | | | | | | | | | 675 | 270 | | 655 | | 40 |
| 55 | | | | | | | 85 | 375 | | | 275 | 655 | | 41 |
| 75 | 530 | 880 | 322 | 430 | 850 | | | | | 270 | | | | 49 |
| 90 | | | | | | | 95 | | 740 | 315 | | 720 | | 72 |
| 110 | | | 337 | | 1020 | | 105 | 530 | | | 430 | | | |
| 132 | 680 | 1050 | | 580 | | | 135 | | | | | 970 | | 100 |
| 160 | 850 | | – | 750 | 1025 | Floor type | 170 | | 1000 | 360 | | | | |
| 200 | | | | | | | | 680 | | | 580 | 970 | | 140 |
| 220 | – | – | – | – | – | – | – | | | | | | | |

Larger than VG3.

An adapter is required for replacement.

The control panel containing VG3 should be modified.

## 13.2.3 Replacing VG

● 200V series

| | VG | | | | | | | VG7S | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | External dimensions | | | Installation dimensions | | Mounting method | Mass (kg) | External dimensions | | | Installation dimensions | | Mounting method | Mass (kg) |
| Ca-pac-ity (Kw) | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | |
| 0.75 | | | | | | | | | | | | | | |
| 1.5 | – | – | – | – | – | | – | 205 | 300 | 235 | 181 | 278 | | 7 |
| 2.2 | | | | | | | | | | | | | | |
| 3.7 | 240 | 500 | 280 | 180 | 480 | | 15 | | | | | | | |
| 5.5 | | | | | | | | 205 | 300 | 235 | 181 | 278 | | 8 |
| 7.5 | 280 | 550 | 280 | 200 | 530 | Wall type | 25 | | | | | | | |
| 11 | 350 | 550 | 310 | 280 | 530 | | 30 | 250 | 380 | 235 | 226 | 358 | | 12.5 |
| 15 | | | | | | | | | | | | | Wall type | |
| 18.5 | 420 | 650 | 310 | 280 | 620 | | 45 | 340 | 480 | 255 | 240 | 460 | | 25 |
| 22 | | | | | | | | | | | | | | |
| 30 | 420 | 750 | 310 | 280 | 720 | | 60 | 340 | 550 | 255 | 240 | 530 | | 30 |
| 37 | 500 | 900 | 320 | 380 | 870 | | 80 | 375 | 615 | 270 | 275 | 595 | | 37 |
| 45 | | | | | | | | | 740 | | | | | 46 |
| 55 | 880 | 1000 | 445 | 750 | 975 | Floor type | 180 | 375 | | 270 | 275 | 720 | | 48 |
| 75 | | | | | | | | 530 | 750 | 285 | 430 | | | 70 |
| 90 | – | – | – | – | – | | – | 680 | 880 | 360 | 580 | 850 | | 115 |

● 400V series

| | VG | | | | | | | VG7S | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | External dimensions | | | Installation dimensions | | Mounting method | Mass (kg) | External dimensions | | | Installation dimensions | | Mounting method | Mass (kg) |
| Ca-pac-ity (kW) | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | | W (mm) | H (mm) | D (mm) | W1 (mm) | H1 (mm) | | |
| 3.7 | 240 | 550 | 295 | 180 | 530 | | 20 | 205 | 300 | 235 | 181 | 278 | | 7 |
| 5.5 | | | | | | | | 205 | 300 | 235 | 181 | 278 | | 8.5 |
| 7.5 | 350 | 600 | 340 | 280 | 580 | | 35 | | | | | | | |
| 11 | | | | | | | | 250 | 380 | 235 | 226 | 358 | | 12.5 |
| 15 | | | | | | Wall type | | | | | | | | |
| 18.5 | 420 | 700 | 360 | 280 | 670 | | 50 | 340 | 480 | 255 | 240 | 460 | | 25 |
| 22 | | | | | | | | | | | | | | |
| 30 | 420 | 800 | 360 | 280 | 770 | | 65 | 340 | 550 | 255 | 240 | 530 | | 30 |
| 37 | 500 | 900 | 370 | 380 | 870 | | 85 | 375 | | | 275 | | Wall type | 35 |
| 45 | | | | | | | | | 675 | 270 | | 655 | | 40 |
| 55 | 580 | 1150 | 410 | 450 | 1125 | Floor type | 110 | 375 | | | 275 | 655 | | 41 |
| 75 | 730 | 1150 | 415 | 600 | 1125 | | 150 | | | 270 | | | | 49 |
| 90 | | | | | | | | | 740 | 315 | | 720 | | 72 |
| 110 | | | | | | | | 530 | | | 430 | | | |
| 132 | – | – | – | – | – | – | – | | | | | 970 | | 100 |
| 160 | | | | | | | | | 1000 | 360 | | | | |
| 200 | | | | | | | | 680 | | | 580 | 970 | | 140 |
| 220 | | | | | | | | | | | | | | |

(grey box) The control panel containing VG should be modified

Replacement Data

## 13.3 Terminal Size

### 13.3.1 Replacing VG5S

● Main circuit terminal (200V series)

<table>
<tr><th></th><th colspan="5">FRENIC5000 VG5S</th><th colspan="5">FRENIC5000 VG7S</th></tr>
<tr><th rowspan="3">Ca-pac-ity (kW)</th><th colspan="5">Terminal size and arrangement</th><th colspan="5">Terminal size and arrangement</th></tr>
<tr><th>Input</th><th>DC link</th><th>Output</th><th>GRD*</th><th>APS*</th><th>Input</th><th>DC link</th><th>Output</th><th>GRD*</th><th>APS*</th></tr>
<tr><th>R,S,T</th><th>P1,P(+),DB, N(–)</th><th>U,V,W</th><th>E(G)</th><th>R0,T0</th><th>LI/R,L2/S, L3/T</th><th>DB,P1, P(+),N(–)</th><th>U,V,W</th><th>G</th><th>R0,T0</th></tr>
<tr><td>0.75</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M4</td><td rowspan="3">M4</td><td rowspan="3">M4</td><td rowspan="3">M4</td><td rowspan="3">M4</td><td rowspan="3">M4</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M4</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M4</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td>M6</td><td>M6</td><td>M6</td><td>M6</td><td rowspan="2">M4</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M4</td></tr>
<tr><td>15</td><td>M8</td><td>M8</td><td>M8</td><td>M8</td></tr>
<tr><td>18.5</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M4</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M4</td></tr>
<tr><td>22</td></tr>
<tr><td></td><td>R,S,T</td><td>P1,P(+),DB, N(–)</td><td>U,V,W</td><td>E(G)</td><td>R0,T0</td><td>LI/R,L2/S, L3/T</td><td>P1,P(+),DB, N(–)</td><td>U,V,W</td><td>G</td><td>R0,T0</td></tr>
<tr><td>30</td><td>M8</td><td>M8</td><td>M8</td><td>M8</td><td>M4</td><td>M8</td><td>M8</td><td>M8</td><td>M8</td><td>M4</td></tr>
<tr><td>37</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M8</td><td rowspan="3">M4</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M8</td><td rowspan="3">M4</td></tr>
<tr><td>45</td></tr>
<tr><td>55</td></tr>
<tr><td></td><td>R,S,T</td><td>P1,P(+), N(–)</td><td>U,V,W</td><td>E(G)</td><td>R0,T0</td><td>LI/R,L2/S, L3/T</td><td>P1,P(+), N(–)</td><td>U,V,W</td><td>G</td><td>R0,T0</td></tr>
<tr><td>75</td><td>M10</td><td>M10</td><td>M10</td><td>M8</td><td>M4</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">M4</td></tr>
<tr><td>90</td><td>M12</td><td>M12</td><td>M12</td><td>M10</td><td>M4</td></tr>
</table>

*GRD: Ground
*APS: Auxiliary power supply

● Main circuit terminal (400V series)

<table>
<tr><th></th><th colspan="5">FRENIC5000 VG5S</th><th colspan="5">FRENIC5000 VG7S</th></tr>
<tr><th rowspan="3">Ca-<br>pac-<br>ity<br>(kW)</th><th colspan="5">Terminal size and arrangement</th><th colspan="5">Terminal size and arrangement</th></tr>
<tr><th>Input</th><th>DC link</th><th>Output</th><th>GRD*</th><th>APS*</th><th>Input</th><th>DC link</th><th>Output</th><th>GRD*</th><th>APS*</th></tr>
<tr><th>R,S,T</th><th>P1,P(+),DB, N(–)</th><th>U,V,W</th><th>E(G)</th><th>R0,T0</th><th>L1/R,L2/S, L3/T</th><th>DB,P1, P(+),N(–)</th><th>U,V,W</th><th>G</th><th>R0,T0</th></tr>
<tr><td>3.7</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M4</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M5</td><td rowspan="3">M4</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M4</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M4</td></tr>
<tr><td>15</td></tr>
<tr><td>18.5</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M4</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M6</td><td rowspan="2">M4</td></tr>
<tr><td>22</td></tr>
<tr><td></td><td>R,S,T</td><td>P1,P(+), DB, N(–)</td><td>U, V, W</td><td>E(G)</td><td>R0,T0</td><td>L1/R,L2/S, L3/T</td><td>P1,P(+), DB,N(–)</td><td>U,V,W</td><td>G</td><td>R0,T0</td></tr>
<tr><td>30</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M4</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M8</td><td rowspan="4">M4</td></tr>
<tr><td>37</td></tr>
<tr><td>45</td></tr>
<tr><td>55</td></tr>
<tr><td></td><td>R,S,T</td><td>DB,P1,P(+), N(–)</td><td>U,V,W</td><td>E(G)</td><td>R0,T0</td><td>L1/R,L2/S, L3/T</td><td>P1,P(+), DB,N(–)</td><td>U,V,W</td><td>G</td><td>R0,T0</td></tr>
<tr><td>75</td><td rowspan="3">M10</td><td>M10</td><td rowspan="3">M10</td><td rowspan="3">M8</td><td rowspan="3">M4</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M8</td><td rowspan="3">M4</td></tr>
<tr><td>90</td><td rowspan="2">M10<br>(No DB terminal)</td></tr>
<tr><td>110</td></tr>
<tr><td></td><td>R,S,T</td><td>P1,P(+), N(–)</td><td>U,V,W</td><td>E(G)</td><td>R0,T0</td><td>L1/R,L2/S, L3/T</td><td>P1,P(+), N(–)</td><td>U,V,W</td><td>G</td><td>R0,T0</td></tr>
<tr><td>132</td><td>M10</td><td>M10</td><td>M10</td><td>M8</td><td rowspan="4">M4</td><td rowspan="4">M12</td><td rowspan="4">M12</td><td rowspan="4">M12</td><td rowspan="4">M10</td><td rowspan="4">M4</td></tr>
<tr><td>160</td><td rowspan="3">M12</td><td rowspan="3">M12</td><td rowspan="3">M12</td><td rowspan="3">M10</td></tr>
<tr><td>200</td></tr>
<tr><td>220</td></tr>
</table>

*GRD: Ground
*APS: Auxiliary power supply

● Control circuit terminal (Common to 200V series and 400V series)

| FRENIC5000 VG5S | FRENIC5000 VG7S |
|---|---|
| Common to all capacities M3 | Common to all capacities M3 |

## 13.3.2 Replacing VG3

● Main circuit terminal (200V series)

| | FRENIC5000 VG3 | | | | | FRENIC5000 VG7S | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Ca-pac-ity (kW) | Terminal size and arrangement | | | | | Terminal size and arrangement | | | | |
| | Input<br>R,S,T | Output<br>U,V,W | DC link<br>DB,P | GRD*<br>E(G) | APS*<br>R0,T0 | Input<br>L1/R,L2/S,L3/T | DC link<br>DB,P1,P(+),N(–) | Output<br>U,V,W | GRD*<br>G | APS*<br>R0,T0 |
| 0.75 | | | | | | | | | | |
| 1.5 | | | | | | M4 | M4 | M4 | M4 | M4 |
| 2.2 | M5 | M5 | M5 | M5 | M4 | | | | | |
| 3.7 | | | | | | | | | | |
| 5.5 | | | | | | M5 | M5 | M5 | M5 | M4 |
| 7.5 | | | | | | | | | | |
| 11 | M6 | M6 | M6 | M6 | M4 | M6 | M6 | M6 | M6 | M4 |
| 15 | M8 | M8 | M8 | M6 | M4 | | | | | |
| 18.5 | | | | | | M6 | M6 | M6 | M6 | M4 |
| | R,S,T | U,V,W | DB,P1,P | E(G) | R0,T0 | | | | | |
| 22 | M8 | M8 | M8 | M6 | M4 | | | | | |
| | R,S,T | U,V,W | DB,P1,P | E(G) | R0,T0 | L1/R,L2/S,L3/T | P1,P(+),DB,N(–) | U,V,W | G | R0,T0 |
| 30 | M8 | M8 | M8 | M8 | M4 | M8 | M8 | M8 | M8 | M4 |
| 37 | | | | | | | | | | |
| 45 | M10 | M10 | M10 | M8 | M4 | M10 | M10 | M10 | M8 | M4 |
| 55 | | | | | | | | | | |
| | Input/Output<br>R,U,S,V,T,W | | DC link<br>N,P1,P | GRD*<br>E(G) | APS*<br>R0,T0 | Input<br>L1/R,L2/S,L3/T | DC link<br>P1,P(+),N(–) | Output<br>U,V,W | GRD*<br>G | APS*<br>R0,T0 |
| 75 | M12 | M12 | M12 | M10 | M4 | M12 | M12 | M12 | M10 | M4 |
| 90 | | | | | | | | | | |

*GRD: Ground
*APS: Auxiliary power supply

## ● Main circuit terminal (400V series)

| | FRENIC5000 VG3 | | | | | FRENIC5000 VG7S | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Terminal size and arrangement | | | | | Terminal size and arrangement | | | | |
| | Input | Output | DC link | GRD* | APS* | Input | DC link | Output | GRD* | APS* |
| Ca-pac-ity (kW) | R,S,T | U,V,W | DB,P | E(G) | R0,T0 | L1/R,L2/S, L3/T | DB,P1,P(+), N(–) | U,V,W | G | R0,T0 |
| 3.7 | M4 | M4 | M4 | M4 | M4 | M5 | M5 | M5 | M5 | M4 |
| 5.5 | | | | | | | | | | |
| 7.5 | M5 | M5 | M5 | M5 | M4 | | | | | |
| 11 | | | | | | M6 | M6 | M6 | M6 | M4 |
| 15 | M6 | M6 | M6 | M6 | M4 | | | | | |
| 18.5 | | | | | | M6 | M6 | M6 | M6 | M4 |
| | R,S,T | U,V,W | DB,P1,P | E(G) | R0,T0 | | | | | |
| 22 | M6 | M6 | M6 | M6 | M4 | | | | | |
| | R,S,T | P1,P(+), DB,N(–) | U,V,W | E(G) | R0,T0 | L1/R,L2/S, L3/T | P1,P(+),DB, N(–) | U,V,W | G | R0,T0 |
| 30 | M8 | M8 | M8 | M8 | M4 | M8 | M8 | M8 | M8 | M4 |
| 37 | | | | | | | | | | |
| 45 | | | | | | | | | | |
| 55 | M10 | M10 | M10 | M8 | M4 | | | | | |
| 75 | | | | | | M10 | M10 | M10 | M8 | M4 |
| 90 | | | | | | | | | | |
| 110 | | | | | | | | | | |
| | Input/Output R,U,S,V,T,W | | DC link N,P1,P | GRD* E(G) | APS* R0,T0 | L1/R,L2/S, L3/T | P1,P(+), N(–) | U,V,W | G | R0,T0 |
| 132 | M12 | | M12 | M10 | M4 | M12 | M12 | M12 | M10 | M4 |
| 160 | | | | | | | | | | |
| 200 | | | | | | | | | | |
| 220 | – | | – | – | – | | | | | |

*GRD: Ground
*APS: Auxiliary power supply

## ● Control circuit terminal (Common to 200V series and 400V series)

| FRENIC5000 VG3 | FRENIC5000 VG7S |
|---|---|
| Common to all capacities M3 | Common to all capacities M3 |

Replacement Data

# 13. Replacement Data

## 13.3.3 Replacing VG

● Main circuit terminal (200V series)

| Capacity (kW) | FRENIC5000 VG | | | | | FRENIC5000 VG7S | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Terminal size and arrangement | | | | | Terminal size and arrangement | | | | |
| | Input<br>R,S,T | Output<br>U,V,W | DC link<br>DC2,DB1, DB2 | GRD*<br>E(G) | APS*<br>R0,S0, T0 | Input<br>L1/R,L2/S, L3/T | DC link<br>DB,P1, P(+), N(–) | Output<br>U,V,W | GRD*<br>G | APS*<br>R0,T0 |
| 0.75 | – | – | – | – | – | M4 | M4 | M4 | M4 | M4 |
| 1.5 | | | | | | | | | | |
| 2.2 | | | | | | | | | | |
| 3.7 | M4 | M4 | M4 | M3.5 | M3.5 | M5 | M5 | M5 | M5 | M4 |
| 5.5 | | | | | | | | | | |
| 7.5 | M6 | M6 | M5 | M3.5 | M3.5 | | | | | |
| 11 | | | | | | M6 | M6 | M6 | M6 | M4 |
| 15 | R,S,T | U,V,W | DC1,DC2, DB1,DB2 | E(G) | R0,S0, T0 | | | | | |
| | M6 | M6 | M6 | M3.5 | M3.5 | | | | | |
| 18.5 | | | | | | M6 | M6 | M6 | M6 | M4 |
| 22 | | | | | | | | | | |
| | R,S,T | U,V,W | DC1,DC2, DB1,DB2 | E(G) | R0,S0, T0 | L1/R,L2/S, L3/T | P1,P(+), DB, N(–) | U,V,W | G | R0,T0 |
| 30 | M8 | M8 | M8 | M3.5 | M3.5 | M8 | M8 | M8 | M8 | M4 |
| 37 | | | | | | M10 | M10 | M10 | M8 | M4 |
| 45 | | | | | | | | | | |
| 55 | DC link<br>DB1,DB2, DC1,DC2 | Input/ Output<br>R,U,S,V,T,W | | GRD*<br>E(G) | APS*<br>R0,S0, T0 | | | | | |
| | M10 | M10 | | M4 | M4 | | | | | |
| | | | | | | L1/R,L2/S, L3/T | P1,P(+), N(–) | U,V,W | G | R0,T0 |
| 75 | | | | | | M12 | M12 | M12 | M10 | M4 |
| 90 | – | – | – | – | – | | | | | |

*GRD: Ground
*APS: Auxiliary power supply

● Main circuit terminal (400V series)

| | FRENIC5000 VG | | | | | FRENIC5000 VG7S | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Terminal size and arrangement | | | | | Terminal size and arrangement | | | | |
| | Input | Output | DC link | GRD* | APS* | Input | DC link | Output | GRD* | APS* |
| Capacity (kW) | R,S,T | U,V,W | DC2, DB1, DB2 | E(G) | R0,S0, T0 | L1/R,L2/S, L3/T | DB,P1,P(+), N(–) | U,V,W | G | R0,T0 |
| 3.7 | M4 | M4 | M4 | M3.5 | M3.5 | M5 | M5 | M5 | M5 | M4 |
| 5.5 | | | | | | | | | | |
| 7.5 | M5 | M5 | M5 | M3.5 | M3.5 | | | | | |
| 11 | | | | | | M6 | M6 | M6 | M6 | M4 |
| | R,S,T | U,V,W | DC1,DC2, DB1,DB2 | E(G) | R0,S0, T0 | | | | | |
| 15 | M6 | M6 | M6 | M3.5 | M3.5 | | | | | |
| 18.5 | | | | | | M6 | M6 | M6 | M6 | M4 |
| 22 | | | | | | | | | | |
| | | | | | | L1/R,L2/S, L3/T | P1,P(+),DB, N(–) | U,V,W | G | R0,T0 |
| 30 | | | | | | M8 | M8 | M8 | M8 | M4 |
| 37 | M8 | M8 | M8 | M3.5 | M3.5 | | | | | |
| 45 | | | | | | | | | | |
| | DC link DC1,DC2, DB1,DB2 | Input/Output R,U,S,V,T,W | | GRD* E(G) | APS* R0,S0, T0 | | | | | |
| 55 | M8 | M8 | | M4 | M4 | | | | | |
| | | | | | | L1/R,L2/S, L3/T | P1,P(+),DB, N(–) | U,V,W | G | R0,T0 |
| 75 | | | | | | M10 | M10 | M10 | M8 | M4 |
| 90 | – | – | – | – | – | | | | | |
| 110 | | | | | | | | | | |
| | | | | | | L1/R,L2/S, L3/T | P1,P(+),N(–) | U,V,W | G | R0,T0 |
| 132 | | | | | | M12 | M12 | M12 | M10 | M4 |
| 160 | | | | | | | | | | |
| 200 | | | | | | | | | | |
| 220 | | | | | | | | | | |

*GRD: Ground

*APS: Auxiliary power supply

Replacement Data

# 13. Replacement Data

## 13.4 Terminal Symbol

### 13.4.1 Replacing VG5

| Category | FRENIC5000 VG5S Terminal symbol | FRENIC5000 VG5S Terminal name | FRENIC5000 VG7S Terminal symbol | FRENIC5000 VG7S Terminal name |
|---|---|---|---|---|
| Main circuit | R,S,T | Power input | L1/R,L2/S,L3/T | Power input |
| | U,V,W | Inverter output | U,V,W | Inverter output |
| | P1,P(+) | Connects a DC REACTOR | P1,P(+) | Connects a DC REACTOR |
| | P(+),N(–) | Connects a braking unit | P(+),N(–) | Connects a braking unit |
| | P(+),DB | Connects an external braking resistor | P(+),DB | Connects an external braking resistor |
| | E(G) | To ground the inverter | G | To ground the inverter |
| | R0,T0 | Auxiliary control power supply | R0,T0 | Auxiliary control power supply |
| Analog input | 13 | Power supply for potentiometer | 13 | Power supply for potentiometer |
| | 12 | Voltage input for speed setting | 12 | Voltage input for speed setting |
| | 11 | Analog input common | 11 | Analog input common |
| | Ai1 | Analog input 1 | Ai1 | Analog input 1 |
| | Ai2 | Analog input 2 | Ai2 | Analog input 2 |
| | [AOFF] | Input signal off | [OFF] | Input signal off |
| | [AAS1] | Auxiliary speed setting 1 | [AUX-N1] | Auxiliary speed setting 1 |
| | [AAS2] | Auxiliary speed setting 2 | [AUX-N2] | Auxiliary speed setting 2 |
| | [ATL1] | Torque limiter (level 1) | [TL-REF1] | Torque limiter (level 1) |
| | [ATL2] | Torque limiter (level 2) | [TL-REF2] | Torque limiter (level 2) |
| | [ATBS] | Torque bias | [TB-REF] | Torque bias |
| | [ATS] | Torque reference (before limit) | [T-REF] | Torque reference (before limit) |
| | [ATCS] | Torque current reference | [IT-REF] | Torque current reference |
| | [AJSS1] | Creep speed 1 | [CRP-N1] | Creep speed 1 |
| | [AJSS2] | Creep speed 2 | [CRP-N2] | Creep speed 2 |
| | [AFLUX] | Magnetic-flux reference | [MF-REF] | Magnetic-flux reference |
| | [ASFB] | Speed feedback | [LINE-N] | Speed override |
| | [AMTMP] | Motor temperature | [M-TMP] | Motor temperature |
| | [ASOR] | Speed override | [N-OR] | Speed override |
| | M | Analog input common | M | Analog input common |
| Digital input | FWD | Forward operation · stop command | FWD | Forward operation · stop command |
| | REV | Reverse operation · stop command | REV | Reverse operation · stop command |
| | X1<br>X2<br>X3<br>X4<br>X5 | Digital input 1<br>Digital input 2<br>Digital input 3<br>Digital input 4<br>Digital input 5 | X1<br>X2<br>X3<br>X4<br>X5<br>X6<br>X7<br>X8<br>X9 | Digital input 1<br>Digital input 2<br>Digital input 3<br>Digital input 4<br>Digital input 5<br>Digital input 6<br>Digital input 7<br>Digital input 8<br>Digital input 9 |
| | [COPC] | Operation command switch over | | |
| | [CSRM] | Speed setting value switch over | [N2/N1] | Speed setting N2/N1 |
| | [CMCS] | Coast-to-stop command | [BX] | Coast-to-stop command |
| | [CPEX] | Pre-exciting command | [EXITE] | Pre-exciting command |
| | [CHLD] | Operation signal hold | [HLD] | Operation signal hold |
| | [CSR1] | Multistep speed selection 1 | [SS1] | Multistep speed selection 1 |
| | [CSR2] | Multistep speed selection 2 | [SS2] | Multistep speed selection 2 |
| | [CSR4] | Multistep speed selection 4 | [SS4] | Multistep speed selection 4 |
| | [CUP] | ACC command in UP/DOWN setter | [UP] | UP command in UP/DOWN setting |
| | [CDOWN] | DEC command in UP/DOWN setter | [DOWN] | DOWN command in UP/DOWN setting |
| | [CCLR] | Zero clear command in UP/DOWN setter | [CLR] | ACC/DEC zero clear command |
| | [CJSC] | Creep switch | [CRP-N2/N1] | Creep speed switching in UP/DOWN setting |
| | [CSUC] | ACC/DEC · UP/DOWN switch | [N2/N1] | Speed setting N2/N1 |
| | [CSRL] | Speed reference limiter | [N-LIM] | Speed reference cancel |
| | [CSTC] | Speed control/Torque limiter switch | [H41-CCL] | H41[torque reference] cancel |
| | [CTL] | Torque limiter | [F40-CCl] | F40 [torque limiter mode] cancel |
| | [CADT] | ACC/DEC time selection | [RT1][RT2] | ASR, ACC/DEC selection |

| Category | FRENIC5000 VG5S | | FRENIC5000 VG7S | |
|---|---|---|---|---|
| | Terminal symbol | Terminal name | Terminal symbol | Terminal name |
| Digital input | [CADB] | ACC/DEC time bypass | [BPS] | Bypass |
| | [CTB1] | Torque bias reference 1 | [TB1] | Torque bias reference 1 |
| | [CTB2] | Torque bias reference 2 | [TB2] | Torque bias reference 2 |
| | [CDRP] | Droop function | [DROOP] | Droop selection |
| | [CPI] | ASR PI switch | [RT1][RT2] | ASR,ACC/DEC selection |
| | [CPPI] | ASR P/PI switch | [RT1][RT2] | ASR,ACC/DEC selection |
| | [CAI1Z] | Ai1-ACC/DEC zero hold | [ZH-Ai1] | Ai1 zero hold |
| | [CAI2Z] | Ai2-ACC/DEC zero hold | [ZH-Ai2] | Ai2 zero hold |
| | [CSAD] | Analog/Digital switch (speed) | [N2/N1] | Speed setting N2/N1 |
| | [CTAD] | Analog/Digital switch (torque) | [H41-CCL] | H41[torque reference]cancel |
| | [CDILS] | Di card input latch signal (speed) | [DIA] | DiA card input latch signal |
| | [CDILT] | Di card input latch signal (torque) | [DIB] | DiB card input latch signal |
| | [CTEN] | T-Link enable | [LE],[WE-LK] | Operation selection through link, Write enable command through link |
| | [CTDI] | DI command for transmission | [U-DI] | Universal DI |
| | [CREN] | RS485 enable | [LE],[WE-LK] | Operation selection through link, Write enable command through link |
| | RST | Alarm reset | [RST] | Alarm reset |
| | THR | External alarm | [THR] | External alarm |
| | – | | PLC | PLC signal power supply |
| | CM | Digital input common | CM | Digital input common |
| Analog output | Ao1 | Analog output 1 | Ao1 | Analog output 1 |
| | Ao2 | Analog output 2 | Ao2 | Analog output 2 |
| | Ao3 | Analog output 3 | Ao3 | Analog output 3 |
| | [BSM1] | Speedometer (one-way deflection) | [N-FB1+] | Speed detection (Speedometer, one-way deflection) |
| | [BSM2] | Speedometer (two-way deflection) | [N-FB1±] | Speed detection (Speedometer, two-way deflection) |
| | [BSR0] | Speed setting 0 | [N-REF2] | Speed setting2 (before ACC/DEC calculation) |
| | [BSR1] | Speed setting 1 | [N-REF4] | Speed setting4 (ASR input) |
| | [BSR2] | Speed setting 2 | [N-REF4] | Speed setting4 (ASR input) |
| | [BSR] | Speed setting | [N-REF4] | Speed setting4 (ASR input) |
| | [BSFB] | Speed feedback | [N-FB2±] | Speed detection (ASR input) |
| | [BTC1] | Torque ammeter (two-way deflection) | [IT-REF±] | Torque current reference (torque ammeter, two-way deflection) |
| | [BTC2] | Torque ammeter (one-way deflection) | [IT-REF+] | Torque current reference (torque ammeter, one-way deflection) |
| | [BTM1] | Torque meter (two-way deflection) | [T-REF±] | Torque reference (torque meter, two-way deflection) |
| | [BTM2] | Torque meter (one-way deflection) | [T-REF+] | Torque reference (torque meter, one-way deflection) |
| | [BTR] | Torque reference output | [T-REF±] | Torque reference (torque meter, two-way deflection) |
| | [BMC] | Effective detected value of motor current | [I-AC] | Motor current |
| | [BMV] | Effective detected value of motor voltage | [V-AC] | Motor voltage |
| | [BMTMP] | Motor temperature detected value | [TMP-M] | Motor temperature |
| | [BVDC] | Main circuit DC voltage | [V-DC] | DC link circuit voltage |
| | M | Analog output common | M | Analog output common |
| Transistor output | Y1 | Digital output 1 | Y1 | Digital output 1 |
| | Y2 | Digital output 2 | Y2 | Digital output 2 |
| | Y3 | Digital output 3 | Y3 | Digital output 3 |
| | – | | Y4 | Digital output 4 |
| | [DVDC] | Establishment of main circuit DC voltage | [RDY] | Ready for operation |
| | [DRUN] | Running | [RUN] | Running |
| | [DACC] | Accelerating | [U-ACC] | Accelerating |
| | [DDEC] | Decelerating | [U-DEC] | Decelerating |
| | [DNZS] | Speed existence | [N-EX] | Speed existence |
| | [DSAR] | Arrival at the preset speed | [N-AR] | Arrival at the preset speed |
| | [DSAG] | Speed agreement | [N-AG] | Speed agreement |
| | [DSD1] | Speed detection | [N-DT1] | Speed detection 1 |
| | [DSD2] | Speed detection | [N-DT2] | Speed detection 2 |
| | [DSD3] | Speed detection | [N-DT3] | Speed detection 3 |
| | [DTLM] | Torque limiting | [TL] | Torque limiting |
| | [DTD] | Torque detection | [T-DT1] | Torque detection |
| | [DOL] | Inverter overload early warning | [INV-OL] | Inverter overload early warning |
| | [DMOH] | Motor temperature overheat early warning | [M-OH] | Motor temperature overheat early warning |

# 13. Replacement Data

| Category | FRENIC5000 VG5S | | FRENIC5000 VG7S | |
|---|---|---|---|---|
| | Terminal symbol | Terminal name | Terminal symbol | Terminal name |
| Transistor output | [DMOL] | Motor overload early warning | [M-OL] | Motor overload early warning |
| | [DBRS] | Brake release signal | [BRK] | Brake release signal |
| | [DBRK] | Braking | [B/D] | Torque polarity detection |
| | [DTDO] | DO for transmission | [U-DO] | Universal DO |
| | [DTER] | Transmission error | [LK-ERR] | Transmission error |
| | [DSYN] | Synchronizing | [SY-C] | Synchronization control completion |
| | CME | Digital output common | CME | Digital output common |
| Relay output | RYA,RYC | Relay output | Y5A,Y5C | Relay output |
| | 30A,30B,30C | Alarm output for any fault | 30A,30B,30C | Alarm output for any fault |
| Communi-cation | DXA,DXB | RS485 communication input/output | RX(+),RX(–), TX(+),TX(–),SD | RS485 communication input/output (dedicated connector) |
| Speed detection | PA,PB | Pulse generator 2-phase signal input | PA,PB | Pulse generator 2-phase signal input |
| | PGP,PGM | Pulse generator power supply | PGP,PGM | Pulse generator power supply |
| | FA,FB | Pulse generator output | FA,FB | Pulse generator output |
| | CM | Common to pulse generator output | CM | Common to pulse generator output |
| Temperature detection | TH1 | Connects a motor thermistor | TH1 | Connects a motor thermistor (Motor temperature can be detected with NTC,PTC thermistors) |
| | THC | Common to motor thermistor | THC | Common to motor thermistor |
| Option power supply | P24 | Power supply to option (+24V) | – | Please utilize the power supply on the market. |
| | M24 | Common terminal to +24V | – | |
| | P15 | Power supply for option (+15V) | – | |
| | (M) | Common terminal to ±15V | – | |
| | N15 | Power supply to option (–15V) | – | |

## 13.4.2 Replacing VG3

| Category | FRENIC5000 VG3 Terminal symbol | FRENIC5000 VG3 Terminal name | FRENIC5000 VG7S Terminal symbol | FRENIC5000 VG7S Terminal name |
|---|---|---|---|---|
| Main circuit | R,S,T | Power input | L1/R,L2/S,L3/T | Power input |
| | U,V,W | Inverter output | U,V,W | Inverter output |
| | P,DB | Connects a barking resistor | P(+),DB | Connects a barking resistor |
| | P,N | Connects a braking unit | P(+),N(–) | Connects a braking unit |
| | P,P1 | Connects a DC REACTOR | P(+),P1 | Connects a DC REACTOR |
| | P,N1 | Connects a backup capacitor | P(+),N(–) | Connects a backup condenser |
| | E(G) | To ground the inverter | G | To ground the inverter |
| | R0,T0 | Auxiliary control power supply | R0,T0 | Auxiliary control power supply |
| Analog input | 11 | Common to analog input | 11 | Common to analog input |
| | 13 | Power supply for potentiometer | 13 | Power supply for potentiometer |
| | 12 | Speed setting voltage input | 12 | Speed setting voltage input |
| | M | Common to analog input | M | Common to analog input |
| | Ai1 | Analog input 1 | Ai1 | Analog input 1 |
| | Ai2 | Analog input 2 | Ai2 | Analog input 2 |
| | [AV2] | Auxiliary speed setting 2 | [AUX-N1] | Auxiliary speed setting 1 |
| | [AV3] | Auxiliary speed setting 3 | [AUX-N2] | Auxiliary speed setting 2 |
| | [ATL1] | Torque limiter value 1 / Torque bias reference value 1 | [TL-REF1] | Torque limiter (level 1) |
| | [ATL2] | Torque limiter value 2 / Torque bias reference value 2 | [TL-REF2] | Torque limiter (level 2) |
| | [ATL3] | Torque limiter value 3 / Torque bias reference value 3 | – | – |
| | [ATL4] | Torque limiter value 4 | – | – |
| | [ATIN] | Torque reference input | [T-REF] | Torque reference (before limit) |
| | [ATR] | Torque reference | | |
| | [AFAI] | Magnetic-flux reference input | [MF-REF] | Magnetic-flux reference |
| | [ANFI] | Speed feedback input | [LINE-N] | Speed override |
| | [ANJF] | Creep setting value in UP/DOWN setter | [CRP-N1] | Creep speed 1 |
| | | | [CRP-N2] | Creep speed 2 |
| | [ATM] | Motor temperature input | [M-TMP] | Motor temperature |
| | V1 | Voltage input for auxiliary speed setting | [AUX-N1] | Auxiliary speed setting 1 |
| Digital input | CM | Digital input common | CM | Digital input common |
| | FWD | Forward operation · stop command | FWD | Forward operation · stop command |
| | REV | Reverse operation · stop command | REV | Reverse operation · stop command |
| | X1<br>X2<br>X3<br>X4<br>X5 | Digital input 1<br>Digital input 2<br>Digital input 3<br>Digital input 4<br>Digital input 5 | X1<br>X2<br>X3<br>X4<br>X5<br>X6<br>X7<br>X8<br>X9 | Digital input 1<br>Digital input 2<br>Digital input 3<br>Digital input 4<br>Digital input 5<br>Digital input 6<br>Digital input 7<br>Digital input 8<br>Digital input 9 |
| | [CNR1] | Multistep speed setting selection 1 | [SS1] | Multistep speed setting selection 1 |
| | [CNR2] | Multistep speed setting selection 2 | [SS2] | Multistep speed setting selection 2 |
| | [CNR4] | Multistep speed setting selection 4 | [SS4] | Multistep speed setting selection 4 |
| | [CUP] | ACC command in UP/DOWN setter | [UP] | UP command in UP/DOWN setting |
| | [CDWN] | DEC command in UP/DOWN setter | [DOWN] | DOWN command in UP/DOWN setting |
| | [CCLR] | Clear command in UP/DOWN setter | [CLR] | ACC/DEC zero clear command |
| | [CBSS] | Soft start · stop bypass | [BPS] | Bypass |
| | [CRT] | Soft start · stop time switch | [RT1] | ASR,ACC/DEC selection |
| | [CNL] | Reverse rotation lock command | H08 | Reverse rotation lock |
| | [CPI] | ASR PI switch | [RT1][RT2] | ASR,ACC/DEC selection |
| | [CPPI] | ASR P/PI switch | [RT1][RT2] | ASR,ACC/DEC selection |
| | [CSTC] | Speed control/Torque control switch | [H41-CCL] | H41 [Torque reference] cancel |
| | [CDRP] | Droop function | [DROOP] | Droop selection |
| | [CTL] | Torque limiter | [F40-CCL] | F40 (Torque limiter mode) cancel |
| | [CTB1] | Torque bias reference 1 | [TB1] | Torque bias reference 1 |
| | [CTB2] | Torque bias reference 2 | [TB2] | Torque bias reference 2 |

# 13. Replacement Data

| Category | FRENIC5000 VG3 Terminal symbol | FRENIC5000 VG3 Terminal name | FRENIC5000 VG7S Terminal symbol | FRENIC5000 VG7S Terminal name |
|---|---|---|---|---|
| | [CPOS] | Simplified position control command | – | – |
| | RST | Alarm reset | [RST] | Alarm reset |
| | THR | External alarm | [THR] | External alarm |
| | EXT | Pre-exciting command | [EXITE] | Pre-exciting command |
| | – | | PLC | PLC signal power supply |
| Analog output | Ao | Analog output | Ao1 | Analog output 1 |
| | | | Ao2 | Analog output 2 |
| | | | Ao3 | Analog output 3 |
| | [BNF0] | Speed feedback output 0 | [N-FB1+] | Speedometer one-way deflection |
| | [BNR0] | Speed setting 0 | [N-REF2] | Speed setting 2 |
| | [BNR1] | Speed setting 1 | [N-REF4] | Speed setting 4 |
| | [BNR2] | Speed setting 2 | [N-REF4] | Speed setting 4 |
| | [BT0] | Torque reference output 0 | [T-REF±] | Torque meter two-way deflection |
| | [BT1] | Torque reference output 1 | [T-REF±] | Torque meter two-way deflection |
| | [BIT] | Torque current reference | [IT-REF±] | Torque ammeter two-way deflection |
| | [BNR] | Speed setting | [N-REF4] | Speed setting 4 |
| | [BNA] | Speed feedback | [N-FB2±] | Speed detection |
| | [BNAB] | Speed feedback absolute value | [N-FB1+] | Speedometer one-way deflection |
| | [BTAB] | Torque reference output absolute value | [T-REF+] | Torque meter one-way deflection |
| | [BITAB] | Torque current reference output absolute value | [IT-REF+] | Torque ammeter one-way deflection |
| | [BIM] | Motor current detected value | [I-AC] | Motor current |
| | LM | For load meter | [IT-REF±] | Torque current reference (torque ammeter two-way deflection) |
| | | | [IT-REF+] | Torque current reference (torque ammeter one-way deflection) |
| | | | [T-REF±] | Torque reference (torque meter two-way deflection) |
| | | | [T-REF+] | Torque reference (torque meter one-way deflection) |
| | SM | For speedometer | [N-FB1+] | Speed detection (speedometer one-way deflection) |
| | | | [N-FB1±] | Speed detection (speedometer two-way deflection) |
| | M | Common to analog output | M | Common to analog output |
| Transistor output | Y1 | Digital output 1 | Y1 | Digital output 1 |
| | Y2 | Digital output 2 | Y2 | Digital output 2 |
| | Y3 | Digital output 3 | Y3 | Digital output 3 |
| | – | | Y4 | Digital output 4 |
| | [DUV] | Establishment of link voltage (undervoltage) | [RDY] | Ready for operation |
| | [DZS] | Speed existence (zero speed) | [N-EX] | Speed existence |
| | [DSAR] | Arrival at the preset speed | [N-AR] | Arrival at the preset speed |
| | [DSAG] | Speed agreement | [N-AG] | Speed agreement |
| | [DSDA] | Arbitrary speed (absolute value) | [N-DT1] | Speed detection 1 |
| | [DSDP] | Arbitrary speed (with polarity) | [N-DT2] | Speed detection 2 |
| | [DTLM] | Torque limiting | [TL] | Torque limiting |
| | [DTDT] | Torque detection | [T-DT1] | Torque detection 1 |
| | [DAX] | Inverter running | [RUN] | Inverter running |
| | [DACC] | Accelerating | [U-ACC] | Accelerating |
| | [DDEC] | Decelerating | [U-DEC] | Decelerating |
| | [DOL] | Inverter overload early warning | [INV-OL] | Inverter overload early warning |
| | [DOLM] | Motor temperature overheat early warning | [M-OH] | Motor temperature overheat early warning |
| | [DTY4] | Transmission data Y4 | [U-DO] | Universal DO |
| | [DTY5] | Transmission data Y5 | | |
| | [DTFT] | Transmission data error | [LK-ERR] | Transmission error |
| | CME | Digital output common | CME | Digital output common |
| Relay output | RYA,RYC | Relay output | Y5A,Y5C | Relay output |
| | 30A,30B,30C | Alarm output for any fault | 30A,30B,30C | Alarm output for any fault |
| Relay output | RYA,RYC | Relay output | Y5A,Y5C | Relay output |
| | 30A,30B,30C | Alarm output for any fault | 30A,30B,30C | Alarm output for any fault |
| Speed detection | PA,PB | Pulse generator 2-phase signal input | PA,PB | Pulse generator 2-phase signal input |
| | PGP,PGM | Pulse generator power supply | PGP,PGM | Pulse generator power supply |
| Temperature detection | THT | Connects motor thermistor | TH1 | Connects motor thermistor (Motor temperature can be detected with the NTC and the PTC thermistors). |
| | THC | Common to motor thermistor | THC | Common to motor thermistor |

| Category | FRENIC5000 VG3 | | FRENIC5000 VG7S | |
|---|---|---|---|---|
| | Terminal symbol | Terminal name | Terminal symbol | Terminal name |
| Option power supply | P24 | Power supply for option (+24V) | – | Please utilize the power supply on the market. |
| | M24 | For +24V common | – | |
| | P15 | Power supply for option (+15V) | – | |
| | (M) | For ±15V common | – | |
| | N15 | Power supply for option (–15V) | – | |

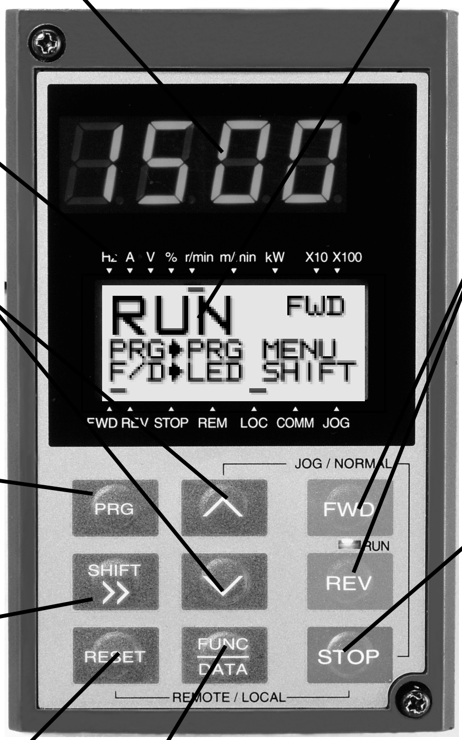
## 13.4.3 Replacing VG

| Category | FRENIC5000 VG Terminal symbol | FRENIC5000 VG Terminal name | FRENIC5000 VG7S Terminal symbol | FRENIC5000 VG7S Terminal name |
|---|---|---|---|---|
| Main circuit | R,S,T | Power input | L1/R,L2/S,L3/T | Power input |
| | U,V,W | Inverter output | U,V,W | Inverter output |
| | DC1,DC2 | Connects a DC REACTOR | P1,P(+) | Connects a DC REACTOR |
| | DB1,DB2 | Connects a braking unit | P(+),N(–) | Connects a braking unit |
| | DB1,DB2 | Connects a braking resistor | P(+),DB | Connects a braking resistor |
| | E | To ground the inverter | G | To ground the inverter |
| | DBR1,DBR2 | Connects a braking resistor thermal sensor. | [THR] | External fault |
| | R0,S0,T0 | Auxiliary control power supply | R0,T0 | Auxiliary control power supply |
| Analog input | 13 | Power supply for potentiometer | 13 | Power supply for potentiometer |
| | 12 | Voltage input for speed setting | 12 | Voltage input for speed setting |
| | 11 | Analog input common | 11 | Analog input common |
| | V1 | Auxiliary speed setting input | [AUX-N1] | Auxiliary speed setting input 1 |
| | M | Analog input common | M | Analog input common |
| Digital input | FWD | Forward operation · stop command | FWD | Forward operation · stop command |
| | REV | Reverse operation · stop command | REV | Reverse operation · stop command |
| | BX | Inverter cut-off command | [BX] | Coast-to stop command |
| | ILS | DEC stop command of torque limiter | [STOP3] | STOP3 (Torque limiter stop) |
| | ITL | External torque limiter command | [F40-CCL] | Torque limiter (mode 1) cancel |
| | RST | Reset command of external fault | [RST] | Alarm reset |
| | EXT | Pre-exciting command | [EXITE] | Pre-exciting command |
| | CM | Digital input common | CM | Digital input common |
| Analog output | SM+,SM– | Speedometer signal | [N-FB1+] | Speedometer (one-way deflection) |
| | SP | Speed signal with polarity | [N-FB1±] | Speedometer (two-way deflection) |
| | LM+,LM– | Torque ammeter signal | [IT-REF±] | Torque ammeter (two-way deflection) |
| | DM+,DM– | Speedometer (digital) signal | FA,FB | Pulse generator output |
| | M | Analog output common | M | Analog output common |
| Relay output | SST1,SST2 | Speed existence signal | [N-EX] | Speed existence*1) |
| | SAR1,SAR2 | Signal for arrival at the preset speed. | [N-AR] | Arrival at the preset speed*1) |
| | UV1,UV2 | Link voltage existence signal | [RDY] | Ready for operation*1) |
| | 30A,30B,30C | Alarm output for any fault | 30A,30B,30C | Alarm output for any fault |
| Speed detection | A+,B+ | Pulse generator 2-phase signal input | PA,PB | Pulse generator 2-phase signal input |
| | PGP,PGM | Pulse generator power supply | PGP,PGM | Pulse generator power supply |
| Temperature detection | TH1,<br>TH2 | Connects the standard motor thermistor<br>Connects the spare motor thermistor | TH1 | Connects the motor thermistor (Motor temperature can be detected with the NTC and the PTC thermistors). |
| | THRC,<br>PGS | Common to motor thermistor<br>Shield terminal for motor thermistor | THC | Common to motor thermistor |
| Option power supply | P24 | Power supply for option (+24V) | – | Please utilize the power supply on the market. |
| | M24 | For +24V common | – | |
| | P15 | Power supply for option (+15V) | – | |
| | (M) | For ±15V common | – | |
| | N15 | Power supply for option (–15V) | – | |

*1) VG7 has only one terminal for relay output, and the remaining are for transistor output.
Therefore, when replacing the relay output signal of VG, take some measures such as sending the signals to the external relays.

# 13.5 KEYPAD Panel

● Appearance




**LED monitor**

Operation mode:
Displays the setting frequency, output current, output voltage, motor speed, and line speed.
Trip mode:
Displays the cause of a trip.

**Unit indication**

Displays the unit for the information that appears on the LED monitor.

**Up/Down keys**

Operation mode:
Increases or decreases the speed.
Program mode:
Changes the function codes and specified data values.

**Program key**

Switches the display to the menu screen or the initial screens for the operation and alarm modes.

**Shift key (column shift)**

Used to move the cursor horizontally for data change and to jump to another function block (when pressed with the UP/DOWN keys)

**Reset key**

Program mode:
Cancels the current input data and changes the screen.
Trip mode:
Releases from a trip stoppage.

**LCD monitor**

Displays different information ranging from operation status to function data.
Operation guidance is displayed scrolling at the bottom.

**FWD/REV keys**

Operation mode:
Pressing the FWD or REV key lights the RUN lamp.
Invalid when the function code F02 (Operation method) is set to 1 (external signal operation).

**Stop key**

Invalid when the function code F02 (Operation method) is set to 1 (external signal operation).

**Function/Data select key**

Used to switch the displayed value of LED monitor, input the speed setting and store the function code data.

# 13. Replacement Data

## ● Difference of operationability of the KEYPAD panel

<table>
<tr><th>Item</th><th colspan="2">FRENIC5000 VG5S</th><th colspan="2">FRENIC5000 VG7S</th></tr>
<tr><td>LED Monitor</td><td colspan="2">● Displays the set speed and the actual speed.<br>● Displays the inverter's operation status.<br>● Alarm display.</td><td colspan="2">● Displays the set speed and the actual speed.<br>● Displays the inverter's operation status.<br>● Alarm display.</td></tr>
<tr><td rowspan="2">LCD Monitor</td><td colspan="2">● Displays the function codes and their abbrebiations.<br>● Displays the function data and the setting range.<br>● Alarm display.<br>● Displays the operation status (selection) in a graph.<br>● Displays the operation guidance.<br>● Function code display scrolls.<br>● The shift of the digit is possible when the function data is changed.<br>● Displays the list of the changed function codes.<br>● Displays the current value and the changed value.</td><td colspan="2">● Displays the function codes and their abbrebiations.<br>● Displays the function data and the setting range.<br>● Alarm display.<br>● Displays the operation status (selection) in a graph.<br>● Displays the operation guidance.<br>● Function code display scrolls.<br>● The shift of the digit is possible when the function data is changed.<br>● Displays the list of the changed function codes.<br>● Displays the current value and the changed value.</td></tr>
<tr><td colspan="2">Screen size : 13chr. x 4lines</td><td colspan="2">Screen size : 13chr. x 5lines<br>(One line is for the indicator display).</td></tr>
<tr><td rowspan="8">Touch Keys</td><td>RUN</td><td>Command key to operate the inverter.</td><td>FWD,REV</td><td>Command key to operate the inverter.</td></tr>
<tr><td>STOP</td><td>Command key to stop the inverter.</td><td>STOP</td><td>Command key to stop the inverter.</td></tr>
<tr><td>∧</td><td rowspan="2">● Increases/Decreases the setting value of the speed.<br>● Up/Down the cursor (screen scrolls).<br>● Increases/Decreases the setting value of the function.</td><td>∧</td><td rowspan="2">● Increases/Decreases the setting value of the speed.<br>● Up/Down the cursor (screen scrolls).<br>● Increases/Decreases the setting value of the function.</td></tr>
<tr><td>∨</td><td>∨</td></tr>
<tr><td>PRG</td><td>Switches the operation mode and program mode.</td><td>PRG</td><td>Switches the operation mode and program mode.</td></tr>
<tr><td>>></td><td>Switches the unit indication.<br>Digit shift in case of the function data change.</td><td>SHIFT<br>>></td><td>Switches the unit indication.<br>Digit shift in case of the function data change.</td></tr>
<tr><td>FUNC<br>DATA</td><td>Reads and writes the function data.</td><td>FUNC<br>DATA</td><td>Reads and writes the function data.</td></tr>
<tr><td>RESET</td><td>Reset of the alarm state.</td><td>RESET</td><td>Reset of the alarm state.</td></tr>
<tr><td>Operation Mode</td><td colspan="2">Displays the switching between the KEYPAD panel and external signal operation.</td><td colspan="2">Displays the switching between the KEYPAD panel and external signal operation.<br>REM/LOC/COMM/JOG,etc. displays the mode.</td></tr>
<tr><td>Unit Indication</td><td colspan="2">r/min,Hz,A,V,%</td><td colspan="2">r/min,Hz,A,V,kW,%</td></tr>
<tr><td>Function Code</td><td colspan="2">● Fundamental function and 7 function block<br>● The number of function codes : 165</td><td colspan="2">● Fundamental function and 10 function block<br>● The number of function codes : 539</td></tr>
<tr><td>Language</td><td colspan="2">Japanese/English</td><td colspan="2">Japanese/English/German/French/Italian/Spanish/Chinese</td></tr>
<tr><td>LCD brightness</td><td colspan="2">Electrical volume<br>(to be adjusted through the function code)</td><td colspan="2">Electrical volume<br>(to be adjusted through the function code)</td></tr>
<tr><td>Mode Switch</td><td colspan="2">–</td><td colspan="2">● Switches remote and local.<br>● Switches JOG mode.</td></tr>
</table>

# 13.6 Function Codes

## 13.6.1 Replacing VG5

| FRENIC5000 VG5S | | FRENIC5000 VG7S | |
|---|---|---|---|
| Function codes | Name | Function codes | Name |
| 01 | Speed setting | F01 | Speed setting N1 |
| 02 | Operation method | F02 | Operation method |
| 03 | Max. speed | F03 | M1 max. speed |
| 04 | Acceleration time 1 | F07 | Acceleration time 1 |
| 05 | Deceleration time 1 | F08 | Deceleration time 1 |
| 06 | S-curve acceleration/deceleration 1 | F67 to F70 | S-curve acceleration/deceleration 1 |
| 07 | Multistep speed 1 | C05 | Multistep speed 1 |
| 08 | Multistep speed 2 | C06 | Multistep speed 2 |
| 09 | Multistep speed 3 | C07 | Multistep speed 3 |
| 10 | Multistep speed 4 | C08 | Multistep speed 4 |
| 11 | Multistep speed 5 | C09 | Multistep speed 5 |
| 12 | Multistep speed 6 / Creep speed 1 | C10/C18 | Multistep speed 6 / Creep speed 1 |
| 13 | Multistep speed 7 / Creep speed 2 | C11/C19 | Multistep speed 7 / Creep speed 2 |
| 14 | ASR1 (P gain) | F61 | ASR1-P(Gain) |
| 15 | (I gain) | F62 | ASR1-I (Constant of integration) |
| 16 | Constant on filtering (Speed setting) | F64 | ASR1 input filter |
| 17 | (Speed detection) | F65 | ASR1 detection filter |
| 18 | Torque limiter (Method selection) | F40,41 | Torque limiter mode |
| 19 | (Limiter value selection) | F42,43 | Torque limiter value selection |
| 20 | Torque limiter (Level 1) | F44 | Torque limiter (Level 1) |
| 21 | (Level 2) | F45 | (Level 2) |
| 22 | Motor electronic thermal (Select) | F10 | M1 motor electronic thermal (Select) |
| 23 | (Level) | F11 | (Level) |
| 24 | Restart after momentary power failure | F14 | Restart after momentary power failure (Operation selection) |
| 25 | DC brake (Time) | F22 | DC brake (Braking time) |
| 26 | (Level) | F21 | (Operation level) |
| 27 | Pre-excitation (Time) | F74 | Pre-excitation time |
| 30 | Function block (31-44) selection | – | |
| 31 | Droop control | H28 | Droop control |
| 32 | Filtering time constant (ASR output) | F66 | ASR1 output filter |
| 33 | Acceleration time 2 | C46 | Acceleration time 2 |
| 34 | Deceleration time 2 | C47 | Deceleration time 2 |
| 35 | S-curve acceleration/deceleration 2 | C49,C50 | S-curve acceleration/deceleration 2 |
| 36 | Ratio setting | F17 | Gain (Speed setting signal 12) |
| 37 | ASR2 (P gain) | C40 | ASR2-P (Gain) |
| 38 | (I gain) | C41 | ASR2-I (Constant of integration) |
| 39 | ASR1,2 switching characteristic | C70 | ASR switching time |
| 40 | Torque bias (Level1) | F47 | Torque bias T1 |
| 41 | (Level2) | F48 | Torque bias T2 |
| 42 | Selection between torque control and torque current control | H41,H42 | Torque reference and torque current reference selection |
| 43 | Magnetic-flux reference (Select) | H43 | Magnetic-flux reference selection |
| 44 | Magnetic-flux reference at light load | F73 | Magnetic-flux level at light load |
| 50 | Function block (51-55) selection | – | |
| 51 | ASR tuning (Action selection) | H46 | Observer type selection |
| 52 | (Operation selection) | H01 | Tuning operation selection |
| 53 | Observer data (Compensation gain) | H47,H48 | Observer settings (Compensation gain) |
| 54 | (Integration time) | H49,H50 | (Integration time) |
| 55 | (Load inertia) | H51,H52 | (Load inertia) |
| 60 | Function block (61-74) selection | – | |
| 61 | Motor overheat protection (temp.) | E30 | Motor overheat protection (temp.) |
| 62 | Motor overheat early warning (temp.) | E31 | Motor overheat early warning (temp.) |
| 63 | Inverter overload early warning (Level) | E33 | Inverter overload early warning |
| 64 | Motor overload early warning (Level) | E34 | Motor overload early warning |
| 65 | Zero speed detection (Level) | F37 | Stop speed |

# 13. Replacement Data

| FRENIC5000 VG5S | | FRENIC5000 VG7S | |
|---|---|---|---|
| Function codes | Name | Function codes | Name |
| 66 | Speed detection (Level 1) | E39 | Speed detection level 1 |
| 67 | (Level 2) | E40 | Speed detection level 2 |
| 68 | (Level 3) | E41 | Speed detection level 3 |
| 69 | Speed detection method | E38 | Speed detection method |
| 70 | Speed equivalence (Detection range) | E42 | Speed equivalence (Detection range) |
| 71 | Speed agreement (Detection range) | E43 | Speed agreement (Detection range) |
| 72 | (Off delay timer) | E44 | (Off delay timer) |
| 73 | Torque detection (Level) | E46 | Torque detection level 1 |
| 74 | Timer for continuous operation | F39 | Stop speed (Zero speed holding time) |
| 80 | Function block (81-101) selection | – | |
| 81 | Auto-restart (Times) | H04 | Auto-restart (Times) |
| 82 | (Interval) | H05 | (Interval) |
| 83 | Speed bias setting | F18 | Bias (Speed setting signal 12) |
| 84 | Speed limiter (Method selection) | F76 | Speed limiter (Method selection) |
| 85 | Speed limiter (Level 1) | F77 | Speed limiter level 1 |
| 86 | (Level 2) | F78 | Speed limiter level 2 |
| 87 | Creep selection (Setting selection) | C73 | Creep speed switching (on UP/DOWN control) |
| 87 | Operation method changeover switch | – | Function selection Di [IVS] |
| 89 | Speed feedback (Signal selection) | H53 | Line speed feedback selection |
| 90 | Suppressing function | H57 | Overvoltage suppressing function |
| 91 | Operation method selection | H11 | Automatic operation OFF function |
| 92 | Torque reference monitor | F51 | Torque reference monitor (Polarity selection) |
| 93 | Language | F58 | LCD monitor (Language selection) |
| 94 | LCD brightness adjustment | F59 | LCD monitor (Contrast adjustment) |
| 95 | LED monitor selection | F55 | LED monitor (Display selection) |
| 96 | Display of load speed (Coefficient 1) | F52 | LED monitor (Display coefficient A) |
| 97 | (Coefficient 2) | F53 | LED monitor (Display coefficient B) |
| 98 | LCD monitor selection | F57 | LCD monitor (Display selection) |
| 99 | Motor sound selection | F26 | Motor sound (Carrier freq.) |
| 100 | Data initialization | H03 | Data initialization |
| 101 | All save | H02 | All save |
| 110 | Function block (111-134) selection | – | |
| 111 | Selection of X1 to X5 functions (X1,X2) | E01,E02 | Selection of X1 function, Selection of X2 function |
| 112 | (X3,X4) | E03,E04 | Selection of X3 function, Selection of X4 function |
| 113 | (X5) | E05 | X5 function selection |
| 114 | Timer for multistep speed reference agreement | C20 | Timer for multistep speed reference agreement |
| 115 | Y1 to Y3,RY function selection (Y1,Y2) | E15,E16 | Y1 function selection,Y2 function selection |
| 116 | (Y3,RY) | E17,E19 | Y3 function selection,Y5 function selection |
| 117 | Ai1,Ai2 function selection | E49,E50 | Ai1 function selection, Ai2 function selection |
| 118 | Increment/decrement limiter (Ai1) | E65 | Increment/decrement limiter (Ai1) |
| 119 | (Ai2) | E66 | Increment/decrement limiter (Ai2) |
| 120 | Offset setting (12) | F17 | Gain (Speed setting signal 12) |
| 121 | (Ai1) | E57 | Ai1 bias setting |
| 122 | (Ai2) | E58 | Ai2 bias setting |
| 123 | Gain setting (12) | F18 | Bias (Speed setting signal 12) |
| 124 | (Ai1) | E53 | Ai1 gain setting |
| 125 | (Ai2) | E54 | Ai2 gain setting |
| 126 | AO1 to AO3 function selection | E69 to E71 | AO1 function selection, AO2 function selection, AO3 function selection |
| 127 | Bias adjustment (AO1) | E79 | AO1 bias setting |
| 128 | (AO2) | E80 | AO2 bias setting |
| 129 | (AO3) | E81 | AO3 bias setting |
| 130 | Gain adjustment (AO1) | E74 | AO1 gain setting |
| 131 | (AO2) | E75 | AO2 gain setting |
| 132 | (AO3) | E76 | AO3 gain setting |
| 133 | Filter selection (AO1,AO2,AO3) | E84 | AO1-5 filter setting |
| 140 | Function block (140-169) selection | – | |
| 141 | Operation command selection | H30 | Serial link |
| 142 | Control input through transmission | S06 | Operation method 1 (through communication) |

| FRENIC5000 VG5S | | FRENIC5000 VG7S | |
|---|---|---|---|
| Function codes | Name | Function codes | Name |
| 143 | Speed reference through transmission | S01 | Speed reference |
| 144 | Action on T-Link error (Mode) | o30 | T-Link option setting (Action on transmission error) |
| 145 | (Action time) | o31 | (Action time on transmission error) |
| 146 | Standard built-in RS485 address | H31 | RS485 (Station address) |
| 147 | Action on RS485 error (Mode) | H32 | Action on RS485 error Operation (Mode select on error) |
| 148 | (Action time) | H33 | (Timer operating time) |
| 149 | (No response error detection time) | H38 | (No response error detection time) |
| 150 | (Response interval) | H39 | (Response interval) |
| 151 | X11 to X14 function selection (X11,X12) | E10,E11 | X11 function selection, X12 function selection |
| 152 | (X13,X14) | E12,E13 | X13 function selection, X14 function selection |
| 153 | Y11 to Y13 function selection (Y11,Y12) | E20,E21 | Y11 function selection, Y12 function selection |
| 154 | (Y13) | E22 | Y13 function selection |
| 155 | Function selection of OPCII-VG5-DI | o01,o02 | DIA function selection, DIB function selection |
| 156 | BCD input speed | o03,o04 | DIA BCD input setting, DIB BCD input setting |
| 157 | Reference pulse correction 1 | o14 | Reference pulse correction 1 |
| 158 | Reference pulse correction 2 | o15 | Reference pulse correction 2 |
| 159 | APR gain | o16 | APR gain |
| 160 | F/F gain | o17 | F/F gain |
| 161 | Deviation excess range | o18 | Deviation excess range |
| 162 | Deviation zero range | o19 | Deviation zero range |
| 170 | Function block (171-197) selection | – | |
| 171 | Motor selection | P02 | M1 motor selection |
| 172 | PG pulse number | P28 | M1-PG pulse number |
| 173 | NTC thermistor selection | P30 | M1 thermistor selection |
| 174 | Motor ratings (Capacity) | P03 | M1 rated capacity |
| 175 | (Voltage) | F05 | M1 rated voltage |
| 176 | (Current) | P04 | M1 rated current |
| 177 | (Base speed) | F04 | M1 rated speed |
| 178 | (No. of pole) | P05 | M1 number of pole |
| 179 | Overload capability | – | |
| 180 | Auto-tuning of motor characteristic (Protection) | – | |
| 181 | (Operation) | H01 | Tuning operation selection |
| 182 | Motor characteristic (%R1) | P06 | M1-%R1 |
| 183 | (%X) | P07 | M1-%X |
| 184 | (Exciting current) | P08 | M1 exciting current |
| 185 | (Torque current ) | P09 | M1 torque current |
| 186 | (Slip on driving) | P10 | M1 slip on driving |
| 187 | (Slip on braking) | P11 | M1 slip on braking |
| 188 | (Iron loss coefficient 1) | P12 | M1 iron loss coefficient 1 |
| 189 | (Iron loss coefficient 2) | P13 | M1 iron loss coefficient 2 |
| 190 | (Iron loss coefficient 3) | P14 | M1 iron loss coefficient 3 |
| 191 | (Magnetic saturation coefficient 1) | P15 | M1 magnetic saturation coefficient 1 |
| 192 | (Magnetic saturation coefficient 2) | P16 | M1 magnetic saturation coefficient 2 |
| 193 | (Magnetic saturation coefficient 3) | P17 | M1 magnetic saturation coefficient 3 |
| 194 | (Magnetic saturation coefficient 4) | P18 | M1 magnetic saturation coefficient 4 |
| 195 | (Magnetic saturation coefficient 5) | P19 | M1 magnetic saturation coefficient 5 |
| 196 | (Secondary time constant) | P20 | M1 secondary time constant |
| 197 | (Induced voltage coefficient ) | P21 | M1 induced voltage coefficient |
| 200 | Data protection | F00 | Data protection |

## 13.6.2 Replacing VG3

| FRENIC5000 VG3 | | FRENIC5000 VG7S | |
|---|---|---|---|
| Function codes | Name | Function codes | Name |
| 01 | Motor rotating speed detection value display | – | LED monitor |
| 02 | Motor rotating speed setting value display | – | LED monitor |
| 03 | Load speed detection value display | – | LED monitor |
| 04 | Torque current reference value display | – | LED monitor |
| 05 | Torque reference value display | – | LED monitor |
| 06 | Motor output display | – | LED monitor |
| 07 | Inverter output current display | – | LED monitor |
| 08 | Motor temperature display | – | LED monitor |
| 09 | Input signal (1) display | – | LCD monitor |
| 0A | Input signal (2) display | – | LCD monitor |
| 0B | Output signal display | – | LCD monitor |
| 0C | Operation mode display | – | LCD monitor |
| 0D | Soft switch (1) display | – | LCD monitor |
| 0E | Soft switch (2) display | | LCD monitor |
| 0F | Magnetic-flux quantity | – | LED monitor |
| 10 | Protection of setting data (11-3F) | – | |
| 11 | Acceleration time 1 | F07 | Acceleration time 1 |
| 12 | Deceleration time 1 | F08 | Deceleration time 1 |
| 13 | S-curve applied range | F67<br>F68<br>F69<br>F70 | S-curve acceleration start side 1<br>S-curve acceleration end side 1<br>S-curve deceleration start side 1<br>S-curve deceleration end side 1 |
| 14 | Multistep speed setting value 1 | C05 | Multistep speed 1 |
| 15 | Multistep speed setting value 2 | C06 | Multistep speed 2 |
| 16 | Multistep speed setting value 3 | C07 | Multistep speed 3 |
| 17 | Multistep speed setting value 4 | C08 | Multistep speed 4 |
| 18 | Multistep speed setting value 5 | C09 | Multistep speed 5 |
| 19 | Acceleration time 2 | C46 | Acceleration time 2 |
| 1A | Deceleration time 2 | C47 | Deceleration time 2 |
| 1B | Speed reference input gain | F17 | Gain(Speed setting signal 12) |
| 20 | ASR P(1) | F61 | ASR1 P |
| 21 | ASR I (1) | F62 | ASR1 I |
| 22 | Speed setting constant on filtering (1) | F64 | ASR1 input filter |
| 23 | Speed detection constant on filtering (1) | F65 | ASR1 detection filter |
| 24 | ASR P(2) | C41 | ASR2 P |
| 25 | ASR I (2) | C42 | ASR2 I |
| 26 | Speed setting constant on filtering (2) | C43 | ASR2 input filter |
| 27 | Speed detection constant on filtering (2) | C44 | ASR2 detection filter |
| 28 | Droop quantity | H28 | Droop control |
| 29 | ASR time constant of P changeover switch | C70 | ASR switching time |
| 2A | Torque limiter value 1/Torque bias reference value 1 | F44 | Torque limiter value (Level 1) |
| 2B | Torque limiter value 2/Torque bias reference value 2 | F45 | Torque limiter value (Level 2) |
| 2C | Torque limiter value 3/Torque bias reference value 3 | – | |
| 2D | Torque limiter value 4 | – | |
| 2E | Magnetic-flux reference level | H44 | Magnetic-flux reference value |
| 2F | Magnetic-flux reference level at light load | F73 | Magnetic-flux level at light load |
| 30 | Zero speed detection level | F37 | Stop speed |
| 31 | Arbitrary speed detection level (Absolute value) | E39 | Speed detection level 1 |
| 32 | Arbitrary speed detection level (With polarity) | E40 | Speed detection level 2 |
| 33 | Speed equivalence detection level | E42 | Speed equivalence |
| 34 | Speed agreement detection level | E43 | Speed agreement |
| 35 | Torque detection level | E46 | Torque detection level 1 |
| 36 | Overload early warning detection level | E33 | Inverter overload early warning |
| 37 | Motor overheat early warning detection level | E31 | Motor overheat early warning |
| 38 | Output calibration coefficient of load meter | – | Adjustment is possible through E69 to 71, by allocating the torque meter into AO1 to 3. |
| 39 | Output calibration coefficient of speedometer | – | Adjustment is possible through E69 to 71, by allocating the speedometer into AO1 to 3. |

| FRENIC5000 VG3 | | FRENIC5000 VG7S | |
|---|---|---|---|
| Function codes | Name | Function codes | Name |
| 3A | Stop position by the simplified position control | – | |
| 40 | First fault | – | LED monitor |
| 41 | Second fault | – | LED monitor |
| 42 | Fault condition | – | LCD monitor |
| 43 | Speed setting value at the occurrence of fault. | – | LCD monitor |
| 44 | Speed detection value at the occurrence of fault. | – | LCD monitor |
| 45 | Torque current reference value at the occurrence of fault. | – | LCD monitor |
| 46 | Motor current value (U-phase) at the occurrence of fault. | – | LCD monitor |
| 47 | Motor current value (W-phase) at the occurrence of fault. | – | LCD monitor |
| 48 | Operation mode (LED display) at the occurrence of fault. | – | LCD monitor |
| 49 | Operation mode (HEX display) at the occurrence of fault. | – | LCD monitor |
| 4A | Soft switch 1 (LED display) at the occurrence of fault. | – | LCD monitor |
| 4B | Soft switch 2 (LED display) at the occurrence of fault. | – | LCD monitor |
| 4C | Soft switch (HEX display) at the occurrence of fault. | – | LCD monitor |
| 4D | Last fault (First fault) | – | LCD monitor |
| 4E | Fault before last (First fault) | – | LCD monitor |
| 4F | Fault before and before last (First fault) | – | LCD monitor |
| 50 | Protection of setting data (51-8F) | – | |
| 51 | Max. speed of motor | F03 | M1 max. speed |
| 52 | Base speed of motor | F04 | M1 rated speed |
| 53 | DC brake using/not using. | F22 | DC brake (Braking time) |
| 54 | | | |
| 55 | DC braking time | F22 | DC brake (Braking time) |
| 56 | | | |
| 57 | Speed setting limiter value (Upper limit) | F77 | Speed limiter level 1 |
| 58 | Definition of the operation method (1) | – | |
| 59 | Definition of the operation method (2) | H11 | Automatic operation OFF function |
| 5A | Definition of the Speed setting method (1) | F01 | Speed setting N1 |
| 5B | Definition of forward• reverse command | – | Possible through function selection DI [IVS]. |
| 5C | Calibration coefficient of load speed | F52,53 | LED monitor (Display coefficient) |
| 5D | Definition of the speed detection area | H53 | Line speed feedback selection |
| 5E | Definition of the Speed setting method (2) | C25 | Speed setting N2 |
| 5F | Creep setting of U/D setter | C73 | Creep speed switching |
| 60 | Definition of the torque limiter method | F40 | Torque limiter mode |
| 61 | Definition of the torque limiter value 1/Torque bias reference value 1. | F42 | Torque limiter value (Level1) selection |
| 62 | Definition of the torque limiter value 2/Torque bias reference value 2. | F43 | Torque limiter value (Level2) selection |
| 63 | Definition of the torque limiter value 3/Torque bias reference value 3. | – | |
| 64 | Definition of the torque limiter value 4. | – | |
| 65 | In use/not in use of external Ai for the torque reference. | H41 | Torque reference selection |
| 66 | Definition of the magnetic-flux reference value. | H43 | Magnetic-flux reference selection |
| 70 | LM terminal definition | – | Possible through function selection from AO1 to 3. |
| 71 | SM terminal definition | – | Possible through function selection from AO1 to 3. |
| 72 | DI definition (X1 to X4,X6,X7) | E01 to 04 | X1 to X4 function selection |
| 73 | DI definition (X5) | E05 | X5 function selection |
| 74 | DO definition (Y1 to Y5) | E15 to 18 | Y1 to Y4 function selection |
| 75 | DO definition (RY) | E19 | Y5 function selection |
| 76 | AI definition (Ai1) | E49 | Ai1 function selection |
| 77 | AI definition (Ai2) | E50 | Ai2 function selection |
| 78 | AO definition (AO1) | E69 | AO1 function selection |
| 79 | AO definition (AO2,AO3) | E70,71 | A02,A03 function selection |
| 7A | No. of motor poles, specification for the pulse generator | P28 | No. of PG pulses |
| 7B | V1 enabled/disabled | – | Possible through function selection Ai [OFF]. |
| 80 | Calibration coefficient of BCD input for speed setting | o03,04 | DI BCD input setting. |
| 81 | Definition of the initial setting value of UP/DOWN settor. | F01,C25 | Speed setting N1,N2 |
| 82 | Enabled/disabled of transmission data | H30 | Serial link |
| 83 | Transmission ID code | – | |

# 13. Replacement Data

| FRENIC5000 VG3 | | FRENIC5000 VG7S | |
|---|---|---|---|
| Function codes | Name | Function codes | Name |
| 84 | | | |
| 85 | AO adjustment | – | Possible through AO function selection [P10], [N10]. |
| 86 | AI1 filter | E61 | Ai1 filter |
| 87 | AI2 filter | E62 | Ai2 filter |
| 88 | 12 offset adjustment value | F18 | Bias (Speed setting signal 12) |
| 89 | 12 gain adjustment value | F17 | Gain (Speed setting signal 12) |
| 8A | V1 offset adjustment value | – | |
| 8B | V1 gain adjustment value | – | |
| 8C | AI1 offset adjustment value | E57 | AI1 bias setting |
| 8D | AI1 gain adjustment value | E53 | AI1 gain setting |
| 8E | AI2 offset adjustment value | E58 | AI2 bias setting |
| 8F | AI2 gain adjustment value | E54 | AI2 gain setting |
| 90 | Display of the transmitted and written DI data | S06 | Operation method 1 |
| 91 | Transmission speed setting mode selection | H30 | Serial link |
| 92 | Transmission speed setting | S01 | Speed reference |
| 93 | Transmission speed setting bias | – | |
| 94 | Transmission torque reference mode selection | H41 | Torque reference selection |
| 95 | Transmission torque reference | S02 | Torque reference |
| 96 | General purpose DO | S07 | Universal DO |
| 97 | Trace data mode | – | |
| 98 | | | |
| 99 | | | |
| 9A | Confirmation of data saving condition | H02 | All save |
| 9B | ALL SAVE function | H02 | All save |

# 13.7 Motor Parameters

## 13.7.1 Replacing VG5S

● 200V series

| Motor specification | | | | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | VG5S code No. | | | 03 | 177 | 175 | 174 | 176 | 178 | 182 | 183 | 184 | 185 | 186 | 187 | 188 |
| | | | VG7S code No. | | | F03 | F04 | F05 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Max. speed | Rated speed | Rated voltage | Rated capacity | Rated current | No. of poles | %R1 | %X | Pre-exciting current | Torque current | Slip on driving | Slip On braking | Iron loss co-ef*. 1 |
| MVK6096A | 0.75kW | 4 | 1500/3600 r/min | 188V | 4.3A | 1500r/min | 1500r/min | 188V | 0.75kW | 4.3A | 4 | 4.34% | 9.07% | 3.21A | 2.92A | 1.320Hz | 1.185Hz | 7.60% |
| MVK6097A | 1.5kW | 4 | 1500/3600 r/min | 188V | 7.0A | 1500r/min | 1500r/min | 188V | 5.5kW | 7.0A | 4 | 7.06% | 14.76% | 3.21A | 5.83A | 2.640Hz | 2.370Hz | 3.80% |
| MVK6107A | 2.2kW | 4 | 1500/3600 r/min | 188V | 11A | 1500r/min | 1500r/min | 188V | 2.2KW | 11A | 4 | 8.27% | 12.95% | 3.81A | 9.75A | 2.622Hz | 3.059Hz | 3.00% |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 188V | 18A | 1500r/min | 1500r/min | 188V | 3.7kW | 18A | 4 | 6.86% | 12.69% | 8.11A | 15.69A | 2.500Hz | 2.370Hz | 3.00% |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 188V | 30A | 1500r/min | 1500r/min | 188V | 5.5kW | 30A | 4 | 6.05% | 13.44% | 12.98A | 21.92A | 1.490Hz | 1.440Hz | 3.00% |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 188V | 37A | 1500r/min | 1500r/min | 188V | 7.5kW | 37A | 4 | 6.70% | 12.45% | 15.62A | 30.66A | 1.771Hz | 1.871Hz | 2.32% |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 188V | 50A | 1500r/min | 1500r/min | 188V | 11kW | 50A | 4 | 4.26% | 11.64% | 24.79A | 40.30A | 0.988Hz | 0.824Hz | 4.53% |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 188V | 65A | 1500r/min | 1500r/min | 188V | 15kW | 65A | 4 | 4.47% | 12.25% | 26.99A | 53.96A | 1.067Hz | 1.067Hz | 0.00% |
| MVK6184A | 18.5kW | 4 | 1500/3600 r/min | 188V | 74A | 1500r/min | 1500r/min | 188V | 18.5kW | 74A | 4 | 3.22% | 10.68% | 30.58A | 72.83A | 0.934Hz | 0.931Hz | 3.50% |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 188V | 90A | 1500r/min | 1500r/min | 188V | 22kW | 90A | 4 | 3.59% | 11.78% | 34.17A | 83.43A | 0.606Hz | 0.855Hz | 1.30% |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 188V | 116A | 1500r/min | 1500r/min | 188V | 30kW | 116A | 4 | 2.53% | 12.13% | 53.42A | 108.18A | 0.606Hz | 0.648Hz | 2.50% |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 188V | 143A | 1500r/min | 1500r/min | 188V | 37kW | 143A | 4 | 2.47% | 14.69% | 60.09A | 133.20A | 0.497Hz | 0.536Hz | 1.80% |
| MVK6208A | 45kW | 4 | 1500/3000 r/min | 188V | 170A | 1500r/min | 1500r/min | 188V | 45kW | 170A | 4 | 2.73% | 15.26% | 56.71A | 169.70A | 0.947Hz | 0.901Hz | 1.00% |
| MVK9250A | 55kW | 4 | 1500/2400 r/min | 185V | 216A | 1500r/min | 1500r/min | 185V | 55kW | 216A | 4 | 2.08% | 12.36% | 66.22A | 197.97A | 0.621Hz | 0.595Hz | 3.00% |
| MVK9252A | 75kW | 4 | 1500/2400 r/min | 183V | 276A | 1500r/min | 1500r/min | 183V | 75kW | 276A | 4 | 1.70% | 15.29% | 99.34A | 261.62A | 0.638Hz | 0.665Hz | 2.00% |
| MVK9280A | 90kW | 4 | 1500/2000 r/min | 183V | 345A | 1500r/min | 1500r/min | 183V | 90kW | 345A | 4 | 2.28% | 20.12% | 89.3A | 332.34A | 0.669Hz | 0.546Hz | 0.00% |

| Motor specification | | | | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | VG5S code No. | | | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | C03 | C04 | 1.000 | C14 |
| | | | VG7S code No. | | | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 |
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Iron loss co-ef*. 2 | Iron loss co-ef*. 3 | Magnetic saturation co-ef*. 1 | Magnetic saturation co-ef*. 2 | Magnetic saturation co-ef*. 3 | Magnetic saturation co-ef*. 4 | Magnetic saturation co-ef*. 5 | Secondary time constant | Induced voltage co-ef*. | R2 correction co-ef*. 1 | R2 correctionc o-ef*. 2 | R3 correction co-ef*. | Pre-exciting current correction co-ef*. |
| MVK6096A | 0.75kW | 4 | 1500/3600 r/min | 188V | 4.3A | 7.60% | 10.00% | 93.0% | 85.8% | 72.6% | 60.0% | 47.6% | 0.108s | 149V | 1.360 | 1.480 | 1.000 | 0.000 |
| MVK6097A | 1.5kW | 4 | 1500/3600 r/min | 188V | 7.0A | 3.80% | 5.00% | 93.0% | 85.8% | 72.6% | 60.0% | 47.6% | 0.108s | 149V | 1.360 | 1.480 | 1.000 | 0.000 |
| MVK6107A | 2.2kW | 4 | 1500/3600 r/min | 188V | 11A | 4.00% | 1.00% | 85.2% | 73.7% | 59.1% | 47.6% | 37.4% | 0.051s | 140V | 2.530 | 1.133 | 1.000 | 0.000 |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 188V | 18A | 2.95% | 2.50% | 88.4% | 80.1% | 66.4% | 54.1% | 43.0% | 0.084s | 146V | 0.899 | 1.320 | 1.000 | 0.022 |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 188V | 30A | 2.50% | 3.00% | 88.3% | 79.5% | 66.0% | 54.1% | 43.0% | 0.090s | 149V | 1.925 | 1.985 | 1.000 | 0.026 |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 188V | 37A | 1.76% | 3.00% | 85.3% | 70.7% | 53.8% | 43.7% | 34.4% | 0.070s | 155V | 0.900 | 0.900 | 1.000 | 0.000 |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 188V | 50A | 1.88% | 0.22% | 84.9% | 75.0% | 61.6% | 50.0% | 39.4% | 0.087s | 175V | 0.900 | 2.343 | 1.000 | 0.000 |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 188V | 65A | 1.50% | 1.00% | 88.7% | 80.7% | 67.2% | 55.2% | 44.0% | 0.133s | 160V | 1.689 | 1.689 | 1.000 | 0.000 |
| MVK6184A | 18.5kW | 4 | 1500/3600 r/min | 188V | 74A | 0.50% | 0.50% | 90.7% | 83.2% | 69.5% | 56.8% | 44.4% | 0.240s | 160V | 1.465 | 1.803 | 1.000 | 0.097 |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 188V | 90A | 0.77% | 2.00% | 91.1% | 83.2% | 69.1% | 56.8% | 44.6% | 0.387s | 160V | 4.000 | 2.200 | 1.000 | 0.089 |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 188V | 116A | 3.50% | 5.00% | 84.4% | 74.0% | 59.5% | 48.9% | 38.0% | 0.173s | 166V | 2.268 | 2.078 | 1.000 | 0.000 |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 188V | 143A | 3.00% | 5.00% | 85.4% | 75.7% | 62.3% | 50.5% | 39.9% | 0.184s | 168V | 3.200 | 2.560 | 1.000 | 0.180 |
| MVK6208A | 45kW | 4 | 1500/3000 r/min | 188V | 170A | 0.00% | 0.15% | 89.2% | 81.6% | 67.6% | 56.2% | 43.4% | 0.295s | 164V | 1.229 | 1.813 | 1.000 | 0.178 |
| MVK9250A | 55kW | 4 | 1500/2400 r/min | 185V | 216A | 0.83% | 0.21% | 91.5% | 83.8% | 70.6% | 57.8% | 45.6% | 0.413s | 168V | 1.615 | 1.753 | 1.000 | 0.000 |
| MVK9252A | 75kW | 4 | 1500/2400 r/min | 183V | 276A | 2.00% | 0.00% | 90.4% | 83.0% | 68.4% | 57.4% | 46.4% | 0.409s | 165V | 1.856 | 1.785 | 1.000 | 0.091 |
| MVK9280A | 90kW | 4 | 1500/2000 r/min | 183V | 345A | 5.00% | 0.00% | 91.1% | 85.1% | 70.9% | 59.2% | 48.7% | 0.490s | 181V | 1.331 | 1.428 | 1.000 | 0.000 |

*co-ef.: coefficient

Note : The above table shows the setting values of VG7.

# 13. Replacement Data

● 400V series

| Motor specification | | | | | | Motor parameters | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | VG5S code No. | | | 03 | 177 | 175 | 174 | 176 | 178 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 |
| | | | VG7S code No. | | | F03 | F04 | F05 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 | P13 |
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Max. speed | Rated speed | Rated voltage | Rated capacity | Rated current | No. of poles | %R1 | %X | Pre-exciting current | Torque current | Slip On driving | Slip On braking | Iron loss co-ef*. 1 | Iron loss co-ef*. 2 |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 376V | 9A | 1500r/min | 1500r/min | 376V | 3.7kW | 9A | 4 | 6.86% | 13.94% | 3.93A | 7.78A | 2.510Hz | 2.340Hz | 2.35% | 2.55% |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 376V | 15A | 1500r/min | 1500r/min | 376V | 5.5kW | 15A | 4 | 5.50% | 12.78% | 7.15A | 10.74A | 1.311Hz | 1.370Hz | 2.00% | 5.00% |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 376V | 18.5A | 1500r/min | 1500r/min | 376V | 7.5kW | 18.5A | 4 | 4.37% | 13.72% | 7.81A | 15.33A | 1.465Hz | 1.686Hz | 7.61% | 2.00% |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 376V | 25.0A | 1500r/min | 1500r/min | 376V | 11kW | 25A | 4 | 4.27% | 11.67% | 12.39A | 20.15A | 0.988Hz | 0.824Hz | 4.53% | 1.88% |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 376V | 31.7A | 1500r/min | 1500r/min | 376V | 15kW | 31.7A | 4 | 4.48% | 13.69% | 14.47A | 28.63A | 1.290Hz | 1.269Hz | 1.00% | 0.50% |
| MVK6184A | 18.5kW | 4 | 1500/3600 r/min | 376V | 37A | 1500r/min | 1500r/min | 376V | 18.5kW | 37A | 4 | 2.66% | 12.45% | 14.02A | 36.06A | 0.882Hz | 0.882Hz | 1.00% | 3.00% |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 376V | 45A | 1500r/min | 1500r/min | 376V | 22kW | 45A | 4 | 3.61% | 14.06% | 16.81A | 41.72A | 0.903Hz | 0.891Hz | 1.50% | 1.50% |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 376V | 58A | 1500r/min | 1500r/min | 376V | 30kW | 58A | 4 | 2.55% | 12.16% | 25.74A | 52.52A | 0.666Hz | 0.648Hz | 2.50% | 3.50% |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 376V | 143A | 1500r/min | 1500r/min | 376V | 37kW | 71A | 4 | 2.49% | 14.11% | 30.07A | 65.54A | 0.497Hz | 0.498Hz | 1.79% | 1.80% |
| MVK6208A | 45kW | 4 | 1500/3000 r/min | 376V | 85A | 1500r/min | 1500r/min | 376V | 45kW | 85A | 4 | 2.73% | 15.30% | 28.36A | 84.85A | 0.947Hz | 0.937Hz | 0.50% | 1.50% |
| MVK9250A | 55kW | 4 | 1500/2400 r/min | 376V | 108A | 1500r/min | 1500r/min | 376V | 55kW | 108A | 4 | 2.05% | 12.20% | 33.11A | 98.98A | 0.621Hz | 0.595Hz | 3.00% | 0.83% |
| MVK9252A | 75kW | 4 | 1500/2400 r/min | 365V | 138A | 1500r/min | 1500r/min | 365V | 75kW | 138A | 4 | 1.71% | 15.39% | 49.67A | 130.81A | 0.638Hz | 0.665Hz | 2.00% | 2.00% |
| MVK9280A | 90kW | 4 | 1500/2000 r/min | 370V | 173A | 1500r/min | 1500r/min | 370V | 90kW | 173A | 4 | 2.23% | 18.47% | 44.37A | 164.10A | 0.685Hz | 0.647Hz | 0.00% | 2.00% |
| MVK9282A | 110kW | 4 | 1500/3000 r/min | 375V | 206A | 1500r/min | 1500r/min | 375V | 110kW | 206A | 4 | 2.14% | 16.83% | 53.03A | 195.87A | 0.557Hz | 0.606Hz | 0.44% | 0.00% |
| MVK9310A | 132kW | 4 | 1500/3000 r/min | 375V | 248A | 1500r/min | 1500r/min | 375V | 132kW | 248A | 4 | 1.56% | 17.21% | 62.05A | 237.35A | 0.481Hz | 0.531Hz | 0.00% | 0.39% |
| MVK9312A | 160kW | 4 | 1500/2400 r/min | 375V | 297A | 1500r/min | 1500r/min | 375V | 160kW | 297A | 4 | 1.15% | 17.47% | 70.71A | 28637A | 0.518Hz | 0.518Hz | 0.00% | 0.00% |
| MVK9316A | 200kW | 4 | 1500/2400 r/min | 375V | 369A | 1500r/min | 1500r/min | 369A | 200kW | 369A | 4 | 1.15% | 14.98% | 107.66A | 341.50A | 0.470Hz | 0.441Hz | 0.00% | 2.50% |
| MVK9318A | 220kW | 4 | 1500/2000 r/min | 370V | 409A | 1500r/min | 1500r/min | 370V | 220kW | 409A | 4 | 1.63% | 14.54% | 98.64A | 385.37A | 0.447Hz | 0.458Hz | 1.00% | 1.00% |

| Motor specification | | | | | | Motor parameters | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | VG5S code No. | | | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | C03 | C04 | 1.000 | C14 |
| | | | VG7S code No. | | | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 |
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Iron loss co-ef*. 3 | Magnetic saturation co-ef*. 1 | Magnetic saturation co-ef*. 2 | Magnetic saturation co-ef*. 3 | Magnetic saturation co-ef*. 4 | Magnetic saturation co-ef*. 5 | Secondary time constant | Induced voltage co-ef*. | R2 correction co-ef*. 1 | R2 correction co-ef*. 2 | R3 Correction co-ef*. | Pre- exciting Current correction co-ef*. |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 376V | 9A | 1.20% | 90.5% | 82.4% | 68.7% | 57.0% | 45.3% | 0.104s | 294V | 0.880 | 1.440 | 1.000 | 0.028 |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 376V | 15A | 7.00% | 88.0% | 79.2% | 65.6% | 53.6% | 42.2% | 0.078s | 299V | 2.361 | 1.985 | 1.000 | 0.019 |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 376V | 18.5A | 1.00% | 85.9% | 76.9% | 63.4% | 51.6% | 40.5% | 0.064s | 310V | 1.607 | 1.427 | 1.000 | 0.000 |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 376V | 25.0A | 0.22% | 84.9% | 75.0% | 61.6% | 50.0% | 39.4% | 0.087s | 348V | 0.910 | 2.343 | 1.000 | 0.000 |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 376V | 31.7A | 1.00% | 88.7% | 81.7% | 67.2% | 55.2% | 44.0% | 0.133s | 306V | 1.090 | 1.318 | 1.000 | 0.027 |
| MVK6184A | 18.5kW | 4 | 1500/3600 r/min | 376V | 37A | 3.00% | 92.5% | 84.3% | 70.3% | 57.1% | 45.1% | 0.295s | 321V | 1.825 | 1.825 | 1.000 | 0.018 |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 376V | 45A | 3.00% | 91.1% | 83.2% | 69.1% | 56.5% | 44.6% | 0.387s | 320V | 1.357 | 1.673 | 1.000 | 0.037 |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 376V | 58A | 9.50% | 84.4% | 74.0% | 59.5% | 48.9% | 38.0% | 0.173s | 331V | 2.268 | 2.078 | 1.000 | 0.070 |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 376V | 143A | 5.00% | 85.4% | 75.7% | 62.3% | 50.5% | 39.9% | 0.184s | 336V | 3.200 | 3.064 | 1.000 | 0.095 |
| MVK6208A | 45kW | 4 | 1500/3000 r/min | 376V | 85A | 1.85% | 89.2% | 81.6% | 67.6% | 56.2% | 43.4% | 0.295s | 328V | 1.229 | 1.502 | 1.000 | 0.089 |
| MVK9250A | 55kW | 4 | 1500/2400 r/min | 376V | 108A | 0.21% | 91.5% | 83.8% | 70.6% | 57.8% | 45.6% | 0.413s | 336V | 1.615 | 1.753 | 1.000 | 0.000 |
| MVK9252A | 75kW | 4 | 1500/2400 r/min | 365V | 138A | 0.00% | 90.4% | 83.0% | 68.4% | 57.4% | 46.4% | 0.409s | 330V | 1.856 | 1.785 | 1.000 | 0.091 |
| MVK9280A | 90kW | 4 | 1500/2000 r/min | 370V | 173A | 0.00% | 90.7% | 83.7% | 69.0% | 57.1% | 44.9% | 0.590s | 348V | 1.093 | 1.212 | 1.000 | 0.163 |
| MVK9282A | 110kW | 4 | 1500/3000 r/min | 375V | 206A | 0.00% | 90.1% | 82.6% | 67.7% | 56.3% | 44.2% | 0.577s | 350V | 1.488 | 1.172 | 1.000 | 0.090 |
| MVK9310A | 132kW | 4 | 1500/3000 r/min | 375V | 248A | 0.00% | 90.1% | 81.2% | 67.7% | 56.2% | 45.9% | 0.689s | 336V | 1.468 | 1.424 | 1.000 | 0.000 |
| MVK9312A | 160kW | 4 | 1500/2400 r/min | 375V | 297A | 0.00% | 91.0% | 84.3% | 71.8% | 59.1% | 47.7% | 1.127s | 330V | 1.496 | 1.496 | 1.000 | 0.000 |
| MVK9316A | 200kW | 4 | 1500/2400 r/min | 375V | 369A | 0.00% | 93.8% | 87.6% | 74.8% | 60.6% | 48.2% | 1.026s | 342V | 1.175 | 1.358 | 1.000 | 0.104 |
| MVK9318A | 220kW | 4 | 1500/2000 r/min | 370V | 409A | 0.00% | 95.1% | 88.5% | 75.0% | 63.1% | 51.3% | 1.758s | 361V | 1.535 | 1.513 | 1.000 | 0.078 |

*co-ef.: coefficient

Note : The above table shows the setting values of VG7.

## 13.7.2 Replacing VG3

### ● 200V series

| Motor specification | | | VG7S code No. | | | Motor parameters F03 | F04 | F05 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Max. speed | Rated speed | Rated voltage | Rated capacity | Rated current | No. of poles | %R1 | %X | Pre-exciting current | Torque current | Slip on driving | Slip on braking | Iron loss co-ef*. 1 |
| MVK6097A | 0.75Kw | 4 | 1500/3600 r/min | 160V | 4.0A | 1500r/min | 1500r/min | 160V | 0.75kW | 5.4A | 4 | 4.62% | 9.16% | 2.65A | 4.55A | 2.360Hz | 2.560Hz | 2.30% |
| MVK6097A | 1.5kW | 4 | 1500/3600 r/min | 160V | 8.0A | 1500r/min | 1500r/min | 160V | 1.5kW | 9.8A | 4 | 8.36% | 16.59% | 2.65A | 9.09A | 4.700Hz | 5.100Hz | 2.30% |
| MVK6098A | 2.2kW | 4 | 1500/3600 r/min | 160V | 12.5A | 1500r/min | 1500r/min | 160V | 2.2KW | 12.2A | 4 | 7.82% | 13.73% | 4.15A | 11.00A | 3.340Hz | 3.600Hz | 4.80% |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 160V | 20A | 1500r/min | 1500r/min | 160V | 3.7kW | 19.9A | 4 | 7.06% | 14.40% | 7.25A | 18.60A | 2.540Hz | 3.440Hz | 0.00% |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 160V | 31A | 1500r/min | 1500r/min | 160V | 5.5kW | 30.2A | 4 | 4.88% | 13.44% | 14.93A | 26.10A | 1.680Hz | 2.200Hz | 0.00% |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 160V | 41A | 1500r/min | 1500r/min | 160V | 7.5kW | 41.8A | 4 | 4.96% | 13.75% | 18.90A | 37.30A | 1.960Hz | 2.000Hz | 0.00% |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 160V | 58A | 1500r/min | 1500r/min | 160V | 11kW | 54.7A | 4 | 3.80% | 13.99% | 24.00A | 49.10A | 1.320Hz | 1.500Hz | 0.00% |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 160V | 74A | 1500r/min | 1500r/min | 160V | 15kW | 70.5A | 4 | 3.17% | 13.21% | 28.20A | 64.60A | 1.320Hz | 1.520Hz | 0.00% |
| MVK6184A | 18.5kW | 4 | 1500/3600 r/min | 160V | 90A | 1500r/min | 1500r/min | 160V | 18.5kW | 89.6A | 4 | 2.63% | 13.94% | 36.80A | 81.70A | 0.820Hz | 0.940Hz | 0.00% |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 160V | 106A | 1500r/min | 1500r/min | 160V | 22kW | 104.3A | 4 | 2.49% | 13.21% | 45.70A | 93.80A | 0.780Hz | 1.000Hz | 0.00% |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 160V | 142A | 1500r/min | 1500r/min | 160V | 30kW | 140.6A | 4 | 2.59% | 15.06% | 51.20A | 130.90A | 0.800Hz | 0.940Hz | 0.00% |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 160V | 177A | 1500r/min | 1500r/min | 160V | 37kW | 164.5A | 4 | 2.46% | 14.03% | 51.10A | 156.30A | 0.720Hz | 0.940Hz | 0.00% |
| MVK6207A | 45kW | 4 | 1500/3000 r/min | 160V | 203A | 1500r/min | 1500r/min | 160V | 45kW | 195.6A | 4 | 2.50% | 16.36% | 54.40A | 187.90A | 0.960Hz | 1.100Hz | 0.00% |

| Motor specification | | | VG7S code No. | | | Motor parameters P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Iron loss co-ef*. 2 | Iron loss co-ef*. 3 | Magnetic saturation co-ef*. 1 | Magnetic saturation co-ef*. 2 | Magnetic saturation co-ef*. 3 | Magnetic saturation co-ef*. 4 | Magnetic saturation co-ef*. 5 | Secondary time constant | Induced voltage co-ef*. | R2 correction co-ef*. 1 | R2 correction co-ef*. 2 | R3 correction co-ef*. | Pre-exciting current correction co-ef*. |
| MVK6097A | 0.75Kw | 4 | 1500/3600 r/min | 160V | 4.0A | 1.90% | 0.10% | 94.1% | 87.8% | 74.9% | 62.7% | 50.2% | 0.152s | 96V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6097A | 1.5kW | 4 | 1500/3600 r/min | 160V | 8.0A | 1.90% | 0.10% | 94.1% | 87.8% | 74.9% | 62.7% | 50.2% | 0.152s | 96V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6098A | 2.2kW | 4 | 1500/3600 r/min | 160V | 12.5A | 0.00% | 0.10% | 93.7% | 87.1% | 74.1% | 60.8% | 47.8% | 0.096s | 116V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 160V | 20A | 0.00% | 0.10% | 89.4% | 80.4% | 66.7% | 54.5% | 42.7% | 0.172s | 115V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 160V | 31A | 0.00% | 0.00% | 87.1% | 77.6% | 63.5% | 51.8% | 40.8% | 0.200s | 122V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 160V | 41A | 0.00% | 0.00% | 82.8% | 72.3% | 58.6% | 48.0% | 38.3% | 0.220s | 120V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 160V | 58A | 0.00% | 0.00% | 77.6% | 79.6% | 65.9% | 53.7% | 43.1% | 0.320s | 130V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 160V | 74A | 0.00% | 0.00% | 91.0% | 83.1% | 69.0% | 56.9% | 45.1% | 0.336s | 135V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6184A | 18.5kW | 4 | 1500/3600 r/min | 160V | 90A | 0.00% | 0.00% | 89.4% | 80.0% | 62.7% | 50.2% | 40.0% | 0.364s | 131V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 160V | 106A | 0.00% | 0.00% | 89.4% | 81.2% | 67.5% | 50.2% | 43.9% | 0.384s | 136V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 160V | 142A | 0.00% | 0.00% | 89.8% | 80.4% | 65.9% | 53.7% | 42.4% | 0.568s | 133V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 160V | 177A | 0.00% | 0.00% | 90.6% | 80.4% | 65.9% | 54.1% | 43.1% | 0.484s | 137V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6207A | 45kW | 4 | 1500/3000 r/min | 160V | 203A | 0.00% | 0.00% | 91.4% | 82.7% | 69.0% | 57.3% | 45.5% | 0.732s | 138V | 1.000 | 1.000 | 1.000 | 0.000 |

*co-ef.: coefficient

Note : The above value is the setting value of VG7.

# 13. Replacement Data

## ● 400V series

| Motor specification | | | VG7S code No. | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | F03 | F04 | F05 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Max. speed | Rated speed | Rated voltage | Rated capacity | Rated current | No. of poles | %R1 | %X | Pre-exciting current | Torque current | Slip on driving | Slip on braking | Iron loss co-ef*. 1 |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 320V | 10A | 1500r/min | 1500r/min | 320V | 3.7kW | 10A | 4 | 7.07% | 14.40% | 3.62A | 9.30A | 2.540Hz | 3.280Hz | 0.00% |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 320V | 15.5A | 1500r/min | 1500r/min | 320V | 5.5kW | 15.1A | 4 | 4.89% | 13.44% | 7.50A | 13.10A | 1.680Hz | 1.880Hz | 0.00% |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 320V | 20.5A | 1500r/min | 1500r/min | 320V | 7.5kW | 20.3A | 4 | 4.84% | 13.35% | 9.30A | 18.00A | 1.960Hz | 2.000Hz | 0.00% |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 320V | 29A | 1500r/min | 1500r/min | 320V | 11kW | 27.4A | 4 | 3.79% | 14.03% | 12.00A | 24.60A | 1.320Hz | 1.420Hz | 0.00% |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 320V | 37A | 1500r/min | 1500r/min | 320V | 15kW | 35.3A | 4 | 3.17% | 13.24% | 14.10A | 32.30A | 1.200Hz | 1.400Hz | 0.00% |
| MVK6185A | 18.5kW | 4 | 1500/3600 r/min | 320V | 45A | 1500r/min | 1500r/min | 320V | 18.5kW | 44.5A | 4 | 2.60% | 13.86% | 18.10A | 39.00A | 0.940Hz | 0.960Hz | 1.10% |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 320V | 53A | 1500r/min | 1500r/min | 320V | 22kW | 53.2A | 4 | 2.52% | 13.46% | 19.90A | 47.60A | 0.960Hz | 1.000Hz | 2.20% |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 320V | 71A | 1500r/min | 1500r/min | 320V | 30kW | 70.3A | 4 | 2.57% | 15.08% | 25.60A | 65.50A | 0.800Hz | 0.940Hz | 0.00% |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 320V | 89A | 1500r/min | 1500r/min | 320V | 37kW | 78.4A | 4 | 2.35% | 13.38% | 25.20A | 74.30A | 0.740Hz | 0.860Hz | 0.00% |
| MVK6208A | 45kW | 4 | 1500/3000 r/min | 320V | 102A | 1500r/min | 1500r/min | 320V | 45kW | 97.8A | 4 | 2.49% | 16.38% | 27.20A | 94.00A | 0.840Hz | 1.100Hz | 0.00% |
| MVK5256A | 75kW | 4 | 1500/2400 r/min | 320V | 170A | 1500r/min | 1500r/min | 320V | 75kW | 170A | 4 | 1.73% | 14.88% | 47.38A | 162.78A | 0.840Hz | 0.960Hz | 0.00% |

| Motor specification | | | VG7S code No. | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 |
| Type | Capacity | No. of poles | Speed (Rated/Max.) | Voltage | Current | Iron loss co-ef*. 2 | Iron loss co-ef*. 3 | Magnetic saturation co-ef*. 1 | Magnetic saturation co-ef*. 2 | Magnetic saturation co-ef*. 3 | Magnetic saturation co-ef* . 4 | Magnetic saturation co-ef* . 5 | Secondary time constant | Induced voltage co-ef* . | R2 correction co-ef*. 1 | R2 correction co-ef*. 2 | R3 correction co-ef*. | Pre-exciting current correctionco-ef*. |
| MVK6115A | 3.7kW | 4 | 1500/3600 r/min | 320V | 10A | 0.00% | 0.00% | 89.4% | 80.4% | 66.7% | 54.5% | 42.7% | 0.172s | 230V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6133A | 5.5kW | 4 | 1500/3600 r/min | 320V | 15.5A | 0.00% | 0.00% | 87.1% | 77.6% | 63.5% | 51.8% | 40.8% | 0.200s | 242V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6135A | 7.5kW | 4 | 1500/3600 r/min | 320V | 20.5A | 0.00% | 0.00% | 86.7% | 76.1% | 60.8% | 49.4% | 38.4% | 0.224s | 241V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6165A | 11kW | 4 | 1500/3600 r/min | 320V | 29A | 0.00% | 0.00% | 88.6% | 79.6% | 65.9% | 53.7% | 43.1% | 0.320s | 258V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6167A | 15kW | 4 | 1500/3600 r/min | 320V | 37A | 0.00% | 0.00% | 91.0% | 83.1% | 69.0% | 56.9% | 45.1% | 0.336s | 268V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6185A | 18.5kW | 4 | 1500/3600 r/min | 320V | 45A | 3.10% | 1.70% | 91.4% | 83.1% | 68.6% | 56.1% | 45.9% | 0.412s | 274V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6185A | 22kW | 4 | 1500/3600 r/min | 320V | 53A | 1.60% | 0.70% | 92.9% | 85.1% | 71.4% | 58.8% | 46.7% | 0.412s | 267V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6206A | 30kW | 4 | 1500/3000 r/min | 320V | 71A | 0.00% | 0.00% | 89.8% | 80.4% | 65.9% | 53.7% | 42.4% | 0.568s | 265V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6207A | 37kW | 4 | 1500/3000 r/min | 320V | 89A | 0.00% | 0.00% | 90.6% | 80.8% | 67.5% | 52.5% | 40.8% | 0.460s | 288V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK6208A | 45kW | 4 | 1500/3000 r/min | 320V | 102A | 0.00% | 0.00% | 91.4% | 82.7% | 69.0% | 57.3% | 45.5% | 0.732s | 277V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5256A | 75kW | 4 | 1500/2400 r/min | 320V | 170A | 0.00% | 0.00% | 92.6% | 85.2% | 72.3% | 60.5% | 48.4% | 0.576s | 266V | 1.000 | 1.000 | 1.000 | 0.000 |

*co-ef.: coefficient

Note : The above value is the setting value of VG7.

# 13.7.3 Replacing VG

● 200V series

| Motor specification | | | VG7S code No. | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | F03 | F04 | F05 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
| Type | Capacity | No.of pole | Speed (Rated/Max.) | Voltage | Current | Max.speed | Rated speed | Rated voltage | Rated capacity | Rated current | No.of pole | %R1 | %X | Pre-exciting current | Torque current | Slip on driving | Slip on braking | Iron loss co-ef*. 1 |
| MVK3115A | 3.7kW | 4 | 1500/3600 r/min | 160V | 20A | 1500r/min | 1500r/min | 160V | 3.7kW | 19.9A | 4 | 7.07% | 14.40% | 7.25A | 18.60A | 2.540Hz | 3.440Hz | 0.00% |
| MVK3133A | 5.5kW | 4 | 1500/3600 r/min | 160V | 31A | 1500r/min | 1500r/min | 160V | 5.5kW | 30.2A | 4 | 4.89% | 13.44% | 14.93A | 26.10A | 1.680Hz | 2.200Hz | 0.00% |
| MVK3135A | 7.5kW | 4 | 1500/3600 r/min | 160V | 41A | 1500r/min | 1500r/min | 160V | 7.5kW | 41.8A | 4 | 4.98% | 13.75% | 18.90A | 37.30A | 1.960Hz | 2.000Hz | 0.00% |
| MVK3165A | 11kW | 4 | 1500/3600 r/min | 160V | 58A | 1500r/min | 1500r/min | 160V | 11kW | 54.7A | 4 | 3.79% | 13.97% | 24.00A | 49.10A | 1.320Hz | 1.500Hz | 0.00% |
| MVK3167A | 15kW | 4 | 1500/3600 r/min | 160V | 74A | 1500r/min | 1500r/min | 160V | 15kW | 70.5A | 4 | 3.17% | 13.21% | 28.20A | 64.60A | 1.320Hz | 1.520Hz | 0.00% |
| MVK3184A | 18.5kW | 4 | 1500/3600 r/min | 160V | 86.3A | 1500r/min | 1500r/min | 160V | 18.5kW | 86.3A | 4 | 2.55% | 13.58% | 31.69A | 80.28A | 0.920Hz | 1.060Hz | 0.00% |
| MVK5187A | 22kW | 4 | 1500/3600 r/min | 160V | 106A | 1500r/min | 1500r/min | 160V | 22kW | 106A | 4 | 2.49% | 13.21% | 42.28A | 95.60A | 0.960Hz | 0.960Hz | 0.00% |
| MVK5206A | 30kW | 4 | 1500/3000 r/min | 160V | 142A | 1500r/min | 1500r/min | 160V | 30kW | 142A | 4 | 2.49% | 11.74% | 57.83A | 135.3A | 1.200Hz | 1.200Hz | 0.00% |
| MVK5207A | 37kW | 4 | 1500/3000 r/min | 160V | 178A | 1500r/min | 1500r/min | 160V | 37kW | 178A | 4 | 1.24% | 7.30% | 70.97A | 160.9A | 0.685Hz | 0.685Hz | 0.00% |
| MVK5223A | 45kW | 4 | 1500/3000 r/min | 160V | 210A | 1500r/min | 1500r/min | 160V | 45kW | 210A | 4 | 2.01% | 14.34% | 68.97A | 191.9A | 0.854Hz | 0.854Hz | 0.00% |

| Motor specification | | | VG7S code No. | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 |
| Type | Capacity | No.of pole | Speed (Rated/Max.) | Voltage | Current | Iron loss co-ef*. 2 | Iron loss co-ef*. 3 | Magnetic saturation co-ef*. 1 | Magnetic saturation co-ef*. 2 | Magnetic saturation co-ef*. 3 | Magnetic saturation co-ef*. 4 | Magnetic saturation co-ef*. 5 | Secondary time constant | Induced voltage co-ef*. | R2 correction co-ef*. 1 | R2 correction co-ef*. 2 | R3 correction co-ef*. | Pre-exciting current Correction co-ef*. |
| MVK3115A | 3.7kW | 4 | 1500/3600 r/min | 160V | 20A | 0.00% | 0.00% | 89.4% | 80.4% | 66.7% | 54.5% | 42.7% | 0.172s | 115V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3133A | 5.5kW | 4 | 1500/3600 r/min | 160V | 31A | 0.00% | 0.00% | 87.1% | 77.6% | 63.5% | 51.8% | 40.8% | 0.200s | 122V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3135A | 7.5kW | 4 | 1500/3600 r/min | 160V | 41A | 0.00% | 0.00% | 82.8% | 72.3% | 58.6% | 48.0% | 38.3% | 0.220s | 120V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3165A | 11kW | 4 | 1500/3600 r/min | 160V | 58A | 0.00% | 0.00% | 77.6% | 79.6% | 65.9% | 53.7% | 43.1% | 0.320s | 130V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3167A | 15kW | 4 | 1500/3600 r/min | 160V | 74A | 0.00% | 0.00% | 91.0% | 83.1% | 69.0% | 56.9% | 45.1% | 0.336s | 135V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3184A | 18.5kW | 4 | 1500/3600 r/min | 160V | 86.3A | 0.00% | 0.00% | 91.8% | 84.0% | 71.1% | 58.2% | 45.7% | 0.312s | 133V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5187A | 22kW | 4 | 1500/3600 r/min | 160V | 106A | 0.00% | 0.00% | 92.6% | 84.8% | 71.1% | 58.6% | 46.5% | 0.412s | 136V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5206A | 30kW | 4 | 1500/3000 r/min | 160V | 142A | 0.00% | 0.00% | 92.7% | 85.4% | 70.8% | 57.6% | 45.0% | 0.349s | 129V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5207A | 37kW | 4 | 1500/3000 r/min | 160V | 178A | 0.00% | 0.00% | 90.5% | 81.3% | 67.3% | 55.3% | 44.3% | 0.423s | 146V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5223A | 45kW | 4 | 1500/3000 r/min | 160V | 210A | 0.00% | 0.00% | 91.0% | 83.1% | 69.5% | 57.9% | 46.3% | 0.483s | 149V | 1.000 | 1.000 | 1.000 | 0.000 |

*co-ef.: coefficient

Note : The above value is the setting value of VG7.

# 13. Replacement Data

## ● 400V series

| Motor specification | | | VG7S code No. | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | F03 | F04 | F05 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
| Type | Capacity | No.of pole | Speed (Rated/Max.) | Voltage | Current | Max.speed | Rated speed | Rated voltage | Rated capacity | Rated current | No.of pole | %R1 | %X | Pre-exciting current | Torque current | Slip on driving | Slip on braking | Iron loss co-ef*. 1 |
| MVK3115A | 3.7kW | 4 | 1500/3600 r/min | 320V | 10A | 1500r/min | 1500r/min | 320V | 3.7kW | 10A | 4 | 7.07% | 14.40% | 3.62A | 9.30A | 2.540Hz | 3.280Hz | 0.00% |
| MVK3133A | 5.5kW | 4 | 1500/3600 r/min | 320V | 15.5A | 1500r/min | 1500r/min | 320V | 5.5kW | 15.1A | 4 | 4.89% | 13.44% | 7.50A | 13.10A | 1.680Hz | 1.880Hz | 0.00% |
| MVK3135A | 7.5kW | 4 | 1500/3600 r/min | 320V | 20.5A | 1500r/min | 1500r/min | 320V | 7.5kW | 20.3A | 4 | 4.84% | 13.35% | 9.30A | 18.00A | 1.960Hz | 2.000Hz | 0.00% |
| MVK3165A | 11kW | 4 | 1500/3600 r/min | 320V | 29A | 1500r/min | 1500r/min | 320V | 11kW | 27.4A | 4 | 3.79% | 14.03% | 12.00A | 24.60A | 1.320Hz | 1.420Hz | 0.00% |
| MVK3167A | 15kW | 4 | 1500/3600 r/min | 320V | 37A | 1500r/min | 1500r/min | 320V | 15kW | 35.3A | 4 | 3.17% | 13.24% | 14.10A | 32.30A | 1.200Hz | 1.400Hz | 0.00% |
| MVK3184A | 18.5kW | 4 | 1500/3600 r/min | 320V | 45A | 1500r/min | 1500r/min | 320V | 18.5kW | 45A | 4 | 2.55% | 13.58% | 15.85A | 40.14A | 0.920Hz | 1.060Hz | 0.00% |
| MVK5187A | 22kW | 4 | 1500/3600 r/min | 320V | 53A | 1500r/min | 1500r/min | 320V | 22kW | 53A | 4 | 2.49% | 13.21% | 21.14A | 47.79A | 0.960Hz | 0.960Hz | 0.00% |
| MVK5206A | 30kW | 4 | 1500/3000 r/min | 320V | 69.8A | 1500r/min | 1500r/min | 320V | 30kW | 69.8A | 4 | 2.49% | 11.74% | 28.92A | 67.66A | 1.200Hz | 1.200Hz | 0.00% |
| MVK5207A | 37kW | 4 | 1500/3000 r/min | 320V | 89A | 1500r/min | 1500r/min | 320V | 37kW | 89A | 4 | 2.52% | 14.59% | 35.49A | 80.40A | 0.685Hz | 0.685Hz | 0.00% |
| MVK5223A | 45kW | 4 | 1500/3000 r/min | 320V | 105A | 1500r/min | 1500r/min | 320V | 45kW | 105A | 4 | 2.01% | 14.34% | 34.49A | 95.93A | 0.854Hz | 0.854Hz | 0.00% |

| Motor specification | | | VG7S code No. | | | Motor parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 |
| Type | Capacity | No.of pole | Speed (Rated/Max.) | Voltage | Current | Iron loss co-ef*. 2 | Iron loss co-ef*. 3 | Magnetic saturation co-ef*. 1 | Magnetic saturation co-ef*. 2 | Magnetic saturation co-ef*. 3 | Magnetic saturation co-ef*. 4 | Magnetic saturation co-ef*. 5 | Secondary time constant | Induced voltage co-ef*. | R2 correction co-ef*. 1 | R2 correction co-ef*. 2 | R3 correction co-ef*. | Pre-exciting current correction co-ef*. |
| MVK3115A | 3.7kW | 4 | 1500/3600 r/min | 320V | 10A | 0.00% | 0.00% | 89.4% | 80.4% | 66.7% | 54.5% | 42.7% | 0.172s | 230V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3133A | 5.5kW | 4 | 1500/3600 r/min | 320V | 15.5A | 0.00% | 0.00% | 87.1% | 77.6% | 63.5% | 51.8% | 40.8% | 0.200s | 242V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3135A | 7.5kW | 4 | 1500/3600 r/min | 320V | 20.5A | 0.00% | 0.00% | 86.7% | 76.1% | 60.8% | 49.4% | 38.4% | 0.224s | 241V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3165A | 11kW | 4 | 1500/3600 r/min | 320V | 29A | 0.00% | 0.00% | 88.6% | 79.6% | 65.9% | 53.7% | 43.1% | 0.320s | 258V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3167A | 15kW | 4 | 1500/3600 r/min | 320V | 37A | 0.00% | 0.00% | 91.0% | 83.1% | 69.0% | 56.9% | 45.1% | 0.336s | 268V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK3184A | 18.5kW | 4 | 1500/3600 r/min | 320V | 45A | 0.00% | 0.00% | 91.8% | 84.0% | 71.1% | 58.2% | 45.7% | 0.312s | 267V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5187A | 22kW | 4 | 1500/3600 r/min | 320V | 53A | 0.00% | 0.00% | 92.6% | 84.8% | 71.1% | 58.6% | 46.5% | 0.412s | 267V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5206A | 30kW | 4 | 1500/3000 r/min | 320V | 69.8A | 0.00% | 0.00% | 92.7% | 85.4% | 70.8% | 57.6% | 45.0% | 0.349s | 257V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5207A | 37kW | 4 | 1500/3000 r/min | 320V | 89A | 0.00% | 0.00% | 90.5% | 81.3% | 67.3% | 55.3% | 44.3% | 0.423s | 291V | 1.000 | 1.000 | 1.000 | 0.000 |
| MVK5223A | 45kW | 4 | 1500/3000 r/min | 320V | 105A | 0.00% | 0.00% | 91.0% | 83.1% | 69.5% | 57.9% | 46.3% | 0.483s | 298V | 1.000 | 1.000 | 1.000 | 0.000 |

*co-ef.: coefficient

Note : The above value is the setting value of VG7

# 13.8 Protective Functions

## 13.8.1 Replacing VG5

| FRENIC5000 VG5S | | FRENIC5000 VG7S | |
|---|---|---|---|
| – | | dbH | DB resistor overheat |
| dcF | DC fuse blown | dcF | DC fuse blown |
| – | | dO | Excessive position deviation |
| EF | Ground fault | EF | Ground fault |
| Er1 | Memory error | Er1 | Memory error |
| Er2 | KEYPAD panel communication error | Er2 | KEYPAD panel communication error |
| Er3 | CPU error | Er3 | CPU error |
| Er4 | T-Link communication error | Er4 | Network error |
| Er5 | RS485 error | Er5 | RS485 communication error |
| Er6 | Operation procedure error | Er6 | Operation procedure error |
| Er7 | Output wiring error | Er7 | Output wiring error |
| Er8 | A/D converter error | Er8 | A/D converter error |
| – | | Er9 | Speed disagreement |
| – | | ErA | UPAC error |
| – | | Erb | Inter-inverter communication error |
| – | | Lin | Input phase loss |
| LU | Undervoltage | LU | Undervoltage |
| nrb | NTC thermistor disconnection | nrb | NTC thermistor disconnection |
| OC | Overcurrent | OC | Overcurrent |
| OH1 | Overheating at heat sink | OH1 | Overheating at heat sink |
| OH2 | External alarm | OH2 | External alarm |
| OH3 | Inverter internal overheat | OH3 | Inverter internal overheat |
| OH4 | Motor overheat | OH4 | Motor overheat |
| OL | Motor overload | OL1 | Motor 1 overload |
| – | | OL2 | Motor 2 overload |
| – | | OL3 | Motor 3 overload |
| OLU | Inverter overload | OLU | Inverter unit overload |
| OS | Overspeed | OS | Overspeed |
| OU | Overvoltage | OU | Overvoltage |
| PbF | Charging circuit error | PbF | Charging circuit error |
| P9 | PG disconnection | P9 | PG disconnection |

## 13.8.2 Replacing VG3

| FRENIC5000 VG3 | | FRENIC5000 VG7S | |
|---|---|---|---|
| – | | dbH | DB resistor overheat |
| dcF | DC fuse blown | dcF | DC fuse blown |
| – | | dO | Excessive position deviation |
| EF | Ground fault | EF | Ground fault |
| Rf | Memory error | Er1 | Memory error |
| – | | Er2 | KEYPAD panel communication error |
| – | | Er3 | CPU error |
| OPF | T-Link communication error | Er4 | Network error |
| – | | Er5 | RS485 communication error |
| – | | Er6 | Operation procedure error |
| – | | Er7 | Output wiring error |
| CF | Current detection circuit error | – | |
| – | | Er8 | A/D converter error |
| – | | Er9 | Speed disagreement |
| – | | ErA | UPAC error |
| – | | Erb | Inter-inverter communication error |
| – | | Lin | Input phase loss |
| LU | Undervoltage | LU | Undervoltage |
| rb | NTC thermistor disconnection | nrb | NTC thermistor disconnection |
| OC | Overcurrent | OC | Overcurrent |
| OH1 | Inverter overheat | OH1 | Overheating at heat sink |
| OH3 | External alarm | OH2 | External alarm |
| – | | OH3 | Inverter internal overheat |
| OH2 | Motor overheat | OH4 | Motor overheat |
| – | | OL1 | Motor 1 overload |
| – | | OL2 | Motor 2 overload |
| – | | OL3 | Motor 3 overload |
| OL | Inverter overload | OLU | Inverter unit overload |
| OS | Overspeed | OS | Overspeed |
| OU | Overvoltage | OU | Overvoltage |
| – | | PbF | Charging circuit error |
| – | | P9 | PG disconnection |

## 13.8.3 Replacing VG

| FRENIC5000 VG | | FRENIC5000 VG7S | |
|---|---|---|---|
| – | | dbH | DB resistor overheat |
| – | DC fuse blown | dcF | DC fuse blown |
| – | | dO | Excessive position deviation |
| – | | EF | Ground fault |
| – | | Er1 | Memory error |
| – | | Er2 | KEYPAD panel communication error |
| – | CPU error | Er3 | CPU error |
| – | | Er4 | Network error |
| – | | Er5 | RS485 communication error |
| – | | Er6 | Operation procedure error |
| – | | Er7 | Output wiring error |
| – | | Er8 | A/D converter error |
| – | | Er9 | Speed disagreement |
| – | | ErA | UPAC error |
| – | | Erb | Inter-inverter communication error |
| – | | Lin | Input phase loss |
| – | Undervoltage | LU | Undervoltage |
| – | NTC thermistor disconnection | nrb | NTC thermistor disconnection |
| – | Overcurrent | OC | Overcurrent |
| – | Inverter overheat | OH1 | Overheating at heat sink |
| – | DB resistor overheat | OH2 | External alarm |
| – | | OH3 | Inverter internal overheat |
| – | Motor overheat | OH4 | Motor overheat |
| – | | OL1 | Motor 1 overload |
| – | | OL2 | Motor 2 overload |
| – | | OL3 | Motor 3 overload |
| – | Inverter overload | OLU | Inverter unit overload |
| – | Overspeed | OS | Overspeed |
| – | Overvoltage | OU | Overvoltage |
| – | | PbF | Charging circuit error |
| – | | P9 | PG disconnection |

## 13.9 Options

### 13.9.1 Replacing VG5S

| Name | FRENIC5000 VG5S option | Possibility of combination with VG7 | Alternative FRENIC5000 VG7S option |
|---|---|---|---|
| Adder | OPCII-VG3-AD | Impossible | |
| I/V,V/I converter | OPCII-VG3-IV | Impossible | |
| Comparator | OPCII-VG3-CP | Impossible | |
| Isolation converter | OPCII-VG3-IA | Impossible | |
| F/V converter | OPCII-VG3-FV | Impossible | OPC-VG7-FV |
| Synchro. interface | OPCII-VG3-SN | Impossible | OPC-VG7-SN |
| Di interface card | OPCII-VG5-DIN | Impossible | OPC-VG7-DI (DIA,DIB) |
| | OPCII-VG5-DIT | Impossible | OPC-VG7-DI (DIA,DIB) |
| DIO expansion card | OPCII-VG5-DIO | Impossible | OPC-VG7-DIO (DIOA) |
| T-Link interface card | OPCII-VG5-TL | Impossible | OPC-VG7-TL |
| PG interface extension card | OPCII-VG5-PG1 | Impossible | Built-in. |
| | OPCII-VG5-PG2 | Impossible | OPC-VG7-PG |
| Pulse train interface card | OPCII-VG5-PTI | Impossible | OPC-VG7-PG |
| Adder | MCAII-VG3-AD | Impossible | |
| I/V,V/I converter | MCAII-VG3-IV | Impossible | |
| Comparator | MCAII-VG3-CP | Impossible | |
| Isolation converter | MCAII-VG3-IA | Impossible | |
| F/V converter | MCAII-VG3-FV | Impossible | MCA-VG7-FV |
| Synchro. interface | MCAII-VG5-SN | Impossible | MCA-VG7-SN |
| Dancer controller | MCAII-PU | Possible | |
| Relay unit | MCAII-RY | Impossible | |
| PG switcher | MCAII-VG5-CPG | Possible | |
| Braking unit | Depends on the capacity | Possible | Depends on the capacity (Built-in for 55kW or less of 200V series, and for 110kW or less of 400V series) |
| Braking resistor | Depends on the capacity | Possible | Depends on the capacity |
| AC reactor | Depends on the capacity | Possible | Depends on the capacity |
| DC REACTOR | Depends on the capacity | Possible | Depends on the capacity (Provided as standard for units of more than 75kW). |
| Ferrite ring for reducing radio noise. | ACL-40B,ACL-74B | Possible | |
| KEYPAD panel extension cable | CBIII-10R-2S<br>CBIII-10R-1C<br>CBIII-10R-2C | Possible | |

## 13.9.2 Replacing VG3

| Name | FRENIC5000 VG3 option | Possibility of combination with VG7 | Alternative FRENIC5000 VG7S option |
|---|---|---|---|
| Adder | OPCII-VG3-AD | Impossible | |
| I/V,V/I converter | OPCII-VG3-IV | Impossible | |
| Comparator | OPCII-VG3-CP | Impossible | |
| Isolation converter | OPCII-VG3-IA | Impossible | |
| F/V converter | OPCII-VG3-FV | Impossible | OPC-VG7-FV |
| Synchro. interface | OPCII-VG3-SN | Impossible | OPC-VG7-SN |
| Di interface card | OPCII-VG3-DI | Impossible | OPC-VG7-DI (DIA,DIB) |
| AO interface | OPCII-VG3-AO | Impossible | OPC-VG7-AIO |
| T-Link interface card | OPCII-VG3-T2<br>OPCII-VG3-TL | Impossible | OPC-VG7-TL |
| Adder | MCAII-VG3-AD | Impossible | |
| I/V,V/I converter | MCAII-VG3-IV | Impossible | |
| Comparator | MCAII-VG3-CP | Impossible | |
| Isolation converter | MCAII-VG3-IA | Impossible | |
| F/V converter | MCAII-VG3-FV | Impossible | MCA-VG7-FV |
| Synchro. interface | MCAII-VG5-SN | Impossible | MCA-VG7-SN |
| Dancer controller | MCAII-PU | Possible | |
| Relay unit | MCAII-RY | Impossible | |
| Ground fault detection unit | MCAII-GFD-1<br>MCAII-GFD-2 | Impossible | Ground fault detection function of the output wiring is a standard built-in for the inverter more than 18.5kW. |
| Braking unit | Depends on the capacity | Possible | Depends on the capacity (Built-in for 55kW or less of 200V series,<br>and for 110kW or less of 400V series) |
| Braking resistor | Depends on the capacity | Possible | Depends on the capacity |
| AC reactor | Depends on the capacity | Possible | Depends on the capacity |
| DC REACTOR | Depends on the capacity | Possible | Depends on the capacity (Provided as standard for units of more than 75kW) |
| Ferrite ring for reducing radio noise. | ACL-10A | Possible | |

## 13.9.3 Replacing VG

| Name | FRENIC5000 VG option | Possibility of combination with VG7 | Alternative FRENIC5000 VG7S option |
|---|---|---|---|
| Adder | OPCII-AD | Impossible | |
| I/V,V/I converter | OPCII-IV | Impossible | |
| Comparator | OPCII-CP | Impossible | |
| Isolation converter | OPCII-IA | Impossible | |
| F/V converter | OPCII-FV | Impossible | OPC-VG7-FV |
| Soft start stop | OPCII-RA | Impossible | Standard built-in. |
| Di interface card | OPCII-BI<br>OPCII-BC | Impossible | OPC-VG7-DI (DIA,DIB) |
| T-Link interface card | OPCII-TL-1<br>OPCII-TL-2 | Impossible | OPC-VG7-TL |
| Adder | MCAII-AD | Impossible | |
| I/V,V/I converter | MCAII-IV | Impossible | |
| Comparator | MCAII-CP | Impossible | |
| Isolation converter | MCAII-IA | Impossible | |
| F/V converter | MCAII-FV | Impossible | MCA-VG7-FV |
| Dancer controller | MCAII-PU | Possible | |
| High-precision correction unit | MCAII-SP | Impossible | Standard built-in. |
| Soft start/stop | MCAII-RA | Impossible | Standard built-in. |
| Braking unit | Depends on the capacity | Possible | Depends on the capacity (Built-in for 55kW or less of 200V series,<br>and for 110kW or less of 400V series) |
| Braking resistor | Depends on the capacity | Possible | Depends on the capacity |
| AC reactor | Depends on the capacity | Possible | Depends on the capacity |
| DC REACTOR | Depends on the capacity | Possible | Depends on the capacity (Provided as standard for units of more than 75kW) |
| REACTOR for noise reduction (For elevators) | Depends on the capacity | Impossible | Not necessary because of the high carrier PWM. |

THE INVERTER

XIV

# XIV. Appendix

Appendix 1. Advantageous Use of Inverters (with Regard to Electrical Noise)

Appendix 2. Effect on Insulation of General-purpose Motor Driven with 400V Class Inverter

Appendix 3. Example Calculation of Energy Savings

# 14. Appendix

## Appendix 1. Advantageous Use of Inverters (with Regard to Electrical Noise)

Excerpt from Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (April, 1994)

### 1 Effect of Inverters on other Devices

This paper describes the effect that inverters, for which the field of applications is expanding, have on electronic devices already installed and on devices installed in the same system as the inverters. Measures to counter these effects are also introduced.
(Refer to 3.3 Specific examples for further details.)

#### 1.1 Effect on AM Radios

(1) When operating an inverter, nearby AM radios may pickup noise from the inverter. (The inverter has almost no effect on FM radios or televisions)
(2) It is considered that radios receive noise radiated from the inverter.
(3) Measures to provide a noise filter on the power supply side of the inverter are effective.

#### 1.2 Effect on Telephones

(1) When operating an inverter, telephones may pickup noise during a conversation, making it difficult to hear.
(2) It is considered that a high-frequency leakage current radiated from the inverter and motors enters shielded telephone cables.
(3) It is effective to commonly connect the grounding terminals of the motors and return the common grounding line to the grounding terminal of the inverter.

#### 1.3 Effect on Proximity Limit Switches

(1) When operating an inverter, proximity limit switches (capacitance-type) may malfunction.
(2) It is considered that malfunction occurs because the capacitance-type proximity limit switches have inferior noise immunity.
(3) Connecting a filter to the input terminals of the inverter or changing the power supply treatment of the proximity limit switches is effective. In addition, the proximity limit switches can be changed to superior noise immunity types such as the magnetic type.

#### 1.4 Effect on Pressure Sensors

(1) When operating an inverter, pressure sensors may malfunction.
(2) It is considered that malfunction occurs because noise penetrates through a grounding wire into the signal line.
(3) It is effective to install a noise filter on the power supply side of the inverter or to change the wiring.

#### 1.5 Effect on Position Detectors (Pulse Generators; PGs, or Pulse Encoders)

(1) When operating an inverter, erroneous pulses from pulse converters may shift the stop position of a machine.
(2) Erroneous pulses are liable to occur when the signal lines of the PG and power lines are bundled together.
(3) The influence of induction noise and radiation noise can be reduced by separating the signal lines of the PG and power lines. Providing noise filters at the input and output terminals is also an effective measure.

# 2 Noise

A summary of the noise generated in inverters and its effect on devices susceptible to noise is described below.

## 2.1 Inverter Noise

Figure 1 shows an outline of the inverter configuration. The inverter converts AC to DC (rectification) in a converter unit, and converts DC to AC (inversion) with 3-phase variable voltage and variable frequency. The conversion (inversion) is performed by PWM implemented by switching 6 transistors, and is used for variable speed motor control.

Switching noise is generated by the high-speed on/off switching of the 6 transistors. Noise current (i) is emitted and at each high-speed on/off switching the noise current flows through stray capacitance (C) of the inverter, cable and motor to the ground. The amount of the noise current,

$$i = C \cdot dv / dt$$

is related to the stray capacitance (C) and dv/dt (switching speed of the transistors). Further, this noise current is related to the carrier frequency since the noise current flows each time the transistors are switched on/off.

The frequency band of this noise is less than approximately 30 to 40MHz. Therefore, devices such as AM radios that use the low frequency band are affected by the noise, but FM radios and television using higher frequency than this frequency band are virtually unaffected.

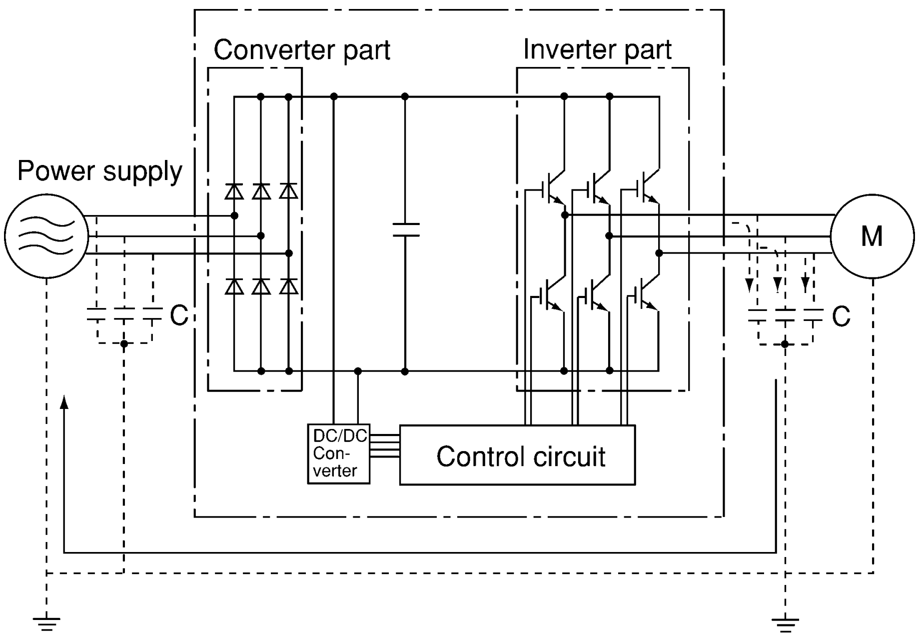



Figure 1 Outline of Inverter Configuration

## 2.2 Types of Noise

The noise generated in the inverter is propagated through the main circuit wiring to the power supply and the motor, and effects a wide range from the power supply transformer to the motor.
The various propagation routes are shown in Figure 2, but these are roughly classified into 3 routes of conduction noise, induction noise and radiation noise.

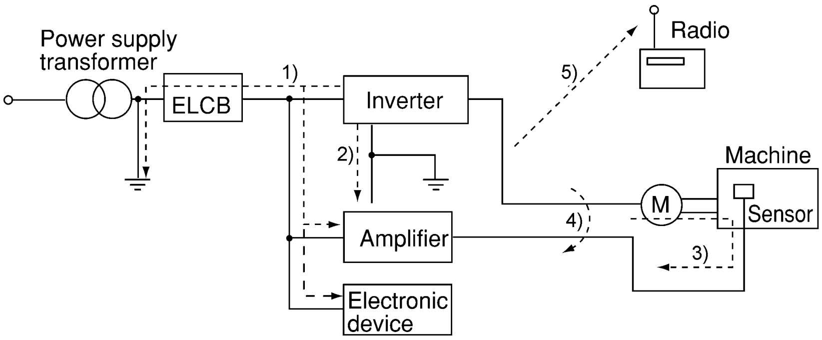



Figure 2 Noise Propagation Routes

(1) Conduction noise

Conduction noise is generated in the inverter, propagates through the conductor and power supply, and effects peripheral devices of the inverter (Figure 3) Some conduction noise 1) propagates through the main circuit. If the ground lines are connected with a common connection, there is conduction through route 2). There is also noise 3) through the signal line and shielded wire.

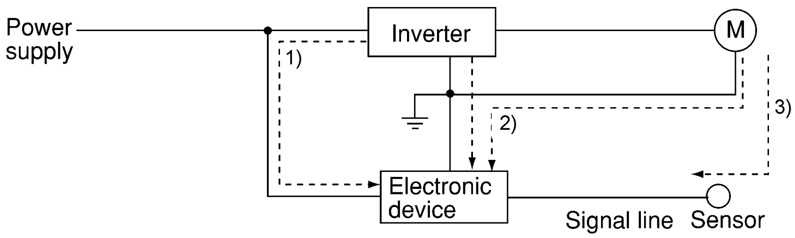



Figure 3 Conduction Noise

(2) Induction noise

When the wire and signal lines of peripheral devices are brought close to the wires on the input and output sides of the inverter, noise is induced in the wire and signal lines of the devices by electromagnetic induction (Figure 4) and electrostatic induction (Figure 5). This is induction noise 4).

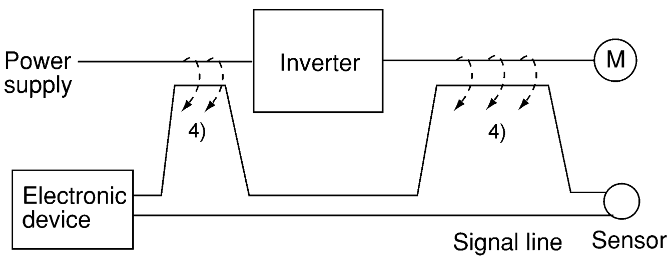



Figure 4 Electromagnetic Noise

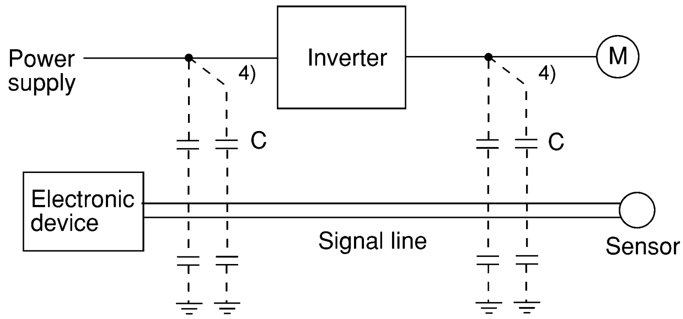



Figure 5 Electrostatic Noise

(3) Radiation noise

Noise generated in the inverter is radiated through the air from antennas consisting of wires at the input and output sides of the inverter. This noise is radiation noise 5) (Figure 6). The antennas that emit radiation noise are not limited only to wires, the motor frame and panel containing the inverter may also act as antennas.

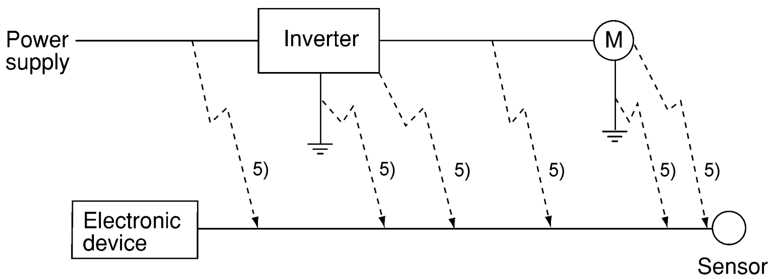



Figure 6 Radiation Noise

# 3 Noise Prevention Measures

As noise prevention measures are strengthened, they become more effective. With the use of appropriate measures, noise problems may be resolved simply. Therefore, it is necessary to implement economical noise prevention measures according to the noise level and the equipment condition.

## 3.1 Noise Prevention Treatments Prior to Installation

Before inserting an inverter in a control panel or installing an inverter panel, it is necessary to consider the noise. Once noise problems occur, great expenditures of apparatuses, materials and time are required.

Noise prevention treatments prior to installation are listed below.

1) Separation of the wiring of the main circuit and control circuit
2) Insertion of the main circuit wiring into a metal pipe (conduit pipe)
3) Use of shielded wire or twisted shielded wire in the control circuit.
4) Implementation of appropriate grounding work and grounding wiring.

These treatments can avoid most noise problems.

Appendix

## 3.2 Implementation of Noise Prevention Measures

There are two types of noise prevention measures, those that correspond to the propagation route and those that counteract the effect of noise on the receiving side (side that is adversely affected by the noise).

The basic measure to lessen the effect of noise on the receiving side is to:

1) Separate the main circuit wiring from the control circuit wiring, making it more difficult to receive noise.

The basic measures to lessen the effect of noise on the generating side are to:

2) Install a noise filter to reduce the noise level.
3) Apply a metal conduit pipe or metal control panel to confine the noise level, and
4) Apply an insulated transformer for the power supply to cut off the noise propagation route.

Table 1 lists the methods for preventing the noise problems, their goals and the propagation routes.

Next, noise prevention measures are presented for the inverter drive configuration.

### (1) Wiring and grounding

Separating the main circuit and control circuit as much as possible, both inside and outside the control panel, and the use of shielded wire and twisted shielded wire, makes it more difficult to receive noise and allows wiring distances to be minimized (refer to Figure 7). Take notice that the wiring of the main circuit and control circuit does not become bundled or parallel wiring.

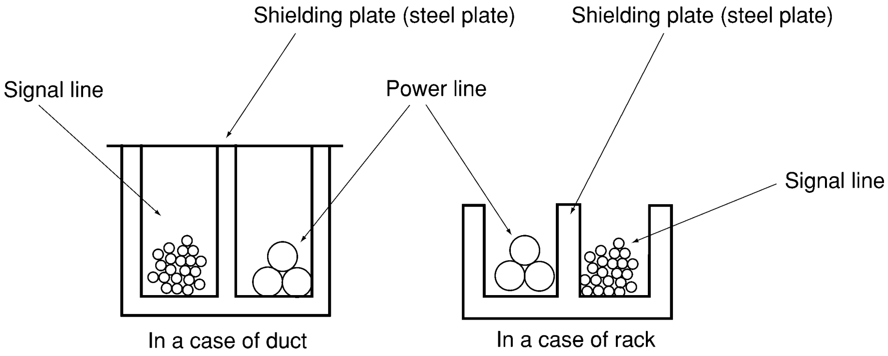



Figure 7 Method of Separating Wiring

For the main circuit wiring, a metal conduit pipe is used and grounded through a grounding wiring to prevent noise propagation (refer to Figure 8).
The shield (braided wire) of the shielded wire is securely connected to the base (common) side of the signal line at only one point to avoid the loop formation resulting from a multi-point connection (refer to Figure 9).
The grounding is effective to not only to reduce the risk of electric shocks, but also to block noise penetration and radiation. Corresponding to the main circuit voltage, the grounding work should be No. 3 grounding work (300V AC or less) and special No. 3 grounding work (300 to 600V AC). Each ground wire is to be provided with its own ground or separately wired to a grounding point.

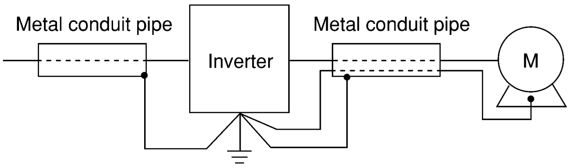



Figure 8 Grounding of Metal Conduit Pipe

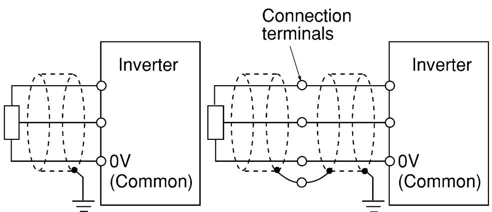



Figure 9 Treatment of Braided Wire of Shielded Wire

Table 1 Noise Prevention Methods

| Noise prevention method | | Goal of noise prevention measure: Make it more difficult to receive noise | Goal of noise prevention measure: Cutoff noise conduction | Goal of noise prevention measure: Confine noise | Goal of noise prevention measure: Reduce noise level | Conduction route: Conduction noise | Conduction route: Induction noise | Conduction route: Radiation noise |
|---|---|---|---|---|---|---|---|---|
| Wiring and installation | Separate main circuit and control circuit | ○ | | | | ○ | | |
| | Minimum wiring distance | ○ | | | ○ | | ○ | ○ |
| | Avoid parallel and bundled wiring | ○ | | | | | ○ | |
| | Use appropriate grounding | ○ | | | ○ | | ○ | |
| | Use shielded wire and twisted shielded wire | ○ | | | | | ○ | ○ |
| | Use shielded cable in main circuit | | | ○ | | | | ○ |
| | Use metal conduit pipe | | | ○ | | | ○ | ○ |
| Control panel | Appropriate arrangement of devices in panel | ○ | | | | | ○ | ○ |
| | Metal control panel | | | ○ | | | ○ | ○ |
| Anti-noise device | Line filter | ○ | | | ○ | ○ | | ○ |
| | Insulation transformer | | ○ | | | ○ | | ○ |
| Treatment on the noise receiving side | Use passing capacitor | ○ | | | | | ○ | ○ |
| | Use ferrite core for control circuit | ○ | | | | | ○ | ○ |
| | Line filter | ○ | | | | ○ | | |
| Others | Separate power supply systems | | ○ | | | ○ | | |
| | Lower the carrier frequency | | | | | ○ | ○ | ○ |

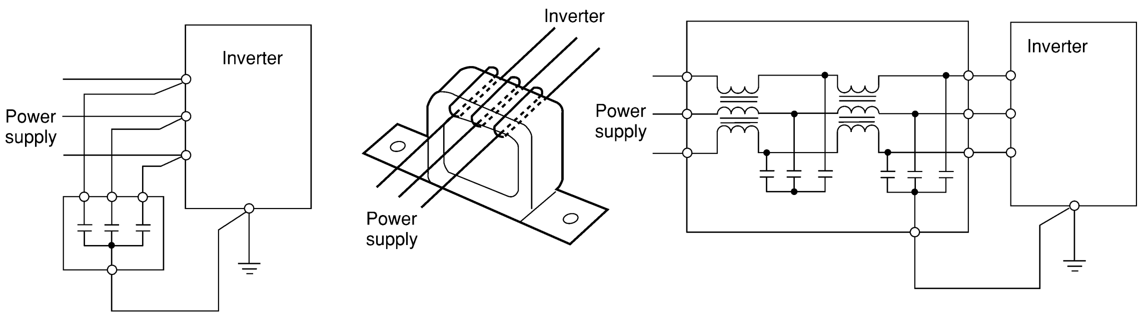
(2) Control panel

The control panel containing the inverter is generally made of metal, and this metal box can shield noise radiated from the inverter itself.

Further, when installing other electronic devices such as a programmable logic controller in the same control panel, attention should be paid to the arrangement of each device. When necessary, a noise prevention measure should be implemented, such as installing a shielding plate between the inverter and peripheral devices.

(3) Anti-noise devices

To reduce the noise propagated through the electrical circuits and the noise radiated from the main circuit wiring to the air, a line filter and power supply transformer are utilized (refer to Figure 10). Among line filters, there are the simple type filters, such as a capacitive filter connected in parallel to the power supply line and an inductive filter connected in series to the power supply line, as well as orthodox filters (LC filters). These filters are used according to the targeted effect for reducing noise. In power supply transformers, there are common insulated transformers, shielded transformers, noise-cut transformers, etc. These transformers have different effectiveness in blocking noise propagation.




(a) Capacitive filter (b) Inductive filter (zero-phase reactor or ferrite ring) (c) LC filter

Figure 10 Various Filters and their Connection Methods

(4) Noise prevention measures on the receiving side

It is important to strengthen the noise immunity of those electronic devices installed in the same control panel as the inverter and/or located near the inverter.

Line filters and shielded or twisted shielded wire is used to block the penetration of noise in the signal lines of these devices. The following treatments are also implemented.

1) The circuit impedance is lowered by connecting capacitors or resistors to the input and output terminals of the signal circuit in parallel.
2) The circuit impedance for noise is increased by inserting choke coils in series in the signal circuit, or, passing the signal through ferrite core beads.
   It is also effective to widen the signal base line (0 V line) or grounding line.

(5) Other

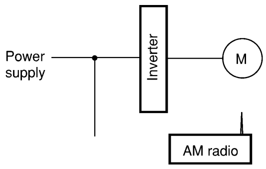
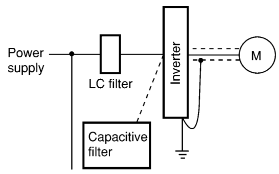
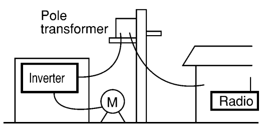
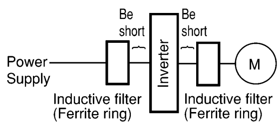
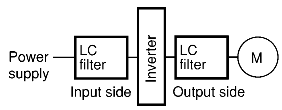
The generating (propagating) level of noise changes with the carrier frequency of the inverter, the higher the carrier frequency, the higher the generated level of noise.

In the case of an inverter for which the carrier frequency can be changed, lowering the carrier frequency can reduce the generation of electrical noise and result in a good balance with the audible noise of the motor under driving conditions.

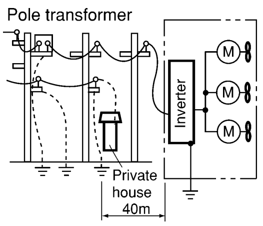
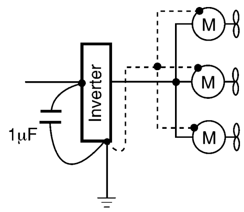
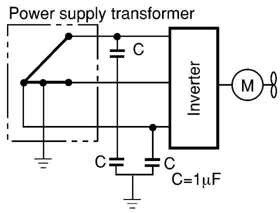
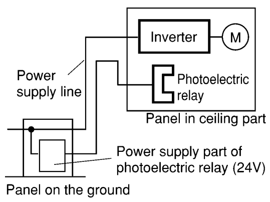
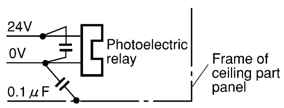
## 3.3 Specific Examples

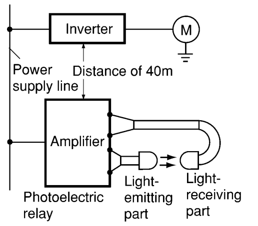
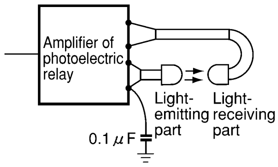
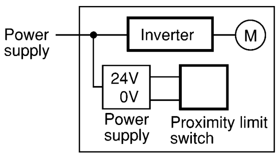
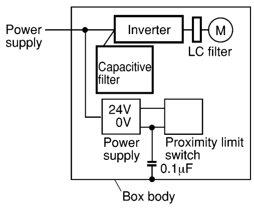
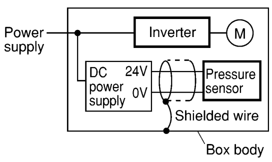
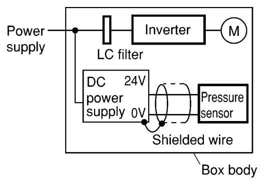
Table 2 lists specific examples of the measures to prevent noise generated by operation of the inverter.

Table 2 Specific Examples of Noise Prevention Measures

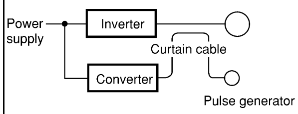
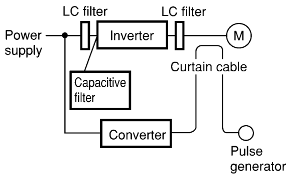
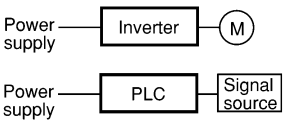
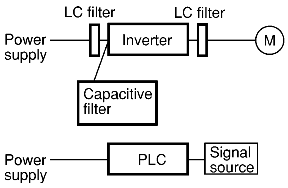
| No. | Target device | Phenomena | Noise prevention measures | Notes |
|---|---|---|---|---|
| 1 | AM radio | When operating an inverter, noise entered into AM radio broadcast (500 to 1500kHz).<br><br><Estimated cause><br>It is considered that the AM radio receives noise radiated from wires at the power supply and output sides of the inverter. | 1) Install an LC filter on the power supply side of the inverter. (A simple method is to install a capacitive filter.)<br>2) Install a metal conduit wiring between the motor and inverter.<br><br>Note: Minimize the distance between the LC filter and inverter as much as possible (within 1m). | 1) The radiation noise of the wiring is reduced.<br>2) The conduction noise to the power supply side is reduced. Further, shielded wiring is used.<br><br>Note: Sufficient improvement may not be expected in narrow regions such as between mountains. |
| 2 | AM radio | When operating an inverter, noise entered into AM radio broadcast (500 to 1500kHz).<br><br><Estimated cause><br>It is considered that the AM radio receives noise radiated from the power line at the power supply side of the inverter. | 1) Install inductive filters at the input and output sides of the inverter.<br><br>The number of turns of the zero-phase reactor (or ferrite ring) should be as large as possible. Further, wiring between the inverter and the zero-phase reactor (or ferrite ring) should be short as possible. (within 1m)<br>2) When further improvement is necessary, install LC filters.<br> | 1) The radiation noise of the wiring is reduced. |

Appendix

| No. | Target device | Phenomena | Noise prevention measures | Notes |
|---|---|---|---|---|
| 3 | Telephone (in a common private residence at a distance of 40m) | When driving a ventilation fan with an inverter, noise entered a telephone in a private residence at a distance of 40m.<br><br><Estimated cause><br>A high-frequency leakage current from the inverter and motor flowed to grounded part of the telephone cable shield. During the current's return trip, it flowed through a grounded pole transformer, and noise entered the telephone by electrostatic induction. | 1) Connect the ground terminals of the motors in a common connection. Return to the inverter panel, and insert a 1μF capacitor between the input terminal of the inverter and ground.<br> | 1) The effect of the inductive filter and LC filter may not be expected because of sound frequency component.<br>2) In the case of a V-connection power supply transformer in a 200V system, it is necessary to connect capacitors as shown in the following figure, because of different potentials to the ground.<br> |
| 4 | Photoelectric relay | A photoelectric relay malfunctioned when the inverter was operated.<br>[The inverter and motor are installed in the same place (for overhead traveling)]<br><br><Estimated cause><br>It is considered that induction noise entered the photoelectric relay since the inverter's input power supply line and the photoelectric relay's wiring are in parallel separated by approximately 25mm over a distance of 30 to 40m. Due to conditions of the installation, these lines cannot be separated. | 1) As a temporary measure, insert a 0.1μF capacitor between the 0V terminal of the power supply circuit in the detection unit of the overhead photoelectric relay and a frame of the overhead panel.<br><br>2) As a permanent measure, move the 24V power supply from the ground to the overhead unit so that signals are sent to the ground side with relay contacts in the ceiling part. | 1) The wiring is separated. (by more than 30cm.)<br>2) When separation is impossible, signals can be received and sent with dry contacts etc.<br>3) Do not wire weak-current signal lines and power lines in parallel. |

<table>
<tr><th>No.</th><th>Target device</th><th>Phenomena</th><th>Noise prevention measures</th><th>Notes</th></tr>
<tr><td>5</td><td>Photoelectric relay</td><td>A photoelectric relay malfunctioned when the inverter was operated.<br><br><br><Estimated cause><br>Although the inverter and photoelectric relay are separated by a sufficient distance, since the power supplies share a common connection, it is considered that conduction noise entered through the power supply line into the photoelectric relay.</td><td>1) Insert a 0.1μF capacitor between the output common terminal of the amplifier of the photoelectric relay and a frame.<br><br></td><td>1) If a weak-current circuit on the malfunctioning side is observed, the countermeasures may be simple and economical.</td></tr>
<tr><td>6</td><td>Proximity limit switch (electrostatic type)</td><td>A proximity limit switch malfunctioned.<br><br><br><Estimated cause><br>It is considered that the capacitance type proximity limit switch is susceptible to conduction and radiation noise because of its low noise immunity.</td><td>1) Install an LC filter on the output side of the inverter.<br>2) Install a capacitive filter on the input side of the inverter.<br>3) Ground the 0 V (common) line of the DC power supply of the proximity limit switch through a capacitor to the box body of the machine.<br><br></td><td>1) Noise generated in the inverter is reduced.<br>2) The switch is superseded by a proximity limit switch of superior noise immunity (such as a magnetic type).</td></tr>
<tr><td>7</td><td>Pressure sensor</td><td>A pressure sensor malfunctioned.<br><br><br><Estimated cause><br>It is considered that the pressure sensor signal malfunction was due to noise that came from the box body and traveled through the shield of the shielded wire.</td><td>1) Install an LC filter on the input side of the inverter.<br>2) Connect the shield of the shielded wire of the pressure sensor to the 0 V line (common) of the pressure sensor, changing the original connection.<br><br></td><td>1) The shielded parts of shield wire for sensor signals are connected to a common point in the system.<br>2) Conduction noise from the inverter is reduced.</td></tr>
</table>

# 14. Appendix

| No. | Target device | Phenomena | Noise prevention measures | Notes |
|---|---|---|---|---|
| 8 | Position detector (pulse generator: PG) | Erroneous-pulse outputs from a pulse converter caused a shift in the stop position of a crane.<br><br><Estimated cause><br>It is considered that erroneous pulses are output by induction noise since the power line of the motor and the signal line of the PG are bundled in a lump. | 1) Install an LC filter and a capacitive filter on the input side of the inverter.<br>2) Install an LC filter on the output side of the inverter.<br> | 1) This is an example of a measure where the power line and signal line cannot be separated.<br>2) Induction noise and radiation noise on the output side of the inverter are reduced. |
| 9 | Programma-ble logic controller (PLC) | The PLC program sometimes malfunctions.<br><br><Estimated cause><br>Since the power supply system is the same for the PLC and inverter, it is considered that noise enters the PLC through the power supply. | 1)Install a capacitive filter and an LC filter on the input side of the inverter.<br>2) Install an LC filter on the output side of the inverter.<br>3) Lower the carrier frequency of the inverter.<br> | 1) Total conduction noise and induction noise in the electric line are reduced. |

# Appendix 2. Effect on Insulation of General-purpose Motor Driven with 400V Class Inverter

Excerpt from Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (March, 1995)

Introduction

When an inverter drives a motor, surge voltages generated by switching the inverter elements are superimposed on the inverter output voltage and applied to the motor terminals. If the surge voltages are too high they may have an effect on the motor insulation and some cases have resulted in damage.
For preventing such cases this document describes the generating mechanism of the surge voltages and countermeasures against them.

## 1 Operating Principle of Inverter

### 1.1 Main Circuit Configuration of Inverter

The main circuit of an inverter is configured with a converter part and an inverter part. The former part rectifies a commercial power source voltage and eliminates resulting ripple components, and the latter part converts DC voltage to AC voltage through a 3-phase bridge circuit composed of switching elements like transistors. (Refer to Figure 1)

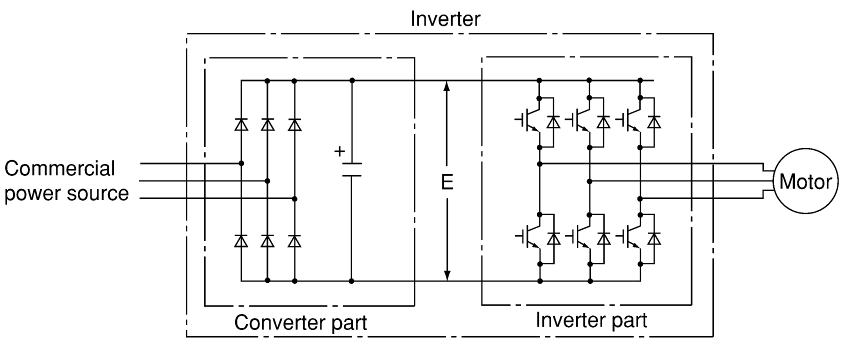



Figure 1  Main Circuit Configuration of Inverter

### 1.2 Control Method of Inverter

The PWM (Pulse Width Modulation) control is commonly adopted in general-purpose inverters. This method generates multiple switching pulses in one output cycle because both the output voltage and frequency are simultaneously controlled in the inverter part. The output voltage control is carried out by varying the pulse width while the pulse magnitude is kept constant.
The number of switching pulses generated in one second is designated as a carrier frequency and is normally high up to 0.7 to 16kHz. So transistors capable of high-speed switching (IGBT, etc.) are used for inverter elements.

## 2 Generating Mechanism of Surge Voltages

As the inverter rectifies a commercial power source voltage and smoothes into a DC voltage, the magnitude E of the DC voltage becomes about $\sqrt{2}$ times of that of the source voltage (about 620V in case of an input voltage of 440V AC). The peak value of the output voltage is usually close to this DC voltage value.
But, as there exists inductance (L) and stray capacitance (C) in wiring between the inverter and the motor, the voltage variation due to switching the inverter elements causes a surge voltage originating in LC resonance and results in the addition of a high voltage to the motor terminals. (Refer to Figure 2)
This voltage sometimes reaches up to about twice of the inverter DC voltage (620V $\times$ 2 = about 1,200V) depending on a switching speed of the inverter elements and a wiring condition.

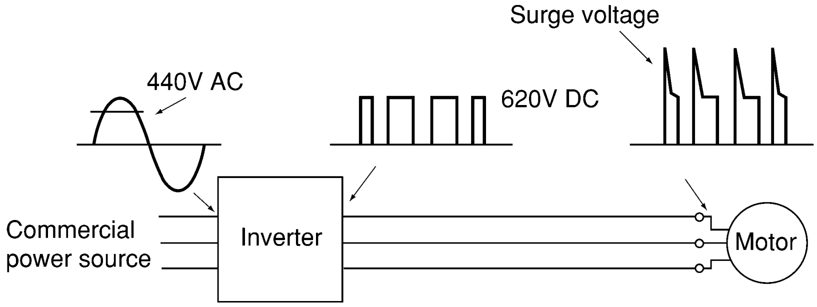
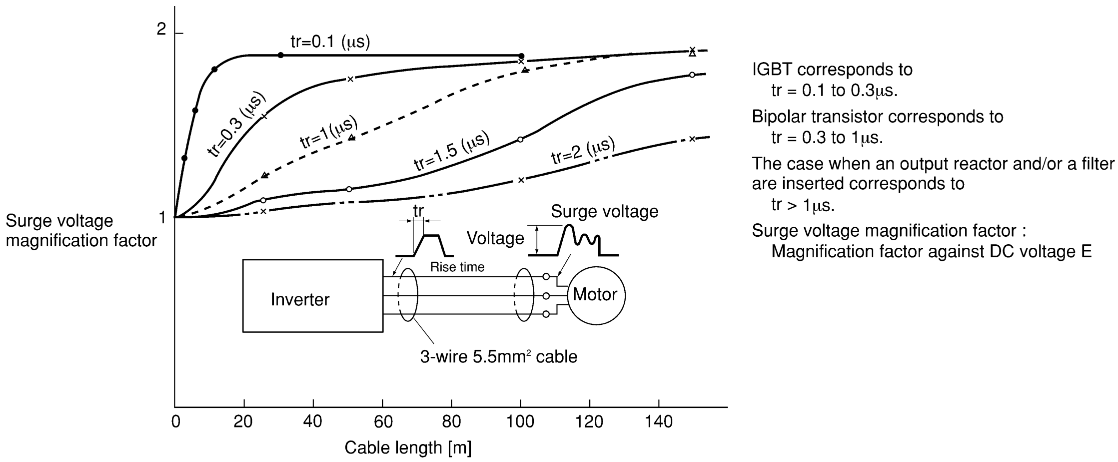



Figure 2 Voltage Wave Shapes of Individual Positions

A measured example in Figure 3 illustrates relation of a peak value of the motor terminal voltage with a wiring length between the inverter and the motor.
From this it can be confirmed that the peak value of the motor terminal voltage ascends as the wiring length increases and becomes saturated at about twice of the inverter DC voltage.
Besides the shorter a pulse rise time becomes, the higher the motor terminal voltage rises even in case of a short wiring length.




Excerpt from [J. IEE Japan, Vol. 107, No.7, 1987]

Figure 3 Measured Example of Wiring Length and Peak Value of Motor Terminal Voltage

## 3 Effect of Surge Voltages

The surge voltages originating in LC resonance of wiring may be applied to the motor input terminals and depending on their magnitude sometimes cause damage to the motor insulation.
When the motor is driven with a 200V class inverter, as for dielectric strength of the insulation it is no problem that the peak value at the motor terminal voltage increases twice due to the surge voltages, since the DC voltage is only about 300V.
But in case of a 400V class inverter the DC voltage becomes about 600V and depending on wiring length the surge voltages may highly rise and sometimes result in damage to the insulation.

# 4 Countermeasures Against Surge Voltages

The following methods are countermeasures against damage to the motor insulation by the surge voltages in case of a motor driven with a 400V class inverter.

## 4.1 Method to Use Motors with Enhanced Insulation

Enhanced insulation of a motor winding allows its surge proof strength to be improved.

## 4.2 Method to Suppress Surge Voltages

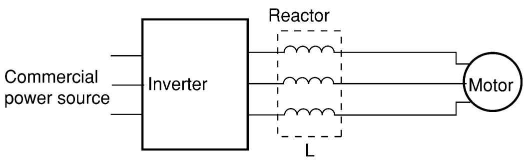
There are two methods for suppressing the surge voltages, one is to reduce the voltage rising and another is to reduce the voltage peak value.

(1) Output reactor

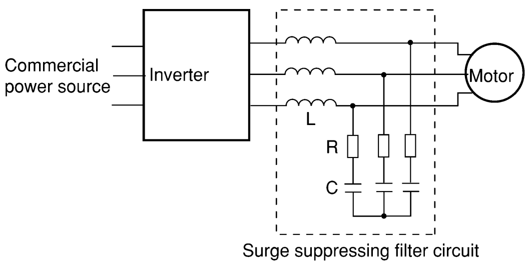
If wiring length is relatively short the surge voltages can be suppressed by reducing the voltage rising (dv/dt) with installation of an AC reactor on the output side of the inverter. (Refer to Figure 4 (1)) However, if the wiring length becomes long, suppressing the peak voltage due to surge voltage may be difficult.

(2) Output filter

Installing a filter on the output side of the inverter allows a peak value of the motor terminal voltage to be reduced. (Refer to Figure 4 (2))




(1) Output reactor




(2) Output filter

Figure 4 Method to Suppress Surge Voltage

# 5 Regarding Existing Equipment

## 5.1 In Case of Motor being Driven with 400V Class Inverter

The last five years survey on motor insulation damage due to the surge voltages originating from switching of inverter elements shows that the damage incidence is 0.013% under the surge voltage condition of over 1,100V and most of the damage occurs in several months after commissioning of the inverter. Therefore there seems to be little probability of occurrence of motor insulation damage after a lapse of several months of commissioning.

## 5.2 In Case of Existing Motor Driven Newly with 400V Class Inverter

We recommend to suppress the surge voltages with the method of 4.2.

## Appendix 3. Example Calculation of Energy Savings

The energy saving that results from use of an inverter is calculated based on a specific calculation result (in the case of a fan and pump). The Q-P characteristic curve corresponding to damper use in Figure 1 changes depending on the motor capacity and manufacturer. Therefore, characteristic curves should be obtained individually when performing a detailed calculation.

### 1 Calculating Condition

[Use]
- Fan for air conditioning

[Usage period]
- 250 days / year (24 hours / day)

[Reduced rate of air flow with damper]
- In accordance with general output characteristics (Q-P curve ) in Figure 1

[Reducing rate of air flow with an inverter (frequency)]
- 60Hz → 40Hz

[Electric power at maximum air flow rate : $P_0$ [kW]]
- $P_0$ = Applied motor [kW] × 1 / Motor efficiency → $P_0$
  = Applied motor [kW] × 1 / 0.9

<In a case of a motor of 37kW>
- $P_0 = 37 \times 1 / 0.9$
  $= 41.1$ kW

[Power rate per 1 kWh : $M_2$ [US$]]
- Suppose US$0.14 / kWh

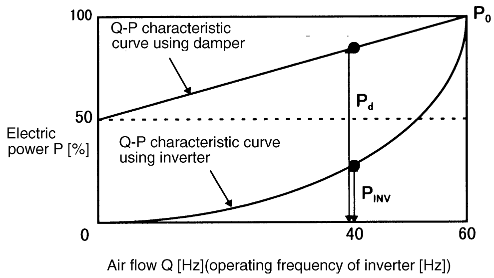



Figure 1 Q-P Characteristic Curve

### 2 Calculation of Shaft Driving Power

[Shaft driving power with damper control : $P_d$ ]

$P_d = ((50 + 50 \times (40 / 60)) / 100 \times P_0$
$= 0.833\ P_0$ [kW]

[Shaft driving power with inverter control : $P_{INV}$]

$P_{INV} = (40 / 60)^3 \times P_0$
$= 0.296 \times P_0$ [kW]

### 3 Calculation of Energy Savings

A specific example of the energy savings is calculated with the following formula.

<Formula>
- $M_1 = (P_d - P_{INV}) \times T \times M_2$ [US$ / year]

  where $M_2$ : Electricity bill of the energy saving [US$ / year]
  T : Operating time per year [h]
  $M_2$ : Power rate per 1 kWh [US$]

■ Calculation example
- $M_1 = (P_d - P_{INV}) \times T \times M_2$ [US$ / year]
  $= (0.833 - 0.296) \times P_0 \times T \times M_2$
  $= 0.537 \times 41.1 \times (250 \times 24) \times 0.14$
  $= 18{,}539$ [US$ / year]

Therefore, energy savings of approximately US$18,500 / year are obtained.

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