Fuji Electric

Innovating *Energy Technology*

User's Manual

USER'S
MANUAL

FRENIC-VG Series

Unit Type / Function Codes Edition

24A7-E-0019b

High Performance, Vector Control Inverter

FRENIC-VG

User's Manual

(Unit Type / Function Codes Edition)

Revision History	Index	Date of Revision	Revision Contents
1st Edition	—	2013-03	First Edition
2nd Edition	a	2019-02	Content is updated
3rd Edition	b	2019-07	Content is updated

Preface

This manual provides the following information on the FRENIC-VG series of inverters.

- Function codes available in the FRENIC-VG series (Unit type/Stack type) and keypad operation
- Unit type inverter specifications, installation, and selection of peripheral equipment

Carefully read this manual for proper use. Incorrect handling of the inverter may prevent the inverter or related equipment from operating correctly, shorten their lives, or cause problems.

The table below lists the materials related to the use of the FRENIC-VG. Read them in conjunction with this manual as necessary.

Name		Manual No.	Description
Catalog		24A1-□-0002* (Old No. MH659)	Product scope, features, specifications, external drawings, and options of the product
User's Manuals	Unit Type / Function Codes Edition (this manual)	24A7-□-0019* (Old No. MHT286)	1) Function codes, keypad operation, etc. for the FRENIC-VG series (Unit type/Stack type) 2) Outline, features, specifications, replacement data, etc. of the FRENIC-VG Unit type
User's Manuals	Option Edition	24A7-□-0045* (Old No. MHT286)	Functions of various option cards, RS-485 interface, etc. available for the FRENIC-VG series * For the optional functional safety card (OPC-VG1-SAFE), refer to the option card instruction manual. Other options are described in this manual.
User's Manuals	Stack Type Edition	24A7-□-0018*	Features, specifications, cabinet design materials, etc. of the FRENIC-VG Stack type and the converter
User's Manuals	UPAC Option Edition	24A7-□-0044*	UPAC option card specifications, INV⇔UPAC interface, application package software (orientation and dancer type of winders), etc.
Instruction Manual (FRENIC-VG Unit Type)		INR-SI47-1580*-□	Acceptance inspection, mounting & wiring of the inverter, operation using the keypad, troubleshooting, and maintenance and inspection, specifications, etc.
FRENIC-VG Loader Instruction Manual	WPS-VG1-STR	INR-SI47-1617*-□	Instructions for inverter support software FRENIC-VG Loader (free version)
FRENIC-VG Loader Instruction Manual	WPS-VG1-PCL	INR-SI47-1589*-□	Instructions for FRENIC-VG Loader (paid-for version) including the tracing function not supported by the WPS-VG1-STR (free version)

Note 1: A box (□) in the above table replaces an alphabet letter: J (Japanese), E (English), or C (Chinese). An asterisk (*) replaces a revision code (a, b, c,…).

Note 2: The materials are subject to change without notice. Be sure to obtain the latest editions for use.

Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances

Our three-phase, 200 V class series inverters of 3.7 kW or less (FRENIC-VG series) were the products of which were restricted by the "Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances" (established in September 1994 and revised in October 1999) issued by the Ministry of Economy, Trade and Industry.

The above restriction, however, was lifted when the Guideline was revised in January 2004. Since then, the inverter makers have individually imposed voluntary restrictions on the harmonics of their products.

We, as before, recommend that you connect a reactor (for suppressing harmonics) to your inverter. As a reactor, select a "DC REACTOR" introduced in this manual. For use of the other reactor, please inquire of us about detailed specifications.

Japanese Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage

Refer to Appendix B in this manual for details on this guideline.

How this manual is organized

This manual contains Chapters 1 through 13 and Appendices.

Chapter 1 OVERVIEW

This chapter describes the overview, features and the control system of the FRENIC-VG series and the recommended configuration for the inverter and peripheral equipment.

Chapter 2 SPECIFICATIONS

This chapter describes specifications of the output ratings, control system, dedicated motor specifications, and terminal functions for the FRENIC-VG series of inverters. It also provides descriptions of the external dimensions, examples of basic connection diagrams, and details of the protective functions.

Chapter 3 PREPARATION AND TEST RUN

This chapter describes the operating and storage environments, installation and wiring, typical connection diagram, names and functions of keypad components, keypad operation, and test run procedure.

Chapter 4 CONTROL AND OPERATION

This chapter provides the main block diagrams for the control logic of the FRENIC-VG series of inverters. It also contains overview tables of function codes and details of function codes.

Chapter 5 USING STANDARD RS-485 … See the Option Edition (24A7-E-0045) separately issued.

This chapter describes the use of standard RS-485 communications ports and provides an overview of the FRENIC-VG Loader.

Chapter 6 CONTROL OPTIONS … See the Option Edition (24A7-E-0045) separately issued.

This chapter describes the FRENIC-VG's control options.

Chapter 7 APPLICATION EXAMPLES

This chapter gives application examples of the FRENIC-VG series of inverters.

Chapter 8 SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-VG's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Chapter 9 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

This chapter provides you with information about the inverter output torque characteristics, selection procedure, and equations for calculating capacities to help you select optimal motor and inverter models. It also helps you select braking resistors and inverter mode (HD, MD, or LD).

Chapter 10 ABOUT MOTORS

This chapter details vector motors that can be connected to the FRENIC-VG series of inverters.

Chapter 11 OPERATION DATA

This chapter provides the characteristics data of the FRENIC-VG series of inverters running.

Chapter 12 REPLACEMENT DATA

When replacing the former inverters (VG, VG3, VG5) with FRENIC-VG, refer to this section.

Chapter 13 TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or detects an alarm or a light alarm condition. In this chapter, first check whether any alarm code or the "light alarm" indication (L-AL) is displayed or not, and then proceed to the troubleshooting items.

Appendices

CONTENTS

Chapter 8 SELECTING PERIPHERAL EQUIPMENT

Chapter 9 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

Safety precautions

Read this manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the device and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

Safety precautions are classified into the following two categories in this manual.

⚠WARNING	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in death or serious bodily injuries.
⚠CAUTION	Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in minor or light bodily injuries and/or substantial property damage.

Failure to heed the information contained under the CAUTION title can also result in serious consequences. These safety precautions are of utmost importance and must be observed at all times.

Application

⚠WARNING

- The FRENIC-VG is designed to drive a three-phase induction motor. Do not use it for single-phase motors or for other purposes.

  Fire or an accident could occur.

- The FRENIC-VG may not be used for a life-support system or other purposes directly related to the human safety.
- Though the FRENIC-VG is manufactured under strict quality control, install safety devices for applications where serious accidents or property damages are foreseen in relation to the failure of it.

  An accident could occur.

Installation

⚠WARNING

- Install the inverter on a base made of metal or other non-flammable material.

  Otherwise, a fire could occur.

- Do not place flammable object nearby.

  Doing so could cause fire.

- Inverters with a capacity of 30 kW or above, whose protective structure is IP00, involve a possibility that a human body may touch the live conductors of the main circuit terminal block. Inverters to which an optional DC reactor is connected also involve the same. Install such inverters in an inaccessible place.

  Otherwise, electric shock or injuries could occur.

⚠CAUTION

- Do not support the inverter by its front cover during transportation.

  Doing so could cause a drop of the inverter and injuries.

- Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink.
- When changing the positions of the top and bottom mounting bases, use only the specified screws.

  Otherwise, a fire or an accident might result.

- Do not install or operate an inverter that is damaged or lacking parts.

  Doing so could cause fire, an accident or injuries.

Wiring

⚠WARNING

- If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only.

  Otherwise, a fire could occur.

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) in the path of each pair of power lines to inverters. Use the recommended devices within the recommended current capacity.
- Use wires in the specified size.
- Tighten terminals with specified torque.

  Otherwise, a fire could occur.

- When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.
- Do not connect a surge killer to the inverter's output (secondary) circuit.

  Doing so could cause a fire.

- Be sure to connect an optional DC reactor (DCR) when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity.

  Otherwise, a fire could occur.

- Ground the inverter in compliance with the national or local electric code.
- Be sure to ground the inverter's grounding terminals ⏚G.

  Otherwise, an electric shock or a fire could occur.

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after turning the power OFF.

  Otherwise, an electric shock could occur.

- Be sure to perform wiring after installing the inverter unit.

  Otherwise, an electric shock or injuries could occur.

- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

  Otherwise, a fire or an accident could occur.

- Do not connect the power supply wires to output terminals (U, V, and W).
- When connecting a DC braking resistor (DBR), never connect it to terminals other than terminals P(+) and DB.

  Doing so could cause fire or an accident.

- In general, sheaths of the control signal wires are not specifically designed to withstand a high voltage (i.e., reinforced insulation is not applied). Therefore, if a control signal wire comes into direct contact with a live conductor of the main circuit, the insulation of the sheath might break down, which would expose the signal wire to a high voltage of the main circuit. Make sure that the control signal wires will not come into contact with live conductors of the main circuit.

  Doing so could cause an accident or an electric shock.

⚠WARNING⚠

- Before changing the switches or touching the control circuit terminal symbol plate, **turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

  Otherwise, an electric shock could occur.

⚠CAUTION

- The inverter, motor and wiring generate electric noise. Be careful about malfunction of the nearby sensors and devices. To prevent them from malfunctioning, implement noise control measures.

  Otherwise an accident could occur.

Operation

⚠WARNING

- Be sure to mount the front cover before turning the power ON. Do not remove the cover when the inverter power is ON.
  Otherwise, an electric shock could occur.
- Do not operate switches with wet hands.
  Doing so could cause electric shock.
- If the auto-reset function has been selected, the inverter may automatically restart and drive the motor depending on the cause of tripping. Design the machinery or equipment so that human safety is ensured at the time of restarting.
  Otherwise, an accident could occur.
- If the stall prevention function (torque limiter) has been selected, the inverter may operate with acceleration/deceleration or speed different from the commanded ones. Design the machine so that safety is ensured even in such cases.
- The STOP key on the keypad is effective only when the keypad operation is enabled with function code F02 (= 0, 2 or 3). When the keypad operation is disabled, prepare an emergency stop switch separately for safe operations. Switching the run command source from keypad (local) to external equipment (remote) by turning ON the "Enable communications link" command ***LE*** disables the STOP key.
  To enable the STOP key for an emergency stop, select the STOP key priority with function code H96 (= 1 or 3).
- If any of the protective functions have been activated, first remove the cause. Then, after checking that the all run commands are set to OFF, release the alarm. If the alarm is released while any run commands are set to ON, the inverter may supply the power to the motor, running the motor.
  Otherwise, an accident could occur.
- If you enable the "Restart mode after momentary power failure" (Function code F14 = 3 to 5), then the inverter automatically restarts running the motor when the power is recovered.
  Design the machinery or equipment so that human safety is ensured after restarting.
- If the user configures the function codes wrongly without completely understanding this Instruction Manual and the FRENIC-VG User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine.
  An accident or injuries could occur.
- Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.
- Even if the run command is set to OFF, voltage is output to inverter output terminals U, V, and W if the servo-lock command is ON.
- Even if the motor is stopped due to DC braking or preliminary excitation, voltage is output to inverter output terminals U, V, and W.
  An electric shock may occur.
- The inverter can easily accept high-speed operation. When changing the speed setting, carefully check the specifications of motors or equipment beforehand.
  Otherwise, injuries could occur.

⚠CAUTION

- Do not touch the heat sink and braking resistor because they become very hot.
  Doing so could cause burns.
- The DC brake function of the inverter does not provide any holding mechanism.
  Injuries could occur.
- Ensure safety before modifying the function code settings.
  Run commands (e.g., "Run forward" ***FWD***), stop commands (e.g., "Coast to a stop" ***BX***), and speed change commands can be assigned to digital input terminals. Depending upon the assignment states of those terminals, modifying the function code setting may cause a sudden motor start or an abrupt change in speed.
- When the inverter is controlled with the digital input signals, switching run or speed command sources with the related terminal commands (e.g., ***SS1***, ***SS2***, ***SS4***, ***SS8***, ***N2/N1***, ***KP/PID***, ***IVS***, and ***LE***) may cause a sudden motor start or an abrupt change in speed.
  An accident or injuries could occur.

Maintenance and inspection, and parts replacement

⚠WARNING⚠

- Before proceeding to the maintenance/inspection jobs, **turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

  Otherwise, an electric shock could occur.
- Maintenance, inspection, and parts replacement should be made only by qualified persons.
- Take off the watch, rings and other metallic objects before starting work.
- Use insulated tools.

  Otherwise, an electric shock or injuries could occur.
- Never modify the inverter.

  Doing so could cause an electric shock or injuries.

Disposal

⚠CAUTION

- Treat the inverter as an industrial waste when disposing of it.

  Otherwise injuries could occur.

Speed control mode

⚠CAUTION

- If the control parameters of the automatic speed regulator (ASR) are not appropriately configured under speed control, even turning the run command OFF may not decelerate the motor due to hunting caused by high gain setting. Accordingly, the inverter may not reach the stop conditions so that it may continue running.

  Even if the inverter starts deceleration, the detected speed deviates from the zero speed area before the zero speed control duration (F39) elapses due to hunting caused by high response in low speed operation. Accordingly, the inverter will not reach the stop conditions so that it enters the deceleration mode again and continues running.

  If any of the above problems occurs, adjust the ASR control parameters to appropriate values and use the speed mismatch alarm function in order to alarm-trip the inverter, switch the control parameters by speed, or judge the detection of a stop speed by commanded values when the actual speed deviates from the commanded one.

  An accident or injuries could occur.

Torque control mode

⚠CAUTION

- When the motor is rotated by load-side torque exceeding the torque command under torque control, turning the run command OFF may not bring the stop conditions so that the inverter may continue running.

  To shut down the inverter output, switch from torque control to speed control and apply a decelerate-to-stop or coast-to-stop command.

  An accident or injuries could occur.

GENERAL PRECAUTIONS

Drawings in this manual may be illustrated without covers or safety shields for explanation of detail parts. Restore the covers and shields in the original state and observe the description in the manual before starting operation.

Icons

The following icons are used throughout this manual.

Note — This icon indicates information which, if not heeded, can result in the inverter not operating to full efficiency, as well as information concerning incorrect operations and settings which can result in accidents.

Tip — This icon indicates information that can prove handy when performing certain settings or operations.

📖 This icon indicates a reference to more detailed information.

Chapter 1
OVERVIEW

This chapter describes the overview, features and the control system of the FRENIC-VG series and the recommended configuration for the inverter and peripheral equipment.

Contents

1.1 Overview

1.1.1 Industry-best control performance

- The FRENIC-VG implements vector control with a speed sensor (induction and synchronous motors), vector control without a speed sensor (induction motors), V/f control (induction motors), and multi-drive functionality.
- Vector control with a speed sensor (for FRENIC-VG induction motors) delivers best-in-industry performance with a speed response of 600 Hz, current response of 2,000 Hz, speed control accuracy of ±0.005%, and torque control accuracy of ±3%.

1.1.2 System support

- The FRENIC-VG has the RS-485 communications function as standard and supports various networks (T-Link, SX bus, and CC-Link, and PROFIBUS) as an option.
- The optional UPAC card with user program functionality allows users to configure and develop proprietary systems, and dedicated package software is also available.
- The direct parallel connection control system is adopted so that two or more inverters can be connected in parallel to drive a single motor (single winding). If some inverters go wrong, therefore, the remaining normal inverters can continue to drive the motor (reduced-inverters operation).

1.1.3 Extensive built-in functionality

- Extensive auto-tuning function for optimal control of all types of motors
- Built-in load oscillation suppression observer function and load compensation control function
- Extensive position control functionality, including zero-speed lock control
- Optional position synchronization control using pulse train input
- Optional orientation control
- Inverter support loader software FRENIC-VG Loader that enables you to read and write the function code data from/to the inverter on the computer. In addition, the multifunction FRENIC-Loader provides the trace function (traceback, real-time trace, and historical trace) for management of inverter function code configuration, the logger tool for setting-up the machinery, and the failure analysis.

  FRENIC-VG Loader runs on Windows XP, Vista, Windows 7 (32/64bit), Windows 8.1 (32/64bit) and Windows 10 (32/64bit).

1.1.4 Broad capacity and application ranges

- A single set of specifications supports a broad range of capacities—from 0.75 kW to 90 kW for 200 V circuits and 3.7 kW to 630 kW for 400 V circuits—simplifying the system development process.
- Three sets of ratings are supported by HD mode (constant-torque), which offers an overload rating of 150% for 1 min. and 200% for 3 sec.; LD mode (square deceleration torque), which supports motors with rated currents one step larger than the inverter and offers an overload rating of 120% for 1 min.; and MD mode, which supports motors with rated currents one step larger than the inverter while limiting the inverter's internal switching frequency and offers an overload rating of 150% for 1 min.

1.1.5 Global support

- The standard model complies with UL/cUL standards, CE Mark requirements, the RoHS Directive, and Radio Waves Act (South Korea, KC certification), making it possible to standardize equipment and machinery specifications both inside and outside Japan.
- The FRENIC-VG has the safety function STO (Safe Torque Off) complying with the IEC/EN61800-5-2 functional safety standard, as standard. Mounting the functional safety option OPC-VG1-SAFE on the FRENIC-VG adds the safety functions SS1 (Safe Stop 1), SLS (Safely Limited Speed), and SBC (Safe Brake Control) to the FRENIC-VG.
- The keypad displays English, Japanese, Chinese, and Korean (Hangul).
- Optional support is available for open networks (e.g. PROFIBUS-DP and DeviceNet).

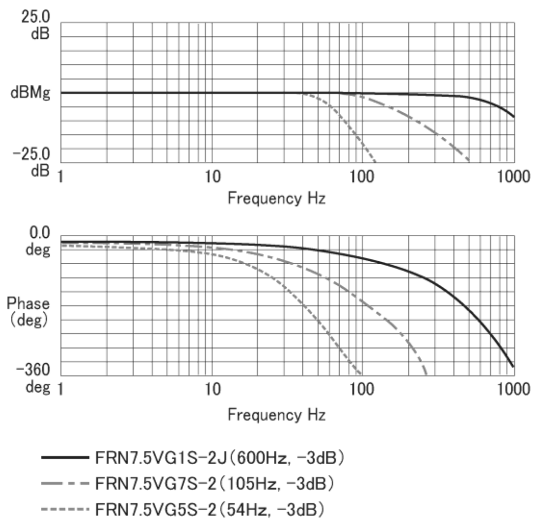
1.2 Features

The FRENIC-VG is a high-performance vector control inverter that provides a high degree of freedom in adjusting speed and torque.

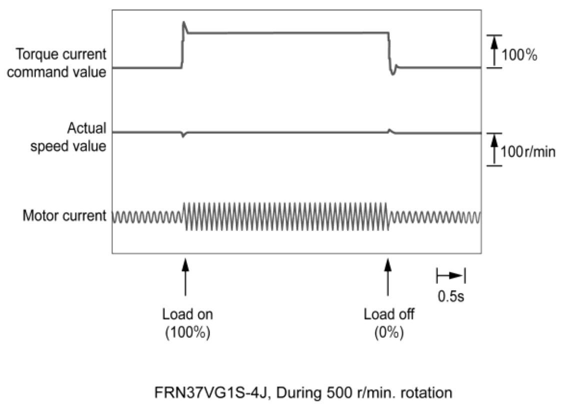
1.2.1 Best-in-industry control performance

- Speed response of 600 Hz (6× Fuji's previous VG7 model when using vector control with a speed sensor)
- Current response of 2,000 Hz (2× Fuji's previous VG7 model when using vector control with a speed sensor)
- Torque control accuracy (linear) of ±3% and speed control accuracy of ±0.005%

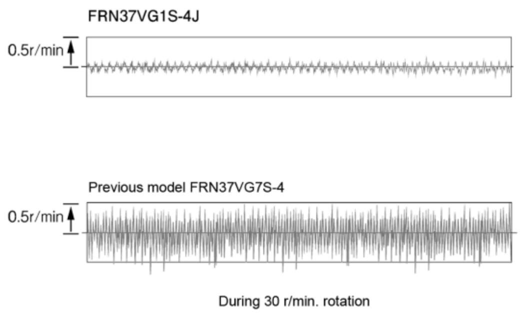
Speed response of 600 Hz



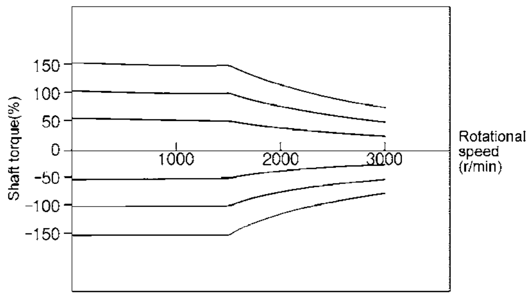
Tracking characteristics with impact load



Reduction of rotational unevenness to 1/3



Speed and torque characteristics



FRN37VG1S-4J

1.2.2 Support for various control systems (multi-drive function)

- Supports vector control with/without a speed sensor and V/f control for induction motors.
- Supports vector control with a speed sensor (requires optional card) for synchronous motors.
- Capable of driving megawatt motors by adopting multi-winding drive or direct parallel connection. This requires the optional high-speed serial communication terminal block.

1.2.3 Broad capacity range/flexible application range

- A single model supports a broad range of capacities from 0.75 kW to 630 kW, simplifying the system development process.
- The standard model supports three modes.

  The operating mode is switched based on the motor's load conditions. In medium-duty (MD) and low-duty (LD) applications, the FRENIC-VG can drive motors one to two steps larger than the inverter.

Mode	Applied load	Characteristics	Applied overload rating
HD	High duty (standard)	Powerful, low noise	Current 150% for 1 min. / 200% for 3 sec.
MD	Medium duty	Can drive a motor one step larger than the inverter*1.	Current 150% for 1 min., carrier 2 to 4 kHz*2
LD	Low duty	Can drive a motor 1 to 2 steps larger than the inverter*1.	Current 120% for 1 min.

*1 Varies with motor specifications and supply voltage.

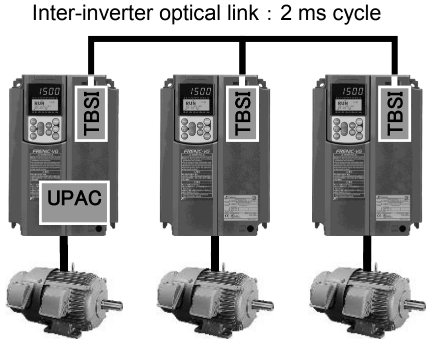
*2 Produces a higher level of noise. Verify suitability of environment in which motor will be installed.

1.2.4 User program functionality (UPAC option)

- The UPAC (User Programmable Application Card) option OPC-VG1-UPAC, which provides user program functionality, allows certain aspects of inverter control and terminal functionality to be changed, making it possible for users to configure and develop proprietary systems.
- Dedicated package software is also available for functionality such as orientation control, dancer control, and tension control.
- The OPC-VG1-UPAC application software is compatible with the FRENIC5000VG7-UPAC one.

  Note: To download the FRENIC5000VG7-UPAC application software to the OPC-VG1-UPAC, the version of the SX-Programmer Expert (D300win) and its UPAC support functions should be V3.6.1.3 or later.

UPAC system



Outline of UPAC Optical Link System Configuration

- The UPAC option is mounted on the FRENIC-VG master.
- The TBSI(Optical link option card) OPC-VG1-TBSI is mounted on each inverter. (Connected with an optical cable that comes with the TBSI.)
- Restrictions on the number of inverters in a UPAC optical link system
  - i) 6-inverter system : 2 to 6 inverters
  - ii) 12-inverter system : 2 to 12 inverters
  - iii) Broadcast : 2 to 156 inverters (1 ms cycle)

  The number of I/O words differs for each inverter.

UPAC: OPC-VG1-UPAC (User programmable application card option)
TBSI: OPC-VG1-TBSI (Optical link option card)

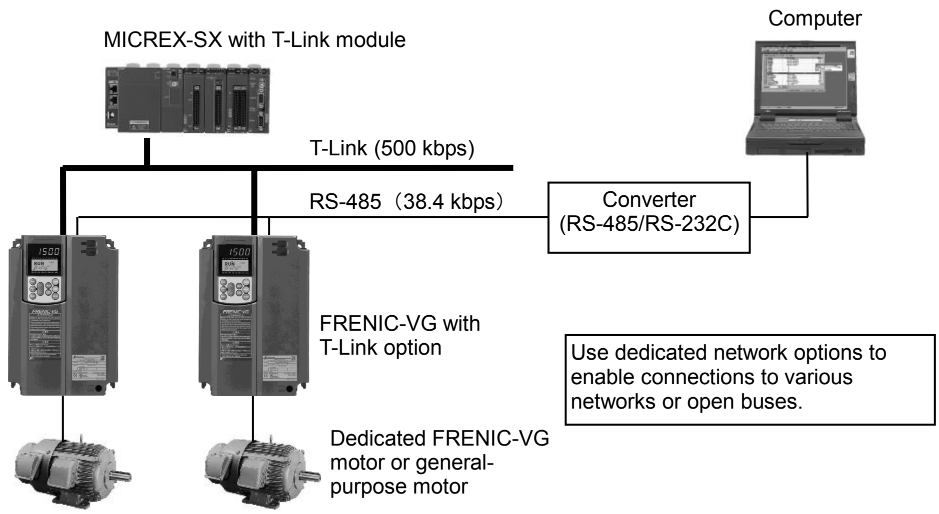
1.2.5 Extensive network support

- The RS-485 communications function is provided as standard. Optional support is available for various networks.

i) RS-485 communications system	:	A standard RS-485 terminal is provided as a control circuit terminal, making it easy to implement multi-drop connections.
ii) Fuji private link	:	T-Link, SX-bus, and E-SX bus
iii) CC-Link	:	CC-Link Ver. 1.10/Ver. 2.00

- It also supports various open buses--PROFIBUS-DP, DeviceNet, and PROFINET-IRT (*1).

  *1 PROFINET-IRT is only supported by special product.



Note: The FRENIC-VG is network-compatible with the FRENIC5000VG7 to facilitate updating.

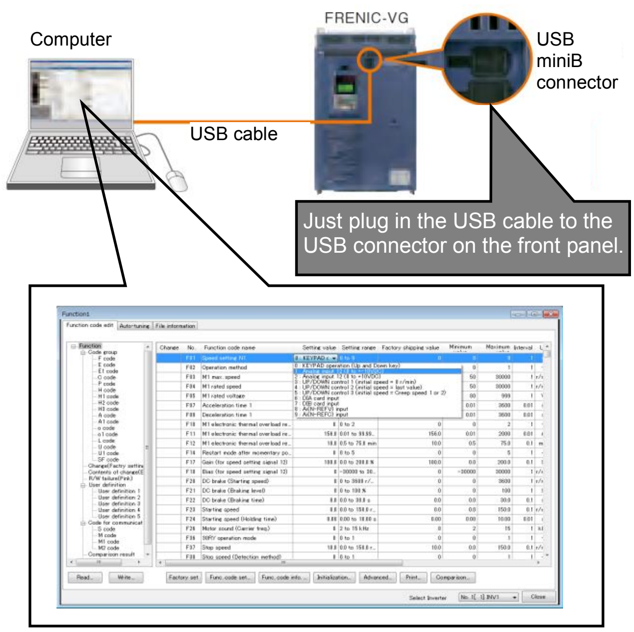
1.2.6 Inverter support software "FRENIC-VG Loader"

The CD-ROM that comes with the FRENIC-VG contains the inverter support software "FRENIC-VG Loader" (WPS-VG1-STR). Installing FRENIC-VG Loader to a computer enables the following.

i) Reading and writing function code data from/to the inverter. Saving function code data and conversion to a CSV file, making management of function codes easy.

ii) Traceback in the trace function, facilitating failure analysis.

- Commercially available USB cables can be used.
- Supports for Windows XP, Vista, Windows 7 (32-/64-bit version), Windows 8.1 (32-/64-bit version), Windows 10 (32-/64-bit version).



1.2.7 Extensive built-in functionality

- Auto-tuning functionality

  i) Possible to tune motor parameters while the motor is in the stopped state.

  ii) Online tuning function that allows motor parameters to be revised while the motor is running.

- Built-in observer function for suppressing load oscillation

- Load compensation control function

  Enables continuous speed control during low-duty operation.

- Extensive position control functionality

  i) Zero-speed lock control

  ii) Optional position synchronization control using pulse train input

  iii) Optional orientation control

- Braking resistor drive circuit incorporated as standard

  The FRENIC-VG of 55 kW or less (for 200 V class series) or 160 kW or less (for 400 V class series) incorporates a braking resistor drive circuit, allowing a braking resistor to be connected directly to the FRENIC-VG unit. This feature helps make devices using the inverter more compact.

  For the FRENIC-VG not incorporating it as standard, a braking unit (BU-C series) can be used.

- Total of 23 I/O contacts

	Input	Output
Analog	3 contacts	3 contacts
Digital	11 contacts	6 contacts

- PG feedback interfaces

  i) Standard built-in complementary PG interface (12 V, 15 V)

  ii) Optional interfaces for line driver PG and open collector PG

  iii) For a permanent magnet synchronous motor (PMSM), optional dedicated interface for line driver PG and open collector PG

  (Magnetic pole position signals support 4-bit or 3-bit gray code.)

  iv) Optional interface for Tamagawa Seiki serial PG (17-bit absolute encoder)

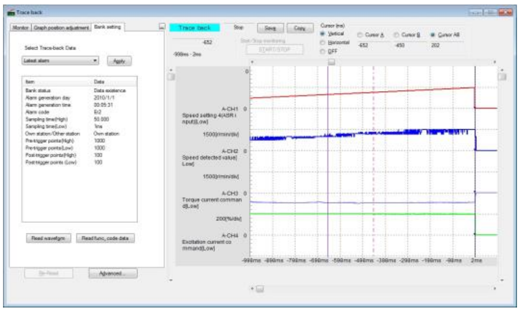
  Optional interfaces given in iv) above are available for controlling both IM (induction motor) and PMSM.

1.2.8 Extensive maintenance and protective functionality

- The calendar & clock function records and displays the date and time at which a trip occurred, making it easier to search for the causes of trips by checking them against the operating state of the machine.
- The traceback function automatically records running state data (traceback data) including the speed, torque, current, and voltage being applied immediately preceding a trip stop, in the inverter. The traceback data can be displayed in a chart.
- The optional paid-for version (WPS-VG1-PCL) of FRENIC-VG Loader has additional running monitor, real-time trace and historical trace functions that are not available in the free version (WPS-VG1-STR).

  Data logger function

  - Running monitor
  - Real-time trace
  - Historical trace
    Note: These functions above are supported by the optional version (WPS-VG1-PCL).
  - Traceback



  Note: The calendar & clock function and traceback function require a built-in battery (included as standard for inverters of 30 kW or above).

- The inverter's operating state at the time of the most recent and three previous trip stops is stored and can be monitored on the keypad.
- Specific alarms can be registered as a light alarm object to make it possible to keep running the inverter without causing a trip. If a light alarm occurs, the inverter merely displays L-AL on the LED monitor and outputs ***Do*** (optional).
- A mock alarm can be triggered by either keypad operation or FRENIC-VG Loader. This capability can be used to check the trip stop sequence.
- I/O terminal check function
- Main circuit capacitor service life detection
- Inverter load rate measurement
- Recording and display of cumulative run time
- Display of operating state data such as output voltage, cooler temperature, and torque command value
- Configuration of the electronic thermal time constant, allowing the inverter to support a variety of motors
- The design life of various consumable parts inside the inverter has been extended to 10 years, which has allowed equipment maintenance cycles to be extended.

Consumable part	Design life
Cooling fan	10 years
Main circuit capacitor	10 years
Electrolytic capacitor on PCB	10 years
Fuse (90 kW or above)	10 years
Calendar/clock backup battery	5 years

Service life figures are based on the following conditions:

- Ambient temperature: 40°C
- Load factor: 100% (HD mode), 80% (MD/LD mode)

*Design life figures are calculated values and are not intended to serve as a guarantee of hardware performance.

- Extensive service life warnings

The inverter provides functionality designed to facilitate machinery maintenance.

Item	Purpose
Cumulative run time (unit: 1 hour)	Displays the total run time for the inverter. The amount of time during which the main power supply is supplied is indicated as a whole number of hours.
Cumulative motor run time (unit: 10 hours)	Displays the total run time for the motor. This figure is used to determine the service life of the machinery (load).
Cumulative startup count	Displays the number of motor startups. This figure can be used as a guide for timing the replacement of machinery parts (such as timing belts) that are placed under load during normal operation.
Equipment maintenance warning Cumulative motor run time (unit: 10 hours) Cumulative startup count	The inverter can output a warning signal when the set value is reached. This functionality makes it possible to manage the motor's cumulative run time and number of startups, which are useful in planning maintenance.
Display of inverter service life alarm	Displays the following: ・ Current capacitance of DC link bus capacitor ・ Total run time of the cooling fan (with on/off compensation) ・ Total run time of the electrolytic capacitor on the PCB

1.2.9 Environmental considerations

- Enhanced environmental resistance

The inverter offers improved resistance to harsh operating environments compared to conventional inverter models.

(1) Enhanced environmental resistance of the cooling fan

(2) Adoption of nickel and tin plating for copper bars

While the FRENIC-VG offers improved resistance to harsh operating environments compared to conventional models, special consideration concerning the operating environment is necessary in the following cases:

a. Environments where sulfide gas is present (some applications in tire manufacturing, paper manufacturing, sewage treatment, and fiber manufacturing)
b. Environments where conductive dust or foreign matter is present (metalworking, extruding machine or printing press operation, waste disposal, etc.)
c. Other: Where the inverter would be used in an environment that differs from the standard specifications

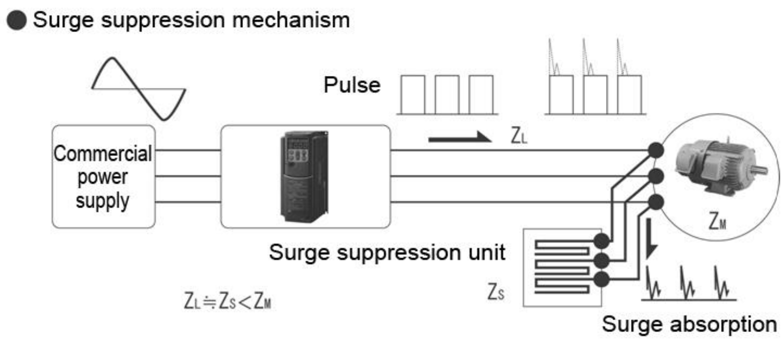
If you are considering using the inverter under any of the above conditions, please contact Fuji in advance.

- Protection against micro-surges (optional)

SSU surge suppression units (optional)

If the motor drive cable is too long, a very low surge voltage (micro-surge) may be generated at the motor connection ends. This surge voltage can cause deterioration of the motor, dielectric breakdown, and increased noise. A surge suppression unit can be used to suppress this surge voltage.

(1) Simply connecting a surge suppression unit to the motor dramatically reduces the surge voltage.
(2) Since no additional work is required, the units can be easily installed on existing equipment.
(3) The units can be used with motors with a capacity of 75 kW or less.
(4) The units require no power source or maintenance.
(5) Two types are available: one for 50 m motor cable and the other for 100 m motor cable.
(6) The units comply with environmental and safety standards (including the RoHS Directive).



- Compliance with the RoHS Directive

The FRENIC-VG complies with the Restriction of Hazardous Substances (RoHS) Directive in its standard configuration. It is an environmentally friendly inverter as use of the following six hazardous substances has been restricted.

Six hazardous substances

Lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ether (PBDE)

*Except certain parts on some models.

About the RoHS Directive

Directive 2002/96/EC, promulgated by the European Parliament and European Council, limits the use of specific hazardous substances in electrical and electronic devices.

1.2.10 Simple, interactive keypad

- A large, easy-to-read LED consisting of five 7-segment digits allows users to visually check monitor values with ease.
- A backlit dot matrix LCD allows users to set function codes and monitor multiple data points at the same time while displaying guidance.
- Standard copy function

  Function code data can be easily copied to another FRENIC-VG unit.
- Out-of-the-box remote operation

  Simply connect the inverter and keypad with a 10Base-T LAN cable to enable remote operation (at distances of up to 20 m).
- Standard support for eight languages (Japanese, English, Chinese and Korean).
- JOG (jogging) operation is possible with keypad key or terminal block input.
- A help key displays guidance on device operation.
- The calendar & clock function can display the time and date.

1.2.11 Compliance with overseas standards

- The FRENIC-VG complies with the following overseas standards in its standard configuration, allowing standardization of device and machinery specifications in Japan and overseas:

  EC directives: Low Voltage Directive, RoHS Directive, Machinery Directive, UL Standards, cUL Standards, KC Certification

- The FRENIC-VG also complies with the EMC Directive when the standard model is combined with an option (EMC filter).

EU	US/Canada
EC Directive (CE marking)	UL Standards/ cUL Standards

Korea
KC certification

1.2.12 Compliance with functional safety standards

- The FRENIC-VG supports the safety function STO (Safe Torque Off) complying with the IEC/EN61800-5-2 Functional Safety Standard, as standard.
- Mounting the functional safety option OPC-VG1-SAFE on the FRENIC-VG adds the safety functions SS1 (Safe Stop 1), SLS (Safely Limited Speed), and SBC (Safe Brake Control) complying with the IEC/EN61800-5-2, to the FRENIC-VG.

Safe Torque Off (STO):	This immediately shuts down the inverter output to the motor (motor torque off).
Safe Stop 1 (SS1):	This decelerates the motor speed and shuts down the inverter output to the motor (motor torque off) by using the STO function immediately when the motor speed decelerates to the specified speed or the specified time has elapsed.
Safely Limited Speed (SLS):	This prevents the motor from exceeding the specified speed.
Safe Brake Control (SBC):	This outputs motor brake control signals.

1.2.13 Compatibility with legacy models

The FRENIC-VG is compatible with previous Fuji vector control inverters, making it easy to update to the FRENIC-VG.

- Compatibility with the FRENIC5000VG7S

  Since the FRENIC-VG's function codes are compatible with the VG7's function codes, the FRENIC-VG can be configured with VG7 function codes without modification. (For details, refer to Chapter 12, Section 12.5.1 "Replacing VG7S.") Additionally, function codes can be captured from a VG7 unit with FRENIC-VG Loader and copied to the FRENIC-VG without modification.

1.3 Control Systems

1.3.1 Control system features and applications

Inverter-based devices for varying AC motor speed are most commonly used to control the rotational speed of a load. This section describes the basic architecture of various speed control systems, their characteristics, and important information to consider when using them in various applications.

Speaking broadly, speed control systems can be classified as either open-loop or closed-loop control systems (see Figure 1.3.1).

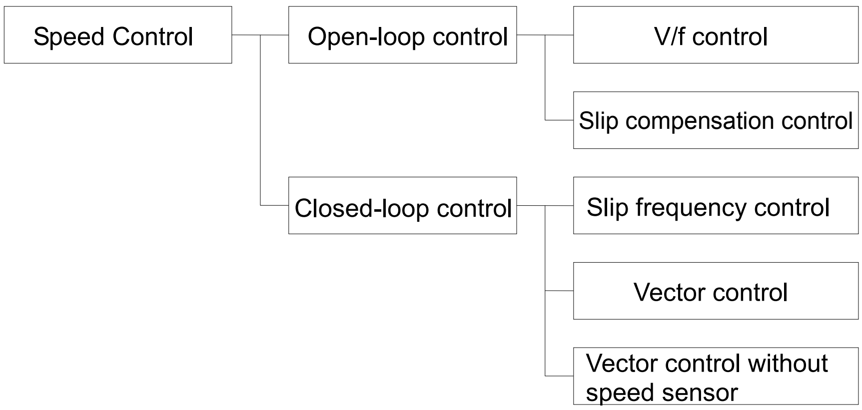


Figure 1.3.1 Classification of Speed Control Systems

1.3.1.1 Open-loop speed control

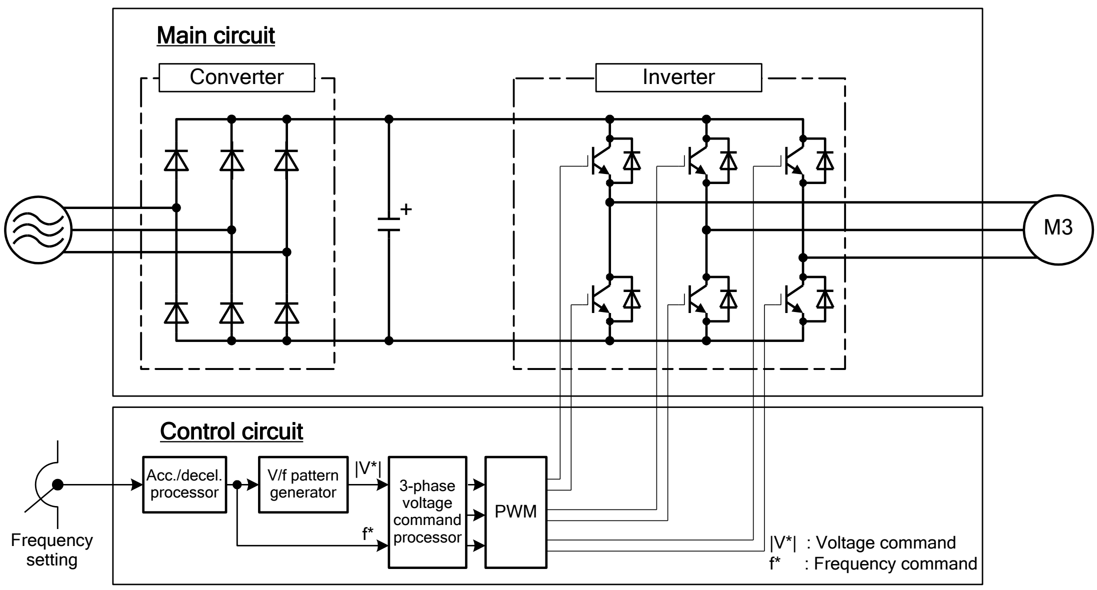


Figure 1.3.2 Open-loop Speed Control: Basic Architecture

As is illustrated in Figure 1.3.2, "Open-loop Speed Control: Basic Architecture," this approach attempts to control the load's rotational speed by means of the frequency of inverter output, without generating feedback in the form of speed information for the control target. As shown in Figure 1.3.3, induction motors' speed versus torque characteristics are characterized by a slight slope across frequencies f1 to f6. If the frequency of the voltage supplied to the motor remains constant, then there is little variation in rotational speed in response to variations in load; for example, slip at the rated torque is on the order of several percent. In other words, when controlling the motor's speed by changing the inverter's output frequency, V/f control, which controls the ratio between the motor's terminal voltage and the applied frequency, is generally used.

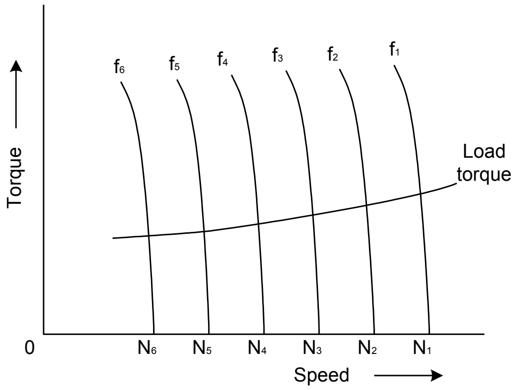


Figure 1.3.3 Speed vs. Torque Characteristics

Since open-loop control does not require a speed sensor, it is primarily used by general-purpose inverters in applications where fast response is not particularly important, for example to enable variable-speed operation of existing motors or with squared-deceleration torque loads such as fans or pumps.

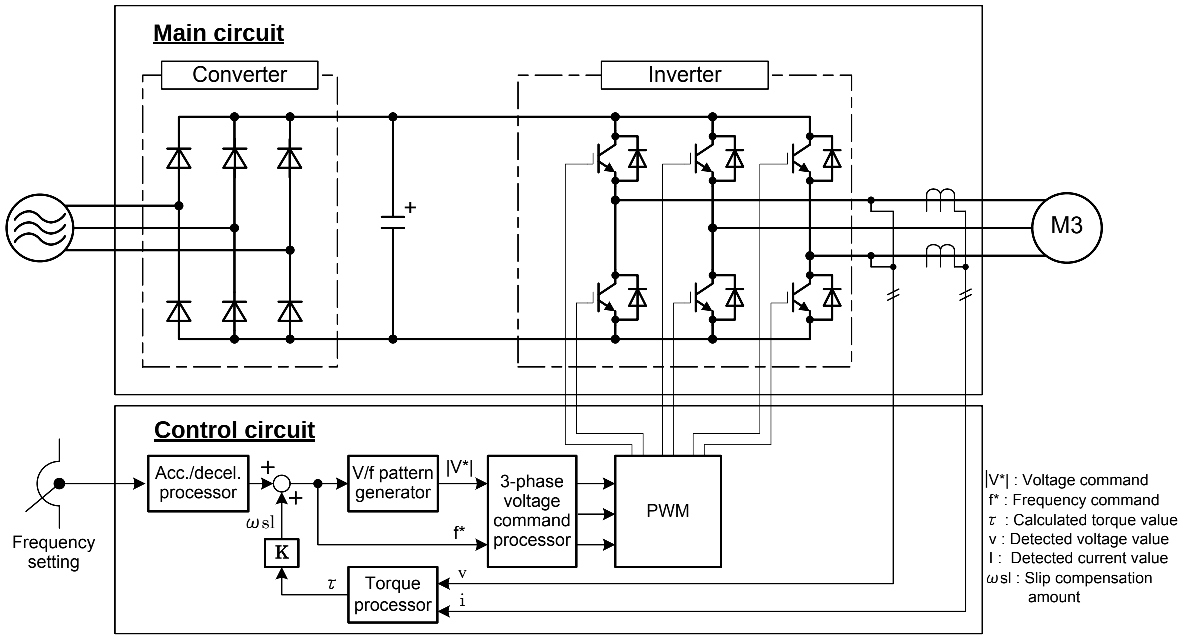


Figure 1.3.4 Speed Control Using the Slip Compensation Systems

Factors determining the accuracy of the rotational speed in open-loop speed control include load torque fluctuations, accuracy of the output frequency, and supply voltage fluctuations. The slip compensation control system addresses load torque fluctuations by calculating the output torque from the motor's terminal voltage and primary current and compensating the inverter's output frequency accordingly in an attempt to maintain a constant rotational speed, as illustrated in Figure 1.3.4.

1.3.1.2 Closed-loop speed control

Closed-loop speed control compensates for speed fluctuations by generating feedback in the form of speed information.

Since highly accurate speed control is possible by generating feedback in the form of the control target's rotational speed, closed-loop speed control can be used in applications such as paper machines and machine tools.

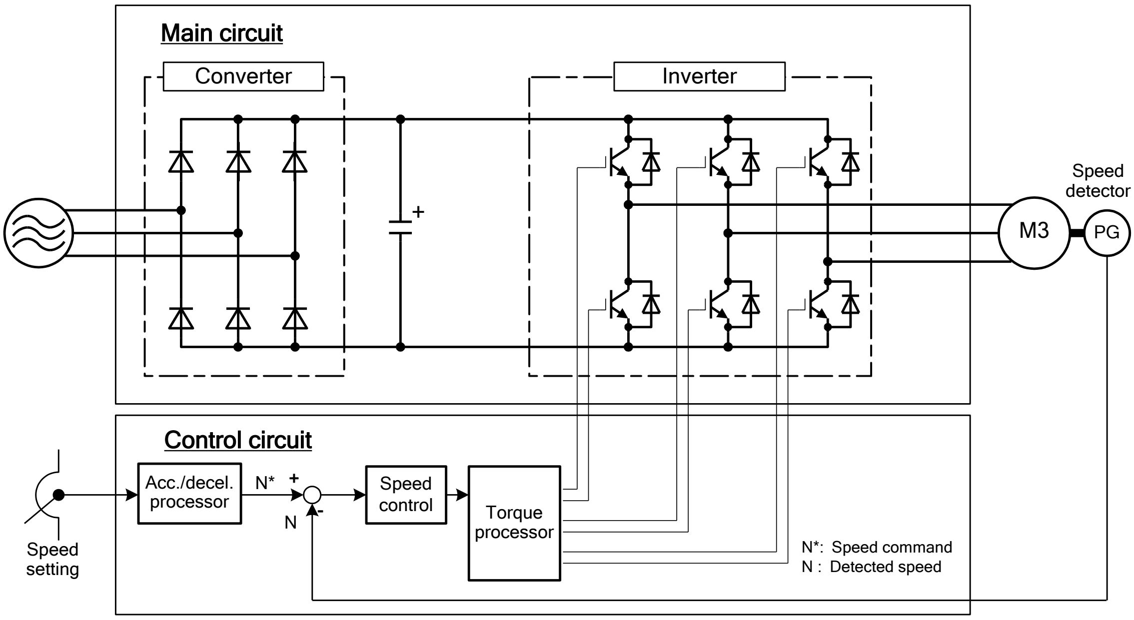


Figure 1.3.5 Closed-loop Speed Control: Basic Architecture

Figure 1.3.5 illustrates the basic architecture of the closed-loop speed control system. Speed information from a speed detection sensor such as a pulse generator (PG) is fed back to the system and compared to the speed command, and the inverter's output frequency is controlled so that the speed command and the detected speed value match.

Speed control systems include slip frequency control, vector control with a speed sensor, and vector control without a speed sensor. An overview of each of these control systems follows.

The FRENIC-VG series of high-performance vector control inverters uses closed-loop vector control to implement speed control.

(a) Slip frequency control

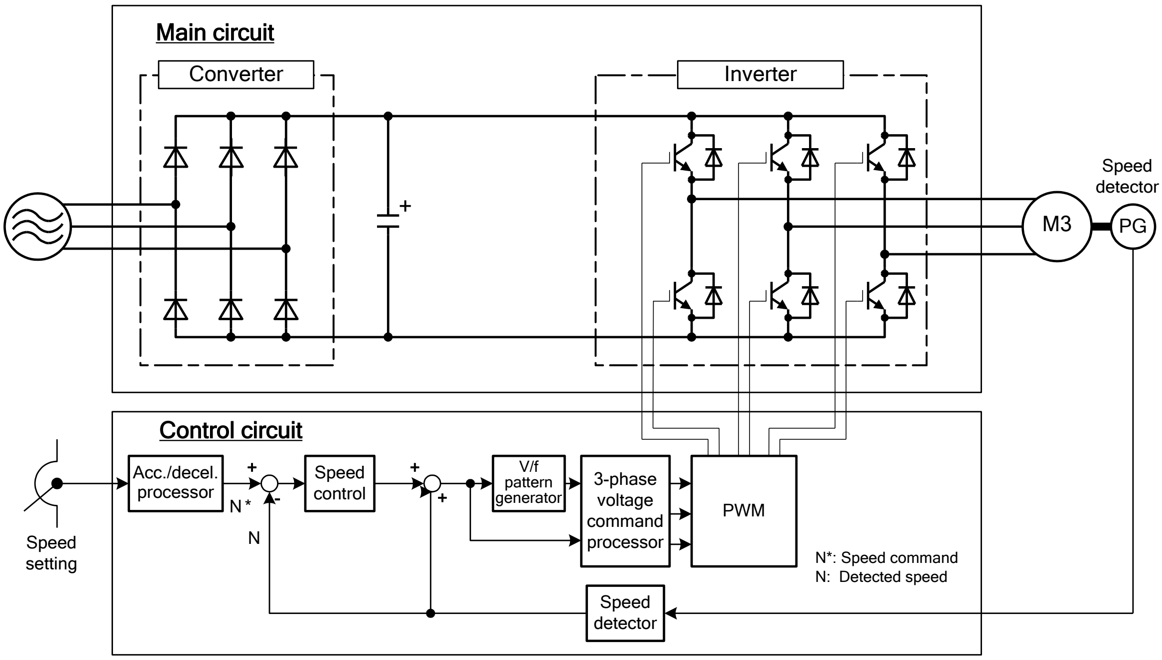


Figure 1.3.6 Slip Frequency Control Architecture

Figure 1.3.6 illustrates the architecture of the slip frequency control system. Output from the speed controller becomes the slip frequency based on the torque, and the inverter compensates for speed fluctuations by adding the slip frequency to the actual speed. Because this system is comparatively simple, it is used in applications such as speed control in general-purpose inverters. However, since basic control is performed using V/f control, this system is used in applications that do not require fast response.

(b) Vector control with a speed sensor

Vector control is used to implement fast response for AC motors. By controlling an AC motor's primary current, magnetic flux current, and torque current separately, vector control attempts to achieve a similar level of control performance as that for DC motors.

Vector control achieves performance that differs from the V/f control system in the following ways, making it well suited for use in applications that require fast response and high accuracy:

(1) Good acceleration and deceleration characteristics

(2) Broad speed control range

(3) Torque control capability

(4) Fast control response

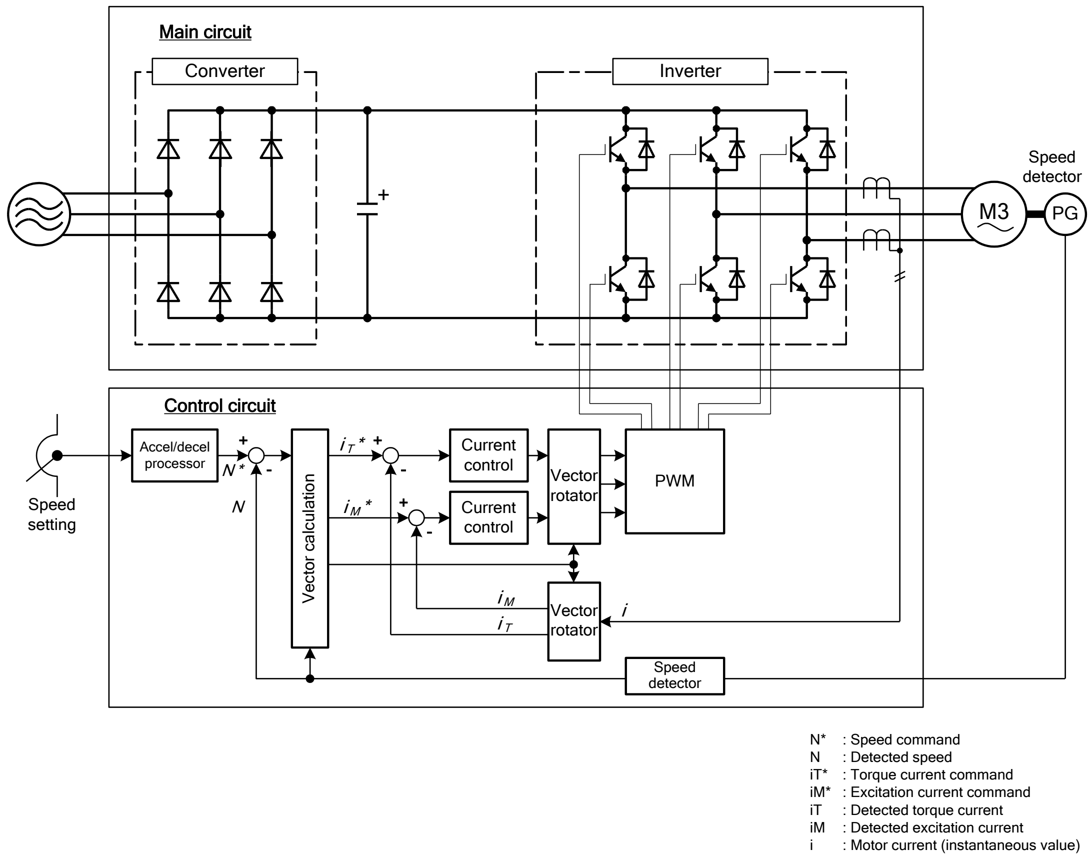


Figure 1.3.7 Example Vector Control Architecture

Figure 1.3.7 illustrates a vector control architecture example. Since the vector calculation unit uses the motor constant, performance varies greatly with the accuracy with which that constant is understood. Performance is also significantly affected by changes to the constant caused by temperature conditions. Since the control system is complex, this system is primarily used with combinations of dedicated inverters and dedicated motors.

(c) Vector control without a speed sensor

Vector control with a speed sensor offers exceptional performance in terms of fast response and high accuracy but suffers from issues such as the need to install a speed sensor and route wiring from the sensor to the inverter. By contrast, vector control without a speed sensor estimates the rotational speed based on the motor's terminal voltage and primary current without relying on sensor input and uses the estimated value as the speed feedback signal. Vector control without a speed sensor delivers performance that is slightly inferior to vector control with a speed sensor.

Figure 1.3.8 illustrates architecture for vector control without a speed sensor.

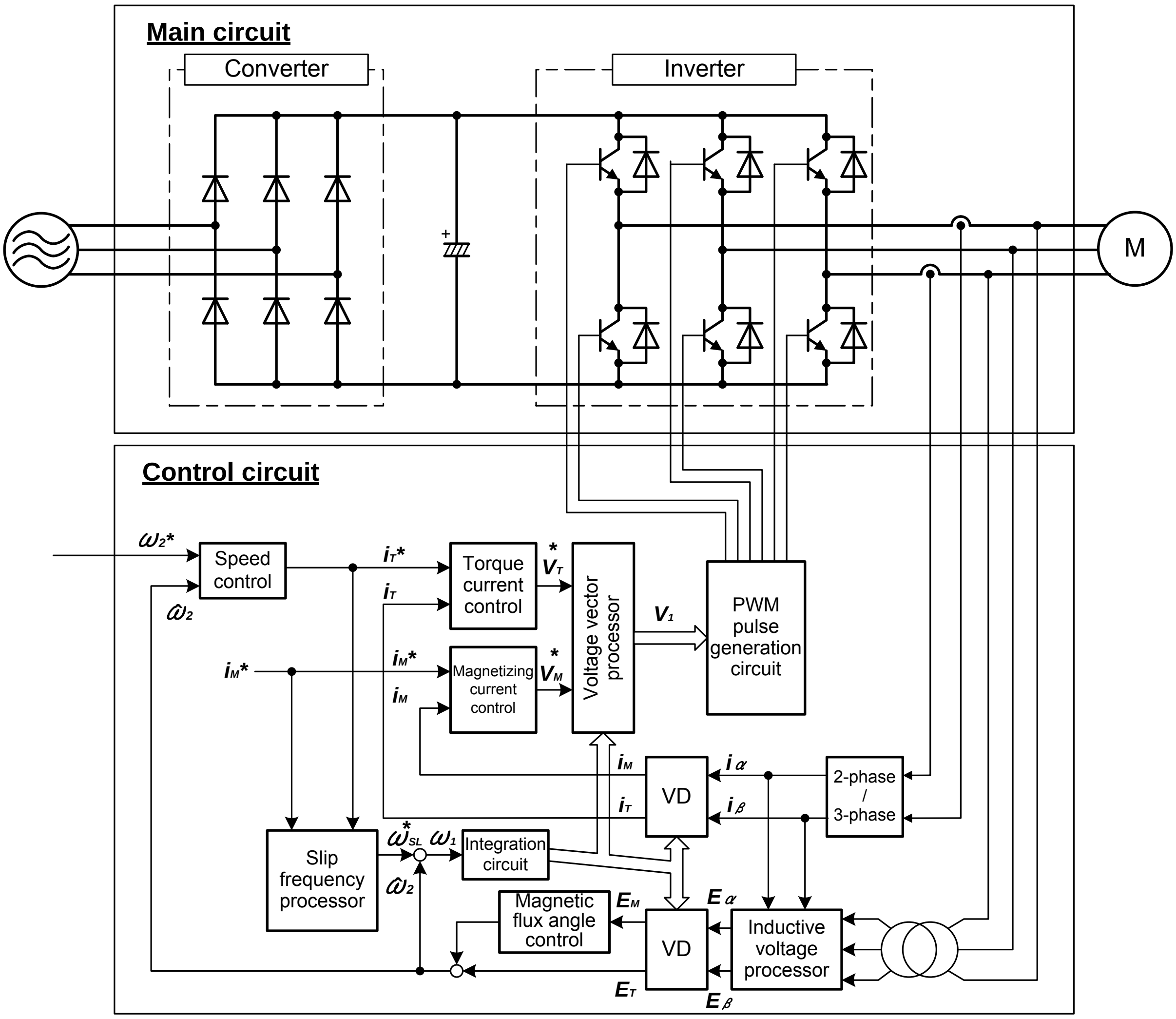


Figure 1.3.8 Example Architecture for Vector Control without a Speed Sensor

The FRENIC-VG can use this type of control when utilized in combination with a general-purpose motor. However, control performance and other specifications are slightly inferior to those of applications where the inverter is used in combination with a dedicated motor.

Chapter 2
SPECIFICATIONS

This chapter describes specifications of the output ratings, control system, dedicated motor specifications, and terminal functions for the FRENIC-VG series of inverters. It also provides descriptions of the external dimensions, examples of basic connection diagrams, and details of the protective functions.

Contents

2.1 Standard Model 1 (Basic Type)

2.1.1 HD (High Duty)-mode inverters for heavy load

Three-phase 200 V class series

Type (FRN_ _ _VG1S-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	45	55	68	81	107	131
Rated current (A)	5	8	11	18	27	37	49	63	76	90	119	146	180	215	283	346
Overload capability	150% of the rated current -1 min. *2 200% of the rated current -3 s. *3															
Input power: Main power input: Phase, voltage, frequency	Three-phase, 200 to 230 V, 50/60 Hz										Three-phase, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *4					
Input power: Auxiliary control power input: Phase, voltage, frequency	Single-phase, 200 to 230V, 50/60 Hz															
Input power: Auxiliary fan power input: Phase, voltage, frequency *5	-											Single-phase 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *4				
Input power: Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *6), Frequency: +5 to -5%															
Input power: Rated current (A) *7 (with DCR)	3.2	6.1	8.9	15.0	21.1	28.8	42.2	57.6	71.0	84.4	114	138	167	203	282	334
Input power: Rated current (A) *7 (without DCR)	5.3	9.5	13.2	22.2	31.5	42.7	60.7	80.1	97.0	112	151	185	225	270	—	—
Input power: Required capacity (kVA) *8	1.2	2.2	3.1	5.2	7.4	10	15	20	25	30	40	48	58	71	98	116
Braking method , Braking torque	Braking resistor discharge control: 150% braking torque, Separately installed resistor (option), Separately installed braking unit (option for FRN75VG1S-2☐ or higher type)															
Carrier frequency (kHz) *9	2 to 15														2 to 10	
Approx. mass (kg)	6.2	6.2	6.2	6.2	6.2	6.2	11	11	11	12	25	32	42	43	62	105
Enclosure	IP20, UL open type										IP00, UL open type (IP20 is optionally available.)					

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 0 (HD mode).
A DC reactor (DCR) is provided as standard for HD-mode inverters of 75 kW or above.

*1 This specification applies when the rated output voltage is 220 V.

*2 When the inverter output frequency converted is less than 10 Hz, the inverter may trip earlier due to overload depending on the ambient temperature and other conditions.

*3 When the inverter output frequency converted is less than 5 Hz, the inverter may trip earlier due to overload depending on the surrounding temperature and other conditions.

*4 Inverters of 200 to 230 V/50 Hz are available on request.

*5 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*6 $$\text{Voltage unbalance}(\%) = \frac{\text{Max. voltage(V) - Min. voltage(V)}}{\text{Three-phase average voltage(V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*7 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for inverters of 55 kW or below.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*9 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

Three-phase 400 V class series

Type (FRN_ _ _VG1S-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	500	630
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	500	630
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	731	891
Rated current (A)		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	960	1170
Overload capability		150% of the rated current -1 min. *2 200% of the rated current -3 s. *3																							
Input power	Main power input: Phase, voltage, frequency	Three-phase, 380 to 480 V, 50/60 Hz											Three-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *4												
	Auxiliary control power input: Phase, voltage, frequency	Single-phase, 380 to 480 V, 50/60 Hz																							
	Auxiliary fan power input: Phase, voltage, frequency *5	-											Single-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *4												
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *6), Frequency: +5 to -5%																							
	Rated current (A) *7 (with DCR)	7.5	10.6	14.4	21.1	28.8	35.5	42.2	57.0	68.5	83.2	102	138	164	210	238	286	357	390	500	559	628	705	881	1115
	(without DCR)	13.0	17.3	23.2	33	43.8	52.3	60.6	77.9	94.3	114	140	-												
	Required capacity (kVA) *8	5.2	7.4	10	15	20	25	30	40	48	58	71	96	114	140	165	199	248	271	347	388	436	489	610	773
Braking method , Braking torque		Braking resistor discharge control: 150% braking torque, Separately installed braking resistor (option), Separately installed braking unit (option for FRN200VG1S-4☐ or higher type)																							
Carrier frequency (kHz) *9		2 to 15											2 to 10											2 to 5	
Approx. mass (kg)		6.2	6.2	6.2	11	11	11	11	25	26	31	33	42	62	64	94	98	130	140	245	245	330	330	555	555
Enclosure		IP20, UL open type							IP00, UL open type (IP20 is optionally available.)																

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 0 (HD mode).
A DC reactor (DCR) is provided as standard for HD-mode inverters of 75 kW or above.

*1 This specification applies when the rated output voltage is 440 V.

*2 When the inverter output frequency converted is less than 10 Hz, the inverter may trip earlier due to overload depending on the ambient temperature and other conditions.

*3 When the inverter output frequency converted is less than 5 Hz, the inverter may trip earlier due to overload depending on the ambient temperature and other conditions.

*4 For 380 to 398 V/50 Hz or 380 to 430 V/60 Hz, connector switching is required inside the inverter.
If the input voltage is 380 V, the output may be reduced. For details, refer to Chapter 10, Section 10.5.1 "Combination list of 380V series."

*5 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*6 $$\text{Voltage unbalance}(\%) = \frac{\text{Max. voltage(V)} - \text{Min. voltage(V)}}{\text{Three-phase average voltage(V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*7 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for inverters of 55 kW or below.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*9 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

2.1.2 MD (Medium Duty)-mode inverters for medium load

Three-phase 400 V class series

	Type (FRN_ _ _VG1S-4□)	90	110	132	160	200	220	280	315	355	400
	Nominal applied motor (kW) *8	110	132	160	200	220	250	315	355	400	450
	Rated capacity (kVA) *1	160	192	231	287	316	356	445	495	563	640
	Rated current (A)	210	253	304	377	415	468	585	650	740	840
	Overload capability	150% of the rated current -1 min. *2									
Input power	Main power input: Phase, voltage, frequency	Three-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *3									
Input power	Auxiliary control power input: Phase, voltage, frequency	Single-phase, 380 to 480 V, 50/60 Hz									
Input power	Auxiliary fan power input: Phase, voltage, frequency *4	Single-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *3									
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *5), Frequency: +5 to -5%									
Input power	Rated current (A) *6 (with DCR)	210	238	286	357	390	443	559	628	705	789
Input power	Rated current (A) *6 (without DCR)	-									
Input power	Required capacity (kVA) *7	140	165	199	248	271	312	388	436	489	547
	Braking method, Braking torque	Braking resistor discharge control: 150% braking torque, Separately installed braking resistor (option), Separately installed braking unit (option for FRN200VG1S-4□ or higher type)									
	Carrier frequency (kHz) *9	2 to 4									
	Approx. mass (kg)	62	64	94	98	130	140	245	245	330	330
	Enclosure	IP00, UL open type (IP20 is optionally available.)									

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 3 (MD mode).
To use the inverter in the MD mode, inform your Fuji Electric representative of the MD-mode use when placing an order. The inverter comes with a DC reactor (DCR) suitable for the nominal applied motor as standard.

*1 This specification applies when the rated output voltage is 440 V.

*2 When the inverter output frequency converted is less than 1 Hz, the inverter may trip earlier due to overload depending on the ambient temperature and other conditions.

*3 For 380 to 398 V/50 Hz or 380 to 430 V/60 Hz, connector switching is required inside the inverter.
If the input voltage is 380 V, the output may be reduced. For details, refer to Chapter 10, Section 10.5.1 "Combination list of 380V series."

*4 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*5 $$\text{Voltage unbalance}(\%) = \frac{\text{Max. voltage(V) - Min. voltage(V)}}{\text{Three-phase average voltage(V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*6 This specification is an estimate to be applied when the power supply capacity is equal to "Inverter capacity x 10" and the power supply with %X = 5% is connected.

*7 This specification applies when a DC reactor (DCR) is used.

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*8 Depending on the load conditions, motor heating may increase due to the low carrier frequency. When placing an order for motors, therefore, specify the MD-mode use.

*9 Running the PMSM at low carrier frequency may overheat the permanent magnet due to the output current harmonics, resulting in demagnetization. The carrier frequency specification of the inverter is low (2 to 4 kHz), so be sure to check the allowable carrier frequency of the motor. If the MD-mode inverter is not applicable due to the low carrier frequency (2 to 4 kHz), consider the HD mode (F80 = 0).

2.1.3 LD (Low Duty)-mode inverters for light load

Three-phase 200 V class series

Type (FRN_ _ _VG1S-2☐)	30	37	45	55	75	90
Nominal applied motor (kW)	37	45	55	75	90	110
Rated capacity (kVA) *1	55	68	81	107	131	158
Rated current (A)	146	180	215	283	346	415
Overload capability	120% of the rated current -1 min. *2					
Input power: Main power input: Phase, voltage, frequency	Three-phase, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *2					
Input power: Auxiliary control power input: Phase, voltage, frequency	Single-phase, 200 to 230 V, 50/60 Hz					
Input power: Auxiliary fan power input: Phase, voltage, frequency *4	-	Single-phase, 200 to 220 V/50 Hz, 200 to 230 V/60 Hz *3				
Input power: Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *5), Frequency: +5 to -5%					
Input power: Rated current (A) *6 (with DCR)	138	167	203	282	334	410
Input power: Rated current (A) *6 (without DCR)	185	225	270	-	–	–
Input power: Required capacity (kVA) *7	48	58	71	98	116	143
Braking method, Braking torque	Braking resistor discharge control: 110% braking torque, Separately installed braking resistor (option), Separately installed braking unit (option for FRN75VG1S-2☐ or higher type)					
Carrier frequency (kHz) *8	2 to 10				2 to 5	
Approx. mass (kg)	25	32	42	43	62	105
Enclosure	IP00, UL open type (IP20 is optionally available.)					

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 1 (LD mode).
To use the inverter of 55 kW or above in the LD mode, inform your Fuji Electric representative of the LD-mode use when placing an order. The inverter comes with a DC reactor (DCR) suitable for the nominal applied motor as standard.

*1 This specification applies when the rated output voltage is 220 V.

*2 When the inverter output frequency converted is less than 10 Hz, the inverter may trip earlier due to overload depending on the ambient temperature and other conditions.

*3 Inverters of 200 to 230 V/50 Hz are available on request.

*4 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*5 $$\text{Voltage unbalance}(\%) = \frac{\text{Max. voltage(V) - Min. voltage(V)}}{\text{Three-phase average voltage(V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*6 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*7 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for the FRN45VG1S-2☐ or lower type.)

If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*8 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.

Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

Three-phase 400 V class series

Type (FRN_ _ _VG1S-4☐)		30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
Nominal applied motor (kW)		37	45	55	75	90	110	132	160	200	220	280	355	400	450	500	630	710
Rated capacity (kVA) *1		57	69	85	114	134	160	192	231	287	316	396	495	563	640	731	891	1044
Rated current (A)		75	91	112	150	176	210	253	304	377	415	520	650	740	840	960	1170	1370
Overload capability		120% of the rated current -1 min. *2																
Input power	Main power input: Phase, voltage, frequency	Three-phase, 380 to 480 V, 50/60 Hz				Three-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *3												
Input power	Auxiliary control power input: Phase, voltage, frequency	Single-phase, 380 to 480 V, 50/60 Hz																
Input power	Auxiliary fan power input: Phase, voltage, frequency *4	-				Single-phase, 380 to 440 V/50 Hz, 380 to 480 V/60 Hz *3												
Input power	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less *5), Frequency: +5 to -5%																
Input power	Rated current (A) *6 (with DCR)	68.5	83.2	102	138	164	210	238	286	357	390	500	628	705	789	881	1115	1256
Input power	(without DCR)	94.3	114	140	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Input power	Required capacity (kVA) *7	48	58	71	96	114	140	165	199	248	271	347	436	489	547	611	773	871
Braking method, Braking torque		Braking resistor discharge control: 110% braking torque, Separately installed braking resistor (option), Separately installed braking unit (option for FRN200VG1S-4☐ or higher type)																
Carrier frequency (kHz) *8		2 to 10				2 to 5												2
Approx. mass (kg)		25	26	31	33	42	62	64	94	98	130	140	245	245	330	330	555	555
Enclosure		IP00, UL open type (IP20 is optionally available.)																

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

Note: The above specifications apply when Function code F80 = 1 (LD mode).
To use the inverter of 55 kW or above in the LD mode, inform your Fuji Electric representative of the LD-mode use when placing an order. The inverter comes with a DC reactor (DCR) suitable for the nominal applied motor as standard.

*1 This specification applies when the rated output voltage is 440 V.

*2 When the inverter output frequency converted is less than 10 Hz, the inverter may trip earlier due to overload depending on the ambient temperature and other conditions.

*3 For 380 to 398 V/50 Hz or 380 to 430 V/60 Hz, connector switching is required inside the inverter.
If the input voltage is 380 V, the output may be reduced. For details, refer to Chapter 10, Section 10.5.1 "Combination list of 380V series."

*4 Use this input as an AC fan power in a power system using a power regenerative PWM converter. (Usually, there is no need to use this input.)

*5 $$\text{Voltage unbalance}(\%) = \frac{\text{Max. voltage(V)} - \text{Min. voltage(V)}}{\text{Three-phase average voltage(V)}} \times 67$$

If this value exceeds 2%, use an AC reactor (ACR).

*6 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity x 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*7 This specification applies when a DC reactor (DCR) is used. (A DCR is optionally available for the FRN45VG1S-4☐ or lower type.)
If the power source uses an electrical generator, it may burn due to the inverter harmonic current. To avoid such an accident, about three or four times the required capacity should be ensured. (About four times when no DCR is connected; about three times when a DCR is connected.)

*8 The inverter may automatically reduce the carrier frequency in accordance with the surrounding temperature or output current in order to protect itself.
Canceling the automatic lowering of the carrier frequency (H104, hundreds digit) lowers the inverter's continuous rated current according to the carrier frequency setting. (For the details about the rated current lowering characteristics, refer to Chapter 2, Section 2.1.4.)

2.1.4 Rated current derating

Canceling the automatic lowering of the carrier frequency (H104, Hundreds digit) when the inverter drives a permanent magnet synchronous motor (PMSM) derates the continuous rated current of the inverter according to the carrier frequency setting (F26). Select the inverter capacity and the carrier frequency (F26) which match the motor specifications, referring to the tables given below.

HD (High Duty)-mode inverters for heavy load

Three-phase 200 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.75	FRN0.75VG1S-2☐	5	5.00 **(100%)**				4.50 (90%)	3.80 (76%)	5.00 **(100%)**		4.55 (91%)		4.15 (83%)			3.50 (70%)
1.5	FRN1.5VG1S-2☐	8	8.00 **(100%)**				7.20 (90%)	6.08 (76%)	8.00 **(100%)**		7.28 (91%)		6.64 (83%)			5.60 (70%)
2.2	FRN2.2VG1S-2☐	11	11.0 **(100%)**				9.90 (90%)	8.36 (76%)	11.0 **(100%)**		10.0 (91%)		9.13 (83%)			7.70 (70%)
3.7	FRN3.7VG1S-2☐	18	18.0 **(100%)**				16.2 (90%)	13.6 (76%)	18.0 **(100%)**		16.3 (91%)		14.9 (83%)			12.6 (70%)
5.5	FRN5.5VG1S-2☐	27	27.0 **(100%)**				24.3 (90%)	20.5 (76%)	27.0 **(100%)**		24.5 (91%)		22.4 (83%)			18.9 (70%)
7.5	FRN7.5VG1S-2☐	37	37.0 **(100%)**				33.3 (90%)	28.1 (76%)	37.0 **(100%)**		33.6 (91%)		30.7 (83%)			25.9 (70%)
11	FRN11VG1S-2☐	49	49.0 **(100%)**				44.1 (90%)	37.2 (76%)	49.0 **(100%)**		44.5 (91%)		40.6 (83%)			34.3 (70%)
15	FRN15VG1S-2☐	63	63.0 **(100%)**				56.7 (90%)	47.8 (76%)	63.0 **(100%)**		57.3 (91%)		52.2 (83%)			44.1 (70%)
18.5	FRN18.5VG1S-2☐	76	76.0 **(100%)**				72.2 (95%)	66.8 (88%)	76.0 **(100%)**				69.9 (92%)			60 (79%)
22	FRN22VG1S-2☐	90	90.0 **(100%)**				85.5 (95%)	79.2 (88%)	90.0 **(100%)**				82.8 (92%)			71.1 (79%)
30	FRN30VG1S-2☐	119	119 **(100%)**				117 (99%)	109 (92%)	119 **(100%)**				113 (95%)			103 (87%)
37	FRN37VG1S-2☐	146	146 **(100%)**				144 (99%)	134 (92%)	146 **(100%)**				138 (95%)			127 (87%)
45	FRN45VG1S-2☐	180	180 **(100%)**				178 (99%)	165 (92%)	180 **(100%)**				171 (95%)			156 (87%)
55	FRN55VG1S-2☐	215	215 **(100%)**				212 (99%)	197 (92%)	215 **(100%)**				204 (95%)			187 (87%)
75	FRN75VG1S-2☐	283	283 **(100%)**		274 (97%)	263 (93%)	283 **(100%)**	271 (96%)	268 (95%)		254 ***1** (90%)					
90	FRN90VG1S-2☐	346	346 **(100%)**		335 (97%)	321 (93%)	346 **(100%)**	332 (96%)	328 (95%)		311 ***1** (90%)					

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.

Three-phase 400 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%)) Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
3.7	FRN3.7VG1S-4□	9	9.00 **(100%)**				8.55 (95%)	7.65 (85%)	9.00 **(100%)**				8.10 (90%)			6.84 (76%)
5.5	FRN5.5VG1S-4□	13.5	13.5 **(100%)**				12.8 (95%)	11.4 (85%)	13.5 **(100%)**				12.1 (90%)			10.2 (76%)
7.5	FRN7.5VG1S-4□	18.5	18.5 **(100%)**				17.5 (95%)	15.7 (85%)	18.5 **(100%)**				16.6 (90%)			14.0 (76%)
11	FRN11VG1S-4□	24.5	24.5 **(100%)**				21.8 (89%)	17.6 (72%)	24.5 **(100%)**		22.2 (91%)		19.8 (81%)			16.4 (67%)
15	FRN15VG1S-4□	32	32.0 **(100%)**				28.4 (89%)	23.0 (72%)	32.0 **(100%)**		29.1 (91%)		25.9 (81%)			21.4 (67%)
18.5	FRN18.5VG1S-4□	39	39.0 **(100%)**				36.2 (93%)	32.3 (83%)	39.0 **(100%)**				34.7 (89%)			28.4 (73%)
22	FRN22VG1S-4□	45	45.0 **(100%)**				41.8 (93%)	37.3 (83%)	45.0 **(100%)**				40.0 (89%)			32.8 (73%)
30	FRN30VG1S-4□	60	60.0 **(100%)**				54.0 (90%)	45.0 (75%)	60.0 **(100%)**				51.0 (85%)		41.4 (69%)	
37	FRN37VG1S-4□	75	75.0 **(100%)**				67.5 (90%)	56.2 (75%)	75.0 **(100%)**				63.7 (85%)		51.7 (69%)	
45	FRN45VG1S-4□	91	91.0 **(100%)**				81.9 (90%)	68.2 (75%)	91.0 **(100%)**				77.3 (85%)		62.7 (69%)	
55	FRN55VG1S-4□	112	112 **(100%)**				100 (90%)	84.0 (75%)	112 **(100%)**				95.0 (85%)		77.2 (69%)	
75	FRN75VG1S-4□	150	150 **(100%)**		141 (94%)	115 (77%)	150 **(100%)**	130 (87%)	126 (84%)		111 ***1** (74%)					
90	FRN90VG1S-4□	176	176 **(100%)**		165 (94%)	135 (77%)	176 **(100%)**	153 (87%)	147 (84%)		130 ***1** (74%)					
110	FRN110VG1S-4□	210	210 **(100%)**		197 (94%)	161 (77%)	210 **(100%)**	182 (87%)	176 (84%)		155 ***1** (74%)					
132	FRN132VG1S-4□	253	253 **(100%)**		237 (94%)	194 (77%)	253 **(100%)**	220 (87%)	212 (84%)		187 ***1** (74%)					
160	FRN160VG1S-4□	304	304 **(100%)**		285 (94%)	234 (77%)	304 **(100%)**	264 (87%)	255 (84%)		224 ***1** (74%)					
200	FRN200VG1S-4□	377	377 **(100%)**		354 (94%)	290 (77%)	377 **(100%)**	327 (87%)	316 (84%)		278 ***1** (74%)					
220	FRN220VG1S-4□	415	415 **(100%)**		390 (94%)	319 (77%)	415 **(100%)**	361 (87%)	348 (84%)		307 ***1** (74%)					
280	FRN280VG1S-4□	520	520 **(100%)**		488 (94%)	400 (77%)	520 **(100%)**	452 (87%)	436 (84%)		384 ***1** (74%)					
315	FRN315VG1S-4□	585	585 **(100%)**		549 (94%)	450 (77%)	585 **(100%)**	509 (87%)	491 (84%)		432 ***1** (74%)					
355	FRN355VG1S-4□	650	650 **(100%)**		611 (94%)	500 (77%)	650 **(100%)**	565 (87%)	546 (84%)		481 ***1** (74%)					
400	FRN400VG1S-4□	740	740 **(100%)**		695 (94%)	569 (77%)	740 **(100%)**	643 (87%)	621 (84%)		547 ***1** (74%)					
500	FRN500VG1S-4□	960	960 **(100%)**			960 ***2** **(100%)**										
630	FRN630VG1S-4□	1170	1170 **(100%)**			1170 ***2** **(100%)**										

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.
*2 The internal carrier frequency is 5 kHz independent of the F26 setting.

MD (Medium Duty)-mode inverters for medium load

Three-phase 400 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%))													
			Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
110	FRN90VG1S-4□	210	210 **(100%)**		210 ***1** **(100%)**											
132	FRN110VG1S-4□	253	253 **(100%)**		253 ***1** **(100%)**											
160	FRN132VG1S-4□	304	304 **(100%)**		304 ***1** **(100%)**											
200	FRN160VG1S-4□	377	377 **(100%)**		377 ***1** **(100%)**											
220	FRN200VG1S-4□	415	415 **(100%)**		415 ***1** **(100%)**											
280	FRN220VG1S-4□	468	468 **(100%)**		468 ***1** **(100%)**											
315	FRN280VG1S-4□	585	585.0 **(100%)**		585.0 ***1** **(100%)**											
355	FRN315VG1S-4□	650	650 **(100%)**		650 ***1** **(100%)**											
400	FRN355VG1S-4□	740	740 **(100%)**		740 ***1** **(100%)**											
450	FRN400VG1S-4□	840	840 **(100%)**		840 ***1** **(100%)**											

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 4 kHz independent of the F26 setting.

LD (Low Duty)-mode inverters for light load

Three-phase 200 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%)) Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
37	FRN30VG1S-2☐	146	146 **(100%)**					140 (96%)	138 (95%)		131 ***1** (90%)					
45	FRN37VG1S-2☐	180	180 **(100%)**					172 (96%)	171 (95%)		162 ***1** (90%)					
55	FRN45VG1S-2☐	215	215 **(100%)**					206 (96%)	204 (95%)		193 ***1** (90%)					
75	FRN55VG1S-2☐	283	283 **(100%)**					271 (96%)	268 (95%)		254 ***1** (90%)					
90	FRN75VG1S-2☐	346	342 (99%)	335 (97%)	346 **(100%)**	335 ***2** (97%)										
110	FRN90VG1S-2☐	415	410 (99%)	402 (97%)	415 **(100%)**	402 ***2** (97%)										

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.
*2 The internal carrier frequency is 5 kHz independent of the F26 setting.

Three-phase 400 V class series

Nominal applied motor (kW)	Inverter type	Rated current (A)	Derated current (A) (Derating rate (%)) Carrier frequency setting made with F26 (kHz)													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15
37	FRN30VG1S-4☐	75	75.0 **(100%)**					66.0 (88%)	63.0 (84%)		54.0 ***1** (72%)					
45	FRN37VG1S-4☐	91	91.0 **(100%)**					80.0 (88%)	76.4 (84%)		65.5 ***1** (72%)					
55	FRN45VG1S-4☐	112	112 **(100%)**					99.0 (88%)	94.0 (84%)		80.6 ***1** (72%)					
75	FRN55VG1S-4☐	150	150 **(100%)**					132 (88%)	126 (84%)		108 ***1** (72%)					
90	FRN75VG1S-4☐	176	161 (92%)	151 (86%)	176 **(100%)**	153 ***2** (87%)										
110	FRN90VG1S-4☐	210	193 (92%)	180 (86%)	210 **(100%)**	182 ***2** (87%)										
132	FRN110VG1S-4☐	253	232 (92%)	217 (86%)	253 **(100%)**	220 ***2** (87%)										
160	FRN132VG1S-4☐	304	279 (92%)	261 (86%)	304 **(100%)**	264 ***2** (87%)										
200	FRN160VG1S-4☐	377	346 (92%)	324 (86%)	377 **(100%)**	327 ***2** (87%)										
220	FRN200VG1S-4☐	415	481 (92%)	356 (86%)	415 **(100%)**	361 ***2** (87%)										
280	FRN220VG1S-4☐	520	478 (92%)	447 (86%)	520 **(100%)**	452 ***2** (87%)										
355	FRN280VG1S-4☐	650	598 (92%)	559 (86%)	650 **(100%)**	565 ***2** (87%)										
400	FRN315VG1S-4☐	740	680 (92%)	636 (86%)	740 **(100%)**	643 ***2** (87%)										
450	FRN355VG1S-4☐	840	772 (92%)	722 (86%)	840 **(100%)**	730 ***2** (87%)										
500	FRN400VG1S-4☐	960	883 (92%)	825 (86%)	960 **(100%)**	835 ***2** (87%)										
630	FRN500VG1S-4☐	1170	1076 (92%)	1006 (86%)	1170 **(100%)**	1017 ***2** (87%)										
710	FRN630VG1S-4☐	1370	1287 (94%)	1219 (89%)	1370 **(100%)**	1287 ***2** (94%)										

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

*1 The internal carrier frequency is 10 kHz independent of the F26 setting.
*2 The internal carrier frequency is 5 kHz independent of the F26 setting.

2.2 Common Specifications

Item				Explanation
Control	Control method	For induction motor (IM)		• Vector control with speed sensor • Vector control without speed sensor • V/f control
		For permanent magnet synchronous motor (PMSM)		Vector control with speed sensor & magnetic pole position sensor
		Test mode		Simulation mode
Driving IM	Vector control with speed sensor	Setting resolution	Speed command	Analog setting: 0.005% of maximum speed Digital setting: 0.005% of maximum speed
			Torque command, Torque current command	0.01% of the rated torque
		Control accuracy	Speed	Analog setting: ±0.1% of maximum speed (at 25 ±10°C) Digital setting: ±0.005% of maximum speed (at -10 to +50°C)
			Torque	±3% of the rated torque (when a dedicated motor is in use)
		Control response	Speed	600 Hz *1
		Maximum speed		500 Hz (when converted to the inverter output frequency) *1 *2
		Speed control range		1 : 1500 When the base speed is 1500 r/min: 1 to 1500 r/min to maximum speed (in the case of the PG pulse resolution 1024 P/R) 1 : 6 (Constant torque range : Constant output range)
	Vector control without speed sensor	Setting resolution	Speed command	Analog setting: 0.005% of maximum speed Digital setting: 0.005% of maximum speed
			Torque command, Torque current command	0.01% of the rated torque
		Control accuracy	Speed	Analog setting: ±0.1% of maximum speed (at 25 ±10°C) Digital setting: ±0.1% of maximum speed (at -10 to +50°C)
			Torque	±5% of the rated torque
		Control response	Speed	40 Hz *1
		Maximum speed		500 Hz (when converted to the inverter output frequency) *1 *3
		Speed control range		1 : 250 When the base speed is 1500 r/min: 6 to 1500 r/min to maximum speed 1 : 4 (Constant torque range : Constant output range)
	V/f control	Setting resolution		Analog setting: 0.005% of maximum frequency Digital setting: 0.005% of maximum frequency
		Output frequency control accuracy		Analog setting: ±0.2% of maximum frequency (at 25 ±10°C) Digital setting: ±0.01% of maximum frequency (at -10 to +50°C)
		Maximum frequency		500 Hz
		Control range		0.2 to 500 Hz 1 : 4 (Constant torque range : Constant output range)

*1 The specified value denotes the maximum value. It may not be reached depending on the carrier frequency setting and other conditions.

*2 Under vector control with speed sensor: 400 Hz when the carrier frequency is 5 kHz, 150 Hz when it is 2 kHz.

*3 Under vector control without speed sensor: 250 Hz when the carrier frequency is 5 kHz, 120 Hz when it is 2 kHz.

Item				Explanation
Driving PMSM	Vector control with speed sensor	Setting resolution	Speed command	Analog setting: 0.005% of maximum speed Digital setting: 0.005% of maximum speed
Driving PMSM	Vector control with speed sensor	Setting resolution	Torque command, Torque current command	0.01% of the rated torque
Driving PMSM	Vector control with speed sensor	Control accuracy	Speed	Analog setting: ±0.1% of maximum speed (at 25 ±10°C) Digital setting: ±0.005% of maximum speed (at -10 to +50°C)
Driving PMSM	Vector control with speed sensor	Control accuracy	Torque	±3% of the rated torque (when a dedicated motor is in use)
Driving PMSM	Vector control with speed sensor	Control response	Speed	600 Hz *1
Driving PMSM	Vector control with speed sensor	Maximum speed		500 Hz (when converted to the inverter output frequency) *1 *2
Driving PMSM	Vector control with speed sensor	Speed control range		1 : 1500 When the base speed is 1500 r/min: 1 to 1500 r/min to maximum speed (in the case of the PG pulse resolution 1024 P/R)
Control functions	Start/stop operation			Keypad: FWD and REV keys (for forward/reverse rotation), STOP key (for stop) Digital input signals: "Switch normal/inverse operation," "Coast to a stop," "Reset alarm," "Select multistep speed," etc.
Control functions	Speed setting			Keypad: ∧ and ∨ keys External potentiometer: Three-terminal variable resistor (1 to 5kΩ) Analog input signals: 0 to ±10 V, 4-20 mA UP/DOWN control: When the digital input signal ***UP*** or ***DOWN*** is ON, the speed increases or decreases, respectively. Multistep speed: The combination of the four digital input signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** enables 15 different speeds to be selected. Digital signal: Using an option card enables speed setting with "16-bit parallel signals." Serial link operation: RS-485 (provided as standard). Various communication options are available. Jogging operation: FWD and REV keys or digital input on [FWD] and [REV] terminals in jogging mode.
Control functions	Speed detection			The receivable frequency differs depending upon the speed detector used.

PG interface		Speed detector	Maximum frequency receivable
IM	PG interface on inverter	Complementary PG	100 kHz
IM	OPC-VG1-PGo	Open-collector PG	100 kHz
IM	OPC-VG1-PG	Line driver PG	500 kHz
PMSM	OPC-VG1-PMPG	Line driver PG (with magnetic pole position function)	100 kHz
PMSM	OPC-VG1-PMPGo	Open-collector PG (with magnetic pole position function)	100 kHz
OPC-VG1-SPGT		Serial PG (17-bit absolute encoder)	1 MHz
OPC-VG1-RD		Resolver	10 kHz

Some PG interface options require a dedicated cable.

Item		Explanation
Control functions	Speed control	PI calculation with feed-forward terms. Control parameters switchable by external signals.
Control functions	Running status signal	Transistor output signals: "Inverter running," "Speed arrival," "Speed detected," "Inverter overload early warning," "Torque limiting," etc. Analog output signals: "Motor speed," "Output voltage," "Torque," "Load factor," etc.

*1 The specified value denotes the maximum value. It may not be reached depending on the carrier frequency setting and other conditions.

*2 Under vector control with speed sensor: 400 Hz when the carrier frequency is 5 kHz, 150 Hz when it is 2 kHz.

Item			Explanation
Control functions	Acceleration/ deceleration time		0.01 to 3600 s (Four independent settings can be made for each of acceleration and deceleration. They are selectable with external signals.) (S-curve acceleration/deceleration in addition to linear acceleration/deceleration)
	Speed setting gain		Proportional relationship between analog speed setting and motor speed can be specified in the range of 0 to 200%.
	Jump speed		Jump speed (3 points) and jump hysteresis width (1 point) can be specified.
	Auto search for idling motor speed		Automatically searches for the idling motor speed to be harmonized and starts to drive it without stopping it. (Available under vector control with/without speed sensor)
	Auto-restart after momentary power failure		Possible to restart the inverter after a momentary power failure without stopping the motor depending on the restart mode setting.
	Slip compensation		Compensates for decrease in speed according to the load for stabilized operation. (Available for IM under V/f control.)
	Droop control		The motor speed droops in proportion to output torque. (Not available under V/f control.)
	Torque limit		Limits the torque to the predetermined values (selectable from "common to 4 quadrants", "independent driving and braking", etc.) Analog and external signal (2 steps) settings are available.
	Torque control		Analog setting: 0 to ±10V/0 to ±150% (Up to 300% by gain adjustment) Digital setting: Using an option card enables torque control with "16-bit parallel signals."
	PID control		PID control with analog input Possible to select whether to use the PID output as speed setting or auxiliary setting to be added or subtracted to/from the main setting.
	Cooling fan ON/OFF control		Stops cooling fans when the motor is stopped and the temperature is low for lifetime extension and noise reduction of the cooling fans.
	Toggle monitor control		Monitors communication between the host equipment (PLC) and the inverter to see whether the communication is normal.
	Torque bias		The combination of the fixed value (one step, with the polarity switching function by the motor rotation direction) and digital input signals ***TB1*** and ***TB2*** provides three steps of torque bias internal setting. Analog setting (with Hold function) is available.
	Motor selection		Selectable from the three types of motors, by Function code F79. Switchable between the three types of motors by the combination of digital input signals.
	Temperature detection		NTC thermistor (Equivalent to Fuji Electric specifications) PTC thermistor exclusively used for protection from motor overheat (The trip level is specified by parameters.)
	Self-diagnostic function for PG detection circuit		Self-diagnoses the detection circuit of pulse generator input signals (PA and PB).
	Load adaptive control		Calculates the maximum allowable elevating speed (e.g., vertical carrier machine) according to the load to improve the operation efficiency of the equipment.
	Multiplex system	Multiwinding motor drive	Option: OPC-VG1-TBSI is required. Maximum number of multiplexes: 6 units Control specifications: Available only under vector control with speed sensor
		Direct parallel connection ***1**	Option: OPC-VG1-TBSI is required. Maximum number of multiplexes: 3 units The carrier frequency is fixed at 2 kHz. Restrictions on the output wiring length and other operating conditions
	UP/DOWN control		Speed setting by the combination of digital input signals ***UP***, ***DOWN***, and ***CLR*** ("Clear ACC/DEC to zero")
	Stop function		Three types of the stop functions by digital input signals ***STOP1***, ***STOP2***, and ***STOP3***.
	PG pulse output		Outputs pulse generator signals (input pulses) with fixed frequency dividing or arbitrary frequency dividing. Switchable between open collector and complementary (equivalent to the voltage on the [PGP] terminal) transistor outputs, by the slide switch in the inverter unit.

*1 Available in the ROM version H1/2 0020 or later.

Item			Explanation
Control functions	Observer		Suppresses load disturbances and vibrations.
	Offline tuning		Tunes the motor parameters while the motor is stopped or running.
	Online tuning		Tunes the motor parameters to compensate for the temperature change.
	Position control		Standard function: Position control by servo-lock and integrated oscillation circuit
		Option	OPC-VG1-PG (PR): For pulse command input of line driver type OPC-VG1-PGo (PR): For pulse command input of open collector type OPC-VG7-SPGT: 17-bit high resolution ABS encoder
	Pulse train, synchronous operation (Option)		OPC-VG1-PG (PR): For pulse command input of line driver type OPC-VG1-PGo (PR): For pulse command input of open collector type
Indication/Setting	Keypad	Display	7-segment LED monitor and backlit LCD
		Multilingual display	Four languages: Japanese, English, Chinese, and Korean
		When the inverter is running or stopped	• Detected speed • Speed command • Output frequency • Reference torque current value • Torque command value • Torque calculation value • Power consumption (Motor output) • Output current • Output voltage • DC link circuit voltage • Magnetic-flux command value • Magnetic-flux calculation value • Load shaft speed • PID command value • PID feedback value • PID output value • Ai adjusted value (12) • Ai adjusted value (Ai1) • Ai adjusted value (Ai2) • Optional monitor 1 to 6 • Presence of digital input/output signal • Motor temperature • Heat sink temperature • Load factor • Input power • Input watt-hour • Operation time • Cumulative run time of the motor/Number of startups (for each motor), etc.
		When function codes are configured	Function code names and data are displayed.
		When an alarm occurs	Alarm factors that appear: • dbH (Braking resistor overheated) • dCF (DC fuse blown) • EF (Ground fault) • Er1 (Memory error) • Er2 (Keypad communications error) • Er3 (CPU error) • Er4 (Communications error) • Er5 (RS-485 communications error) • Er6 (Operation error) • Er7 (Output wire fault) • Er8 (A/D converter error) • Er9 (Speed mismatch) • Lin (Input phase loss) • LU (Undervoltage) • nrb (NTC wire break error) • OC (Overcurrent) • OH1 (Heat sink overheat) • OH2 (External alarm) • OH3 (Inverter internal overheat) • OH4 (Motor protection) • OL1 (Overload of motor 1) • OL2 (Overload of motor 2) • OL3 (Overload of motor 3) • OLU (Inverter overload) • OS (Overspeed) • OU (Overvoltage) • PG (PG wire break) • PbF (Charger circuit fault) • dbA (Braking transistor broken) • Err (Mock alarm) • OPL (Output phase loss) • dFA (DC fan locked) • ErH (Hardware error) • EC (Encoder communications error) • ErA (UPAC error) *1 • Et1 (Encoder error) • Erb (Inter-inverter communications link error) • ECF (Functional safety circuit error) *1 • dO (Excessive positioning deviation) • LoC (Start delay) • ArE (E-SX error) • ArF (Toggle error detection alarm) • SiF (Functional safety card error) *1 • SrF (Functional safety card error) *1

*1 Available in the ROM version H1/2 0020 or later.

Chap. 2 SPECIFICATIONS

Item			Explanation
Indication/Setting	Keypad	When a light alarm occurs	The light-alarm display L-AL appears. The inverter retains the cause of the light alarm to display it.
		When the inverter is running or an alarm occurs	The inverter retains the latest and the last 10 alarm codes and the latest and the last three pieces of alarm information to display them. The calendar clock function retains the date and time*2 when an alarm occurred to display them. (Precision: ±27 seconds/month (Ta = 25°C)) Data retention period *2: At least 5 years (at the surrounding temperature 25°C)
	FRENIC-VG Loader	Historical trace *1	Reads out the sampling data held in the inverter and shows it graphically. Sampling interval: 50 µs to 1 s
		Real-time trace *1	Reads out the current data of the running inverter and shows it graphically in real-time. Sampling interval: 1 ms to 1 s
		Traceback	Reads out the sampling data held in the inverter and shows it graphically when an alarm has occurred. Sampling interval: 50 µs to 1s (400 µs for sampling data except current) The sampling data is retained in the memory by the backup battery. *2 Data retention period: At least 5 years (at the surrounding temperature 25°C)
		Operation monitor *1	I/O monitor, system monitor, alarm history monitor, etc.
		Configuration of function code	Shows the configuration of the function codes, as well as enabling editing, transmitting, comparing, and initialization.
	Charge lamp		Lights when power is applied to the inverter unit. (Lights when power is applied to the control circuit only.)
Maintenance	Main circuit capacitor life		Life judgment function installed
	Common functions		• Retains and displays the cumulative run time of the main circuit capacitor and the cumulative run time of cooling fans. • Retains and displays the inverter operation time. • Retains and displays the maximum output current and the maximum internal temperature for the past one hour.
Communications	RS-485		I/O terminals to connect the inverter with a computer or programmable logic controller (PLC) for RS-485 communication.
	USB		USB connector (mini B) to connect the inverter with a computer. This enables you to use the inverter support loader running on the computer for editing, transferring and verifying the inverter function codes, making a test run of the inverter, and monitoring various inverter statuses.
Compatibility	VG7	Function code data	Compatible with the VG7 function codes, except function codes for the 3rd motor. (Using the VG7 function codes as is produces the same operation on the FRENIC-VG.) Possible to read out VG7 function code data using FRENIC-VG Loader and write it as is into the FRENIC-VG. (Except special inverter versions)
		Various communications tools	Fully compatible with T-Link, SX-bus, and CC-Link. (Software in the host equipment PLC is available as is. Except special software.)
	Mounting adapter		Mounting adapters are provided for matching the FRENIC-VG with conventional models in mounting dimensions.

*1 Available in the paid-for version of FRENIC-VG Loader (WPS-VG1-PCL).

*2 Backup battery: Included as standard for inverters of 30 kW or above
Option (OPK-BP) for inverters of 22 kW or below

Item				Explanation
Product standards	UL Standards and Canadian Standards *1			UL, cUL (UL508C, C22.2 No.14) *2
	European Standards (CE marking) *1	Machinery Directive		EN ISO13849-1: PL-d category: 3 IEC/EN 60204-1: Stop category 0
		Low Voltage Directive		IEC/EN 61800-5-1 (Overvoltage category: 3)
		EMC Standards		IEC/EN 61800-3, IEC/EN 61326-3-1 Emission (EMC-filter: option) 220 kW or below: Category C2 280 kW or above: Category C3 Immunity 2nd Env.
	Functional Safety (European Standards)			IEC/EN 61800-5-2: SIL2 IEC/EN 62061: SIL2
		Safe Torque Off (STO)		Turning off external digital input signals on terminals [EN1] and [EN2] activates the STO function that shuts down the inverter output transistor by hardware to coast the motor to a stop.
		The optional functional safety card OPC-VG1-SAFE has the following functions. Refer to the Functional Safety Card instruction manual (INR-SI47-1541).		
			Safe Torque Off (STO) (standard function)	Turning off external digital input signals on terminals [EN1] and [EN2] activates the STO function that shuts down the inverter output transistor by hardware to coast the motor to a stop.
			Safe Stop 1 (SS1)	This SS1 function decelerates the motor speed and shuts down the inverter output to the motor (torque off) by using the STO function immediately when the motor speed decelerates to the specified speed or the specified time has elapsed.
			Safely Limited Speed (SLS)	The SLS function prevents the motor from exceeding the specified speed.
			Safe Brake Control (SBC)	The SBC function outputs motor brake control signals.
Environment	Installation location			Shall be free from corrosive gases, flammable gases, oil mist, dusts, and direct sunlight. (Pollution degree 2 (IEC60664-1)). Indoor use only.
	Surrounding temperature			-10 to +50°C (-10 to +40°C when installed side-by-side without clearance (22 kW or below))
	Relative humidity			5 to 95% RH (without condensation)
	Altitude			Lower than 3,000 m If the altitude is 1,001 to 3,000 m, output current derating is required. If it is 2,001 to 3,000 m, the insulation level of the control circuits lowers from the reinforced insulation to the basic insulation. Refer to Chapter 3, Section 3.3 "Mounting and Wiring."
	Vibration			200 V 55 kW, 400 V 75 kW or below 3 mm: 2 to less than 9 Hz, 9.8m/s²: 9 to less than 20 Hz 2 m/ s²: 20 to less than 55 Hz 1 m/ s²: 55 to less than 200 Hz 200V 75 kW, 400 V 90 kW or above 3 mm: 2 to less than 9 Hz 2 m/s²: 9 to less than 55 Hz 1 m/s²: 55 to less than 200 Hz
	Storage temperature			-25 to +70°C
	Storage humidity			5 to 95% RH (without condensation)

*1 Available in the ROM version H1/2 0020 or later.

*2 The FRN45/55VG1S-2☐ and FRN75/160/200/220/355/400VG1S-4☐ do not conform to C22.2 No. 14.
If necessary, contact your Fuji Electric representative.

2.3 External Dimensions

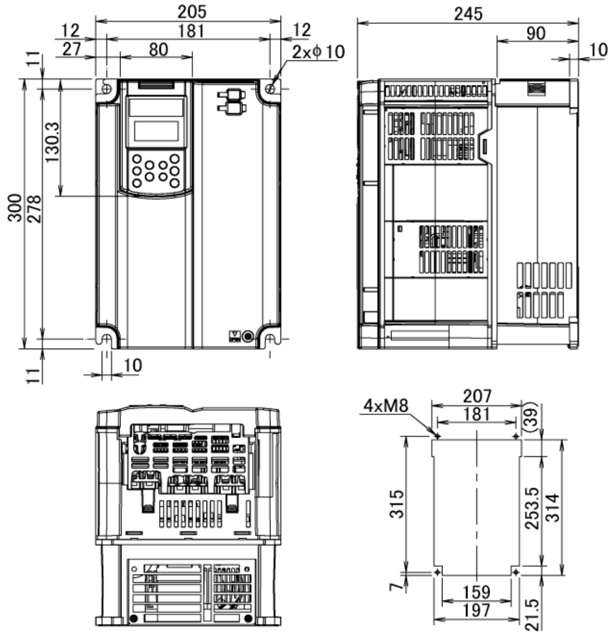
2.3.1 Standard models

The diagrams below show external dimensions of the FRENIC-VG series of inverters according to the inverter capacity. (Three-phase 200 V/400 V class series)

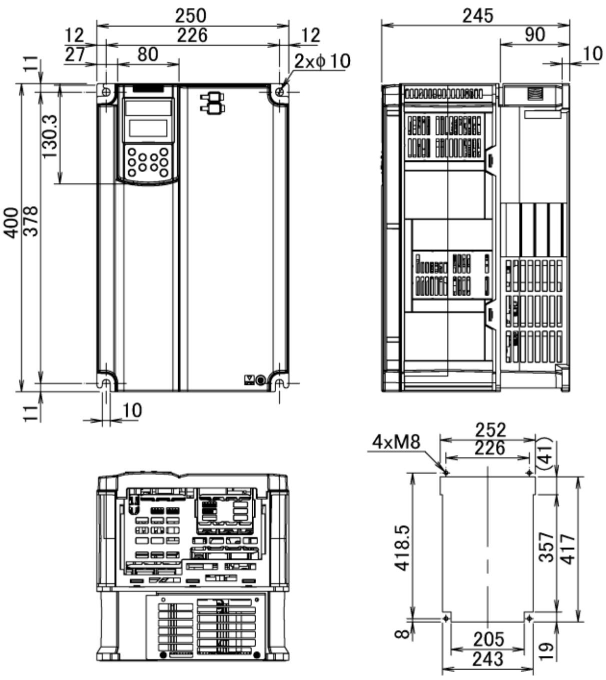
A figure given in the lower right-hand corner of each set of drawings shows the dimension of panel cutting required for external cooling. To employ external cooling for inverters of 22 kW or below, the optional mounting adapter for external cooling is necessary. For the external dimensions of the mounting adapter, refer to Chapter 8, Section 8.5.8 "Mounting adapter for external cooling."

(Unit: mm)

■ FRN0.75 to 7.5VG1S-2□
■ FRN3.7 to 7.5VG1S-4□



■ FRN11 to 22VG1S-2□
■ FRN11 to 22VG1S-4□

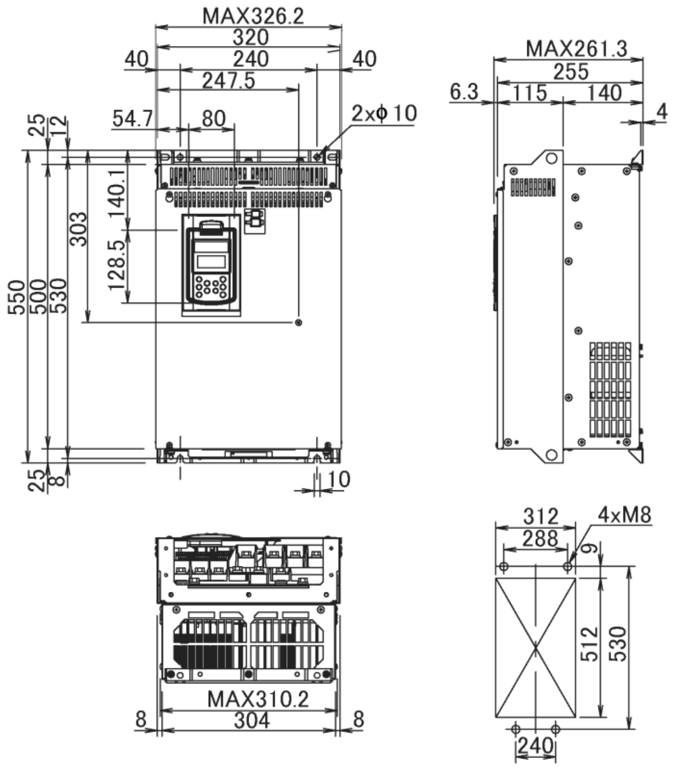


Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

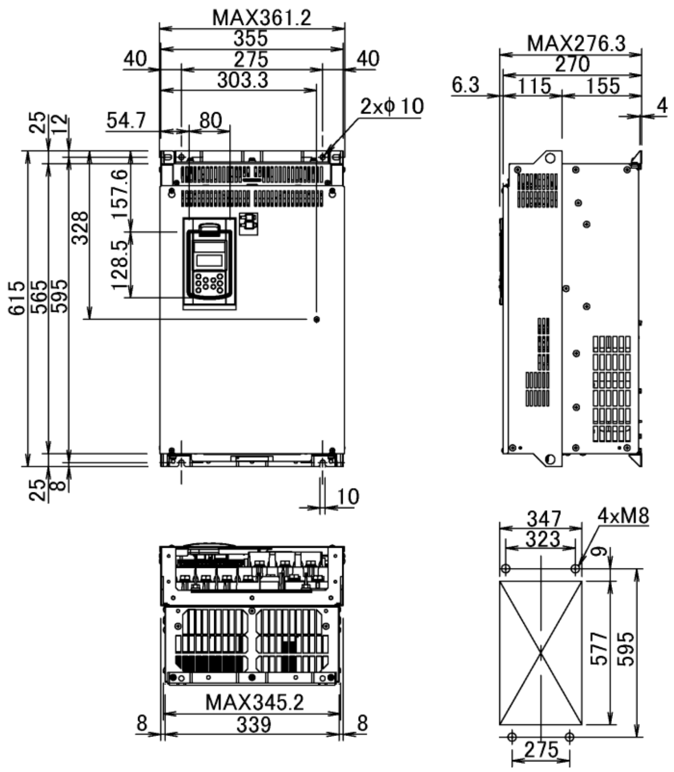
A figure given in the lower right-hand corner of each set of drawings shows the dimension of panel cutting required for employing external cooling. To employ external cooling for inverters of 30 kW or above, change the positions of the mounting bases. For details, refer to Chapter 3, Section 3.3.2 "Installing the Inverter, ■ When employing external cooling."

(Unit: mm)

■ FRN30VG1S-2☐
■ FRN30/37VG1S-4☐



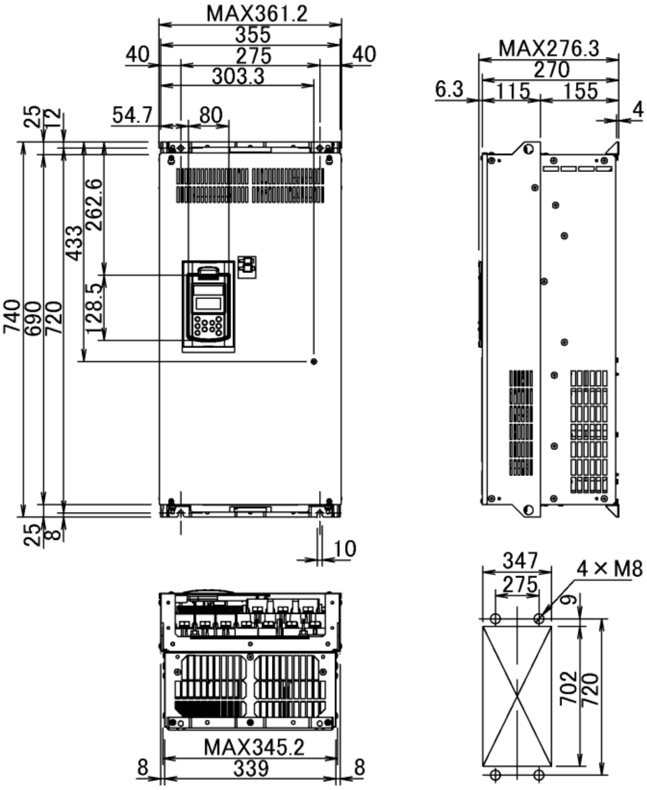
■ FRN37VG1S-2☐
■ FRN45VG1S-4☐



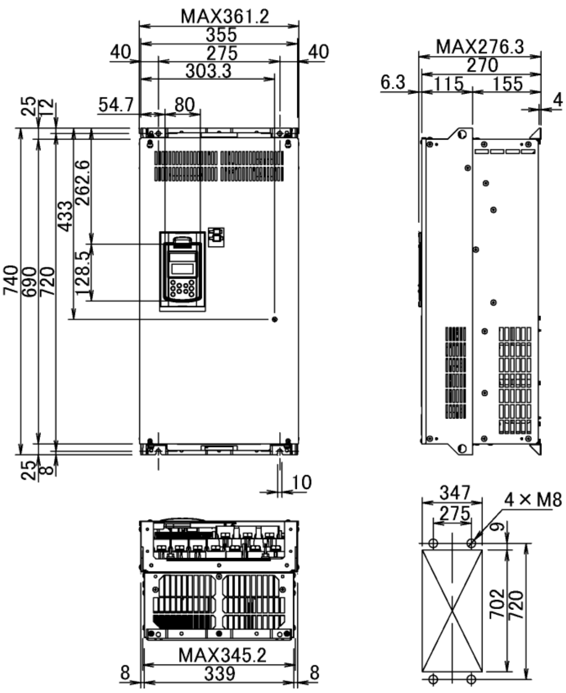
Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN45VG1S-2□



■ FRN55VG1S-2□



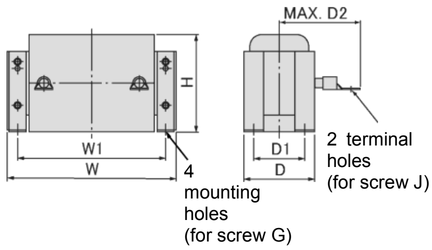


Figure C

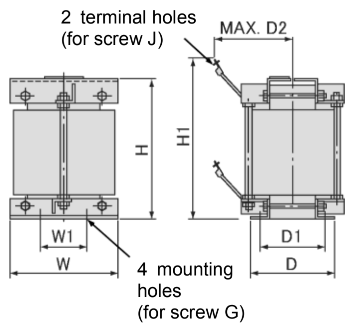


Figure D

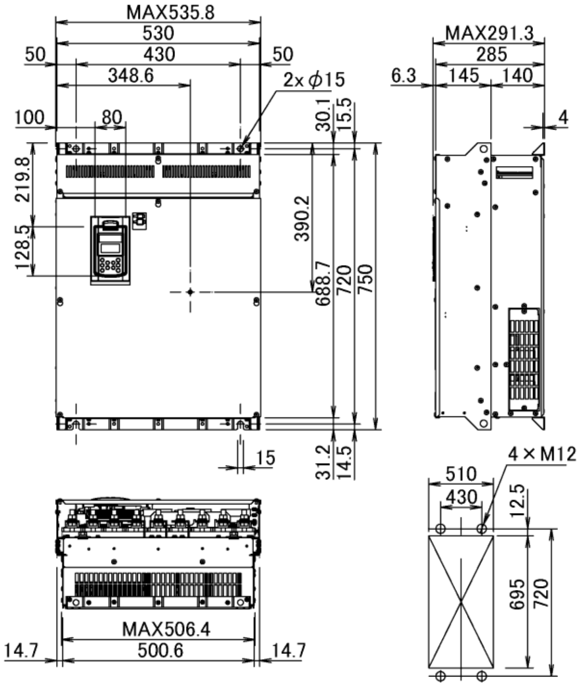
	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR2-55B *1	D	190	160	131	90	100	M6 (φ8)	210	250	M12	16
	DCR2-55C *1	C	255	225	96	76	140	M6 (7*13)	145	-	M12	11
LD mode	DCR2-75C	C	255	225	106	86	145	M6 (7*13)	145	-	M12	12

*1 The DCR2-55B and DCR2-55C are optionally available.

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN75VG1S-2□



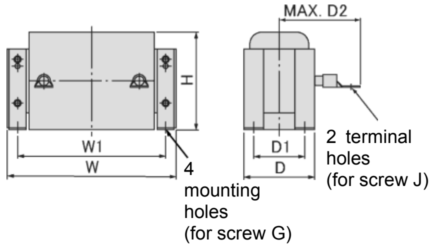
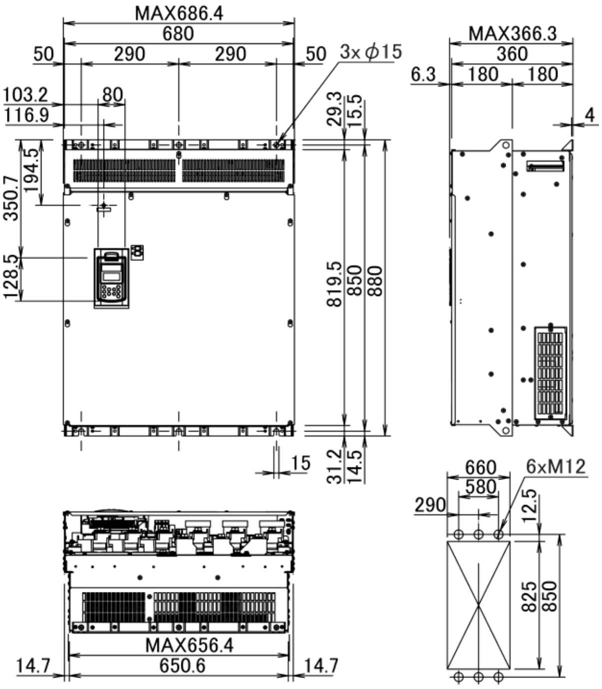


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR2-75C	C	255	225	106	86	145	M6 (7*13)	145	-	M12	12
LD mode	DCR2-90C		255	225	116	96	155	M6 (7*13)	145	-	M12	14

■ FRN90VG1S-2□



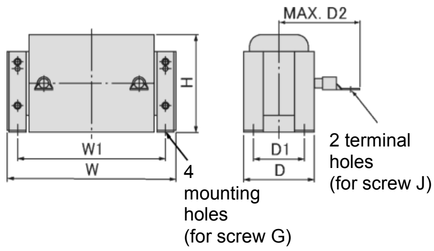


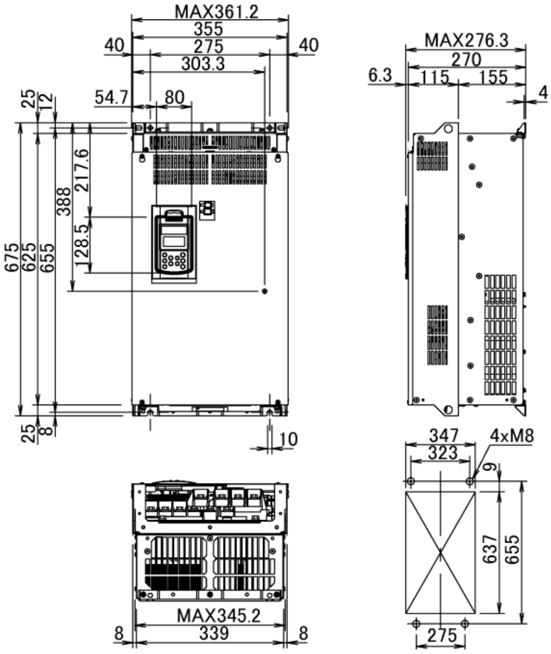
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR2-90C	C	255	225	116	96	155	M6 (7*13)	145	-	M12	14
LD mode	DCR2-110C		300	265	116	90	185	M8 (10*18)	160	-	M12	17

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN55VG1S-4□



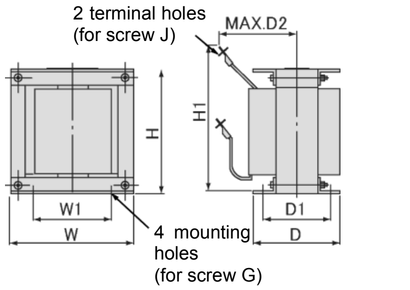


Figure B

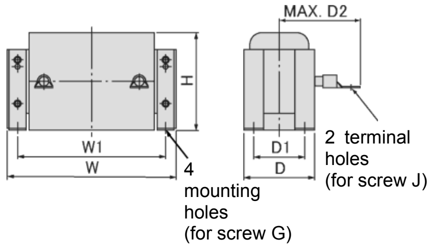
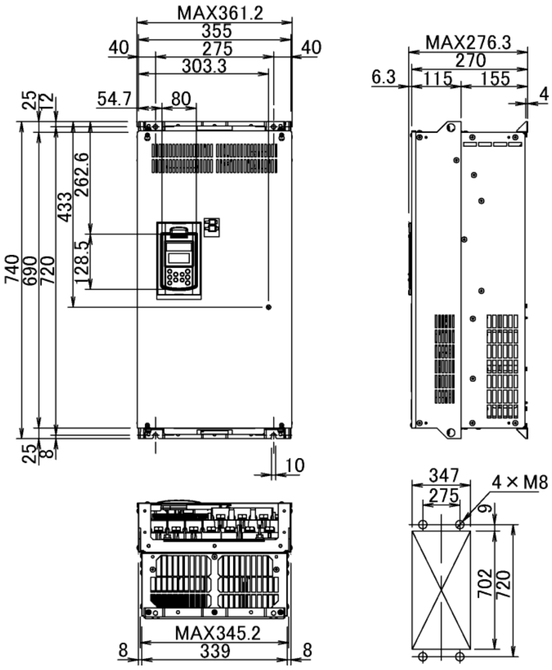


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-55B *1	B	171	110	170	130	110	M6 (φ8)	150	210	M8	20
	DCR4-55C *1	C	255	225	96	76	120	M6 (7*13)	145	-	M10	11
LD mode	DCR4-75C	C	255	225	106	86	125	M6 (7*13)	145	-	M10	13

*1 The DCR4-55B and DCR4-55C are optionally available.

■ FRN75VG1S-4□



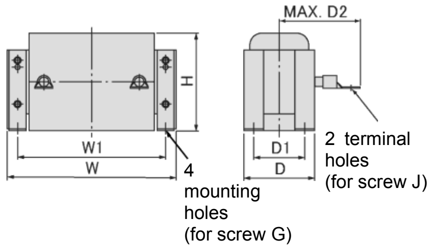


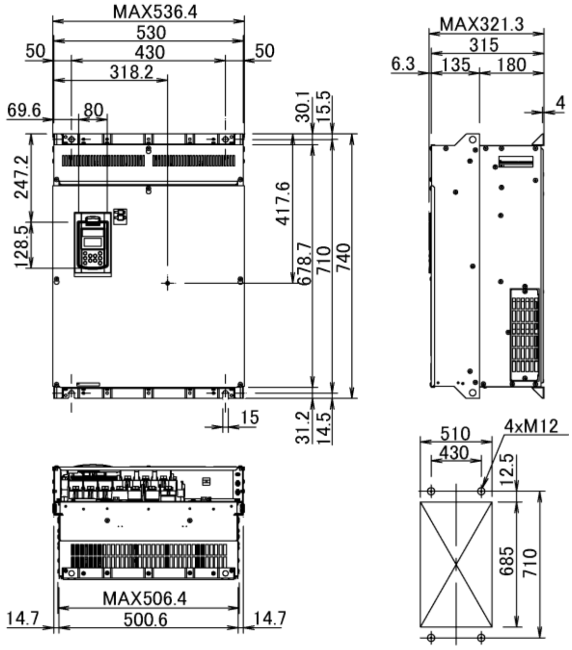
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-75C	C	255	225	106	86	125	M6 (7*13)	145	-	M10	13
LD mode	DCR4-90C		255	225	116	96	140	M6 (7*13)	145	-	M12	15

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN90VG1S-4□



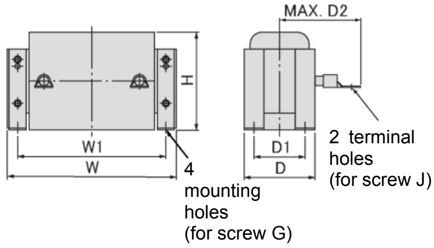
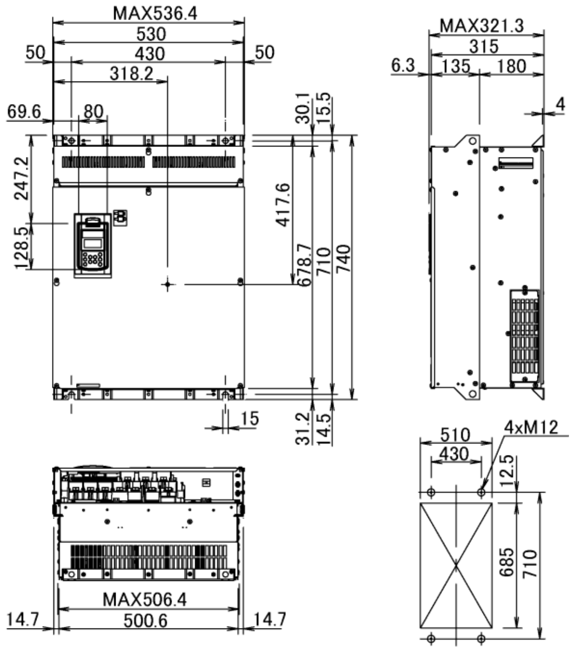


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-90C	C	255	225	116	96	140	M6 (7*13)	145	-	M12	15
MD mode	DCR4-110C		300	265	116	90	175	M8 (10*18)	155	-	M12	19
LD mode												

■ FRN110VG1S-4□



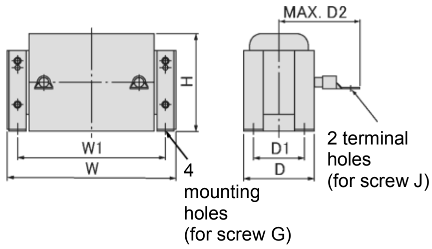


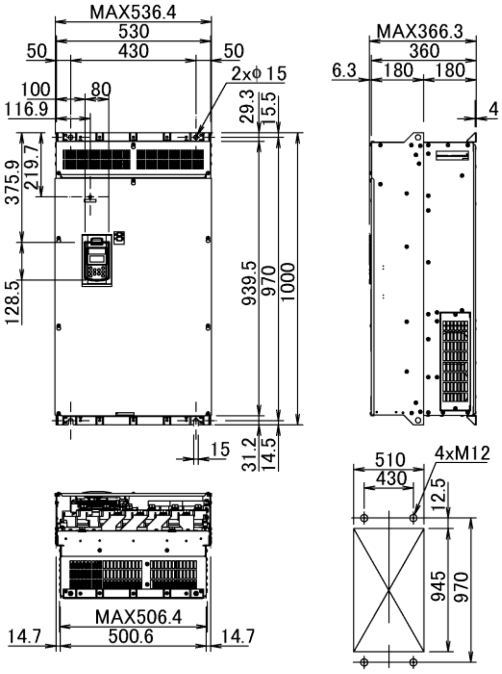
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-110C	C	300	265	116	90	175	M8 (10*18)	155	-	M12	19
MD mode	DCR4-132C		300	265	126	100	180	M8 (10*18)	160	-	M12	22
LD mode												

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN132VG1S-4☐



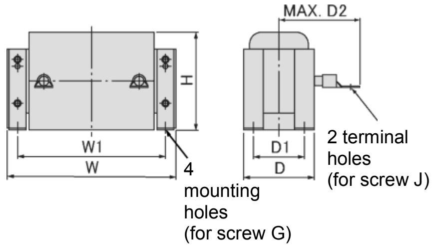
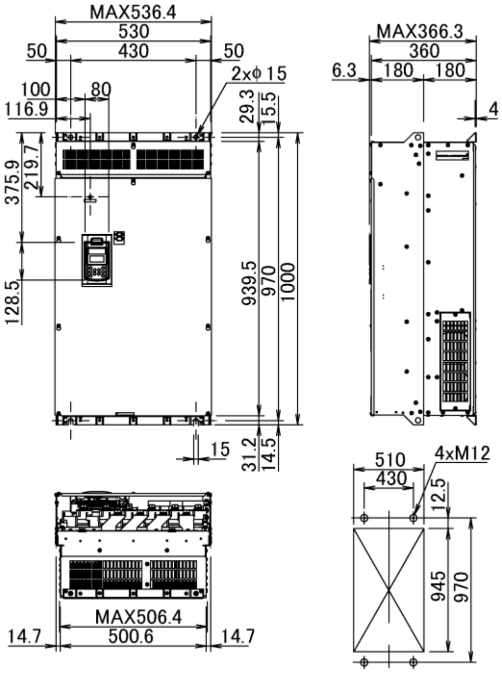


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-132C	C	300	265	126	100	180	M8 (10*18)	160	-	M12	22
MD mode	DCR4-160C		350	310	131	103	180	M10 (12*22)	190	-	M12	26
LD mode												

■ FRN160VG1S-4☐



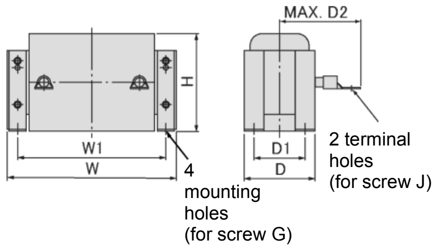


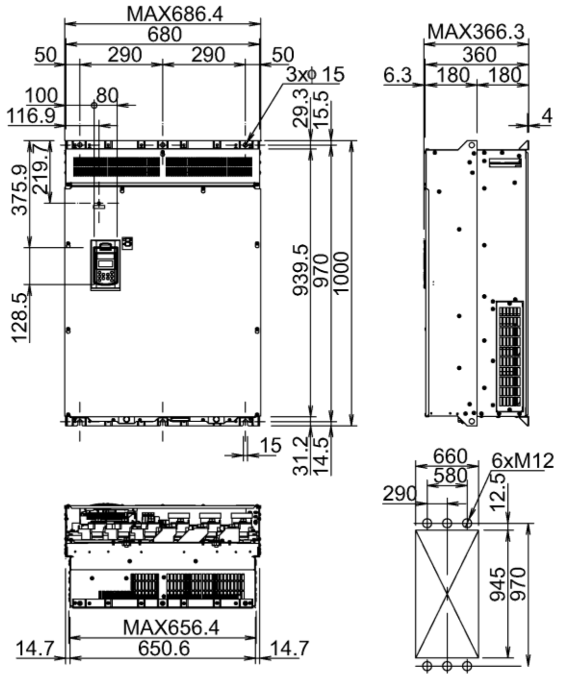
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-160C	C	350	310	131	103	180	M10 (12*22)	190	-	M12	26
MD mode	DCR4-200C		350	310	141	113	185	M10 (12*22)	190	-	M12	30
LD mode												

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN200VG1S-4☐



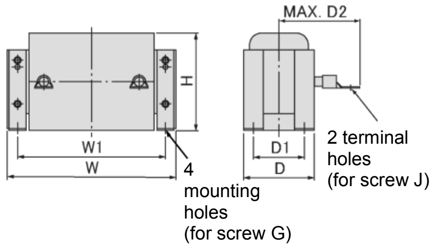
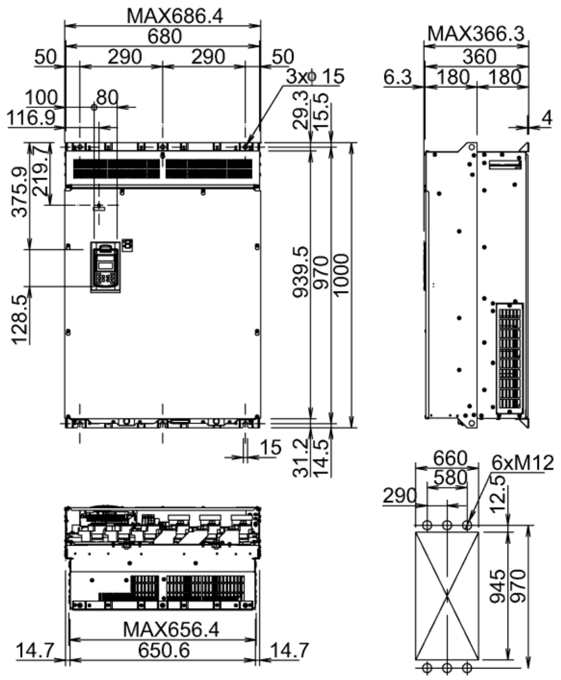


Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-200C	C	350	310	141	113	185	M10 (12*22)	190	-	M12	30
MD mode	DCR4-220C		350	310	146	118	200	M10 (12*22)	190	-	M12	33
LD mode												

■ FRN220VG1S-4☐



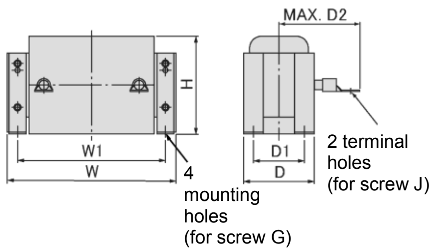


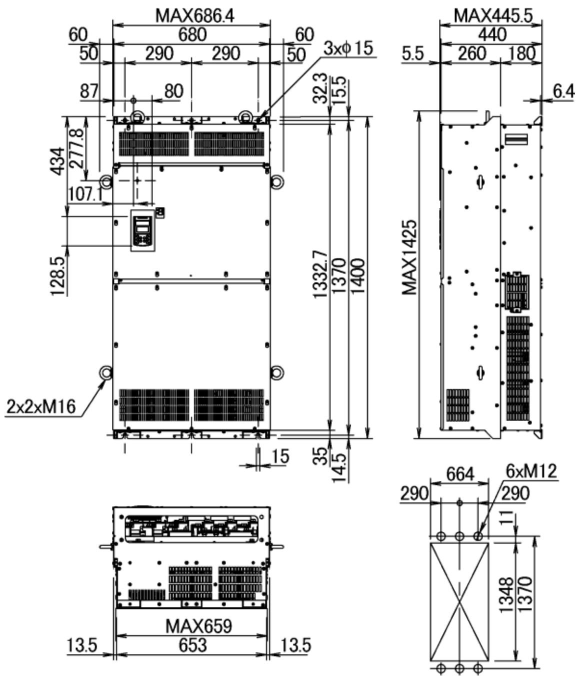
Figure C

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-220C	C	350	310	146	118	200	M10 (12*22)	190	-	M12	33
MD mode	DCR4-250C		350	310	161	133	210	M10 (12*22)	190	-	M12	35
LD mode	DCR4-280C		350	310	161	133	210	M10 (12*22)	190	-	M16	37

Note: A box (☐) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN280VG1S-4□



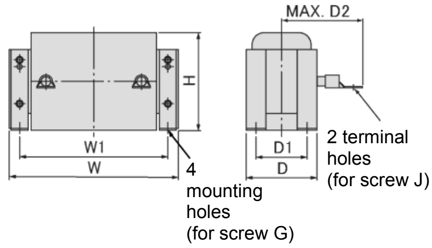


Figure C

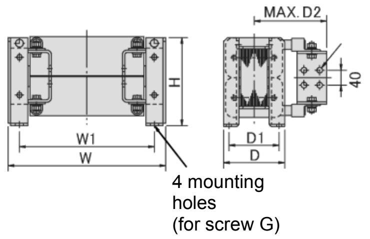
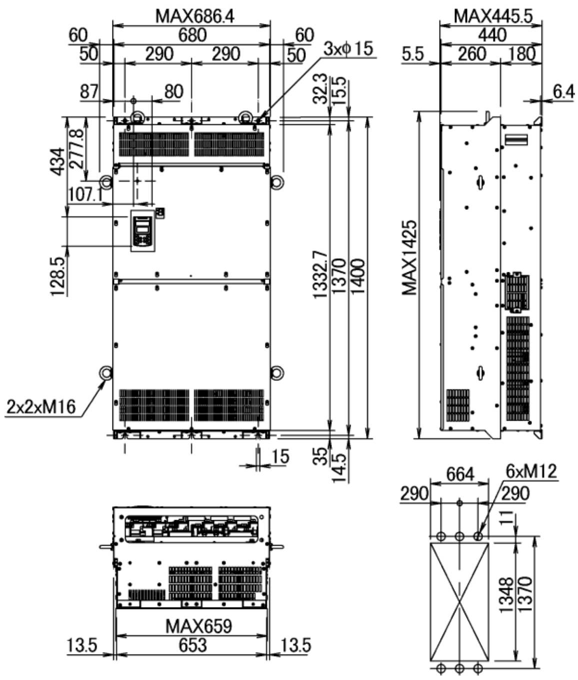


Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-280C	C	350	310	161	133	210	M10 (12*22)	190	-	M16	37
MD mode	DCR4-315C		400	345	146	118	200	M10 (12*22)	225	-	M16	40
LD mode	DCR4-355C	E	400	345	156	128	200	M10 (12*22)	225	-	4*M12	49

■ FRN315VG1S-4□



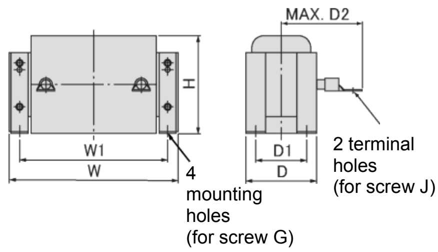


Figure C

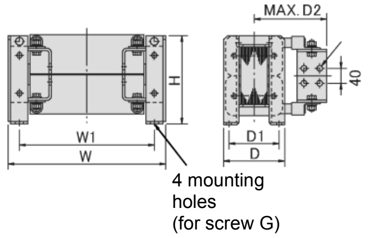


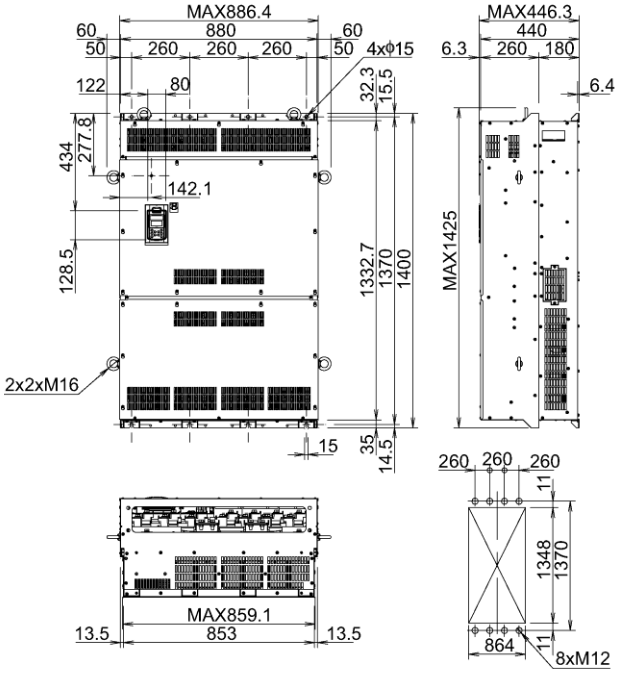
Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-315C	C	400	345	146	118	200	M10 (12*22)	225	-	M16	40
MD mode	DCR4-355C	E	400	345	156	128	200	M10 (12*22)	225	-	4*M12	49
LD mode	DCR4-400C		445	385	145	117	213	M10 (12*22)	245	-	4*M12	52

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN355VG1S-4□



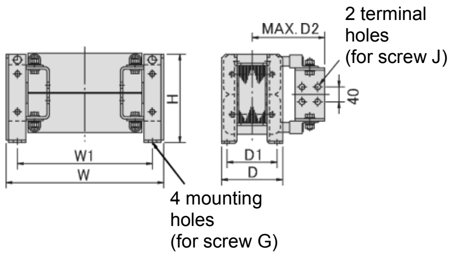
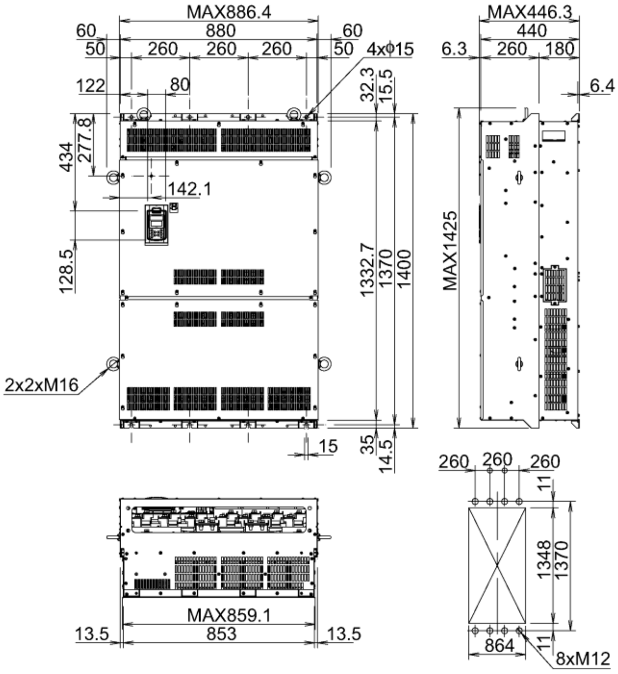


Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-355C	E	400	345	156	128	200	M10(12*22)	225	-	4*M12	49
MD mode	DCR4-400C		445	385	145	117	213	M10(12*22)	245	-	4*M12	52
LD mode	DCR4-450C		440	385	150	122	215	M10(12*22)	245	-	4*M12	62

■ FRN400VG1S-4□



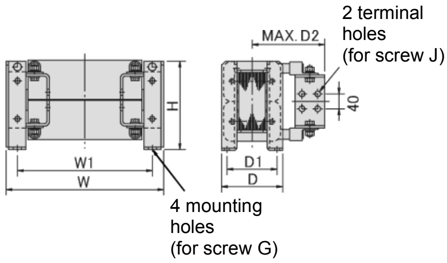


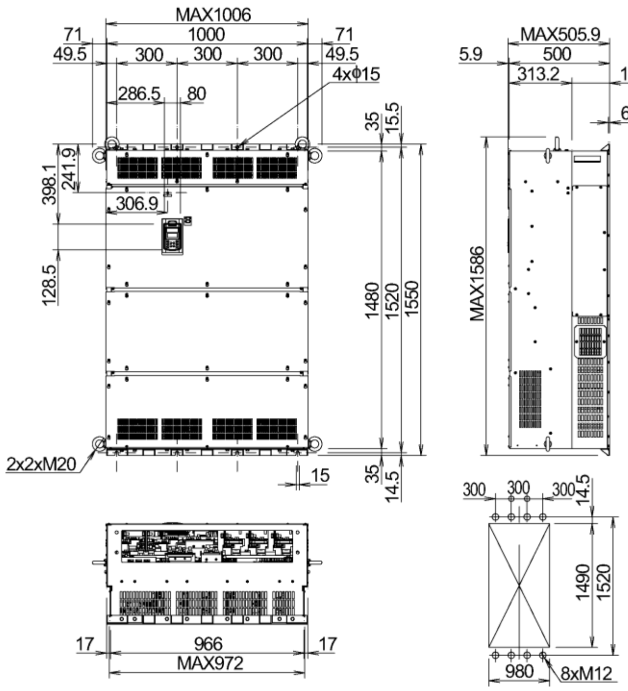
Figure E

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-400C	E	445	385	145	117	213	M10(12*22)	245	-	4*M12	52
MD mode	DCR4-450C		440	385	150	122	215	M10(12*22)	245	-	4*M12	62
LD mode	DCR4-500C		445	390	165	137	220	M10(12*22)	245	-	4*M12	72

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

(Unit: mm)

■ FRN500VG1S-4□



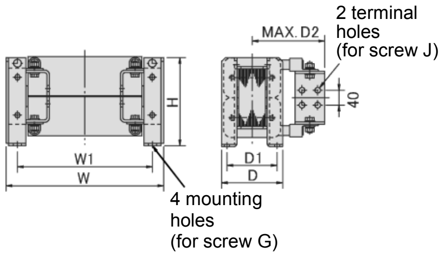


Figure E

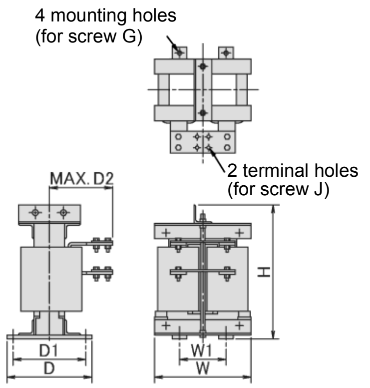
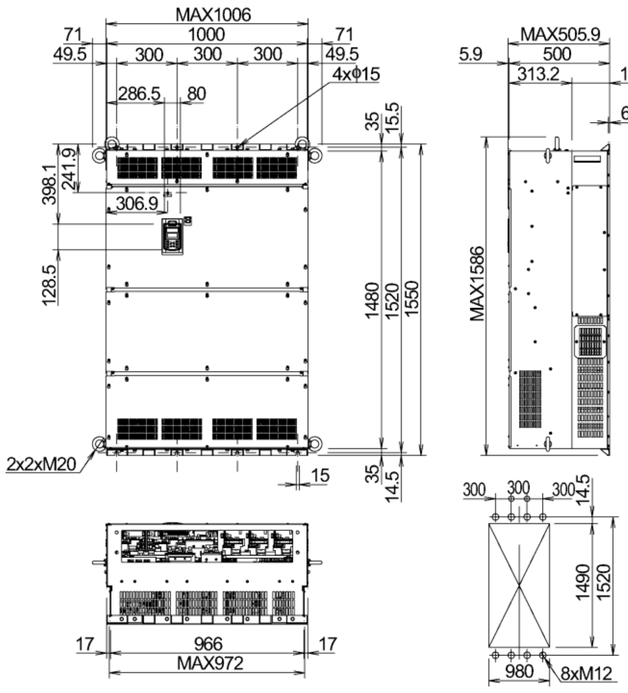


Figure F

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-500C	E	445	390	165	137	220	M10(12*22)	245	-	4*M12	72
LD mode	DCR4-630C	F	285	145	203	170	195	M12(14*20)	480	-	2*M12	75

■ FRN630VG1S-4□



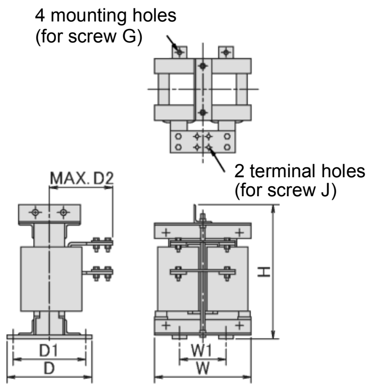
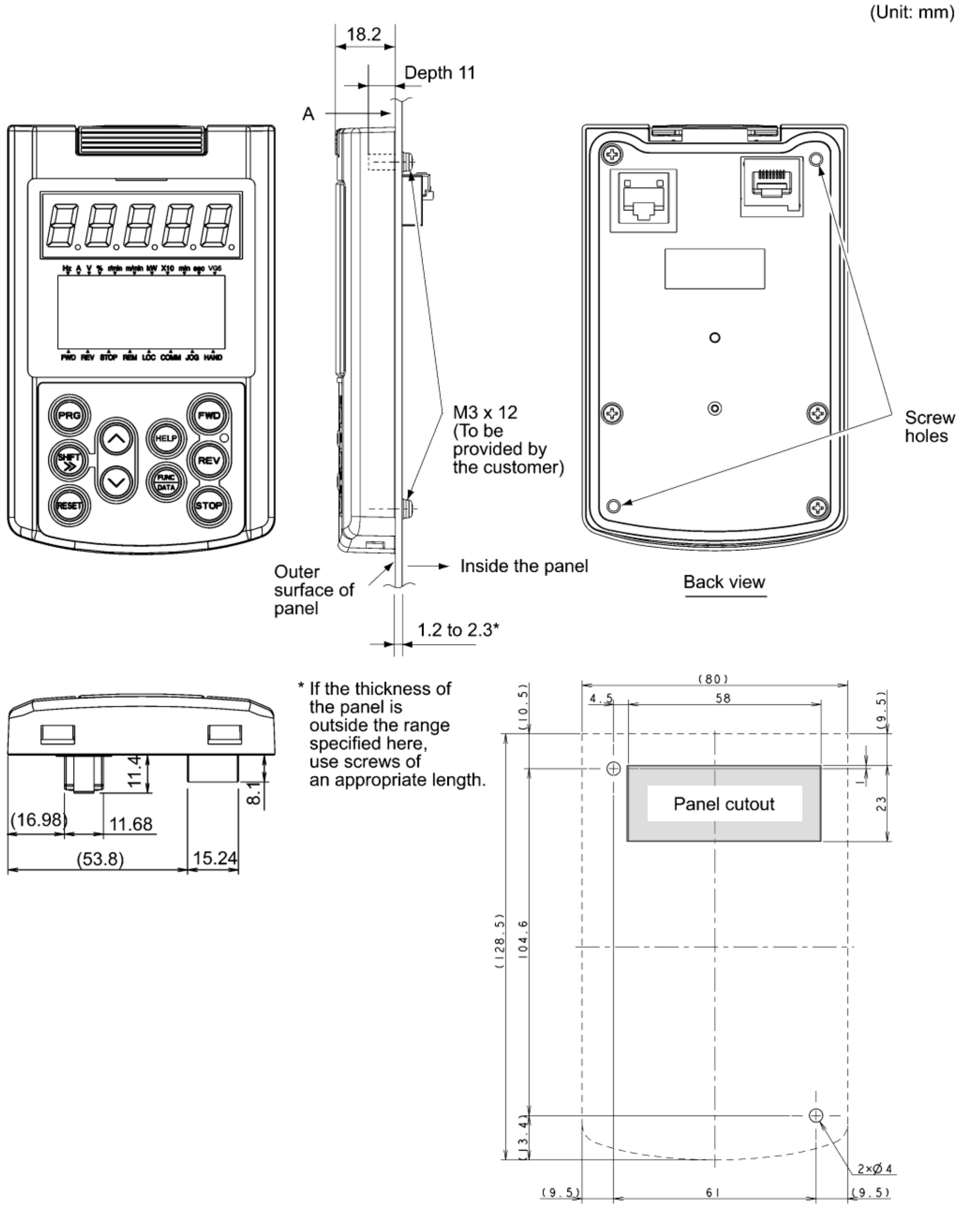


Figure F

	Reactor	Figure	W	W1	D	D1	D2	G	H	H1	J	Approx. mass (kg)
HD mode	DCR4-630C	F	285	145	203	170	195	M12 (14*20)	480	-	2*M12	75
LD mode	DCR4-710C		340	160	295	255	225	M12 (φ15)	480	-	4*M12	95

Note: A box (□) replaces an alphabetic letter depending on the shipping destination.

2.3.2 Keypad



Dimensions of panel cutting (viewed from A)

2.4 Dedicated Motor Specifications

2.4.1 Induction motor (IM) with speed sensor

● Standard specifications for three-phase 200 V series

<table>
<tr><th colspan="2">Item</th><th colspan="16">Specifications</th></tr>
<tr><td colspan="2">Dedicated motor rated output (kW)</td><td>0.75</td><td>1.5</td><td>2.2</td><td>3.7</td><td>5.5</td><td>7.5</td><td>11</td><td>15</td><td>18.5</td><td>22</td><td>30</td><td>37</td><td>45</td><td>55</td><td>75</td><td>90</td></tr>
<tr><td colspan="2">Applicable motor type (MVK_)</td><td>8095A</td><td>8097A</td><td>8107A</td><td>8115A</td><td>8133A</td><td>8135A</td><td>8165A</td><td>8167A</td><td>8184A</td><td>8185A</td><td>8187A</td><td>8207A</td><td>8208A</td><td>9224A</td><td>9254A</td><td>9256A</td></tr>
<tr><td colspan="2">Moment of inertia of rotor ($kg \cdot m^2$)</td><td>0.009</td><td>0.009</td><td>0.009</td><td>0.016</td><td>0.030</td><td>0.037</td><td>0.085</td><td>0.11</td><td>0.21</td><td>0.23</td><td>0.34</td><td>0.41</td><td>0.47</td><td>0.53</td><td>0.88</td><td>1.03</td></tr>
<tr><td colspan="2">Rotor GD^2 ($kg \cdot m^2$)</td><td>0.036</td><td>0.036</td><td>0.036</td><td>0.065</td><td>0.12</td><td>0.15</td><td>0.34</td><td>0.47</td><td>0.83</td><td>0.92</td><td>1.34</td><td>1.65</td><td>1.87</td><td>2.12</td><td>3.52</td><td>4.12</td></tr>
<tr><td colspan="2">Rated speed/ Max. speed (r/min)</td><td colspan="9">1500/3600</td><td colspan="4">1500/3000</td><td colspan="2">1500/2400</td><td>1500/ 2000</td></tr>
<tr><td colspan="2">Vibration</td><td colspan="13">V10 or less</td><td colspan="3">V15 or less</td></tr>
<tr><td rowspan="4">Cooling fan</td><td>Voltage (V)</td><td colspan="13">200 to 210 V/50 Hz, 200 to 230 V/60 Hz</td><td colspan="3">200/50 Hz,
200, 220 V/60 Hz</td></tr>
<tr><td>Number of phases/ poles</td><td>-</td><td colspan="5">Single-phase, 4P</td><td colspan="10">Three-phase, 4P</td></tr>
<tr><td>Input power (W)</td><td>-</td><td colspan="5">40/50</td><td colspan="2">90/120</td><td colspan="5">150/210</td><td>80/120</td><td colspan="2">270/390</td></tr>
<tr><td>Current (A)</td><td>-</td><td colspan="5">0.29/0.27 to 0.31</td><td colspan="2">0.49/0.44 to 0.48</td><td colspan="5">0.75/0.77 to 0.8</td><td>0.76/
0.8, 0.8</td><td colspan="2">1.9/2.0, 2.0</td></tr>
<tr><td colspan="2">Approx. mass (kg)</td><td>28</td><td>29</td><td>32</td><td>46</td><td>63</td><td>73</td><td>111</td><td>133</td><td>190</td><td>197</td><td>235</td><td>280</td><td>296</td><td>380</td><td>510</td><td>570</td></tr>
</table>

● Standard specifications for three-phase 400 V series

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_)	8115A	8133A	8135A	8165A	8167A	8184A	8185A	8187A	8207A	8208A	9224A	9254A	9256A	9284A	9286A	528KA	528LA	531FA
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	0.47	0.53	0.88	1.03	1.54	1.77	1.72	1.83	2.33
Rotor GD^2 (kg•m^2)	0.065	0.12	0.15	0.34	0.47	0.83	0.92	1.34	1.65	1.87	2.12	3.52	4.12	6.16	7.08	6.88	7.32	9.32
Rated 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 210 V/50 Hz, 200 to 230 V/60 Hz			400 to 420 V/50 Hz, 400 to 440 V/60 Hz							400 V/50 Hz, 400, 440 V/60 Hz					380, 400, 415 V/50 Hz, 400, 440 V/ 60 Hz		
Cooling fan: Number of phases/ poles	Single-phase, 4P			Three-phase, 4P														
Cooling fan: Input power (W)	40/50			90/120		150/210					80/ 120	270/390				2200		3700
Cooling fan: Current (A)	0.29/0.27 to 0.31			0.27/ 0.24 to 0.25		0.38/0.39 to 0.4					0.39/ 0.4, 0.4	1.0/1.0, 1.0				4.6/4.3,4.1		7.8/ 7.1, 7.6
Approx. mass (kg)	46	63	73	111	133	190	197	235	280	296	380	510	570	710	760	1270	1310	1630

Item	Specifications					
Dedicated motor rated output (kW)	250	280	300	315	355	400
Applicable motor type (MVK_)	531GA	531HA	535GA	535GA	535HA	535JA
Moment of inertia of rotor (kg•m^2)	2.52	2.76	5.99	5.99	6.53	7.18
Rotor GD^2 (kg•m^2)	10.08	12.34	23.96	23.96	26.12	28.72
Rated speed / Max. speed (r/min)	1500/2000					
Vibration	V15 or less					
Cooling fan: Voltage (V)	400 V/50 Hz, 400, 440 V/60 Hz					
Cooling fan: Number of phases/ poles	Three-phase, 4P					
Cooling fan: Input power (W)	3700					
Cooling fan: Current (A)	7.8/7.1, 7.6					
Approx. mass (kg)	1685	1745	2230	2230	2310	2420

● Common specifications

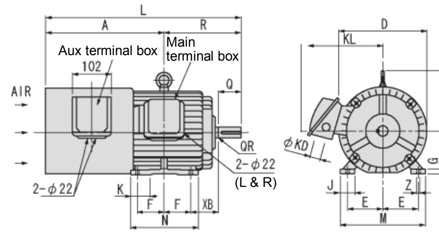
Item	Specifications
Insulation class, Number of poles	Class F, 4P
Terminal structure	Main terminal box (lug type): Three or six main circuit terminals, Two NTC thermistor terminals (MVK8 series), Three NTC thermistor terminals (MVK9 or MVK5 series. One terminal is reserved.) Auxiliary terminal box (terminal 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 your Fuji Electric representative for other mounting.
Degree of protection, Cooling method	IP44, Totally enclosed forced-ventilation system with cooling fan motor. A cooling fan blows air over the motor toward the drive-end. *Only MVK8095A (0.75 kW): Self-cooling
Installation location	Indoors, 1000 m or less in altitude.
Ambient temperature, humidity	-10 to +40°C, 90% RH or less (no condensation)
Finishing color	Munsell N5
Standard conformity	MVK8 series: JEM1466 or JEC-2137-2000 MVK9 or MVK5 series: JEC-2137-2000
Standard accessories	Pulse generator (1024 P/R, +15V, complementary output), NTC thermistor(s) (1 or 2), and cooling fan (except MVK8095A)

Note 1: For applicable motors of 55 kW or above, the torque accuracy is ±5%. When higher accuracy is required, contact your Fuji Electric representative.

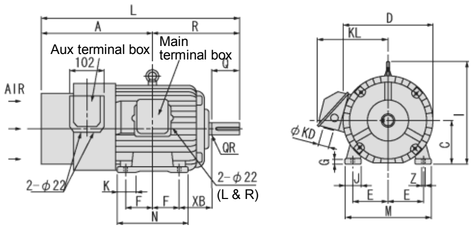
Note 2: For dedicated motors other than 4-pole ones with the base speed of 1500 r/min, contact your Fuji Electric representative.

● External dimensions of dedicated motors

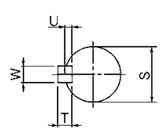
● Figure A



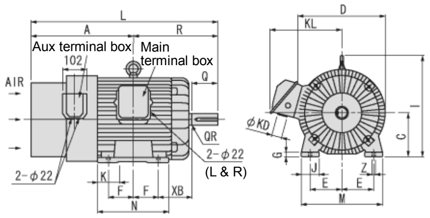
● Figure B



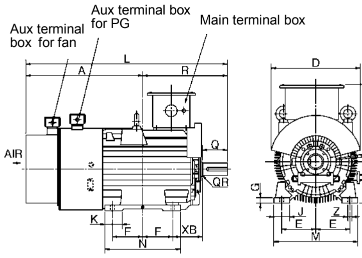
Shaft extension



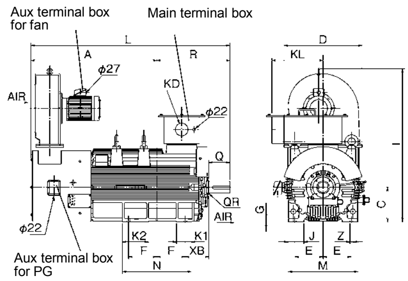
● Figure C



● Figure D



● Figure E



● Dimensions common 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	K1	K2	KD	KL	L	M	N	R	XB	Z	Q	QR	S	T	U	W	
0.75	MVK8095A	A	201.5	90	204	70	62.5	10	195	35.5	35.5			27	189	370	170	150	168.5	56	10	50	0.5	24j6	7	4	8	28
1.5	MVK8097A		277.5		203											446												29
2.2	MVK8107A		292	100		80	70	12.5	238	40	40				190	485	195	170	193	63	12	60		28j6				32
3.7	MVK8115A		299	112	236	95		14	270		50				205	499	224	175	200	70								46
5.5	MVK8133A	B	309	132	273	108		17	311	45				34	223	548	250	180	239	89		80		38k6	8	5	10	63
7.5	MVK8135A		328				89									586		212	258									73
11	MVK8165A	A	400	160	321	127	105	18	376	50	63			48	272	723	300	250	323	108	14.5	110	1	42k6			12	111
15	MVK8167A		422				127									767		300	345									133
18.5	MVK8184A		435	180	376	139.5	120.5	20	428	75	75	-	-		305	786.5	350	292	351.5	121			1.5	48k6	9	5.5	14	190
22	MVK8185A																											197
30	MVK8187A		454				139.5							60		824.5		330	370.5					55m6	10	6	16	235
37	MVK8207A	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	280
45	MVK8208A																											296
55	MVK9224A		723	225	445	178	143		515		95				391	1155	436	366	432	149				65m6				380
75	MVK9254A	D	693.5	250	545	203	155.5	30	743	100	120				106	1157	506	411	463.5	168	24			75m6	12	7.5	20	510
90	MVK9256A		711.5				174.5									1194		449	483.5									570
110	MVK9284A		764	280	605	228.5	184	35	798						203	1308	557	468	544	190		170		85m6	14	9	22	710
132	MVK9286A		789.5				209.5									1359		519	569.5									760
160	MVK528JA	E	1015.5		628		228.5	30	1234	125	-	120	210	102	413	1604	560	557	588.5				1					1230
200	MVK528LA																											1350
220	MVK531FA		1073	315	689	254	254	36	1425	150		140	240			1713	630	648	640	216	28		2	95m6			25	1690
250	MVK531GA																											1750
280	MVK531HA																											1820
300	MVK535GA		1111	355	778	305	355		1510	160		180	330			1956	730	890	845	280		210		100m6	16	10	28	2230
315																												
355	MVK535HA																											2310
400	MVK535JA																											2420

Note 1: The MVK8095A (0.75 kW) has a shaft-driven fan (Cooling system: IC410).

Note 2: The MVK8095A (0.75 kW) has a single cable lead-in hole of ϕ22.

Note 3: The MVK9224A (55 kW) has an auxiliary terminal box for fan, in addition to the configuration shown in Figure C.

Note 4: Dimensional tolerance of rotary shaft height C
$C \leq 250$ mm: 0 to -0.5 mm, $C > 250$ mm: 0 to 1.0 mm

2.4.2 Permanent magnet synchronous motor (PMSM) with speed sensor

● Standard specifications for three-phase 200 V series

Item		Specifications											
Dedicated motor rated output (kW)		5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
Dedicated motor type (GNF_)		2114A	2115A	2117A	2118A	2136A	2137A	2139A	2165A	2167A	2185A	2187A	2207A
Moment of inertia of rotor (kg•m^2)		0.018	0.021	0.027	0.036	0.065	0.070	0.090	0.153	0.191	0.350	0.467	0.805
Rotor GD^2 (kg•m^2)		0.072	0.084	0.107	0.143	0.259	0.281	0.360	0.610	0.763	1.401	1.868	3.220
Base speed/Max. speed (r/min)		1500/2000											
Rated current (A)		20/20	29/29	42/42	57/57	71/70	82/81	113/108	144/144	165/165	200/200	270/270	316/316
Vibration		V10 or less											
Cooling fan	Voltage (V), Frequency (Hz)	200 to 240, 50/60							200 to 210/50, 200 to 230/60				
	Number of phases/poles	Three-phase, 2P							Three-phase, 4P				
	Input power (W)	38 to 44/56 to 58				54 to 58/70 to 78			90/120		150/210		
	Current (A)	0.13 to 0.16/0.18 to 0.16				0.18 to 0.18/0.22 to 0.21			0.49/ 0.44 to 0.48		0.75/0.77 to 0.8		
Approx. mass (kg)		51	55	69	78	100	106	127	170	192	247	325	420

● Standard specifications for three-phase 400 V series

Item		Specifications											
Dedicated motor rated output (kW)		5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
Dedicated motor type (GNF_)		2114A	2115A	2117A	2118A	2136A	2137A	2139A	2165A	2167A	2185A	2187A	2207A
Moment of inertia of rotor (kg•m^2)		0.018	0.021	0.027	0.036	0.065	0.070	0.090	0.153	0.191	0.350	0.467	0.805
Rotor GD^2 (kg•m^2)		0.072	0.084	0.107	0.143	0.259	0.281	0.360	0.610	0.763	1.401	1.868	3.220
Base speed/Max. speed (r/min)		1500/2000											
Rated current (A)		10/10	15/15	21/21	29/29	36/35	41/41	57/54	72/72	83/83	100/100	135/135	158/158
Vibration		V10 or less											
Cooling fan	Voltage (V), Frequency (Hz)	200 to 240, 50/60							400 to 420/50, 400 to 440/60				
	Number of phases/poles	Three-phase, 2P							Three-phase, 4P				
	Input power (W)	38 to 44/56 to 58				54 to 58/70 to 78			90/120		150/210		
	Current (A)	0.13 to 0.16/0.18 to 0.16				0.18 to 0.18/0.22 to 0.21			0.27/ 0.24 to 0.25		0.38/0.39 to 0.4		
Approx. mass (kg)		51	55	69	78	100	106	127	170	192	247	325	420

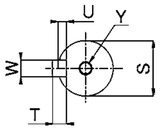
Item		Specifications							
Dedicated motor rated output (kW)		110	132	160	200	220	250	280	300
Dedicated motor type (GNF_)		2224B	2226B	2254B	2256B	2284B		2286B	
Moment of inertia of rotor (kg•m^2)		0.882	0.994	1.96	2.22	2.89		3.24	
Rotor GD^2 (kg•m^2)		3.53	3.98	7.84	8.88	11.6		13.0	
Base speed/Max. speed (r/min)		1500/2000							
Rated current (A)		198	232	273	340	369	420	480	520
Vibration		V10 or less							
Cooling fan	Voltage (V)	380, 400, 415/400, 415, 440, 460							
	Number of phases/poles	Three-phase, 4P							
	Power frequency (Hz)	50/60							
	Input power (W)	80/120		270/390					
	Current (A)	0.36, 0.38, 0.41/0.4, 0.4, 0.4, 0.4		0.95, 0.95, 1/1, 1, 1, 1					
Approx. mass (kg)		520	580	760	810	1020		1080	

● Common specifications

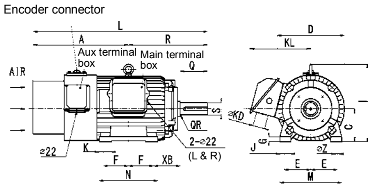
Item	Specifications
Insulation class, Number of poles	Class F, 6P
Terminal structure	Main terminal box (lug type): Three or six main circuit terminals, Two NTC thermistor terminals (Three for 110 kW or above. One terminal is reserved.) Auxiliary terminal box (terminal block): Cooling fan (FU, FV, FW)
	Pulse generator (connector type), Cooling fan (FU, FV, FW)
Rotation direction	CCW when viewed from the drive side
Mounting method	Legs mounted (IMB3) Note: Contact your Fuji Electric representative for other mounting.
Overload resistance	150% for 1 minute
Time rating	S1
Degree of protection, Cooling method	IP44, Totally enclosed forced-ventilation system with cooling fan motor. A cooling fan blows air over the motor toward the drive-end.
Installation location	Indoors, 1000 m or less in altitude.
Ambient temperature, humidity	-10 to +40°C, 90% RH or less (no condensation)
Noise	5.5 to 90 kW: 80 dB (A) or less at 1 m, 110 to 300 kW: 90 dB(A) or less at 1 m
Vibration resistance	6.86 m/s^2 (0.7 G)
Finishing color	Munsell N1.2
Standard conformity	JEM1487: 2005
Standard built-in parts	Pulse generator (1024 P/R, +5VDC, A, B, Z, U, V, W line driver output), One NTC thermistor (Two for 110 kW or above) and Cooling fan

● External dimensions of dedicated motors

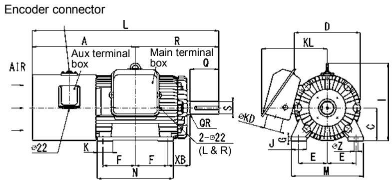
Shaft extension



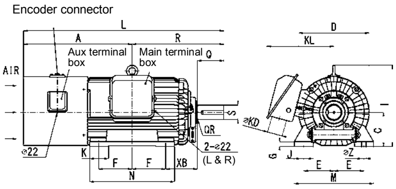
● Figure A



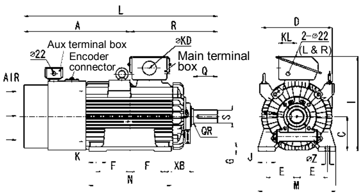
● Figure B



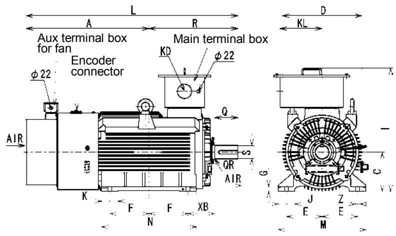
● Figure C



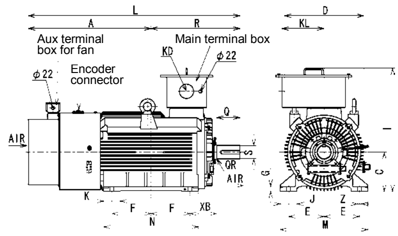
● Figure D



● Figure E



● Figure F



● Dimensions common to 200V and 400V series

Motor rated output (kW)	Motor type	Flame no.	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	Y	
5.5	GNF2114A	112Mh	A	335.5	112	235	95	70	14	270	40	50	34	200	555.5	224	175	220	70	12	80	0.5	38k6	8	5	10	M10X20	51
7.5	GNF2115A																											55
11	GNF2117A	112Jh		380.5				100	18		55		48	235	698.5	228	238	318	108	14.5	110	1	42k6			12		69
15	GNF2118A																											78
18.5	GNF2136A	132Lh		386	132	272	108	101.5	20	311	45			247	705.5	250		319.5				1.5	48k6	9	5.5	14		100
22	GNF2137A																											106
30	GNF2139A	132Hh		424.5				140					60		782.5		313	358					55m6	10	6	16		127
37	GNF2165A	160Lg	B	470.5	160	319	139.5	127		376	75	75	80	320	845.5	350	300	375		18.5	140	2	60m6	11	7	18	M12X25	170
45	GNF2167A	160Jg		501				157.5							906.5		370	405.5										192
55	GNF2185A	180Lg		510	180	375	159	139.5	25	428	80	85		356	910.5	390	330	400.5	121				65m6					247
75	GNF2187A	180Jg	C	576				177.5			100	100			1061.5	420	450	485.5	168	24			75m6	12	7.5	20		325
90	GNF2207A	200Jg	D	618.5	200	410	178	200		549				107	1126.5	450	479	508										420
110	GNF2224B	225Kg		711	225	446	203		28	628		120		142	1249	506	526	538			170	1	85m6	14	9	22	M20×35	520
132	GNF2226B	225Hg		761				250							1349		626	588										580
160	GNF2254B	250Hg	E	829	250	508	228.5	280	32	763				203	1469	557	677	640	190				95m6			25		760
200	GNF2256B					505																						810
220	GNF2284B	280Jf	F	881	280	570	254		35	878	120		102	303	1521	628	680			28								1020
250																												1020
280	GNF2286B																											1080
300																												1080

Note 1: Models of 110 kW output or above are exclusive to direct connection. For indirect connection, contact your Fuji Electric representative.

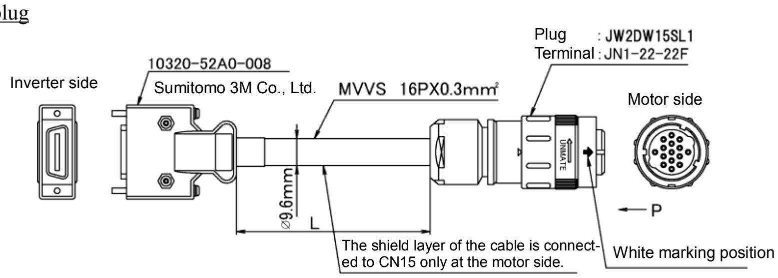
Note 2: Dimensional tolerance of rotary shaft height C
C ≤ 250 mm: 0 to -0.5 mm, C > 250 mm: 0 to 1.0 mm

● Cables exclusive to inverter connection

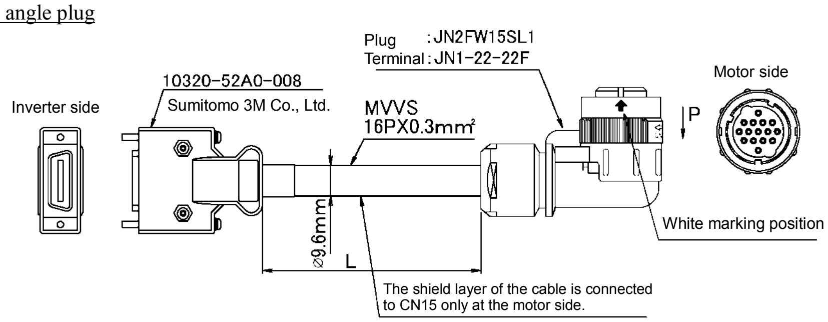
Name	Specifications			
Cable type	Wiring length (L dimension)	Plug shape at the motor side		Remarks
		Straight plug	Right angle plug	
	5 m	CB-VG1-PMPG-05S	CB-VG1-PMPG-05A	
	15 m	CB-VG1-PMPG-15S	CB-VG1-PMPG-15A	
	30 m	CB-VG1-PMPG-30S	CB-VG1-PMPG-30A	
	50 m	CB-VG1-PMPG-50S	CB-VG1-PMPG-50A	

Cable structure

Straight plug



Right angle plug



Wiring table and pin assignment

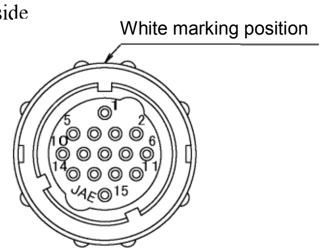
• Wiring

Connector # at the motor side	Connector # at the inverter side	Function
1	9 or 20	Power +5V
2	10 or 19	0V common
3	3	A phase
4	2	A phase reversed
5	5	B phase
6	4	B phase reversed
7	-	Z phase (*1)
8	-	Z phase reversed (*1)
9	8	Magnetic pole position F0
10	7	Magnetic pole position *F0
11	13	Magnetic pole position F1
12	12	Magnetic pole position *F1
13	15	Magnetic pole position F2
14	14	Magnetic pole position *F2
15	-	Shield layer

(*1) For the PG card (OPC-VG1-PMPG), no Z phase or Z phase reversed are required.

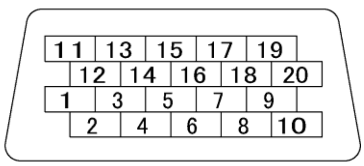
• Pin assignment

At the motor side

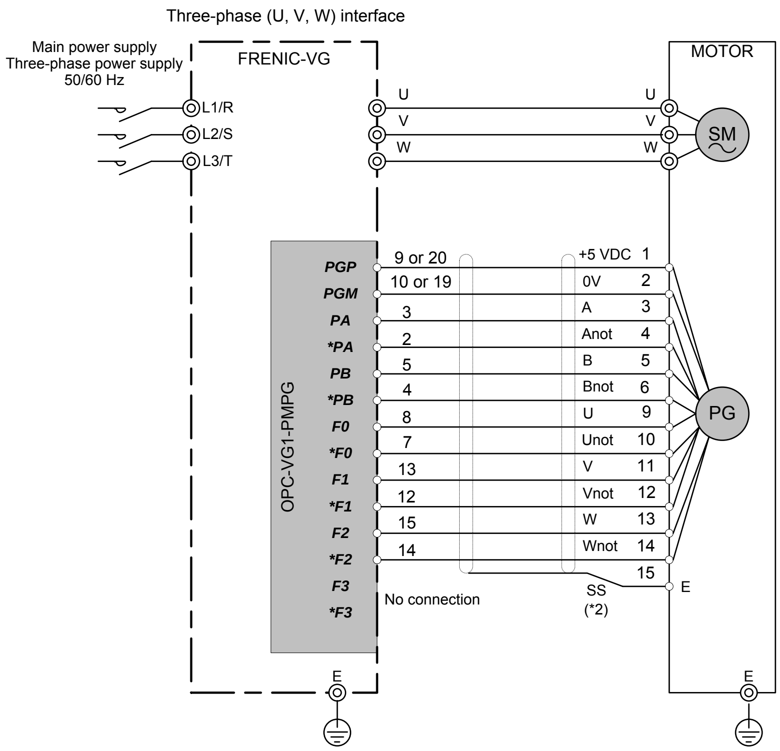


Viewed from P in the above figure

OPC-VG1-PMPG connector



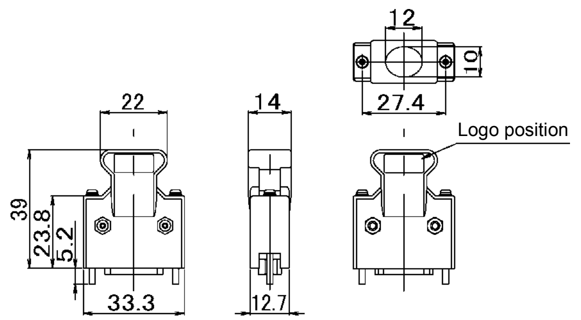
Inside the connector

Name	Specifications
Connection example	 (*2) When the customer produces the inverter connection cable, the shield (SS) of the PG shield layer should be connected to CN15 at the motor side. No connection is required at the inverter side.

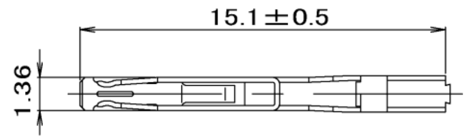
● Reference: Connectors and contact terminals recommended

The following specifications are recommended for customers who produce inverter connection cables.

At the inverter side: Connector (10320-52F0-008)
Sumitomo 3M Co., Ltd.

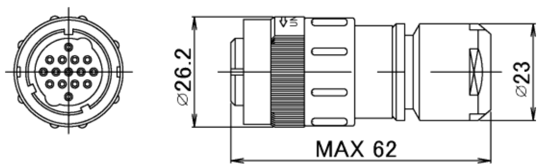


At the motor side: Connector contact terminal (JN1-22-22F-PKG100)
Japan Aviation Electronics Industry, Limited

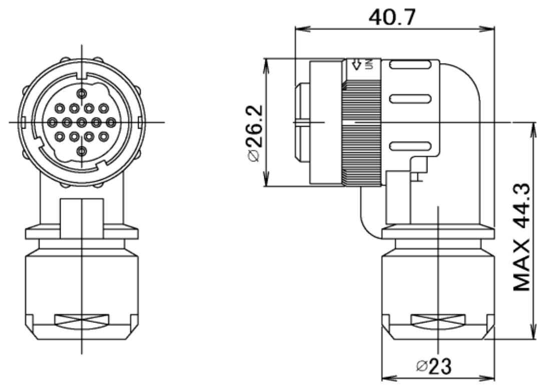


Max. applicable wire size:
AWG20 (Outer dia. of coated cable: φ1.5 mm or less)

At the motor side: Straight plug connector (JN2DW15SL)
Japan Aviation Electronics Industry, Limited



At the motor side: Angle plug connector (JN2FW15SL1)
Japan Aviation Electronics Industry, Limited



Note 1: The following specifications are recommended for PG shield layers.

Type	Braided, shielded wires (Twisted-pair cable (Outer dia.: Approx. φ10))
Number of cores	14 or more
Dia. of lead	0.2 to 0.3 mm^2
Outer dia. of coated cable	Max. φ1.5 mm

Note 2: The PKG in contact terminal models denotes that 100 terminals are packed in bulk.

Note 3: Joint with contact terminals should be presoldered.

2.5 Protective Functions

The table below lists the name of the protective functions, description, alarm codes on the LED monitor, and presence of alarm output at terminals [30A/B/C]. If an alarm code appears on the LED monitor, remove the cause of activation of the alarm function referring to Chapter 13 "TROUBLESHOOTING."

Name	Description	LED monitor displays	Related function code
Braking transistor broken	If a breakdown of the braking transistor is detected, this protective function stops the inverter output. (For models of 55 kW or below in 200 V class series and 160 kW or below in 400 V class series) If this alarm is detected, be sure to shut down the power on the primary side of the inverter.	dbA	H103
Braking resistor overheated	This function estimates the temperature of the braking resistor and stops the inverter output if the temperature exceeds the allowable value. It is necessary to configure Function codes E35 to E37 depending on the resistor (integrated or externally mounted).	dbH	E35 to E37
DC fuse blown	If a fuse in the main DC circuit blows due to a short circuit in the IGBT circuit, this protective function displays the error to prevent the secondary damage. The inverter could be broken, so immediately contact your Fuji Electric representative. (For models of 75 kW or above in 200 V class series and 90 kW or above in 400 V class series)	dCF	
Excessive positioning deviation	This function is activated when the positioning deviation between the command and the detected values exceeds "Setting of function code o18 (Excessive deviation value) x 10" in synchronous operation.	dO	o18
PG communications error	This function is activated if a PG communication error occurs when the 17-bit high resolution ABS interface (OPC-VG1-SPGT) is used.	EC	
Functional safety circuit failure *1	This function is activated when the input to either one of EN1 and EN2 is OFF for the duration exceeding 50 ms (which is regarded as a mismatch). The alarm state can be reset only by restarting the inverter.	ECF	
Ground fault	This function is activated when a ground fault is detected in the inverter output circuit. If the ground-fault current is large, the overcurrent protection may be activated. This protective function is to protect the inverter. For the sake of prevention of accidents such as human damage and fire, connect a separate earth-leakage protective relay or an earth-leakage circuit breaker (ELCB).	EF	H103
Memory error	This function is activated when a memory error such as a data write error occurs. **Note:** The inverter memory has a limited number of rewritable times (100,000 to 1,000,000 times). Saving data with the Save All function into the memory so many times will no longer allow the memory to save data, causing a memory error.	Er1	
Keypad communications error	This function is activated if a communications error occurs between the keypad and the inverter control circuit when the start/stop command given from the keypad is valid (Function code F02=0). **Note:** Even if a keypad communications error occurs when the inverter is being driven via the control circuit terminals or the communications link, the inverter continues running without displaying any alarm or issuing an alarm output (for any alarm).	Er2	F02
CPU error	This function is activated if a CPU error occurs.	Er3	
Network error	This function is activated: - if a communications error occurs due to noise when the inverter is being driven via the T-Link, SX-bus, E-SX bus, CC-Link or Field bus.	Er4	o30, o31, H107 E01 to E14 E15 to E28

*1 Available in the ROM version H1/2 0020 or later.

Name	Description	LED monitor displays	Related function code
RS-485 communications error	This function is activated if an RS-485 communications error occurs and is kept for the duration (0.1 to 60.0 sec.) specified by H38 when the inverter is being driven via the RS-485 interface and Function code H32 is set to any of "0" through "2."	Er-5	H32, H33, H38 H107
Operation error	This function is activated if: 1) Two or more network options are mounted, 2) The SW configuration is the same on two or more PG options (More than one PG option can be mounted.), 3) Auto tuning (Function code H01) is attempted when any of the digital input signals ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** is ON, or 4) Auto tuning is selected with Function code H01 but the FWD key on the keypad is not pressed within 20 seconds.	Er-6	H01
Output wiring fault	This function is activated if the wires in the inverter output circuit are not connected during auto-tuning.	Er-7	H01
A/D converter error	This function is activated if an error occurs in the A/D converter circuit.	Er-8	
Speed not agreed	This function is activated if the deviation between the speed command (reference speed) and the motor speed (detected or estimated speed) becomes excessive. The detection level and detection time can be specified with function codes.	Er-9	E43, E44, E45 H108, H149
UPAC error *1	This function is activated if the UPAC option causes a hardware failure or a communications error in communication with the inverter controller, or the backup battery runs out.	Er-A	
Inter-inverter communications link error	This function is activated if a communications error occurs in the inverter-to-inverter communications link using a high-speed serial communication terminal block (option).	Er-b	
Hardware error	This function is activated upon detection of an LSI failure on the printed circuit board.	Er-H	
Mock alarm	This can be caused with an external signal input (FTB), keypad operation or FRENIC-VG Loader.	Err	E01 to E14 H108, H142
PG failure	This function is activated if a PG data error or PG failure is detected when the 17-bit serial PG (OPC-VG1-SPGT) is used.	Et1	
Input phase loss	This function protects the inverter when an input phase loss is detected. If the connected load is light or a DC reactor is connected to the inverter, this function may not detect input phase loss if any.	Lin	E45
Start delay	This function is activated when the reference torque current exceeds the start delay detection level (H140) and the detected or estimated speed drops below the stop speed (F37) and then the low-speed state is kept for the specified duration (H141). The detection level and detection timer can be specified with function codes.	LoC	H108, H140, H141
Undervoltage	This function is activated when the DC link bus voltage drops below the undervoltage detection level (180 VDC for 200 V series, 360 VDC for 400 V series). Note that, if the restart mode after momentary power failure is selected (F14 = 3, 4 or 5), no alarm is output even if the DC link bus voltage drops.	LU	F14
NTC wire break error	This function is activated if the thermistor wire breaks when the NTC thermistor is selected with Function code P30/A31/A131 for motor M1/M2/M3. This function works even at extremely low temperatures (approx. -30°C or below).	nrb	P30, A31, A131 H106
Overcurrent	This function stops the inverter output if the output current to the motor exceeds the overcurrent level of the inverter. When the inverter is driving a PMSM, this function is activated if the output current to the motor exceeds the overcurrent protection level (P44, A64, A164).	OC	P44, A64, A164

*1 Available in the ROM version H1/2 0020 or later.

Name	Description	LED monitor displays	Related function code
Heat sink overheat	This function is activated if the temperature surrounding the heat sink (that cools down the rectifier diodes and the IGBTs) increases due to stopped cooling fans.	OH1	
External alarm	Assigning ***THR*** ("Enable external alarm trip") to a digital input terminal and operating the contact stops the inverter as an alarm. Connecting an alarm signal of external equipment such as a braking unit or braking resistor to the input terminal (to which the ***THR*** is assigned) operates the inverter according to the contact signal status.	OH2	E01 to E14, H106
Inverter internal overheat	This function is activated if the temperature surrounding the control printed circuit board increases due to poor ventilation inside the inverter.	OH3	
Motor overheat	This function is activated if the temperature detected by the NTC thermistor of a dedicated motor exceeds the motor overheat protection level (E30).	OH4	E30, H106
Motor 1 overload	This function is activated by the electronic thermal overload protection if the motor 1 current (inverter output current) exceeds the operation level specified by Function code F11.	OL1	F11, H106
Motor 2 overload	This function is activated by the electronic thermal overload protection if the motor 2 current (inverter output current) exceeds the operation level specified by Function code A33.	OL2	A33, H106
Motor 3 overload	This function is activated by the electronic thermal overload protection if the motor 3 current (inverter output current) exceeds the operation level specified by Function code A133.	OL3	A133, H106
Inverter overload	This function is activated if the output current exceeds the overload characteristic of the inverse time characteristic. It stops the inverter output depending upon the heat sink temperature and switching element temperature calculated from the output current.	OLU	F80
Output phase loss	This function detects a break in inverter output wiring during running and stops the inverter output. (Available under vector control for IM with speed sensor.)	OPL	H103, P01 A01, A101
Overspeed	This function Stops the inverter output if the detected speed is 120% or over of the maximum frequency. This function is activated if the motor speed (detected or estimated speed) exceeds 120% (adjustable with Function code H90) of the maximum speed (F03, A06, A106).	OS	H90
Overvoltage	This function is activated if the DC link bus voltage exceeds the overvoltage detection level (405 VDC for 200 V series, 820 VDC for 400 V series) due to an increase of supply voltage or regenerative braking current from the motor. Note that this function cannot protect the inverter if an excessive power (high voltage, for example) is connected mistakenly.	OU	
PG wire break	This function is activated if a wire breaks in the PA/PB signal lines or PGP/PGM power lines on the PG interface. It does not work under vector control without speed sensor or under V/f control. When the PG interface card (OPC-VG1-PG, OPC-VG1-PMPG) is used, this function is activated by a wire break in PG signal lines or wrong wiring.	PG	H104
Charger circuit fault	This function is activated if the bypass circuit of the DC link bus is not configured (that is, the magnetic contactor for bypass of the charging circuit is not closed) even after the main power is applied. (For models of 37 kW or above in 200 V class series and 75 kW or above in 400 V class series)	PbF	
DC fan locked	This function is activated if the DC fan is stopped. (For models of 45 kW or above in 200 V class series and 75 kW or above in 400 V class series)	dFA	H108

Name	Description	LED monitor displays	Related function code
E-SX bus tact synchronization error	This error occurs when the E-SX tact and inverter control cycle are out of synchronization with each other.	Ar-E	H108
Toggle abnormality error	The inverter monitors 2-bit signals of toggle signal 1 ***TGL1*** and toggle signal 2 ***TGL2*** which are sent from the PLC. When the inverter receives no prescribed change pattern within the time specified by H144, this error occurs.	Ar-F	H107
Functional safety card error *1	Protective function for the functional safety card. 📖 For details, refer to the Functional Safety Card instruction manual (INR-SI47-1541).	SiF Sr-F	
Light alarm (warning)	If an alarm or warning preset as a light alarm occurs, this function displays L-AL on the LED monitor. It also outputs the ***L-ALM*** signal onto the Y terminal (transistor output) if the signal is assigned to the terminal beforehand. Note that this function does not issue an alarm relay output ([30A], [30B], [30C]), so the inverter continues to run. <u>Light alarm objects (selectable)</u> Motor overheat (OH4), Motor overload (OL1 to OL3), NTC wire break error (nrb), External failure (OH2), RS-485 communications error (Er-5), Network error (Er-4), Toggle abnormality error (Ar-F), Mock alarm (Err), DC fan locked (dFA), Speed mismatch (Er-9), E-SX bus tact synchronization error (Ar-E), Motor overheat early warning (MOH), Motor overload early warning (MOL), Lifetime alarm (LiF), Heat sink overheat early warning (OH), Inverter overload early warning (OL), Battery life expired (bA), Start delay (LoC)	L-AL	H106 to H111
Surge protection	This function protects the inverter against surge voltages which might appear between one of the power lines, using surge absorbers connected to the main circuit power terminals (L1/R, L2/S, L3/T) and control power terminals (R0, T0).	-	
Main power shut down	This function monitors the AC input power to the inverter and judges whether the AC input power (main power) is established. When the main power is not established, whether to run the inverter or not can be selected. (When the power is supplied via a PWM converter or the DC link bus, there is no AC input. In this case, do not change the data of Function code H76 from the default (H76 = 0).	-	H76

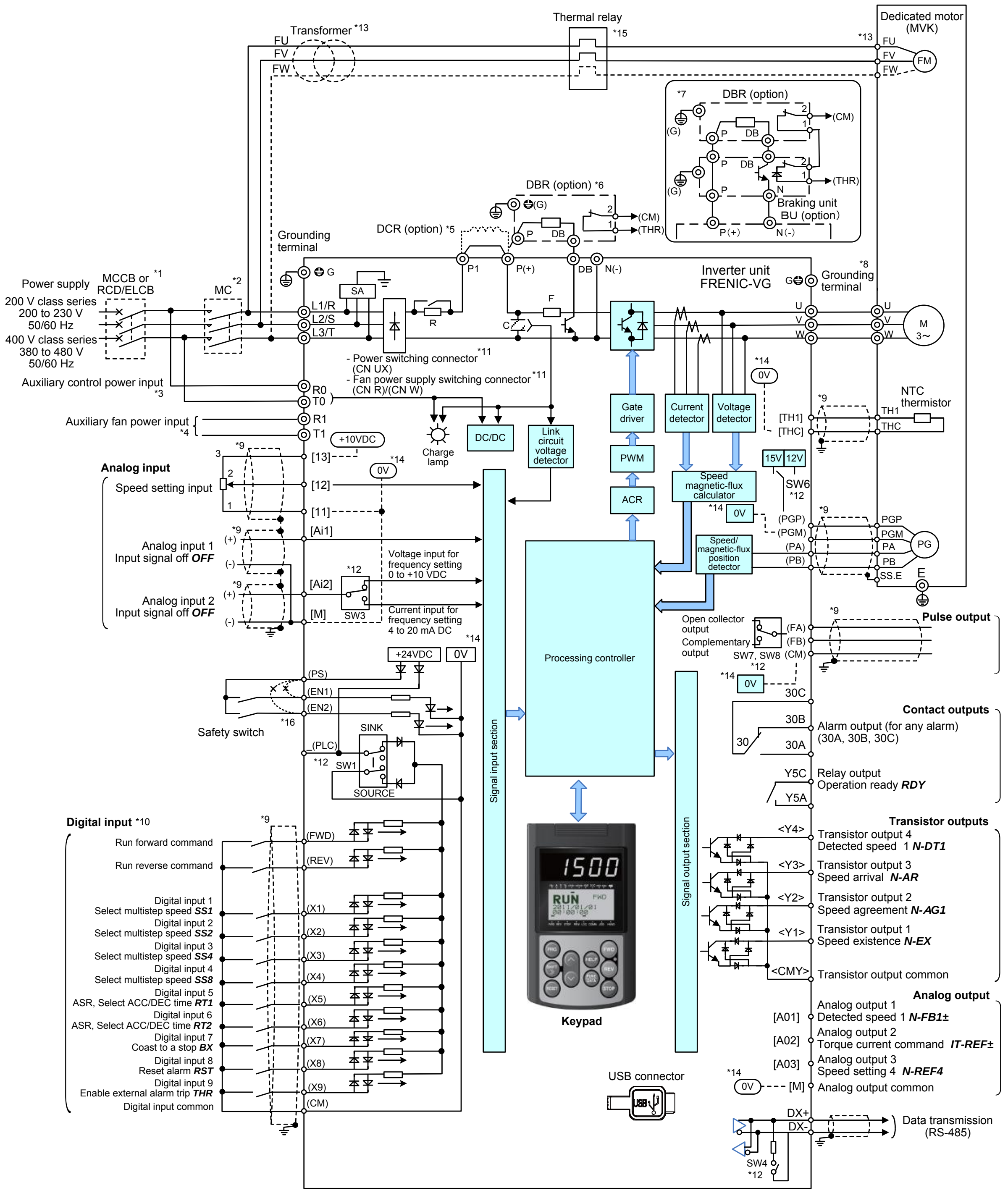
*1 Available in the ROM version H1/2 0020 or later.

Note
- All protective functions are automatically reset if the control power voltage decreases until the inverter control circuit no longer operates.
- The inverter retains the latest and the last 10 alarm codes and the latest and the last three pieces of alarm information..
- Stoppage due to a protective function can be reset by the RESET key on the keypad or turning OFF and then ON between the X terminal (to which ***RST*** is assigned) and the CM. This action is invalid if the cause of an alarm is not removed.
- The inverter cannot reset until the causes of all alarms are removed. (The causes of alarms not removed can be checked on the keypad.).

2.6 Connection Diagrams and Terminal Functions

2.6.1 Connection diagrams

2.6.1.1 Running the MVK type of an induction motor (dedicated motor)



(Note 1) Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

(Note 2) Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

(Note 3) To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

(Note 4) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

(Note 5) When connecting an optional DC reactor (DCR), remove the jumper bar from the main circuit terminals P1 and P(+).

Inverters of 75 kW or above and LD-mode inverters of 55 kW come with a DCR as standard. Be sure to connect the DCR.

Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

(Note 6) Inverters of 55 kW or below (200 V class series) and those of 160 kW or below (400 V class series) have a built-in braking transistor, allowing a braking resistor (DBR) to be directly connected between terminals P(+) and DB.

(Note 7) When connecting an optional braking resistor (DBR) to inverters of 75 kW or above (200 V class series) or those of 200 kW or above (400 V class series), be sure to use an optional braking unit (BU) together.

Connect the BU between terminals P(+) and N(-). Auxiliary terminals [1] and [2] have polarity, so make connection as shown in the connection diagram.

(Note 8) A grounding terminal for a motor. It is recommended that the motor be grounded via this terminal for suppressing inverter noise.

(Note 9) For wiring enclosed with [ ], use twisted or shielded wires.

In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to (0V) ([M], [11], [THC]) or [0V] ([CM], (PGM)) may be effective to suppress the influence of noise.

Keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

(Note 10) The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X9], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C].

(Note 11) Switching connectors in the main circuits. For details, refer to Chapter 3, Section 3.3.3.7 "Switching connectors."

(Note 12) Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."

(Note 13) The cooling fan power supply for motors of 7.5 kW or less is single-phase. Connect terminals [FU] and [FV].

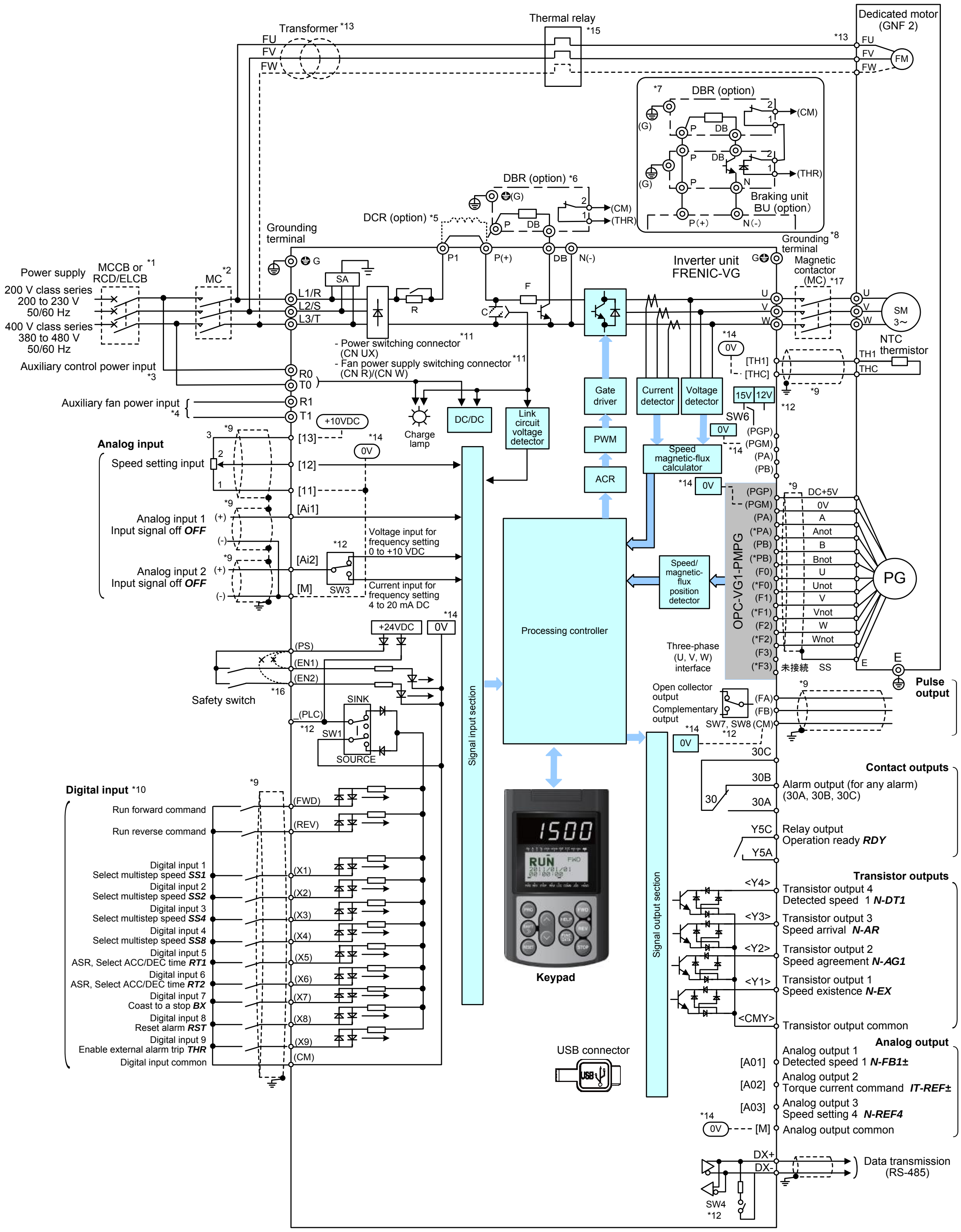
For motors of 7.5 kW or less (400 V class series), the power voltage/frequency rating of the cooling fan is 200 V/50 Hz or 200-230 V/60 Hz. For motors of 11 kW or above (400 V class series), it is 400-420 V/50 Hz or 400-440 V/60 Hz. To use the fan with power voltage other than the above specifications, a transformer is necessary.

(Note 14) (0V) ([M], [11], [THC]) and [0V] ([CM], (PGM)) are insulated inside the inverter unit.

(Note 15) Use the auxiliary contact (manual reset) of the thermal relay to trip the MCCB or MC.

(Note 16) Jumper bars are mounted between safety terminals [EN1]/[EN2] and [PS] by factory default. To use the safety function, remove the jumper bars before connection of safety devices.

2.6.1.2 Running the GNF2 type of a permanent magnet synchronous motor (dedicated motor)



(Note 1) Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

(Note 2) Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

(Note 3) To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

(Note 4) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

(Note 5) When connecting an optional DC reactor (DCR), remove the jumper bar from the main circuit terminals P1 and P(+).

Inverters of 75 kW or above and LD-mode inverters of 55 kW come with a DCR as standard. Be sure to connect the DCR.

Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

(Note 6) Inverters of 55 kW or below (200 V class series) and those of 160 kW or below (400 V class series) have a built-in braking transistor, allowing a braking resistor (DBR) to be directly connected between terminals P(+) and DB.

(Note 7) When connecting an optional braking resistor (DBR) to inverters of 75 kW or above (200 V class series) or those of 200 kW or above (400 V class series), be sure to use an optional braking unit (BU) together.

Connect the BU between terminals P(+) and N(-). Auxiliary terminals [1] and [2] have polarity, so make connection as shown in the connection diagram.

(Note 8) A grounding terminal for a motor. It is recommended that the motor be grounded via this terminal for suppressing inverter noise.

(Note 9) For wiring enclosed with , use twisted or shielded wires.

In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to 0V ([M], [11], [THC]) or 0V ([CM], (PGM)) may be effective to suppress the influence of noise.

Keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

(Note 10) The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X9], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C].

(Note 11) Switching connectors in the main circuits. For details, refer to Chapter 3, Section 3.3.3.7 "Switching connectors."

(Note 12) Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."

(Note 13) The cooling fan power supply for motors of 7.5 kW or less is single-phase. Connect terminals [FU] and [FV].

For motors of 7.5 kW or less (400 V class series), the power voltage/frequency rating of the cooling fan is 200 V/50 Hz or 200-230 V/60 Hz. For motors of 11 kW or above (400 V class series), it is 400-420 V/50 Hz or 400-440 V/60 Hz. To use the fan with power voltage other than the above specifications, a transformer is necessary.

(Note 14) 0V ([M], [11], [THC]) and 0V ([CM], (PGM)) are insulated inside the inverter unit.

(Note 15) Use the auxiliary contact (manual reset) of the thermal relay to trip the MCCB or MC.

(Note 16) Jumper bars are mounted between safety terminals [EN1]/[EN2] and [PS] by factory default. To use the safety function, remove the jumper bars before connection of safety devices.

(Note 17) If the activation of the inverter protective function may result in a high-speed motor rotation due to the load, be sure to insert an MC.

(Note 18) A single inverter cannot drive two or more PMSMs.

(Note 19) A PMSM (GNF2 type) cannot be driven by commercial power. Driving the PMSM may result in a motor burnout.

(Note 20) Driving a PMSM requires setting the inverter carrier frequency high in order to prevent permanent magnet overheat and demagnetization due to the output current harmonics (except Fuji GNF2 type). Be sure to check the allowable carrier frequency of the motor and determine the settings of the carrier frequency (F26) and automatic lowering of the carrier frequency (H104, Hundreds digit).

When canceling the automatic lowering of the carrier frequency, take care since it derates the continuous rated current of the inverter according to the carrier frequency setting (F26). (For the rated current derating, refer to Section 2.1.4.)

2.6.2 List of terminal functions

Main Circuit Terminals and Analog Input Terminals

Classification	Symbol	Name	Functions
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connect the three-phase input power lines.
	U, V, W	Inverter outputs	Connect a three-phase motor.
	P (+), P1	DC reactor connection	Connect a DC reactor (DCR) for correcting power factor. HD- and MD-mode inverters: A DCR is provided as an option for inverters of 55 kW or below, and as standard for those of 75 kW or above. LD-mode inverters: A DCR is provided as an option for inverters of 45 kW or below, and as standard for those of 55 kW or above.
	P (+), N (-)	Braking unit connection	Connect a braking resistor (DBR) via a braking unit. For connection to the DC link bus.
	P (+), DB	External braking resistor connection	Connect an optional external braking resistor.
	⏚ G	Grounding for inverter	Grounding terminals of the inverter.
	R0, T0	Auxiliary power input for the control circuit	For a backup of the control circuit power supply, connect AC power lines same as that of the main power input.
	R1, T1	Auxiliary power input for the fans	For use in combination with a power regenerative PWM converter (RHC series), use these terminals for an auxiliary power input of the AC fans inside the inverter. (For 200 V class series of inverters with 37 kW or above and 400 V class series with 75 kW or above) Normally, no need to use these terminals.
Speed setting	[13]	Power supply for the potentiometer	Power supply (+10 VDC, 10 mA max.) for a speed command potentiometer (Variable resistor: 1 to 5kΩ).
	[12]	Setting voltage input	The speed is commanded according to the external analog voltage input. Reversed operation with ± signals: 0 to ±10V DC/0 to maximum speed
	[11]	Analog input common	Common for analog input signals.
Analog input	[Ai1]	Analog input 1	Selectable from the following functions to assign. Possible to make setting according to analog input voltage specified from the external equipment. 0: Input signal off (***OFF***) 1: Auxiliary speed setting 1 (***AUX-N1***) 2: Auxiliary speed setting 2 (***AUX-N2***) 3: Torque limiter (level 1) (***TL-REF1***) 4: Torque limiter (level 2) (***TL-REF2***) 5: Torque bias command (***TB-REF***) 6: Torque command (***T-REF***) 7: Torque current command (***IT-REF***) 8: Creep speed 1 under UP/DOWN control (***CRP-N1***) 9: Creep speed 2 under UP/DOWN control (***CRP-N2***) 10: Magnetic-flux reference (***MF-REF***) 11: Line speed detected (***LINE-N***) 12: Motor temperature (***M-TMP***) 13: Speed override (***N-OR***) 14: Universal Ai (***U-AI***) 15: PID feedback value 1 (***PID-FB1***) 16: PID command (***PID-REF***) 17: PID correction gain (***PID-G***) 18-24: Custom Ai1 to 7 (***C-AI 1 to 7***) 25: Main speed reference (***N-REFV***) 26: Current input speed reference (***N-REFC***) 27: PID feedback value 2 (***PID-FB2***) * Ai2 is switchable between voltage input and current input by using the internal switch. Note that current input supports "speed setting" only.
	[Ai2]	Analog input 2	
	[M]	Analog input common	Common for analog input signals.

Digital Input Terminals

Classifi-cation	Symbol	Name	Functions
Digital input (Sink/source switchable)	[FWD]	Run forward command Stop command	FWD-CM: ON Run the motor in the forward direction. FWD-CM: OFF Decelerate the motor to stop.
	[REV]	Run reverse command Stop command	REV-CM: ON Run the motor in the reverse direction. REV-CM: OFF Decelerate the motor to stop.
	[X1] [X2] [X3] [X4] [X5] [X6] [X7] [X8] [X9]	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5 Digital input 6 Digital input 7 Digital input 8 Digital input 9	00, 01, 02, 03: Select multistep speed (1 to 15 steps) (00: ***SS1***, 01: ***SS2***, 02: ***SS4***, 03: ***SS8***) 04, 05: Select ASR and ACC/DEC time (4 steps) (04: ***RT1***, 05: ***RT2***) 06: Enable 3-wire operation (***HLD***) 07: Coast to a stop (***BX***) 08: Reset alarm (***RST***) 09: Enable external alarm trip (***THR***) 10: Ready for jogging (***JOG***) 11: Select speed command N2/N1 (***N2/N1***) 12: Select motor 2 (***M-CH2***) 13: Select motor 3 (***M-CH3***) 14: Enable DC braking (***DCBRK***) 15: Clear ACC/DEC to zero (***CLR***) 16: Switch creep speed under UP/DOWN control (***CRP-N2/N1***) 17: UP (Increase speed under UP/DOWN control) (***UP***) 18: DOWN (Decrease speed under UP/DOWN control) (***DOWN***) 19: Enable data change with keypad (***WE-KP***) 20: Cancel PID control (***KP/PID***) 21: Switch normal/inverse operation (***IVS***) 22: Interlock (52-2) (***IL***) 23: Enable data change via communications link (***WE-LK***) 24: Enable communications link (***LE***) 25: Universal DI (***U-DI***) 26: Enable auto search for idling motor speed at starting (***STM***) 27: Synchronous operation command (***SYC***) 28: Lock at zero speed (***LOCK***) 29: Pre-excitation (***EXITE***) 30: Cancel speed limiter (***N-LIM***) 31: Cancel H41 (Torque command) (***H41-CCL***) 32: Cancel H42 (Torque current command) (***H42-CCL***) 33: Cancel H43 (Magnetic flux command) (***H43-CCL***) 34: Cancel F40 (Torque limiter mode 1) (***F40-CCL***) 35: Select torque limiter level 2/1 (***TL2/TL1***) 36: Bypass ACC/DEC processor (***BPS***) 37, 38: Select torque bias command 1/2 (37: ***TB1***, 38: ***TB2***) 39: Select droop control (***DROOP***) 40: Zero-hold Ai1 (***ZH-AI1***) 41: Zero-hold Ai2 (***ZH-AI2***) 42: Zero-hold Ai3 (***ZH-AI3***) 43: Zero-hold Ai4 (***ZH-AI4***) 44: Reverse Ai1 polarity (***REV-AI1***) 45: Reverse Ai2 polarity (***REV-AI2***) 46: Reverse Ai3 polarity (***REV-AI3***) 47: Reverse Ai4 polarity (***REV-AI4***) 48: Inverse PID output (***PID-INV***) 49: Cancel PG alarm (***PG-CCL***) 50: Cancel undervoltage alarm (***LU-CCL***) 51: Hold Ai torque bias (***H-TB***) 52: STOP1 (Decelerate to stop with normal deceleration time) (***STOP1***) 53: STOP2 (Decelerate to stop with deceleration time 4) (***STOP2***) 54: STOP3 (Decelerate to stop with max. braking torque) (***STOP3***) 55: Latch DIA data (***DIA***) 56: Latch DIB data (***DIB***) 57: Cancel multiplex system (***MT-CCL***) 58-67: Custom Di1-Di10 (***C-DI1*** to ***C-DI10***) 68: Select load adaptive parameters 2/1 (***AN-P1/2***) *1 69: Cancel PID components (***PID-CCL***) 70: Enable PID FF component (***PID-FF***) 71: Reset completion of speed limit calculation (***NL-RST***) *1 72: Toggle signal 1 (***TGL1***) 73: Toggle signal 2 (***TGL2***) 74: Cause external mock alarm (***FTB***) 75: Cancel NTC thermistor alarm (***NTC-CCL***) 76: Cancel lifetime alarm signal (***LF-CCL***) 78: Switch PID feedback signals (***PID-1/2***) 79: Select PID torque bias (***TB-PID***)
	[PLC]	PLC signal power	Connect the PLC output signal power supply. This terminal also supplies power to the load connected to the transistor output terminals. +24 V (22 to 27 V), 100 mA max.
	[CM]	Digital input common	Common terminal for digital input signals.

*1 Available soon

Classification	Symbol	Name	Functions
Digital input (Safety function)	[EN1], [EN2]	Safety function input terminals	Opening the circuit between [EN1] and [PS] or [EN2] and [PS] turns off the switching element of the inverter main circuit, shutting down output.
	[PS]		

Analog Output Terminals and Transistor Output Terminals

Classification	Symbol	Name	Functions
Analog output	[Ao1]	Analog output 1	Selectable from the following functions to assign. Possible to output monitor signals of 0 to ±10 VDC. 00: Detected speed (Speedometer, one-way deflection) (***N-FB1+***) 01: Detected speed (Speedometer, two-way deflection) (***N-FB1±***) 02: Speed setting 2 (Before acceleration/deceleration calculation) (***N-REF2***) 03: Speed setting 4 (ASR input) (***N-REF4***) 04: Detected speed (***N-FB2±***) 05: Detected line speed (***LINE-N±***) 06: Torque current command (Torque ammeter, two-way deflection) (***IT-REF±***) 07: Torque current command (Torque ammeter, one-way deflection) (***IT-REF+***) 08: Torque command (Torque meter, two-way deflection) (***T-REF±***) 09: Torque command (Torque meter, one-way deflection) (***T-REF+***) 10: Motor current rms value (***I-AC***) 11: Motor voltage rms value (***V-AC***) 12: Input power (***PWR***) 13: DC link circuit voltage (***V-DC***) 14: +10V output test (***P10***) 15: -10V output test (***N10***) 30: Universal AO (***U-AO***) 31-37: Custom Ao1 to Ao7 (***C-AO1*** to ***C-AO7***) 38: Input power (***PWR-IN***) 39: Magnetic pole position signal (***SMP***) 40: PID output value (***PID-OUT***)
	[Ao2]	Analog output 2	
	[Ao3]	Analog output 3	
	[M]	Analog output common	Common terminal for analog output signals.
Transistor output	[Y1]	Transistor output 1	Possible to output a signal selected from the following functions. 00: Inverter running (***RUN***) 01: Speed existence (***N-EX***) 02: Speed agreement (***N-AG1***) 03: Speed arrival signal (***N-AR***) 04, 05, 06: Detected speed 1/2/3 (04: ***N-DT1***, 05: ***N-DT2***, 06: ***N-DT3***) 07: Undervoltage detected (Inverter stopped) (***LU***) 08: Torque polarity detected (***B/D***) 09: Torque limiting (***TL***) 10, 11: Detected torque 1/2 (10: ***T-DT1***, 11: ***T-DT2***) 12: Keypad operation enabled (***KP***) 13: Inverter stopped (***STOP***) 14: Inverter ready to run (***RDY***) 15: Magnetic-flux detected (***MF-DT***) 16: Motor M2 selected (***SW-M2***) 17: Motor M3 selected (***SW-M3***) 18: Brake release signal (***BRK***) 19: Alarm content 1 (***AL1***) 20: Alarm content 2 (***AL2***) 21: Alarm content 3 (***AL4***) 22: Alarm content 4 (***AL8***) 23: Cooling fan in operation (***FAN***) 24: Resetting (***TRY***) 25: Universal DO (***U-DO***) 26: Heat sink overheat early warning (***INV-OH***) 27: Synchronization completion signal (***SY-C***) 28: Lifetime alarm (***LIFE***) 29: Under acceleration (***U-ACC***) 30: Under deceleration (***U-DEC***) 31: Inverter overload early warring (***INV-OL***) 32: Motor overheat early warring (***M-OH***) 33: Motor overload early warring (***M-OL***) 34: DB overload early warring (***DB-OL***) 35: Link transmission error (***LK-ERR***) 36: In limiting under load adaptive control (***ANL***) 37: In calculation under load adaptive control (***ANC***) 38: Analog torque bias being held (***TBH***) 39-48: Custom Do1-Do10 (***C-DO1*** to ***C-DO10***) 51: Multiplex system communications link being established (***MTS***) 52: Answerback to cancellation of multiplex system (***MEC-AB***) 53: Multiplex system master selected (***MSS***) 54: Multiplex system local station failure (***AL-SF***) 55: Stopped due to communications link error (***LES***) 56: Alarm output (for any alarm) (***ALM***) 57: Light alarm (***L-ALM***) 58: Maintenance timer (***MNT***) 59: Braking transistor broken (***DBAL***) 60: DC fan locked (***DCFL***)
	[Y2]	Transistor output 2	
	[Y3]	Transistor output 3	
	[Y4]	Transistor output 4	

*1 Available soon

Classification	Symbol	Name	Functions
Transistor output	[Y4]	Transistor output 4	61: Speed agreement 2 (***N-AG2***) 62: Speed agreement 3 (***N-AG3***) 63: Axial fan stopped (***MFAN***) 64: Answerback to toggle signal 1 (***TGL1-AB***) 65: Answerback to toggle signal 2 (***TGL2-AB***) 66: Answerback to droop control enabled (***DSAB***) 67: Answerback to cancellation of torque command/torque current command (***TCL-C)*** 68: Answerback to cancellation of torque limiter mode 1 (***F40-AB***) 71: 73 ON command (***PRT-73***) 72: Turn ON Y-terminal test output (***Y-ON***) 73: Turn OFF Y-terminal test output (***Y-OFF***) 75: System clock battery lifetime expired (***BATT***) 77: SPGT battery warning (***SPGT-B***) (Available soon) 80: EN terminal detection circuit failure (***DECF***) ***1** 81: EN terminal OFF (***ENOFF***) ***1** 82: Safety function in progress (***SF-RUN***) ***1** 84: STO under testing by safety function (***SF-TST***) ***1**
	[CMY]	Transistor output common	Common terminal for transistor output signals.
Relay output	[Y5A], [Y5C]	Relay output	Same signals as listed in [Y1] to [Y4] are selectable.
	[30A], [30B], [30C]	Alarm relay output	Outputs a no-voltage contact signal (1C) when the protective function has been activated to stop the motor. Switchable whether excitation or non-excitation outputs an alarm.
Communication	[DX+], [DX-]	RS-485 communication input/output	Input/output terminals for RS-485 communication. Multi-drop connection enables up to 31 inverters to connect to one host equipment. Half-duplex mode.
	USB connector	USB port	Accessible from the front of the inverter. USB connector: mini B, USB 2.0 Full Speed
Speed detection	[PA], [PB]	Pulse generator 2-phase signal input	Connection of 2-phase signals sent from a pulse generator.
	[PGP], [PGM]	Pulse generator power supply	Power supply (+15 VDC, switchable to +12 VDC) to a PG.
	[FA], [FB]	Pulse generator output	Outputs frequency-divided (programmable with Function code E29) pulse generator signals. Switchable between open collector and complementary (equivalent to the voltage on the [PGP] terminal) transistor outputs.
	[CM]	Pulse generator output common	A common terminal for [FA] and [FB].
Temperature detection	[TH1], [THC]	NTC/PTC thermistor connection	Monitor of the motor temperature with NTC or PTC thermistor. For a PTC thermistor, the motor overheat protection level can be specified with Function code E32.

*1 Available in the ROM version H1/2 0020 or later.

Chapter 3
PREPARATION AND TEST RUN

This chapter describes the operating and storage environments, installation and wiring, typical connection diagram, names and functions of keypad components, keypad operation, and test run procedure.

Contents

3.1 Before Use

3.1.1 Acceptance inspection (Nameplates and type of inverter)

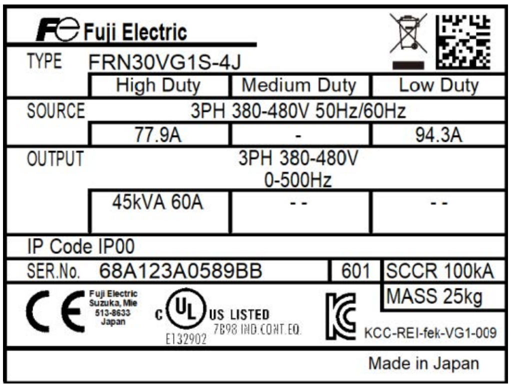
Unpack the package and check the following:

(1) An inverter and the following accessories are contained.

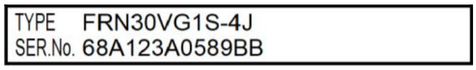
Accessories - DC reactor (DCR)
(for inverters of 75 kW or above and LD-mode inverters of 55 kW)
- Instruction manual
- CD-ROM (containing the FRENIC-VG User's Manual, FRENIC-VG Loader software (free version), and FRENIC-VG Loader Instruction Manual)

(2) The inverter has not been damaged during transportation—there should be no dents or parts missing.

(3) The inverter is the type you ordered. You can check the type and specifications on the main and sub nameplates. (The main and sub nameplates are attached to the inverter as shown in Figure 3.1-2.) For inverters of 30 kW or above, the mass is printed on the main nameplate.



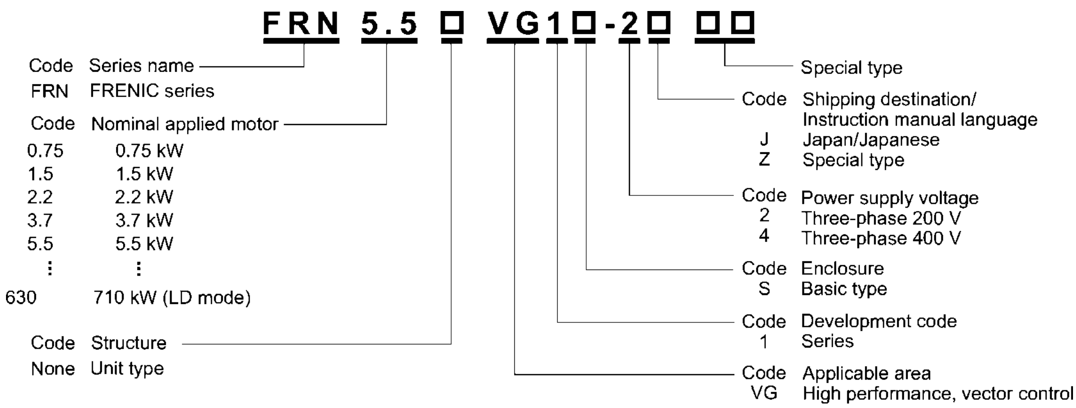
(a) Main Nameplate



(b) Sub Nameplate

Figure 3.1-1 Nameplates

TYPE: Type of inverter



Note In this manual, inverter types are denoted as "FRN_ _ _VG1□-2□/4□."

The FRENIC-VG is available in two or three drive modes depending upon the inverter capacity: High Duty (HD) and Low Duty (LD) modes or High Duty (HD), Medium Duty (MD) and Low Duty (LD) modes. One of these modes should be selected to match the load property of your system. Specifications in each mode are printed on the main nameplate.

High Duty: HD mode designed for heavy duty load applications.
Overload capability: 150% for 1 min, 200% for 3 s. Continuous ratings = Inverter ratings

Medium Duty: MD mode designed for medium duty load applications.
Overload capability: 150% for 1 min. Continuous ratings = One rank higher capacity of inverters

Low Duty: LD mode designed for light duty load applications.
Overload capability: 120% for 1 min. Continuous ratings = One rank or two ranks higher capacity of inverters

SOURCE: Number of input phases (three-phase: 3PH), input voltage, input frequency, input current

OUTPUT: Number of output phases, rated output voltage, output frequency range, rated output capacity, rated output current, and overload capability

SCCR: Short-circuit capacity

MASS: Mass of the inverter in kilogram (for 30 kW or above)

SER. No.: Product number

6 8 A 1 2 3 A 0 5 8 9 BB 6 0 1

- 0 1 — Production week : The 1st week in January is defined as ”01” and the following weeks keep counting up.
- 6 — Production year: Last digit of year
- BB — Production version *

: Mark of conformity with European standards
: Mark of conformity with UL Standards and CSA Standards (cUL-listed for Canada)
: Mark of conformity with the Radio Waves Act (South Korea)
: Mark of conformity with WEEE Directive

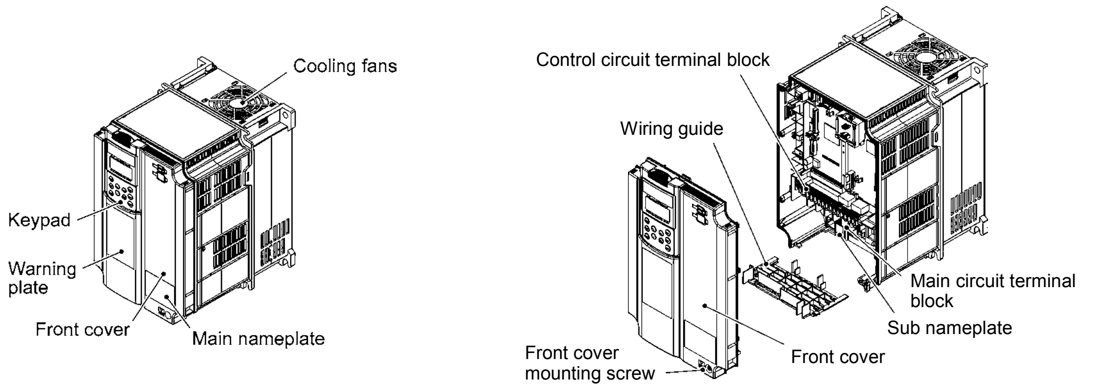
For details about conformity with standards, refer to the FRENIC-VG Instruction Manual (INR-SI47-1580*-E).

* Only product version other than “AA” and “AB” support functional safety standards.

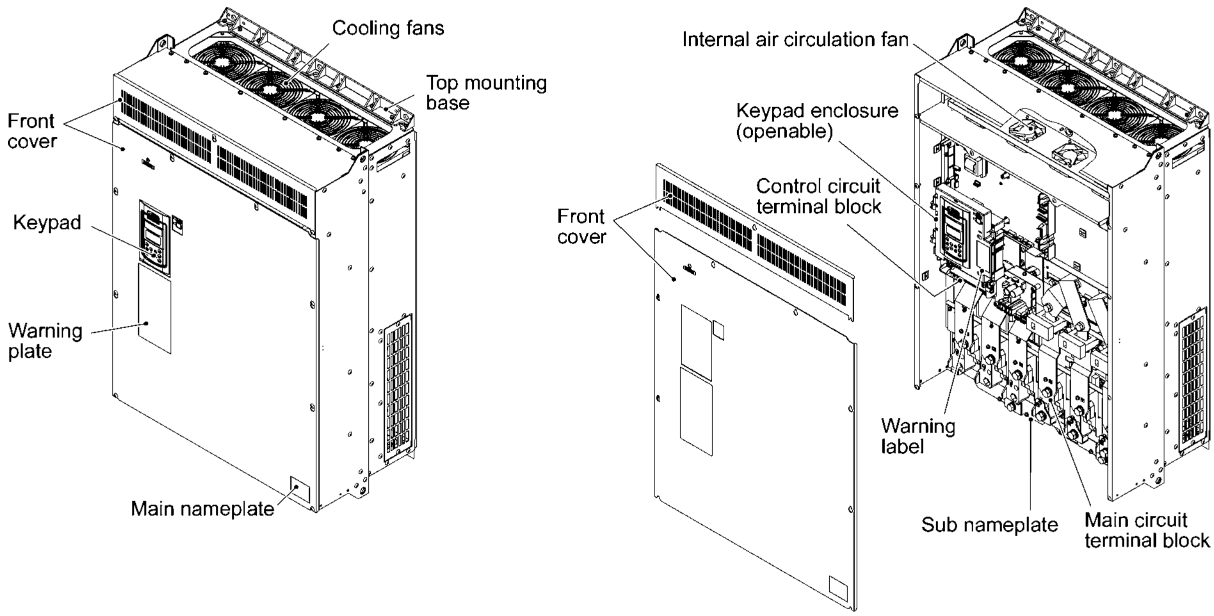
If you suspect the product is not working properly or if you have any questions about your product, contact your Fuji Electric representative.

3.1.2 External view and terminal blocks

(1) Outside and inside views



(a) FRN7.5VG1□-2□



(b) FRN220VG1□-4□

Figure 3.1-2 Outside and Inside Views of Inverters

(2) Warning plates and label

(a) FRN7.5VG1□-2□

(b) FRN220VG1□-4□

Figure 3.1-3 Warning Plates and Label

3.2 Precautions for Using Inverters

This section provides precautions in introducing inverters, e.g. precautions for installation environment, power supply lines, wiring, and connection to peripheral equipment. Be sure to observe those precautions.

3.2.1 Installation environment

Install the inverter in an environment that satisfies the requirements listed in Chapter 2, Section 2.2 "Common Specifications."

Fuji Electric strongly recommends installing inverters in a panel for safety reasons, in particular, when installing the ones whose enclosure rating is IP00.

When installing the inverter in a place out of the specified environmental requirements, it is necessary to derate the inverter or consider the panel engineering design suitable for the special environment or the panel installation location. For details, refer to the Fuji Electric technical information "Engineering Design of Panels" or consult your Fuji Electric representative.

The special environments listed below require using the specially designed panel or considering the panel installation location.

Environments	Possible problems	Sample measures	Applications
Highly concentrated sulfidizing gas or other corrosive gases	Corrosive gases cause parts inside the inverter to corrode, resulting in an inverter malfunction.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel with IP6X or air-purge mechanism. - Place the panel in a room free from influence of the gases.	Paper manufacturing, sewage disposal, sludge treatment, tire manufacturing, gypsum manufacturing, metal processing, and a particular process in textile factories.
A lot of conductive dust or foreign material (e.g., metal powders or shavings, carbon fibers, or carbon dust)	Entry of conductive dust into the inverter causes a short circuit.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel. - Place the panel in a room free from influence of the conductive dust.	Wiredrawing machines, metal processing, extruding machines, printing presses, combustors, and industrial waste treatment.
A lot of fibrous or paper dust	Fibrous or paper dust accumulated on the heat sink lowers the cooing effect. Entry of dust into the inverter causes the electronic circuitry to malfunction.	Any of the following measures may be necessary. - Mount the inverter in a sealed panel that shuts out dust. - Ensure a maintenance space for periodical cleaning of the heat sink in panel engineering design. - Employ external cooling when mounting the inverter in a panel for easy maintenance and perform periodical maintenance.	Textile manufacturing and paper manufacturing.
High humidity or dew condensation	In an environment where a humidifier is used or where the air conditioner is not equipped with a dehumidifier, high humidity or dew condensation results, which causes a short-circuiting or malfunction of electronic circuitry inside the inverter.	- Put a heating module such as a space heater in the panel.	Outdoor installation. Film manufacturing line, pumps and food processing.
Vibration or shock exceeding the specified level	If a large vibration or shock exceeding the specified level is applied to the inverter, for example, due to a carrier running on seam joints of rails or blasting at a construction site, the inverter structure gets damaged.	- Insert shock-absorbing materials between the mounting base of the inverter and the panel for safe mounting.	Installation of an inverter panel on a carrier or self-propelled machine. Ventilating fan at a construction site or a press machine.
Fumigation for export packaging	Halogen compounds such as methyl bromide used in fumigation corrodes some parts inside the inverter.	- When exporting an inverter built in a panel or equipment, pack them in a previously fumigated wooden crate. - When packing an inverter alone for export, use a laminated veneer lumber (LVL).	Exporting.

3.2.2 Storage environment

The storage environment in which the inverter should be stored after purchase differs from the installation environment. Store the inverter in an environment that satisfies the requirements listed below.

[1] Temporary storage

Table 3.2-1 Storage and Transport Environments

Item	Specifications	
Storage temperature *1	-25 to +70°C	Places not subjected to abrupt temperature changes or condensation or freezing
Relative humidity	5 to 95% *2	
Atmosphere	The inverter must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. The atmosphere must contain only a low level of salt. (0.01 mg/cm^2 or less per year)	
Atmospheric pressure	86 to 106 kPa (during storage)	
	70 to 106 kPa (during transportation)	

***1** Assuming comparatively short time storage, e.g., during transportation or the like.

***2** Even if the humidity is within the specified requirements, avoid such places where the inverter will be subjected to sudden changes in temperature that will cause condensation to form.

Precautions for temporary storage

(1) Do not leave the inverter directly on the floor.

(2) If the environment does not satisfy the specified requirements listed in Table 3.2-1, wrap the inverter in an airtight vinyl sheet or the like for storage.

(3) If the inverter is to be stored in a high-humidity environment, put a drying agent (such as silica gel) in the airtight package described in (2) above.

[2] Long-term storage

The long-term storage method of the inverter varies largely according to the environment of the storage site. General storage methods are described below.

(1) The storage site must satisfy the requirements specified for temporary storage.

However, for storage exceeding three months, the surrounding temperature range should be within the range from -10 to 30°C. This is to prevent electrolytic capacitors in the inverter from deterioration.

(2) The package must be airtight to protect the inverter from moisture. Add a drying agent inside the package to maintain the relative humidity inside the package within 70%.

(3) If the inverter has been installed to the equipment or panel at construction sites where it may be subjected to humidity, dust or dirt, then temporarily remove the inverter and store it in the environment specified in Table 3.2-1.

Precautions for storage over 1 year

If the inverter has not been powered on for a long time, the property of the electrolytic capacitors may deteriorate. Power the inverters on once a year and keep the inverters powering on for 30 to 60 minutes. Do not connect the inverters to the load circuit (secondary side) or run the inverter.

3.2.3 Wiring precautions

(1) Route the wiring of the control circuit terminals as far from the wiring of the main circuit as possible. Otherwise electric noise may cause malfunctions.

(2) Fix the control circuit wires inside the inverter to keep them away from the live parts of the main circuit (such as the terminal block of the main circuit).

(3) If more than one motor is to be connected to a single inverter, the wiring length should be the sum of the length of the wires to the motors.

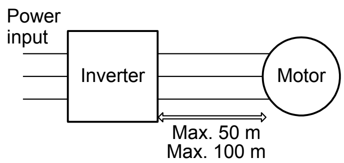
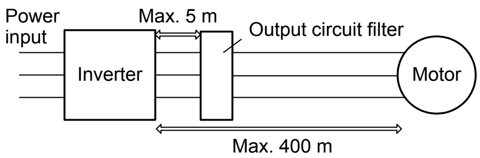
(4) Precautions for high frequency leakage currents

If the wiring distance between an inverter and a motor is long, high frequency currents flowing through stray capacitance across wires of phases may cause an inverter overheat, overcurrent trip, increase of leakage current, or it may not assure the accuracy in measuring leakage current. Depending on the operating condition, an excessive leakage current may damage the inverter.

To avoid the above problems when directly connecting an inverter to a motor, keep the wiring distance 50 m or less for inverters with a capacity of 3.7 kW or below, and 100 m or less for inverters with a higher capacity.

If the wiring distance longer than the specified above is required, lower the carrier frequency or insert an output circuit filter (OFL-□□□-□A) as shown below.

When a single inverter drives two or more motors connected in parallel (group drive), in particular, using shielded wires, the stray capacitance to the earth is large, so lower the carrier frequency or insert an output circuit filter (OFL-□□□-□A).

No output circuit filter installed	Output circuit filter installed
	

Note
- If the drive motor is equipped with a pulse generator (PG) and the wiring distance exceeds 100 m, inserting an isolated signal conditioner in the PG wiring or any other measure is required. (For recommended isolated signal conditioners and the connection method, refer to Chapter 8, Section 8.7 "PG Amplifier (Isolated signal conditioner).")
- If further longer secondary wiring is required, consult your Fuji Electric representative.

(5) Precautions for surge voltage in driving a motor by an inverter (especially for 400 V class motors)

If the motor is driven by a PWM-type inverter, surge voltage generated by switching the inverter component may be superimposed on the output voltage and may be applied to the motor terminals. Particularly if the wiring length is long, the surge voltage may deteriorate the insulation resistance of the motor. Implement any of the following measures.

- Use a motor with insulation that withstands the surge voltage. (All Fuji standard motors feature reinforced insulation.)
- Connect a surge suppressor unit (SSU50/100TA-NS) at the motor terminal.
- Connect an output circuit filter (OFL-□□□-□A) to the output terminals (secondary circuits) of the inverter.
- Minimize the wiring length between the inverter and motor (10 to 20 m or less).

(6) When an output circuit filter is inserted in the secondary circuit or the wiring between the inverter and the motor is long, a voltage loss occurs due to reactance of the filter or wiring so that the insufficient voltage may cause output current oscillation or a lack of motor output torque.

3.2.4 Precautions for connection of peripheral equipment

(1) Phase-advancing capacitors for power factor correction

Do not mount a phase-advancing capacitor for power factor correction in the inverter's input (primary) or output (secondary) circuit. Mounting it in the input (primary) circuit takes no effect. To correct the inverter power factor, use an optional DC reactor (DCR). Mounting it in the output (secondary) circuit causes an overcurrent trip, disabling operation.

An overvoltage trip that occurs when the inverter is stopped or running with a light load is assumed to be due to surge current generated by open/close of phase-advancing capacitors in the power system. An optional DC/AC reactor (DCR/ACR) is recommended as a measure to be taken at the inverter side.

Input current to an inverter contains a harmonic component that may affect other motors and phase-advancing capacitors on the same power supply line. If the harmonic component causes any problems, connect an optional DCR/ACR to the inverter. In some cases, it is necessary to insert a reactor in series with the phase-advancing capacitors.

(2) Power supply lines (Application of a DC/AC reactor)

Use an optional DC reactor (DCR) when the capacity of the power supply transformer is 500 kVA or more and is 10 times or more the inverter rated capacity or when there are thyristor-driven loads. If no DCR is used, the percentage-reactance of the power supply decreases, and harmonic components and their peak levels increase. These factors may break rectifiers or capacitors in the converter section of the inverter, or decrease the capacitance of the capacitors.

If the input voltage unbalance rate is 2% to 3%, use an optional DCR/ACR.

$$\text{Voltage unbalance (\%)} = \frac{\text{Max voltage (V)} - \text{Min voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$

(3) Optional DCR for correcting the inverter input power factor (for suppressing harmonics)

To correct the inverter input power factor (to suppress harmonics), use an optional DCR. Using a DCR increases the reactance of inverter’s power source so as to decrease harmonic components on the power source lines and correct the power factor of the inverter.

DCR models	Input power factor	Remarks
DCR2/4-□□/□□A/□□B	Approx. 90% to 95%	The last letter identifies the capacitance. These DCR models comply with "Standard Specifications for Public Building Construction" (Electric Equipment, 2010 version) supervised by the Ministry of Land, Infrastructure, Transport and Tourism. (The input power factor is 94% or above when the power factor of the fundamental harmonic is assumed as "1" according to the 2010 version.)
DCR2/4-□□C	Approx. 86% to 90%	Exclusively designed for nominal applied motor of 37 kW or above.

Note

- Select a DCR matching not the inverter capacity but the nominal applied motor capacity. Applicable reactor models differ depending upon the selected HD, MD, or LD mode even on the same type of inverters.
- Inverters of 75 kW or above and LD-mode inverters of 55 kW are provided together with a DCR as standard. Be sure to connect the DCR to the inverter.

(4) PWM converter for correcting the inverter input power factor

Using a PWM converter (High power-factor, regenerative PWM converter, RHC series) corrects the inverter power factor up to nearly "1." When combining an inverter with a PWM converter, disable the main power down detection by setting the function code H76 to "0" (default). If the main power down detection is enabled (H76 = 1), the inverter interprets the main power as being shut down, ignoring an entry of a run command.

(5) Molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB)

Install a recommended MCCB or RCD/ELCB (with overcurrent protection) in the primary circuit of the inverter to protect the wiring. Since using an MCCB or RCD/ELCB with a lager capacity than recommended ones breaks the protective coordination of the power supply system, be sure to select recommended ones. Also select ones with short-circuit breaking capacity suitable for the power source impedance.

Molded Case Circuit Breaker (MCCB) and
Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (kW)</th><th rowspan="2">Inverter type</th><th rowspan="2">HD/MD/LD mode</th><th colspan="2">Rated current of MCCB and RCD/ELCB (A)</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="22">Three-phase 200 V</td><td>0.75</td><td>FRN0.75VG1□-2□</td><td>HD</td><td>5</td><td>10</td></tr>
<tr><td>1.5</td><td>FRN1.5VG1□-2□</td><td>HD</td><td rowspan="2">10</td><td>15</td></tr>
<tr><td>2.2</td><td>FRN2.2VG1□-2□</td><td>HD</td><td>20</td></tr>
<tr><td>3.7</td><td>FRN3.7VG1□-2□</td><td>HD</td><td>20</td><td>30</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-2□</td><td>HD</td><td>30</td><td>50</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-2□</td><td>HD</td><td>40</td><td>75</td></tr>
<tr><td>11</td><td>FRN11VG1□-2□</td><td>HD</td><td>50</td><td>100</td></tr>
<tr><td>15</td><td>FRN15VG1□-2□</td><td>HD</td><td>75</td><td>125</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-2□</td><td>HD</td><td rowspan="2">100</td><td>150</td></tr>
<tr><td>22</td><td>FRN22VG1□-2□</td><td>HD</td><td>175</td></tr>
<tr><td>30</td><td rowspan="2">FRN30VG1□-2□</td><td>HD</td><td>150</td><td>200</td></tr>
<tr><td rowspan="2">37</td><td>LD</td><td rowspan="2">175</td><td rowspan="2">250</td></tr>
<tr><td rowspan="2">FRN37VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">45</td><td>LD</td><td rowspan="2">200</td><td rowspan="2">300</td></tr>
<tr><td rowspan="2">FRN45VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">55</td><td>LD</td><td rowspan="2">250</td><td rowspan="2">350</td></tr>
<tr><td rowspan="2">FRN55VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">350</td><td rowspan="5">-</td></tr>
<tr><td rowspan="2">FRN75VG1□-2□</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">400</td></tr>
<tr><td rowspan="2">FRN90VG1□-2□</td><td>HD</td></tr>
<tr><td>110</td><td>LD</td><td>350</td></tr>
</table>

Molded Case Circuit Breaker (MCCB) and
Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) (continued)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (kW)</th><th rowspan="2">Inverter type</th><th rowspan="2">HD/MD/LD mode</th><th colspan="2">Rated current of MCCB and RCD/ELCB (A)</th></tr>
<tr><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="46">Three-phase 400 V</td><td>3.7</td><td>FRN3.7VG1□-4□</td><td>HD</td><td>10</td><td>20</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-4□</td><td>HD</td><td>15</td><td>30</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-4□</td><td>HD</td><td>20</td><td>40</td></tr>
<tr><td>11</td><td>FRN11VG1□-4□</td><td>HD</td><td>30</td><td>50</td></tr>
<tr><td>15</td><td>FRN15VG1□-4□</td><td>HD</td><td rowspan="2">40</td><td>60</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-4□</td><td>HD</td><td>75</td></tr>
<tr><td>22</td><td>FRN22VG1□-4□</td><td>HD</td><td>50</td><td>100</td></tr>
<tr><td>30</td><td rowspan="2">FRN30VG1□-4□</td><td>HD</td><td>75</td><td rowspan="3">125</td></tr>
<tr><td rowspan="2">37</td><td>LD</td><td rowspan="4">100</td></tr>
<tr><td rowspan="2">FRN37VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">45</td><td>LD</td><td rowspan="2">150</td></tr>
<tr><td rowspan="2">FRN45VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">55</td><td>LD</td><td rowspan="2">125</td><td rowspan="2">200</td></tr>
<tr><td rowspan="2">FRN55VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">175</td><td rowspan="32">-</td></tr>
<tr><td rowspan="2">FRN75VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">200</td></tr>
<tr><td rowspan="2">FRN90VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">110</td><td>MD/LD</td><td rowspan="2">250</td></tr>
<tr><td rowspan="2">FRN110VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">132</td><td>MD/LD</td><td rowspan="2">300</td></tr>
<tr><td rowspan="2">FRN132VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">160</td><td>MD/LD</td><td rowspan="2">350</td></tr>
<tr><td rowspan="2">FRN160VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">200</td><td>MD/LD</td><td rowspan="4">500</td></tr>
<tr><td rowspan="2">FRN200VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">220</td><td>MD/LD</td></tr>
<tr><td rowspan="3">FRN220VG1□-4□</td><td>HD</td></tr>
<tr><td>250</td><td>MD</td><td rowspan="3">600</td></tr>
<tr><td rowspan="2">280</td><td>LD</td></tr>
<tr><td rowspan="2">FRN280VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">315</td><td>MD</td><td rowspan="5">800</td></tr>
<tr><td>FRN315VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="3">355</td><td>FRN280VG1□-4□</td><td>LD</td></tr>
<tr><td>FRN315VG1□-4□</td><td>MD</td></tr>
<tr><td>FRN355VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="3">400</td><td>FRN315VG1□-4□</td><td>LD</td><td rowspan="7">1200</td></tr>
<tr><td>FRN355VG1□-4□</td><td>MD</td></tr>
<tr><td>FRN400VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">450</td><td>FRN355VG1□-4□</td><td>LD</td></tr>
<tr><td rowspan="2">FRN400VG1□-4□</td><td>MD</td></tr>
<tr><td rowspan="2">500</td><td>LD</td></tr>
<tr><td rowspan="2">FRN500VG1□-4□</td><td>HD</td></tr>
<tr><td rowspan="2">630</td><td>LD</td><td rowspan="2">1400</td></tr>
<tr><td rowspan="2">FRN630VG1□-4□</td><td>HD</td></tr>
<tr><td>710</td><td>LD</td><td>1600</td></tr>
</table>

⚠WARNING

If no zero-phase current (earth leakage current) detective device such as a ground-fault relay is installed in the upstream power supply line in order to avoid the entire power supply system's shutdown undesirable to factory operation, install a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) individually to inverters to break the individual inverter power supply lines only.

Otherwise, a fire could occur.

(6) Magnetic contactor (MC) in the inverter input (primary) circuit

Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input circuit; otherwise, the inverter failure may result. If frequent start/stop of the motor is required, use ***FWD***/***REV*** terminal signals or the FWD / REV / STOP keys on the inverter's keypad.

The frequency of the MC's ON/OFF should not be more than once per 30 minutes. To assure 10-year or longer service life of the inverter, it should not be more than once per hour.

Tip

- From the system's safety point of view, it is recommended to employ such a sequence that shuts down the magnetic contactor (MC) in the inverter input circuit with an alarm output signal ***30X*** issued on inverter's programmable output terminals. The sequence minimizes the secondary damage even if the inverter breaks.

  When the sequence is employed, connecting the MC's primary power line to the inverter's auxiliary control power input makes it possible to monitor the inverter's alarm status on the keypad.

- The breakdown of a braking unit or misconnection of an external braking resistor may trigger that of the inverter's internal parts (e.g., charging resistor). To avoid such a breakdown linkage, introduce an MC and configure a sequence that shuts down the MC if a DC link voltage establishment signal is not issued within three seconds after the MC is switched on.

  For the braking transistor built-in type of inverters, assign a transistor error output signal ***DBAL*** on inverter's programmable output terminals to switch off the MC in the input circuit.

(7) Magnetic contactor (MC) in the inverter output (secondary) circuit

If a magnetic contactor (MC) is inserted in the inverter's output (secondary) circuit for switching the motor to a commercial power or for any other purposes, it should be switched on and off when both the inverter and motor are completely stopped. This prevents the contact point from getting rough due to a switching arc of the MC. The MC should not be equipped with any main circuit surge killer.

Applying a commercial power to the inverter's output circuit breaks the inverter. To avoid it, interlock the MC on the motor's commercial power line with the one in the inverter output circuit so that they are not switched ON at the same time.

(8) Surge absorber/surge killer

Do not install any surge absorber or surge killer in the inverter's output (secondary) lines.

3.2.5 Noise reduction

If noise generated from the inverter affects other devices, or that generated from peripheral equipment causes the inverter to malfunction, follow the basic measures outlined below.

(1) If noise generated from the inverter affects the other devices through power wires or grounding wires:

- Isolate the grounding terminals of the inverter from those of the other devices.
- Connect a noise filter to the inverter power wires.
- Isolate the power system of the other devices from that of the inverter with an insulated transformer.
- Decrease the inverter's carrier frequency (F26). (See **Note** below.)

(2) If induction or radio noise generated from the inverter affects other devices:

- Isolate the main circuit wires from the control circuit wires and other device wires.
- Put the main circuit wires through a metal conduit pipe, and connect the pipe to the ground near the inverter.
- Install the inverter into the metal panel and connect the whole panel to the ground.
- Connect a noise filter to the inverter's power wires.
- Decrease the inverter's carrier frequency (F26). (See **Note** below.)

(3) When implementing measures against noise generated from peripheral equipment:

- For inverter's control signal wires, use twisted or shielded-twisted wires. When using shielded-twisted wires, connect the shield of the shielded wires to the common terminals of the control circuit.
- Connect a surge absorber in parallel with magnetic contactor's coils or other solenoids (if any).

Note Running a permanent magnet synchronous motor (PMSM) at a low carrier frequency may heat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

3.2.6 Leakage current

A high frequency current component generated by insulated gate bipolar transistors (IGBTs) switching on/off inside the inverter becomes leakage current through stray capacitance of inverter input and output wires or a motor. If any of the problems listed below occurs, take an appropriate measure against them.

Problem	Measures
An earth leakage circuit breaker* that is connected to the input (primary) side has tripped. *With overcurrent protection	1) Decrease the carrier frequency. (See **Note** given in Section 3.2.5 above.) 2) Make the wires between the inverter and motor shorter. 3) Use an earth leakage circuit breaker with lower sensitivity than the one currently used. 4) Use an earth leakage circuit breaker that features measures against the high frequency current component (Fuji SG and EG series).
An external thermal relay was falsely activated.	1) Decrease the carrier frequency. (See **Note** given in Section 3.2.5 above.) 2) Increase the current setting of the thermal relay. 3) Use the electronic thermal overload protection built in the inverter, instead of the external thermal relay.

3.2.7 Precautions in driving a permanent magnet synchronous motor (PMSM)

When using a PMSM, note the following.

- When using a PMSM other than the Fuji standard synchronous motor (GNF2), consult your Fuji Electric representative.
- A single inverter cannot drive two or more PMSMs.
- A PMSM cannot be driven by commercial power.

3.3 Mounting and Wiring the Inverter

3.3.1 Operating environment

Install the inverter in an environment that satisfies the requirements listed in Table 3.3-1.

Table 3.3-1 Environmental Requirements

<table>
<tr><th>Item</th><th colspan="2">Specifications</th></tr>
<tr><td>Site location</td><td colspan="2">Indoors</td></tr>
<tr><td>Surrounding temperature</td><td colspan="2">-10 to +50°C (Note 1)</td></tr>
<tr><td>Relative humidity</td><td colspan="2">5 to 95% (No condensation)</td></tr>
<tr><td>Atmosphere</td><td colspan="2">The inverter must not be exposed to dust, direct sunlight, corrosive gases, flammable gases, oil mist, vapor or water drops.
Pollution degree 2 (IEC60664-1) (Note 2)
The atmosphere can contain a small amount of salt. (0.01 mg/cm2 or less per year)
The inverter must not be subjected to sudden changes in temperature that will cause condensation to form.</td></tr>
<tr><td>Altitude</td><td colspan="2">3,000 m max.
• 1,001 to 3,000 m: Output current derating is required. (Note 3)
• 2,001 to 3,000 m: The insulation level of the control circuits lowers from the reinforced insulation to the basic one. (Note 4)</td></tr>
<tr><td>Atmospheric pressure</td><td colspan="2">86 to 106 kPa</td></tr>
<tr><td rowspan="2">Vibration</td><td>55 kW or below (200 V class series)
75 kW or below (400 V class series)</td><td>75 kW or above (200 V class series)
90 kW or above (400 V class series)</td></tr>
<tr><td>3 mm (Max. amplitude) 2 to less than 9 Hz
9.8 m/s2 9 to less than 20 Hz
2 m/s2 20 to less than 55 Hz
1 m/s2 55 to less than 200 Hz</td><td>3 mm (Max. amplitude) 2 to less than 9 Hz
2 m/s2 9 to less than 55 Hz
1 m/s2 55 to less than 200 Hz</td></tr>
</table>

(Note 1) When inverters are mounted side-by-side without any clearance between them (22 kW or below), the surrounding temperature should be within the range from -10 to +40°C.

(Note 2) Do not install the inverter in an environment where it may be exposed to lint, cotton waste or moist dust or dirt which will clog the heat sink of the inverter. If the inverter is to be used in such an environment, install it in a dustproof panel of your system.

(Note 3) When installing the inverter in an altitude above 1,000 m, apply an output current derating factor as listed in Table 3.3-2.

(Note 4) The FRENIC-VG inverter unit is compliant with the Low Voltage Directive IEC/EN61800-5-1 (Overvoltage category: 3). If it is installed in an altitude above 2,000 m, however, the insulation level lowers from the reinforced insulation to the basic one. To keep compliance with the Low Voltage Directive in the altitude, take necessary measure to keep the reinforced insulation at the equipment side to which the inverter is installed.

Table 3.3-2 Output Current Derating Factor in Relation to Altitude

Altitude	Output current derating factor
1000 m or lower	1.00
1000 to 1500 m	0.97
1500 to 2000 m	0.95
2000 to 2500 m	0.91
2500 to 3000 m	0.88

3.3.2 Installing the Inverter

(1) Mounting base

Install the inverter on a base made of metal or other non-flammable material. Do not mount the inverter upside down or horizontally.

⚠WARNING
Install the inverter on a base made of metal or other non-flammable material. **Otherwise, a fire could occur.**

Figure 3.3-1
Mounting Direction and Required Clearances

(2) Clearances

Ensure that the minimum clearances indicated in Figure 3.3-1 and Table 3.3-3 are maintained at all times. When mounting the inverter in the panel of your system, take extra care with ventilation inside the panel as the surrounding temperature easily rises. Do not mount the inverter in a small panel with poor ventilation.

■ When mounting two or more inverters

When mounting two or more inverters in the same unit or panel, basically lay them out side by side. When mounting them necessarily one above the other, be sure to separate them with a partition plate or the like so that any heat radiating from an inverter will not affect the one/s above.

As long as the surrounding temperature is 40°C or lower, inverters with a capacity of 22 kW or below can be mounted side by side without any clearance between them.

Table 3.3-3 Clearances (mm)

Inverter capacity	A	B	C
0.75 to 22 kW	20	100	0
30 to 220 kW	50		100
280 to 630 kW		150	150

C: Space required in front of the inverter unit

■ When employing external cooling

In external cooling, the heat sink, which dissipates about 70% of the total heat (total loss) generated into air, is situated outside the equipment or the panel. The external cooling, therefore, significantly reduces heat radiating inside the equipment or panel.

To employ external cooling for inverters with a capacity of 22 kW or below, use the mounting adapter for external cooling (option); for those with a capacity of 30 kW or above, simply change the positions of the mounting bases.

For the dimensional outline drawing of the mounting adapter (option), refer to Chapter 8, Section 8.5.8.

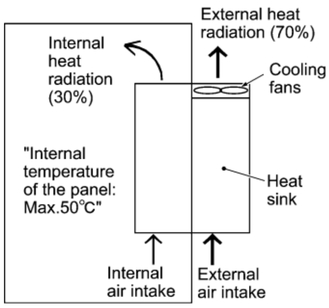


Figure 3.3-2 External Cooling

⚠CAUTION
Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink. **Otherwise, a fire or accident could occur.**

To utilize external cooling for inverters with a capacity of 30 kW or above, change the positions of the top and bottom mounting bases from the edge to the center of the inverter as shown below (Figure 3.3-3).

Screws differ in size and count for each inverter. Refer to the table below.

For the panel cutting size, refer to Chapter 2, Section 2.3 "External Dimensions."

Table 3.3-4 Screw Size, Count and Tightening Torque

Inverter type	Base fixing screw (Screw size and q'ty)	Case fixing screw (Screw size and q'ty)	Tightening torque (N·m)
FRN30VG1□-2□/FRN37VG1□-2□ FRN30VG1□-4□ to FRN55VG1□-4□	M6 × 20 5 pcs for upper side, 3 pcs for lower side	M6 × 20 2 pcs for upper side	5.8
FRN45VG1□-2□/FRN55VG1□-2□ FRN75VG1□-4□	M6 × 20 3 pcs each for upper and lower sides	M6 × 12 3 pcs for upper side	5.8
FRN75VG1□-2□ FRN90VG1□-4□/FRN110VG1□-4□	M5 ×12 7 pcs each for upper and lower sides	M5 × 12 7 pcs for upper side	3.5
FRN132VG1□-4□/FRN160VG1□-4□	M5 × 16 7 pcs each for upper and lower sides	M5 × 16 7 pcs for upper side	3.5
FRN90VG1□-2□ FRN200VG1□-4□/FRN220VG1□-4□	M5 × 16 8 pcs each for upper and lower sides	M5 × 16 8 pcs for upper side	3.5
FRN280VG1□-4□/FRN315VG1□-4□ FRN355VG1□-4□/FRN400VG1□-4□	M5 × 16 2 pcs each for upper and lower sides M6 × 20 6 pcs each for upper and lower sides	M5 × 16 2 pcs each for upper and lower sides M6 × 20 6 pcs each for upper and lower sides	3.5 5.8
FRN500VG1□-4□/FRN630VG1□-4□	M8 × 20 8 pcs each for upper and lower sides	M8 × 20 8 pcs each for upper and lower sides	13.5

1) Remove all of the base fixing screws and the case fixing screws from the top of the inverter.
2) Move the top mounting base to the center of the inverter and secure it to the case fixing screw holes with the base fixing screws. (After changing the position of the top mounting base, some screws may be left unused.)
3) Remove the base fixing screws from the bottom of the inverter, move the bottom mounting base to the center of the inverter, and secure it with the base fixing screws, just as in step 2). (Inverters with a capacity of 220 kW or below have no case fixing screws on the bottom.)

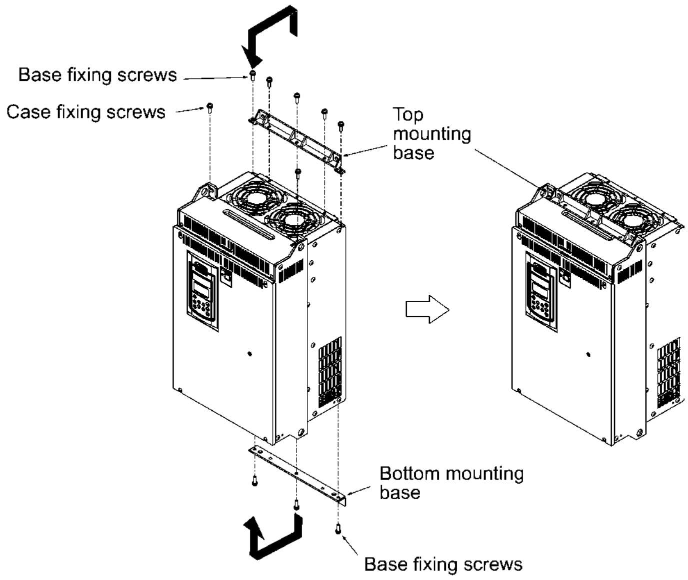


Figure 3.3-3 Changing the Positions of the Top and Bottom Mounting Bases

⚠CAUTION

When changing the positions of the top and bottom mounting bases, use only the specified screws.

Otherwise, a fire or accident could occur.

3.3.3 Wiring

Follow the procedure below. (In the following description, the inverter has already been installed.)

Note: In tables given in this manual, inverter types are denoted as "FRN_ _ _VG1☐-2☐/4☐.

3.3.3.1 Removing and mounting the front cover and the wiring guide

⚠CAUTION
Be sure to disconnect the USB cable from the USB connector before removing the front cover. **Otherwise, a fire or accident could occur.**

(1) For inverters with a capacity of 22 kW or below

① First loosen the front cover fixing screw, hold the cover with both hands, slide it downward, tilt it toward you, and then pull it upward, as shown below.

② While pressing the wiring guide upward, pull it out toward you.

③ After carrying out wiring, put the wiring guide and the front cover back into place in the reverse order of removal.

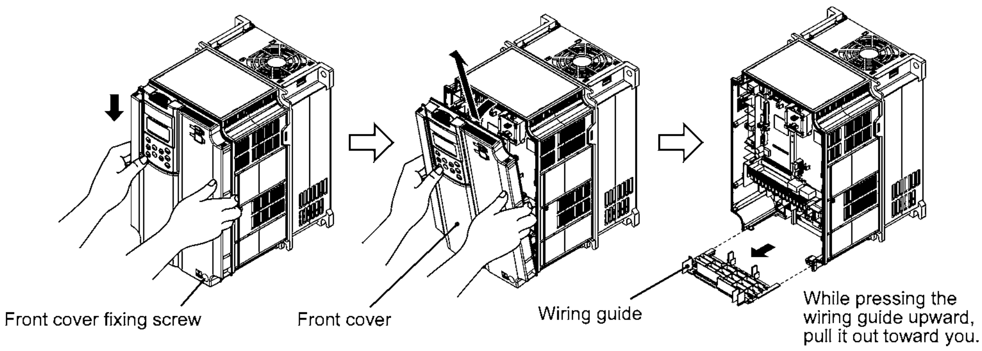


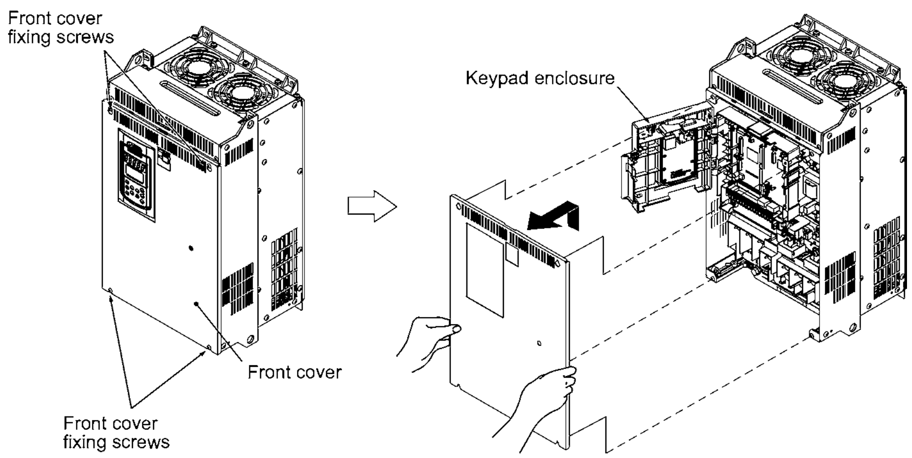
Figure 3.3-4 Removing the Front Cover and the Wiring Guide (FRN11VG1☐-2☐)

(2) For inverters with a capacity of 30 to 630 kW

① Loosen the four front cover fixing screws, hold the cover with both hands, slide it upward slightly, and pull it toward you, as shown below.

② After carrying out wiring, align the screw holes provided in the front cover with the screws on the inverter case, then put the front cover back into place in the reverse order of removal.

Tip: To expose the control printed circuit board (control PCB), open the keypad enclosure.



Tightening torque: 1.8 N•m (M4)
3.5 N•m (M5)

Figure 3.3-5 Removing the Front Cover (FRN30VG1☐-2☐)

3.3.3.2 Screw specifications and recommended wire sizes

(1) Main circuit terminals

The tables and figures given below show the screw specifications and wire sizes. Note that the terminal arrangements differ depending on the inverter types. In each of the figures, two grounding terminals (⏚G) are not exclusive to the power supply wiring (primary circuit) or motor wiring (secondary circuit).

Use crimp terminals covered with an insulation sheath or with an insulation tube. The recommended wire sizes for the main circuits are examples of using a single HIV wire (for 75°C) at a surrounding temperature of 50°C.

Table 3.3-5 Screw Specifications

<table>
<tr><th colspan="2">Inverter type</th><th rowspan="3">Refer to Section 3.3.3.3.</th><th colspan="8">Screw specifications</th></tr>
<tr><th rowspan="2">Three-phase 200 V</th><th rowspan="2">Three-phase 400 V</th><th colspan="2">Main circuit terminals</th><th colspan="2">Grounding terminals</th><th colspan="2">Auxiliary control power input terminals [R0, T0]</th><th colspan="2">Auxiliary fan power input terminals [R1, T1]</th></tr>
<tr><th>Screw size (Screw-driver size)</th><th>Tightening torque (N·m)</th><th>Screw size (Screw-driver size)</th><th>Tightening torque (N·m)</th><th>Screw size</th><th>Tightening torque (N·m)</th><th>Screw size</th><th>Tightening torque (N·m)</th></tr>
<tr><td>FRN0.75VG1□-2□</td><td>FRN0.75VG1□-4□</td><td rowspan="6">Figure A</td><td rowspan="6">M5 (No. 2)</td><td rowspan="6">3.5</td><td rowspan="6">M5 (No. 2)</td><td rowspan="6">3.5</td><td rowspan="30">M3.5</td><td rowspan="30">1.2</td><td rowspan="14">--</td><td rowspan="14">--</td></tr>
<tr><td>FRN1.5VG1□-2□</td><td>FRN1.5VG1□-4□</td></tr>
<tr><td>FRN2.2VG1□-2□</td><td>FRN2.2VG1□-4□</td></tr>
<tr><td>FRN3.7VG1□-2□</td><td>FRN3.7VG1□-4□</td></tr>
<tr><td>FRN5.5VG1□-2□</td><td>FRN5.5VG1□-4□</td></tr>
<tr><td>FRN7.5G1□-2□</td><td>FRN7.5VG1□-4□</td></tr>
<tr><td>FRN11VG1□-2□</td><td>FRN11VG1□-4□</td><td rowspan="4">Figure B</td><td rowspan="4">M6 (No. 3)</td><td rowspan="4">5.8</td><td rowspan="4">M6 (No. 3)</td><td rowspan="4">5.8</td></tr>
<tr><td>FRN15VG1□-2□</td><td>FRN15VG1□-4□</td></tr>
<tr><td>FRN18.5VG1□-2□</td><td>FRN18.5VG1□4□</td></tr>
<tr><td>FRN22VG1□-2□</td><td>FRN22VG1□-4□</td></tr>
<tr><td rowspan="4">FRN30VG1□-2□</td><td>FRN30VG1□-4□</td><td rowspan="4">Figure C</td><td rowspan="4">M8</td><td rowspan="4">13.5</td><td rowspan="9">M8</td><td rowspan="9">13.5</td></tr>
<tr><td>FRN37VG1□-4□</td></tr>
<tr><td>FRN45VG1□-4□</td></tr>
<tr><td>FRN55VG1□-4□</td></tr>
<tr><td>FRN37VG1□-2□</td><td rowspan="3">FRN75VG1□-4□</td><td rowspan="3">Figure D</td><td rowspan="5">M10</td><td rowspan="5">27</td><td rowspan="16">M3.5</td><td rowspan="16">1.2</td></tr>
<tr><td>FRN45VG1□-2□</td></tr>
<tr><td>FRN55VG1□-2□</td></tr>
<tr><td>--</td><td>FRN90VG1□-4□</td><td rowspan="2">Figure E</td></tr>
<tr><td>--</td><td>FRN110VG1□-4□</td></tr>
<tr><td>FRN75VG1□-2□</td><td>--</td><td>Figure F</td><td rowspan="11">M12</td><td rowspan="11">48</td><td rowspan="11">M10</td><td rowspan="11">27</td></tr>
<tr><td>--</td><td>FRN132VG1□-4□</td><td rowspan="2">Figure G</td></tr>
<tr><td>--</td><td>FRN160VG1□-4□</td></tr>
<tr><td rowspan="2">FRN90VG1□-2□</td><td>FRN200VG1□-4□</td><td rowspan="2">Figure H</td></tr>
<tr><td>FRN220VG1□-4□</td></tr>
<tr><td>--</td><td>FRN280VG1□-4□</td><td rowspan="2">Figure I</td></tr>
<tr><td>--</td><td>FRN315VG1□-4□</td></tr>
<tr><td>--</td><td>FRN355VG1□-4□</td><td rowspan="2">Figure J</td></tr>
<tr><td>--</td><td>FRN400VG1□-4□</td></tr>
<tr><td>--</td><td>FRN500VG1□-4□</td><td rowspan="2">Figure K</td></tr>
<tr><td>--</td><td>FRN630VG1□-4□</td></tr>
</table>

⚠WARNING⚠

When the inverter power is ON, a high voltage is applied to the following terminals.

Main circuit terminals: L1/R, L2/S, L3/T, P1, P(+), N(-), DB, U, V, W, R0, T0, R1, T1, AUX-contact (30A, 30B, 30C, Y5A, Y5C)

Insulation level

Main circuit — Enclosure : Basic insulation (Overvoltage category III, Pollution degree 2)
Main circuit — Control circuit : Reinforced insulation (Overvoltage category III, Pollution degree 2)
Relay output — Control circuit : Reinforced insulation (Overvoltage category II, Pollution degree 2)

An electric shock may occur.

Table 3.3-6 Recommended Wire Sizes

<table>
<tr><th rowspan="3">Power supply voltage</th><th rowspan="3">Nominal applied motor (kW)</th><th colspan="3" rowspan="2">Inverter type</th><th colspan="5">Recommended wire size (mm^2)</th></tr>
<tr><th colspan="2">Main circuit power input (L1/R, L2/S, L3/T)</th><th rowspan="2">Grounding [⏚G]</th><th rowspan="2">Inverter output [U, V, W]</th><th rowspan="2">DCR [P1, P(+)]</th></tr>
<tr><th>HD mode</th><th>LD mode</th><th>MD mode</th><th>w/ DCR</th><th>w/o DCR</th></tr>
<tr><td rowspan="17">Three-phase 200 V</td><td>0.75</td><td>FRN0.75VG1□-2□</td><td>--</td><td>--</td><td rowspan="5">2.0</td><td rowspan="4">2.0</td><td rowspan="4">2.0</td><td rowspan="4">2.0</td><td rowspan="4">2.0</td></tr>
<tr><td>1.5</td><td>FRN1.5VG1□-2□</td><td>--</td><td>--</td></tr>
<tr><td>2.2</td><td>FRN2.2VG1□-2□</td><td>--</td><td>--</td></tr>
<tr><td>3.7</td><td>FRN3.7VG1□-2□</td><td>--</td><td>--</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-2□</td><td>--</td><td>--</td><td>3.5</td><td>3.5</td><td>3.5</td><td>3.5</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-2□</td><td>--</td><td>--</td><td>3.5</td><td>5.5</td><td rowspan="2">5.5</td><td>5.5</td><td>5.5</td></tr>
<tr><td>11</td><td>FRN11VG1□-2□</td><td>--</td><td>--</td><td>5.5</td><td>14</td><td>8.0</td><td>8.0</td></tr>
<tr><td>15</td><td>FRN15VG1□-2□</td><td>--</td><td>--</td><td rowspan="2">14</td><td rowspan="2">22</td><td rowspan="4">14</td><td rowspan="2">14</td><td>14</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-2□</td><td>--</td><td>--</td><td rowspan="2">22</td></tr>
<tr><td>22</td><td>FRN22VG1□-2□</td><td>--</td><td>--</td><td>22</td><td>38 *1</td><td>22</td></tr>
<tr><td>30</td><td>FRN30VG1□-2□</td><td>--</td><td>--</td><td rowspan="2">38</td><td rowspan="2">60</td><td rowspan="2">38</td><td>38</td></tr>
<tr><td>37</td><td>FRN37VG1□-2□</td><td>FRN30VG1□-2□</td><td>--</td><td rowspan="5">22</td><td>60</td></tr>
<tr><td>45</td><td>FRN45VG1□-2□</td><td>FRN37VG1□-2□</td><td>--</td><td>60</td><td rowspan="2">100</td><td>60</td><td rowspan="2">100</td></tr>
<tr><td>55</td><td>FRN55VG1□-2□</td><td>FRN45VG1□-2□</td><td>--</td><td>100</td><td>100</td></tr>
<tr><td>75</td><td>FRN75VG1□-2□</td><td>FRN55VG1□-2□</td><td>--</td><td>150 *2</td><td rowspan="3">--</td><td>150 *2</td><td>150</td></tr>
<tr><td>90</td><td>FRN90VG1□-2□</td><td>FRN75VG1□-2□</td><td>--</td><td>150</td><td>150</td><td>200</td></tr>
<tr><td>110</td><td>--</td><td>FRN90VG1□-2□</td><td>--</td><td>200</td><td>38</td><td>200</td><td>250</td></tr>
<tr><td rowspan="27">Three-phase 400 V</td><td>3.7</td><td>FRN3.7VG1□-4□</td><td>--</td><td>--</td><td rowspan="4">2.0</td><td rowspan="3">2.0</td><td rowspan="2">2.0</td><td rowspan="3">2.0</td><td rowspan="3">2.0</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-4□</td><td>--</td><td>--</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-4□</td><td>--</td><td>--</td><td rowspan="2">3.5</td></tr>
<tr><td>11</td><td>FRN11VG1□-4□</td><td>--</td><td>--</td><td>3.5</td><td rowspan="2">3.5</td><td>3.5</td></tr>
<tr><td>15</td><td>FRN15VG1□-4□</td><td>--</td><td>--</td><td>3.5</td><td>5.5</td><td rowspan="3">5.5</td><td rowspan="2">5.5</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-4□</td><td>--</td><td>--</td><td rowspan="2">5.5</td><td>8.0 *3</td><td>5.5</td></tr>
<tr><td>22</td><td>FRN22VG1□-4□</td><td>--</td><td>--</td><td>14</td><td>8.0 *3</td><td>8.0 *3</td></tr>
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<tr><td>37</td><td>FRN37VG1□-4□</td><td>FRN30VG1□-4□</td><td>--</td><td rowspan="2">22</td></tr>
<tr><td>45</td><td>FRN45VG1□-4□</td><td>FRN37VG1□-4□</td><td>--</td><td rowspan="2">22</td><td rowspan="2">38</td><td>22</td></tr>
<tr><td>55</td><td>FRN55VG1□-4□</td><td>FRN45VG1□-4□</td><td>--</td><td rowspan="3">14</td><td>38</td><td>38</td></tr>
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<tr><td>90</td><td>FRN90VG1□-4□</td><td>FRN75VG1□-4□</td><td>--</td><td>60</td><td rowspan="2">100</td></tr>
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<tr><td>200</td><td>FRN200VG1□-4□</td><td>FRN160VG1□-4□</td><td>FRN160VG1□-4□</td><td rowspan="5">38</td><td rowspan="2">200</td><td rowspan="2">250</td></tr>
<tr><td>220</td><td>FRN220VG1□-4□</td><td>FRN200VG1□-4□</td><td>FRN200VG1□-4□</td><td>200</td></tr>
<tr><td>250</td><td>--</td><td>--</td><td>FRN220VG1□-4□</td><td rowspan="3">250</td><td>250</td><td>325</td></tr>
<tr><td rowspan="2">280</td><td>--</td><td>FRN220VG1□-4□</td><td>--</td><td>150x2</td><td rowspan="3">200x2</td></tr>
<tr><td>FRN280VG1□-4□</td><td>--</td><td>--</td><td rowspan="2">325</td></tr>
<tr><td>315</td><td>FRN315VG1□-4□</td><td>--</td><td>FRN280VG1□-4□</td><td>150x2</td><td rowspan="4">60</td></tr>
<tr><td>355</td><td>FRN355VG1□-4□</td><td>FRN280VG1□-4□</td><td>FRN315VG1□-4□</td><td rowspan="2">200x2</td><td>200x2</td><td>250x2</td></tr>
<tr><td>400</td><td>FRN400VG1□-4□</td><td>FRN315VG1□-4□</td><td>FRN355VG1□-4□</td><td rowspan="2">250x2</td><td rowspan="2">325x2</td></tr>
<tr><td>450</td><td>--</td><td>FRN355VG1□-4□</td><td>FRN400VG1□-4□</td><td>250x2</td></tr>
<tr><td>500</td><td>FRN500VG1□-4□</td><td>FRN400VG1□-4□</td><td>--</td><td>325x2</td><td rowspan="3">100</td><td>325x2</td><td rowspan="2">325x3</td></tr>
<tr><td>630</td><td>FRN630VG1□-4□</td><td>FRN500VG1□-4□</td><td>--</td><td>325x3</td><td>325x3</td></tr>
<tr><td>710</td><td>--</td><td>FRN630VG1□-4□</td><td>--</td><td>250x4</td><td>325x4</td><td>325x4</td></tr>
</table>

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 When using 150 mm^2 wires for main circuit terminals of FRN55VG1□-2□ (LD mode), use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

*3 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Terminals common to all inverters	Recommended wire size (mm^2)	Remarks
Auxiliary control power input terminals R0 and T0	2.0	--
Auxiliary fan power input terminals R1 and T1	2.0	200 V class series with 37 kW or above and 400 V class series with 75 kW or above

(2) Control circuit terminals (common to all inverter types)

Table 3.3-7 lists the screw specifications and recommended wire size for wiring of the control circuit terminals. The control circuit terminals are common to all inverter types regardless of their capacities.

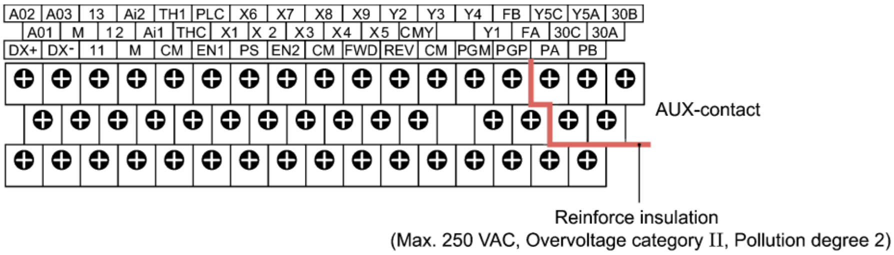
Table 3.3-7 Screw Specifications and Recommended Wire Size

Terminals common to all inverter types	Screw specifications		Recommended wire size (mm^2)
	Screw size	Tightening torque (N·m)	
Control circuit terminals	M3	0.7	1.25 *

* Using wires exceeding the recommended sizes may lift the front cover depending upon the number of wires used, impeding keypad's normal operation.

3.3.3.3 Arrangement of terminals

(1) Control circuit terminals (common to all inverter types)



(2) Main circuit terminals

Figure A

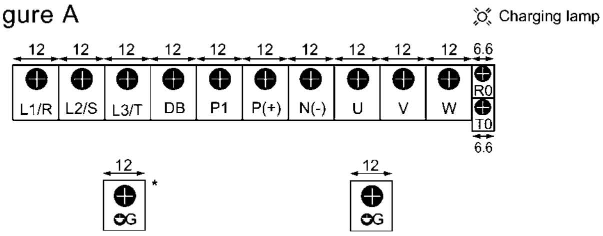


Figure B

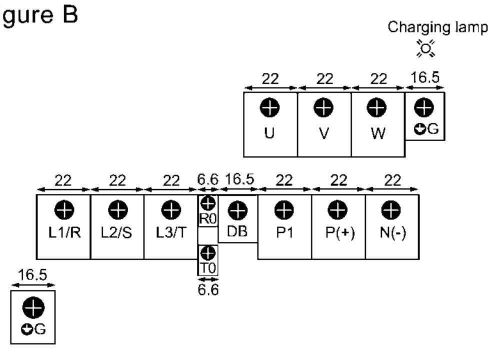


Figure C

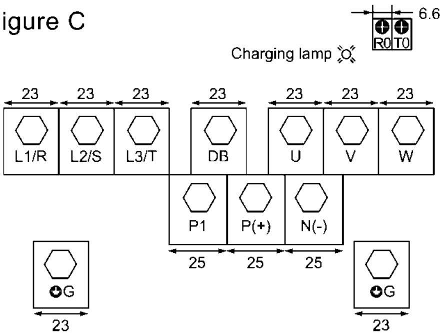


Figure D / Figure E

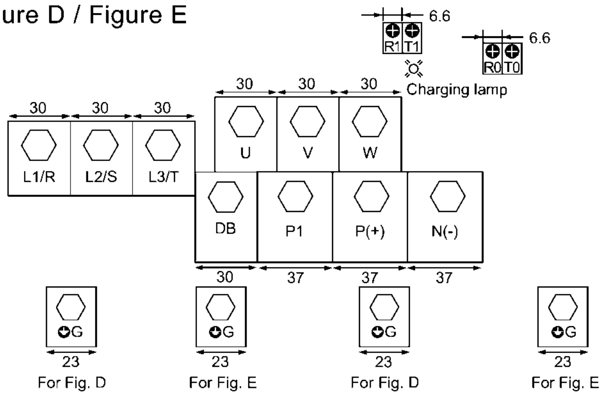


Figure F

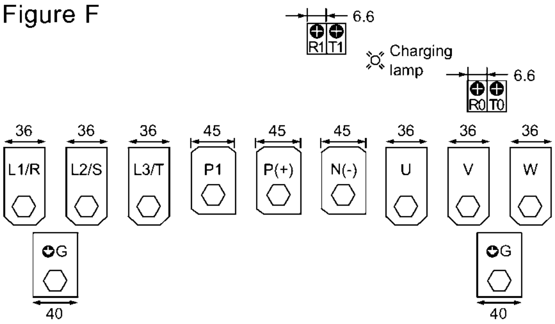


Figure G

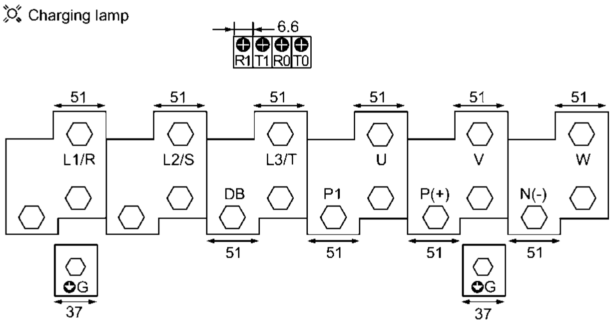


Figure H

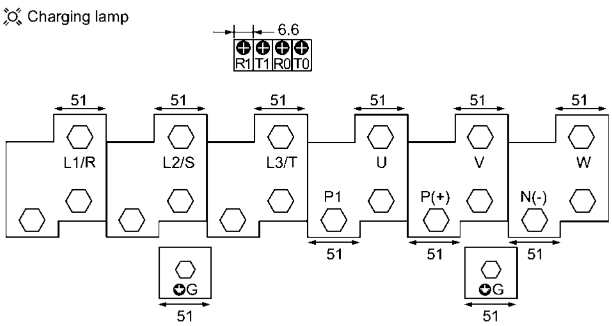


Figure I ☼ Charging lamp

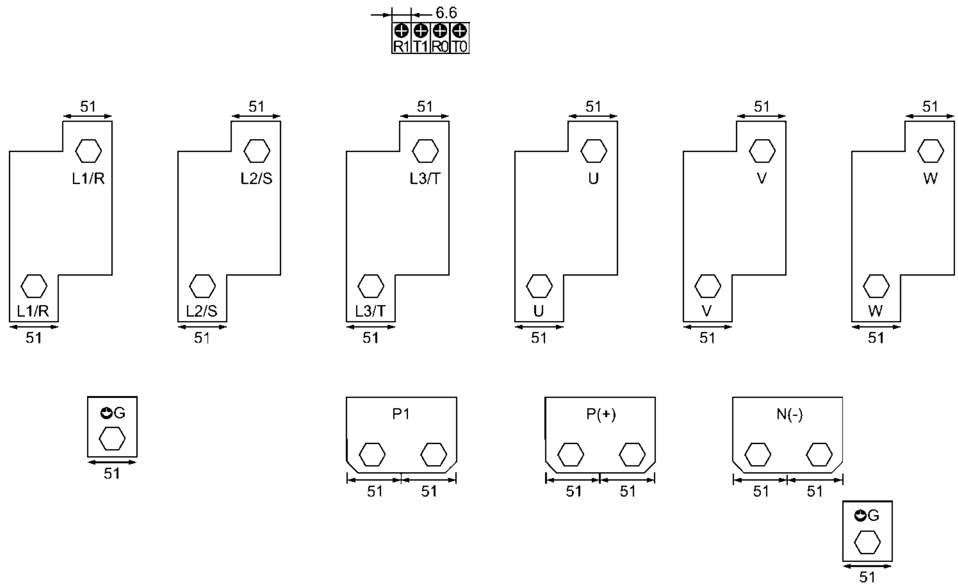


Figure J ☼ Charging lamp

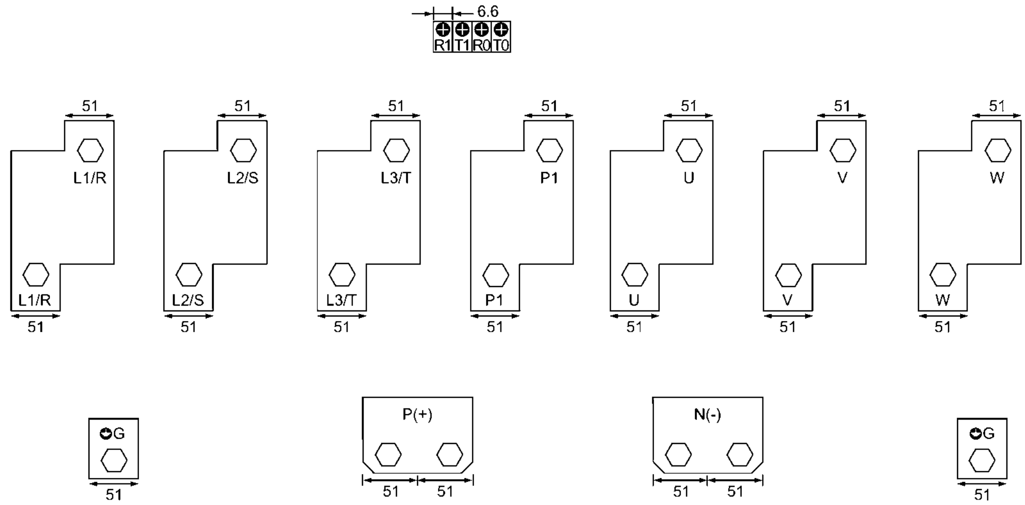
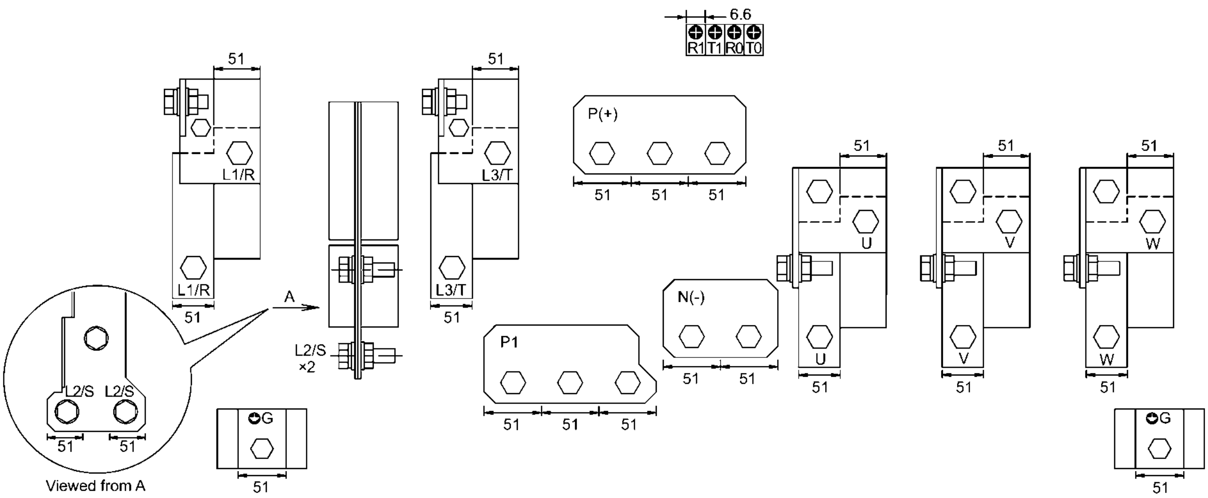


Figure K ☼ Charging lamp



3.3.3.4 Wiring precautions

Follow the rules below when performing wiring for the inverter.

(1) Make sure that the source voltage is within the rated voltage range specified on the nameplate.

(2) Be sure to connect the three-phase power wires to the main circuit power input terminals L1/R, L2/S and L3/T of the inverter. If the power wires are connected to other terminals, the inverter will be damaged when the power is turned ON.

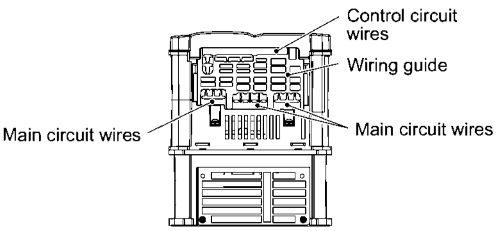
(3) Always connect the grounding terminal to prevent electric shock, fire or other disasters and to reduce electric noise.

(4) Use crimp terminals covered with insulated sleeves for the main circuit terminal wiring to ensure a reliable connection.

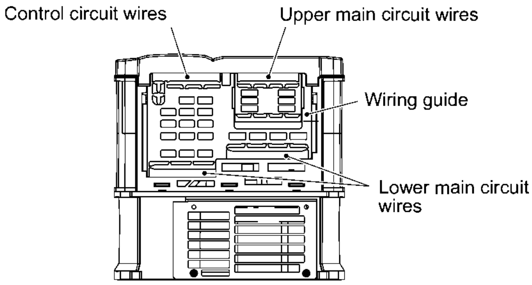
(5) Keep the power supply wiring (primary circuit) and motor wiring (secondary circuit) of the main circuit, and control circuit wiring as far away as possible from each other.

(6) After removing a screw from the main circuit terminal block, be sure to restore the screw even if no wire is connected.

(7) Use the wiring guide to separate wiring. For inverters with a capacity of 7.5 kW or below, the wiring guide separates the main circuit wires and the control circuit wires. For inverters with a capacity of 11 to 22 kW, it separates the upper and lower main circuit wires, and control circuit wires. Be careful about the wiring order.



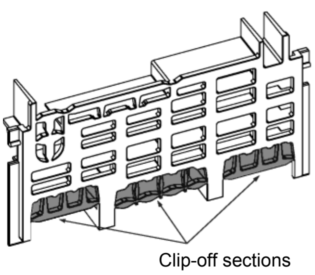
FRN7.5VG1□-2□



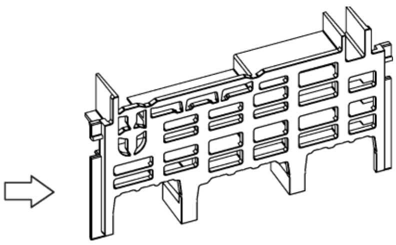
FRN22VG1□-2□

■ **Preparing for the wiring guide**

Inverters with a capacity of 22 kW or below are sometimes lacking in wiring space for main circuit wires depending upon the wire materials used. To assure a sufficient wiring space, remove the clip-off sections (see below) as required with a nipper. Note that the enclosure rating of IP20 is not ensured when the wiring guide itself is removed to secure a space for thick main circuit wiring.

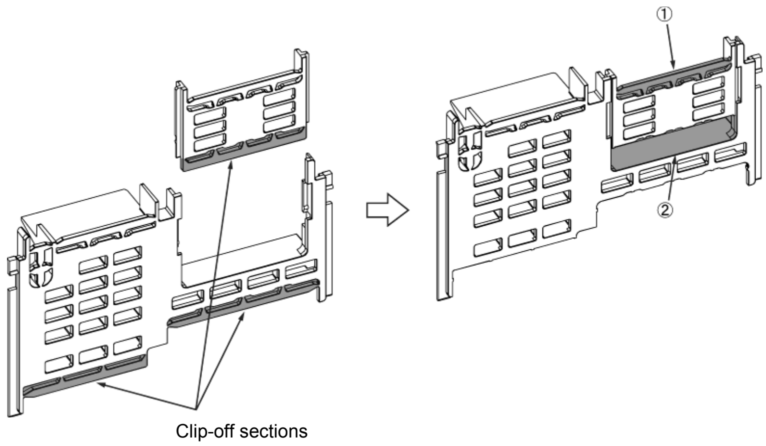


Before removal of clip-off sections



After removal of clip-off sections

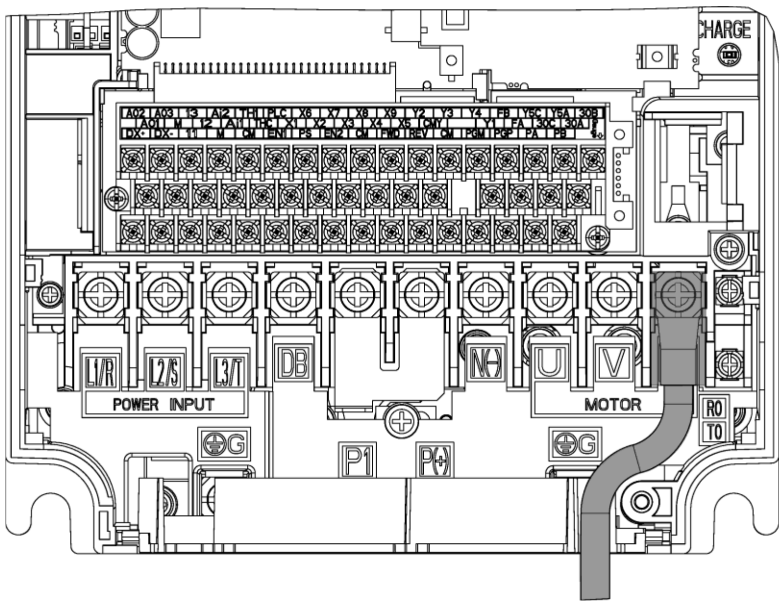
Wiring Guide (FRN7.5VG1□-2□)



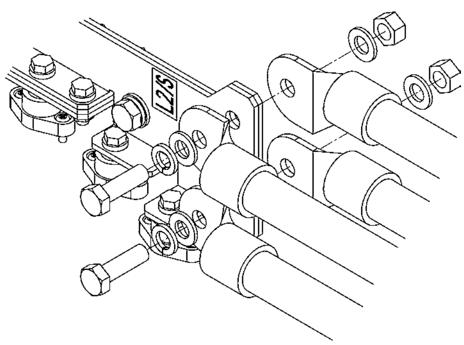
If the inverter output wire size is 22 mm², remove clip-off section ①; if it is 38 mm², remove clip-off section ② before wiring.

Wiring Guide (FRN22VG1☐-2☐)

(8) In some types of inverters, the wires from the main circuit terminal block cannot be straight routed. Route such wires as shown below so that the front cover is set into place.



(9) For inverters with a capacity of 500 kW or 630 kW, two L2/S input terminals are arranged vertically to the terminal block. When connecting wires to these terminals, use the bolts, washers and nuts that come with the inverter, as shown below.



⚠WARNING

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) in the path of each pair of power lines to inverters. Use the recommended devices within the recommended current capacity.
- Be sure to use wires in the specified size.
- Tighten terminals with specified torque.

Otherwise, a fire could occur.

- When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.
- Do not connect a surge killer to the inverter's output (secondary) circuit.

Doing so could cause a fire.

- Ground the inverter in compliance with the national or local electric code.
- Be sure to ground the inverter's grounding terminals ⏚G.

Otherwise, an electric shock or fire could occur.

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after shutting down the power.

Otherwise, electric shock could occur.

- Be sure to perform wiring after installing the inverter unit.

Otherwise, electric shock or injuries could occur.

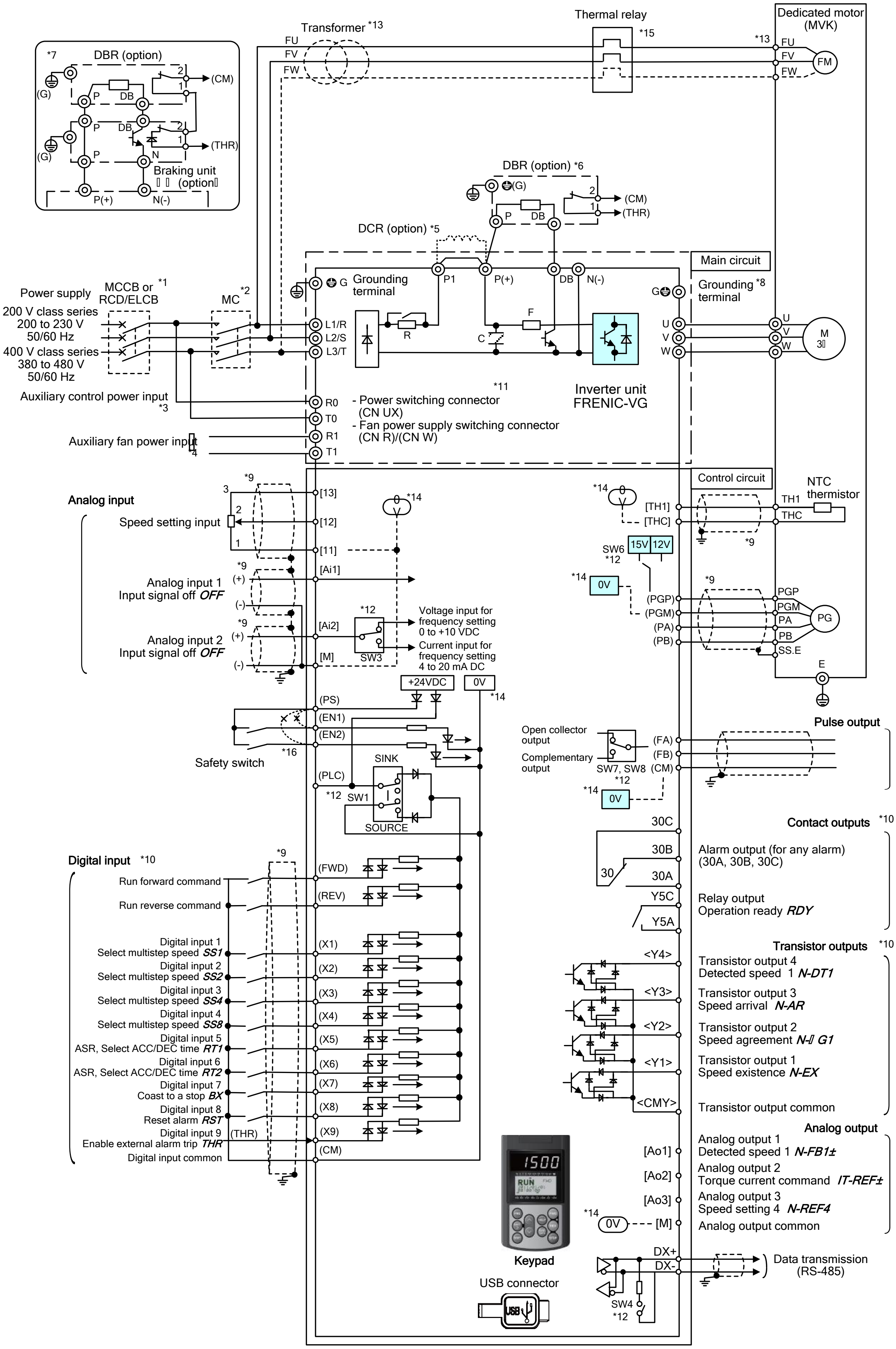
- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

Otherwise, a fire or an accident could occur.

- Do not connect the power source wires to inverter output terminals (U, V, and W).

Doing so could cause fire or an accident.

3.3.3.5 Connection diagram



(Note 1) Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

(Note 2) Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

(Note 3) To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

(Note 4) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

(Note 5) When connecting an optional DC reactor (DCR), remove the jumper bar from the main circuit terminals P1 and P(+).

Inverters of 75 kW or above and LD-mode inverters of 55 kW come with a DCR as standard. Be sure to connect the DCR.

Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

(Note 6) Inverters of 55 kW or below (200 V class series) and those of 160 kW or below (400 V class series) have a built-in braking transistor, allowing a braking resistor (DBR) to be directly connected between terminals P(+) and DB.

(Note 7) When connecting an optional braking resistor (DBR) to inverters of 75 kW or above (200 V class series) or those of 200 kW or above (400 V class series), be sure to use an optional braking unit (BU) together.

Connect the BU between terminals P(+) and N(-). Auxiliary terminals [1] and [2] have polarity, so make connection as shown in the connection diagram.

(Note 8) A grounding terminal for a motor. It is recommended that the motor be grounded via this terminal for suppressing inverter noise.

(Note 9) For wiring enclosed with [ ], use twisted or shielded wires.

In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to (0V) ([M], [11], [THC]) or [0V] ([CM], (PGM)) may be effective to suppress the influence of noise.

Keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

(Note 10) The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X9], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C].

(Note 11) Switching connectors in the main circuits. For details, refer to Section 3.3.3.7 "Switching connectors."

(Note 12) Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Section 3.3.3.9 "Setting up the slide switches."

(Note 13) The cooling fan power supply for motors of 7.5 kW or less is single-phase. Connect terminals [FU] and [FV].

For motors of 7.5 kW or less (400 V class series), the power voltage/frequency rating of the cooling fan is 200 V/50 Hz or 200-230 V/60 Hz. For motors of 11 kW or above (400 V class series), it is 400-420 V/50 Hz or 400-440 V/60 Hz. To use the fan with power voltage other than the above specifications, a transformer is necessary.

(Note 14) (0V) ([M], [11], [THC]) and [0V] ([CM], (PGM)) are insulated inside the inverter unit.

(Note 15) Use the auxiliary contact (manual reset) of the thermal relay to trip the MCCB or MC.

(Note 16) Jumper bars are mounted between safety terminals [EN1]/[EN2] and [PS] by factory default. To use the safety function, remove the jumper bars before connection of safety devices.

3.3.3.6 Detailed functions of main circuit terminals and grounding terminals

① **Primary grounding terminal (⏚G) for inverter enclosure**

Two grounding terminals (⏚G) are not exclusive to the power supply wiring (primary circuit) or motor wiring (secondary circuit). Be sure to ground either of the two grounding terminals for safety and noise reduction. The inverter is designed for use with safety grounding to avoid electric shock, fire and other disasters.

The grounding terminal for inverter enclosure should be grounded as follows:

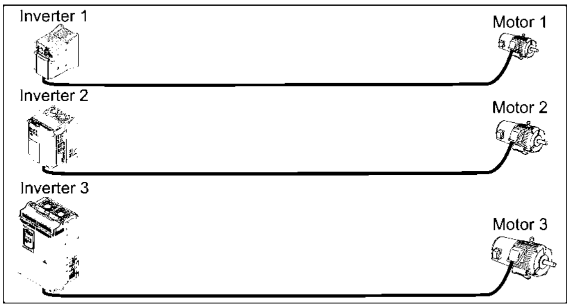
1) Ground the inverter in compliance with the national or local electric code.
2) Use a thick grounding wire with a large surface area and keep the wiring length as short as possible.

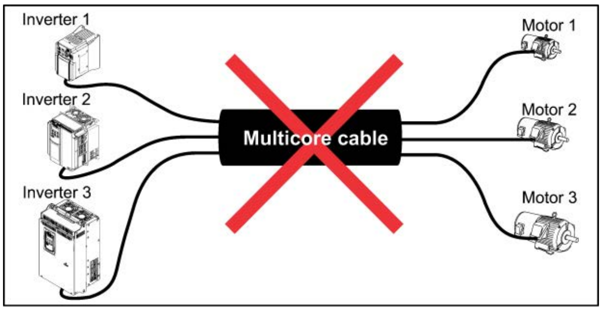
② **Inverter output terminals U, V, and W and secondary grounding terminals (⏚G) for motor**

Inverter's output terminals should be connected as follows:

1) Connect the three wires of the 3-phase motor to terminals U, V, and W, aligning the phases each other.
2) Connect the secondary grounding wire to the grounding terminal (⏚G).

Note When there is more than one combination of an inverter and motor, do not use a multicore cable for the purpose of handling their wirings together.





③ **DC reactor terminals P1 and P(+)**

Connect a DC reactor (DCR) to these terminals for power factor correction.

1) Remove the jumper bar from terminals P1 and P(+).
   (Inverters of 75 kW or above and LD-mode inverters of 55 kW are not equipped with a jumper bar.)
2) Connect an optional DCR to those terminals.

Note
- The wiring length should be 10 m or below.
- Do not remove the jumper bar when a DCR is not used.
- For inverters of 75 kW or above and LD-mode inverters of 55 kW, a DCR is provided as standard. Be sure to connect the DCR to the inverter.
- When a PWM converter is connected to the inverter, no DCR is required.

⚠WARNING
Be sure to connect an optional DC reactor (DCR) when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity. **Otherwise, a fire could occur.**

④ DC braking resistor terminals P(+) and DB (Inverters of 55 kW or below for 200 V class series and those of 160 kW or below for 400 V class series)

1) Connect an optional DBR to terminals P(+) and DB.
2) Arrange the DBR and inverter so that the wiring length comes to 5 m or less and twist the two DBR wires or route them together in parallel.

⚠WARNING
When connecting a DC braking resistor (DBR), never connect it to terminals other than terminals P(+) and DB. **Otherwise, a fire could occur.**

⑤ DC link bus terminals P(+) and N(-)

Capacity (kW)	Braking transistor	Built-in DC braking resistor (DBR)	Optional devices	Devices and terminals
75 to 90 (200 V) 200 to 630 (400 V)	None	None	Braking unit DC braking resistor (DBR)	Inverter–Braking unit: P(+) and N(-)

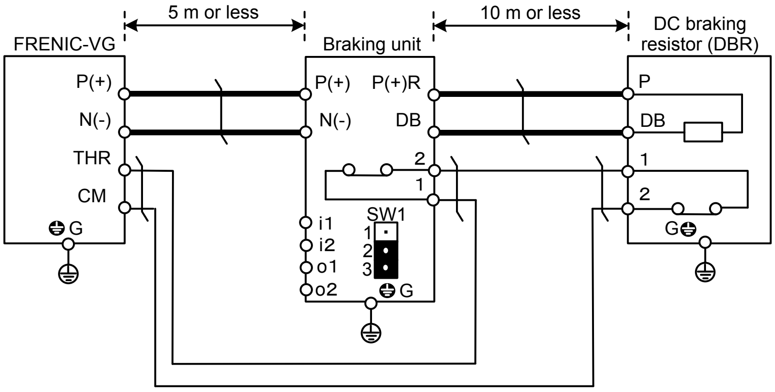
1) Connecting an optional braking unit or DC braking resistor (DBR)

Inverters of 75 kW or above (200 V class series) and those of 200 kW or above (400 V class series) require both a braking unit and DBR.

Connect the terminals P(+) and N(-) of a braking unit to those on the inverter. Arrange the inverter and the braking unit so that the wiring length comes to 5 m or less and twist the two wires or route them together in parallel.

Next, connect the terminals P(+) and DB of a DBR to those on the braking unit. Arrange the braking unit and DBR so that the wiring length comes to 10 m or less and twist the two wires or route them together in parallel.

For details about the wiring, refer to the Braking Unit Instruction Manual.



2) Connecting other external devices

A DC link bus of other inverter(s) or a PWM converter is connectable to these terminals.

For connection examples at the PWM converter side, refer to Chapter 8, Section 8.5.2 "Power regenerative PWM converters, RHC series."

⑥ Main circuit power input terminals L1/R, L2/S, and L3/T (three-phase input)

The three-phase input power lines are connected to these terminals.

1) For safety, make sure that the molded case circuit breaker (MCCB) or magnetic contactor (MC) is turned OFF before wiring the main circuit power input terminals.
2) Connect the main circuit power supply wires (L1/R, L2/S and L3/T) to the input terminals of the inverter via an MCCB or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB)*, and an MC if necessary.

   It is not necessary to align phases of the power supply wires and the input terminals of the inverter with each other.

* With overcurrent protection

Tip It is recommended to insert a manually operable magnetic contactor (MC) that allows you to disconnect the inverter from the power supply in an emergency (e.g., when the protective function is activated), preventing a failure or accident from causing secondary disasters.

⑦ Auxiliary control power input terminals R0 and T0

In general, the inverter runs normally without power supplied to the auxiliary control power input terminals R0 and T0. If the inverter main power is shut down, however, no power is supplied to the control circuit so that the inverter cannot issue a variety of output signals or display on the keypad.

To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect the auxiliary control power input terminals R0 and T0 to the power supply lines. If a magnetic contactor (MC) is installed in the inverter's primary circuit, connect the primary circuit of the MC to these terminals R0 and T0.

Terminal rating:

200 to 240 VAC, 50/60 Hz, Maximum current 1.0 A (200 V class series with 22 kW or below)
200 to 230 VAC, 50/60 Hz, Maximum current 1.0 A (200 V class series with 30 kW or above)
380 to 480 VAC, 50/60 Hz, Maximum current 0.5 A (400 V class series)

Note When introducing a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB), connect its output (secondary) side to terminals R0 and T0. Connecting its input (primary) side to those terminals causes the RCD/ELCB to malfunction since the input power voltage to the inverter is three-phase but the one to terminals R0 and T0 is single-phase. To avoid such problems, be sure to insert an insulation transformer or auxiliary B contacts of a magnetic contactor in the location shown below.

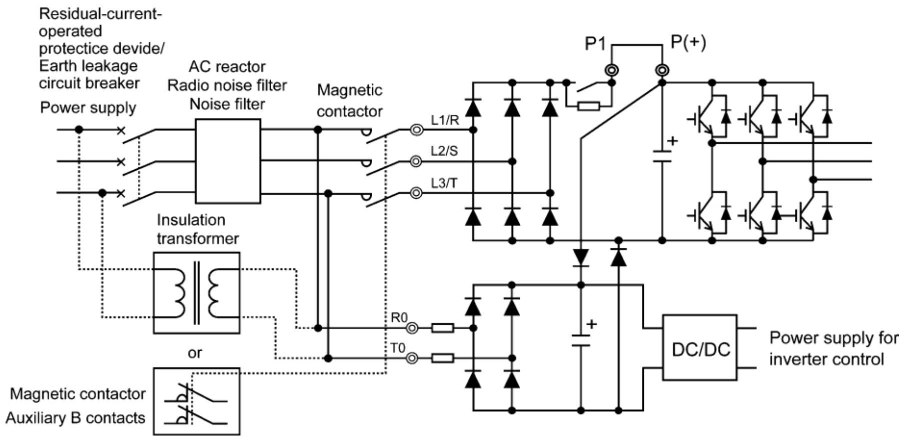


Figure 3.3-6 Connection Example of Residual-current-operated Protective Device (RCD)/ Earth Leakage Circuit Breaker (ELCB)

Note: When connecting a PWM converter with an inverter, do not connect the power supply line directly to terminals R0 and T0. If a PWM is to be connected, insert an insulation transformer or auxiliary B contacts of a magnetic contactor at the power supply side.

For connection examples at the PWM converter side, refer to Chapter 8, Section 8.5.2 "Power regenerative PWM converters, RHC series."

⑧ Auxiliary fan power input terminals R1 and T1

The 200 V class series with 37 kW or above and 400 V class series with 75 kW or above are equipped with terminals R1 and T1. Only if the inverter works with the DC-linked power input whose source is a PWM converter, these terminals are used to feed AC power to the fans, while they are not used in any power system of ordinary configuration.

In this case, set up the fan power supply switching connectors (CN R and CN W).

Terminal rating:

(200 V class series with 37 kW or above)
200-220 VAC/50 Hz, 200-230 VAC/60 Hz, Maximum current 1.0 A

(400 V class series with 75 kW to 400 kW)
380-440 VAC/50 Hz, 380-480 VAC/60 Hz, Maximum current 1.0 A

(400 V class series with 500 kW and 630 kW)
380-440 VAC/50 Hz, 380-480 VAC/60 Hz, Maximum current 2.0 A

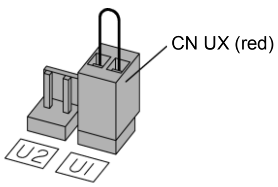
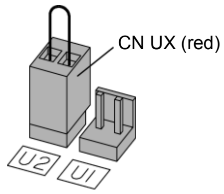
3.3.3.7 Switching connectors

■ **Power switching connectors (CN UX), for inverters of 75 kW or above (400 V class series)**

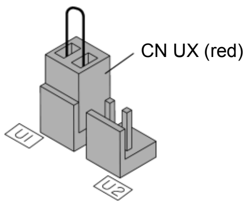
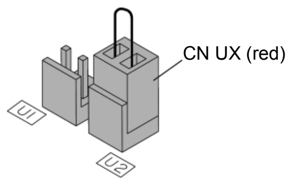
Inverters of 75 kW or above (400 V class series) are equipped with a set of switching connectors (male) which should be configured according to the power source voltage and frequency. By factory default, a jumper (female connector) is set to U1. If the power supply to the main power inputs (L1/R, L2/S, L3/T) or the auxiliary fan power input terminals (R1, T1) matches the conditions listed below, change the jumper to U2.

For the switching instructions, see Figures 3.3-7 and 3.3-8.

(a) FRN75VG1S-4□ to FRN110VG1S-4□

Connector configuration		
Power source voltage	398 to 440 V/50 Hz, 430 to 480 V/60 Hz (Factory default)	380 to 398 V/50 Hz 380 to 430 V/60 Hz

(b) FRN132VG1S-4□ to FRN630VG1S-4□

Connector configuration		
Power source voltage	398 to 440 V/50 Hz, 430 to 480 V/60 Hz (Factory default)	380 to 398 V/50 Hz, 380 to 430 V/60 Hz

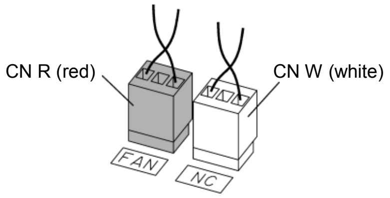
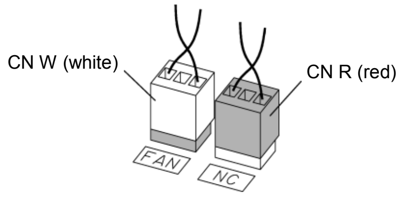
Note
- The allowable power input voltage fluctuation is within -15% to +10% of the power source voltage.
- A box (□) replaces an alphabetic letter depending on the shipping destination.

■ **Fan power supply switching connectors (CN R and CN W), for inverters of 37 kW or above (200 V class series) and those of 75 kW or above (400 V class series)**

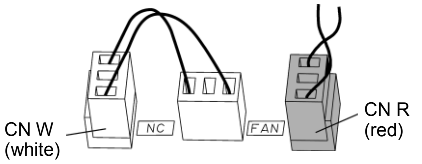
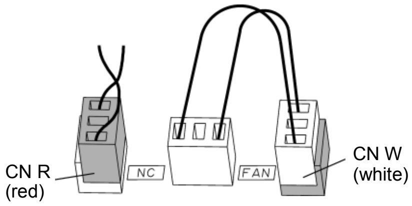
The standard FRENIC-VG series accepts DC-linked power input in combination with a PWM converter. The 200 V class series with 37 kW or above and 400 V class series with 75 kW or above, however, contain AC-driven components such as AC fans. To supply AC power to those components, exchange the CN R and CN W connectors as shown below and connect the AC power line to the auxiliary fan power input terminals (R1, T1).

For the switching instructions, see Figures 3.3-7 and 3.3-8.

(a) FRN37VG1S-2□ to FRN75VG1S-2□, FRN75VG1S-4□ to FRN110VG1S-4□

Connector configuration		
Use conditions	When not using terminal R1 or T1 (Factory default)	When using terminals R1 and T1 • Feeding the DC-linked power • Combined with a PWM converter

(b) FRN90VG1S-2□, FRN132VG1S-4□ to FRN630VG1S-4□

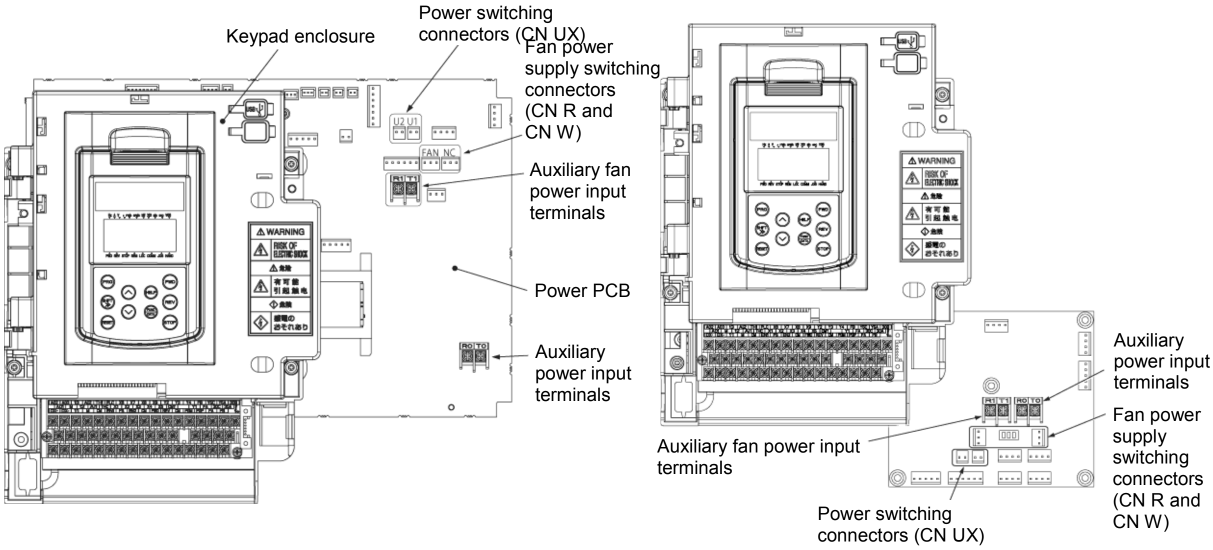
Connector configuration		
Use conditions	When not using terminal R1 or T1 (Factory default)	When using terminals R1 and T1 • Feeding the DC-linked power • Combined with a PWM converter

Note

- By factory default, the fan power supply switching connectors CN R and CN W are set on the FAN and NC positions, respectively. Do not exchange them unless you drive the inverter with a DC-linked power supply.
- Wrong configuration of these switching connectors cannot drive the cooling fans, causing a heat sink overheat alarm OH1 or a charger circuit alarm PbF.
- A box (□) replaces an alphabetic letter depending on the shipping destination.

■ **Location of the switching connectors**

The switching connectors are located on the power printed circuit board (power PCB) as shown below.



(a) FRN37VG1□-2□ to FRN75VG1□-2□, FRN75VG1□-4□ to FRN110VG1□-4□

(b) FRN90VG1□-2□, FRN132VG1□-4□ to FRN630VG1□-4□

Figure 3.3-7 Location of Switching Connectors and Auxiliary Power Input Terminals

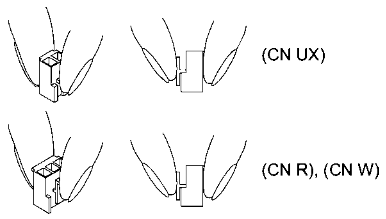


Figure 3.3-8 Inserting/Removing the Jumpers

Note: To remove each of the jumpers, pinch its upper side between your fingers, unlock its fastener, and pull it up.

When mounting it, fit the jumper over the connector until it snaps into place.

3.3.3.8 Detailed functions of control circuit terminals

⚠WARNING

In general, the covers of the control signal wires are not specifically designed to withstand a high voltage (i.e., reinforced insulation is not applied). Therefore, if a control signal wire comes into direct contact with a live conductor of the main circuit, the insulation of the cover might break down, which would expose the signal wire to a high voltage of the main circuit. Make sure that the control signal wires will not come into contact with live conductors of the main circuit.

Failure to observe these precautions could cause electric shock or an accident.

⚠CAUTION

Noise may be emitted from the inverter, motor and wires. Take appropriate measures to prevent the nearby sensors and devices from malfunctioning due to such noise.

It takes a maximum of 5 seconds to establish the input/output of the control circuit after the main power is turned ON. Take appropriate measures, such as external timers.

An accident could occur.

Table 3.3-8 lists the symbols, names and functions of the control circuit terminals. The wiring to the control circuit terminals differs depending upon the setting of the function codes, which reflects the use of the inverter. Route wires properly to reduce the influence of noise.

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals

Classification	Symbol	Name	Functions
Analog input	[13]	Power supply for potentiometer	Power supply (+10 VDC) for an external speed command potentiometer. (Variable resistor: 1 to 5kΩ) The potentiometer of 1/2 W rating or more should be connected. Specifications: 10 VDC/10 mA max.
	[12]	Analog setting voltage input	The speed is commanded according to the external voltage input. Specifications: • 0 to ±10 VDC/0 to maximum speed Maximum input voltage: ±15 VDC Note that the input voltage out of the range of ±10 VDC is regarded as ±10 VDC. • Input impedance: 10kΩ
	[Ai1] [Ai2]	Analog input 1 Analog input 2	(1) Analog input voltage from external equipment. Possible to assign various signal functions (Input signal off, Auxiliary speed setting 1, Torque limiter (level 1, etc.), selected with Function codes E49 and E50 to these terminals. For details, refer to Chapter 4, Section 4.2 "Function Codes." (2) Only for terminal [Ai2], the input is switchable between voltage and current with the SW3 configuration. (For details about slide switches, refer to Section 3.3.3.9.) (3) To use terminal [Ai2] for current input speed setting (***N-REFC***), turn SW3 to the I position, set F01 or C25 to "9" and set E50 to "26." After that, check that the current input is normal on the I./O check screen (given in Section 3.4.4.5). Specifications: • Voltage input: 0 to ±10 VDC, Input impedance: 10kΩ Maximum input voltage: ±15 VDC Note that the input voltage out of the range of ±10 VDC is regarded as ±10 VDC. • Current input (only on terminal [Ai2]): Input impedance: 250Ω Maximum input current: 30 mADC Note that the input current exceeding 20 mADC is regarded as 20 mADC.
	[11] [M]	Analog input common	Common for analog input signals ([12], [Ai1] and [Ai2]). Isolated from terminals [CM], [CMY] and [PGM].

Note

- Since low level analog signals are handled, these signals are especially susceptible to the external noise effects. Route the wiring as short as possible (within 20 m) and use shielded wires. In principle, ground the shielded sheath of wires; if effects of external inductive noises are considerable, connection to terminal [11] may be effective. As shown in Figures 3.3-9 and 3.3-10, be sure to ground the single end of the shield to enhance the shield effect.
- Use a twin-contact relay for low level signals if the relay is used in the control circuit. Do not connect the relay's contact to terminal [11] or [M].
- When the inverter is connected to an external device outputting the analog signal, the external device may malfunction due to electric noise generated by the inverter. If this happens, according to the circumstances, connect a ferrite core (a toroidal core or equivalent) to the device outputting the analog signal or connect a capacitor having the good cut-off characteristics for high frequency between control signal wires as shown in Figures 3.3-9 and 3.3-10.
- Do not apply a voltage of +7.5 VDC or higher to terminal [C1]. Doing so could damage the internal control circuit.

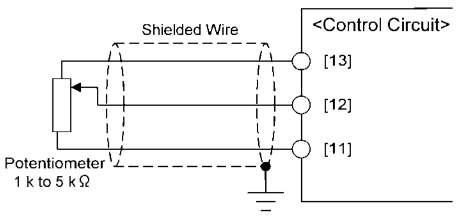


Figure 3.3-9 Connection of Shielded Wire

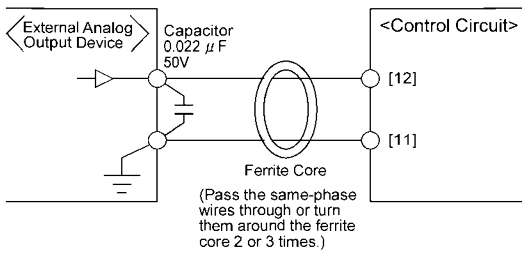


Figure 3.3-10 Example of Electric Noise Reduction

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

Classifi-cation	Symbol	Name	Functions
Digital input	[FWD]	Run forward command	(1) In SINK mode: When terminals [FWD] and [CM] are closed, the motor runs in the forward direction; when they are opened, the motor decelerates to a stop. In SOURCE mode: When terminals [FWD] and [PLC] are closed, the motor runs in the forward direction; when they are opened, the motor decelerates to a stop. (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. Factory default: SINK (Refer to Section 3.3.3.9 "Setting up the slide switches.")
	[REV]	Run reverse command	(1) In SINK mode: When terminals [REV] and [CM] are closed, the motor runs in the reverse direction; when they are opened, the motor decelerates to a stop. In SOURCE mode: When terminals [REV] and [PLC] are closed, the motor runs in the reverse direction; when they are opened, the motor decelerates to a stop. (SOURCE) (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. Factory default: SINK (Refer to Section 3.3.3.9 "Setting up the slide switches.")
	[X1] [X2] [X3] [X4] [X5] [X6] [X7] [X8] [X9]	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5 Digital input 6 Digital input 7 Digital input 8 Digital input 9	(1) Various signals such as "Coast to a stop," "Enable external alarm trip," and "Select multistep speed" can be assigned to these terminals by setting Function codes E01 to E09. For details, refer to Chapter 4, Section 4.2 "Function Codes." (2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. Factory default: SINK (Refer to Section 3.3.3.9 "Setting up the slide switches.") (3) Function code E14 switches the logic value (1/0) for ON/OFF of the terminals [X1] to [X9]. If the logic value for ON of the terminal [X1] is "1" in the normal logic system, for example, OFF is "1" in the negative logic system and vice versa. (Digital input circuit specifications)

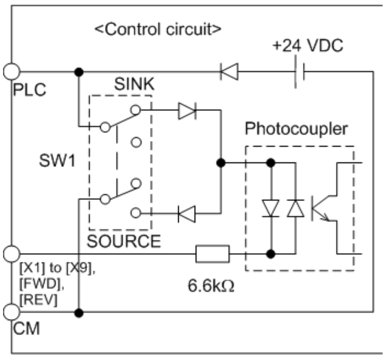
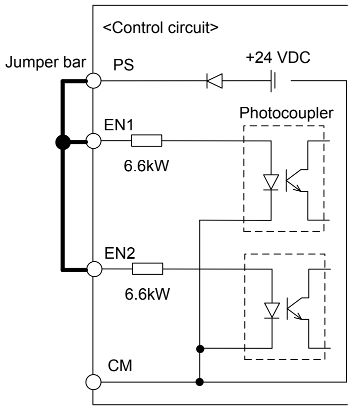
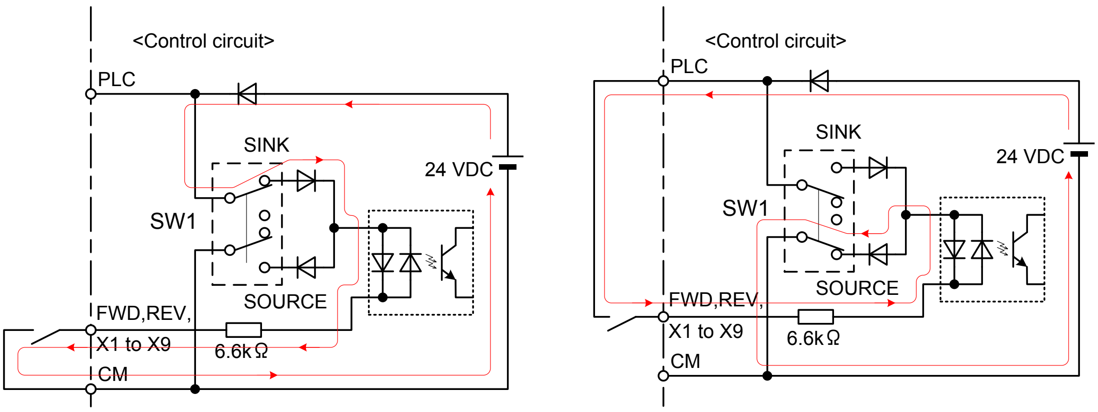


Figure 3.3-11 Digital Input Circuit

Item		Min.	Max.
Operating voltage (SINK)	ON level	0 V	2 V
	OFF level	22 V	27 V
Operating voltage (SOURCE)	ON level	22 V	27 V
	OFF level	0 V	2 V
Operating current at ON (Input voltage is at 0 V)		–	4.5 mA
Allowable leakage current at OFF		–	0.5 mA

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="5">Digital input</td><td>[EN1]
[EN2]</td><td>Enable input</td><td>(1) When [EN1]-[PS] or [EN2]-[PS] is opened (OFF), the inverter output transistor stops its operation. (Safe Torque Off, STO)
To enable the STO function, remove the jumper bars.
(2) The input mode of terminals [EN1] and [EN2] is fixed at SOURCE. It cannot be switched to SINK.
(3) When not using the Enable input function, short the circuit between [EN1]-[PS] and [EN2]-[PS] with jumper bars (that is, keep the short bars connected).
(Terminal EN circuit specification)


<table>
<tr><th colspan="2">Item</th><th>Min.</th><th>Max.</th></tr>
<tr><td rowspan="2">Operating voltage (SOURCE)</td><td>ON level</td><td>22 V</td><td>27 V</td></tr>
<tr><td>OFF level</td><td>0 V</td><td>2 V</td></tr>
<tr><td colspan="2">Operating current at ON (Input voltage is at 0 V)</td><td>–</td><td>4.5 mA</td></tr>
<tr><td colspan="2">Allowable leakage current at OFF</td><td>–</td><td>0.5 mA</td></tr>
</table></td></tr>
<tr><td>[PS]</td><td>[EN] terminal power</td><td>Power terminal for terminals [EN1] and [EN2].
This terminal outputs +24 VDC (Reference for terminal [CM]).</td></tr>
<tr><td>[PLC]</td><td>PLC signal power</td><td>(1) Connects to PLC output signal power supply.
Rated voltage: +24 VDC (Allowable range: +22 to +27 VDC), Maximum 100 mA DC
(2) This terminal also supplies a power to the load connected to the transistor output terminals. Refer to "Transistor output" described later in this table for more.</td></tr>
<tr><td>[CM]</td><td>Digital input common</td><td>Two common terminals for digital input signals
Electrically isolated from terminals [11], [M], and [CMY].</td></tr>
<tr><td>Tip</td><td colspan="2">■ Using a relay contact to turn [FWD], [REV], or [X1] to [X9] ON or OFF
Figure 3.3-12 shows two examples of a circuit configuration that uses a relay contact to turn control signal input [X1] to [X9], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch is turned to SINK, whereas in circuit (b) it is turned to SOURCE.
Note: To configure this kind of circuit, use a highly reliable relay.
(Recommended product: Fuji control relay Model HH54PW.)


(a) With the switch turned to SINK   (b) With the switch turned to SOURCE
Figure 3.3-12 Circuit Configuration Using a Relay Contact</td></tr>
</table>

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td>Digital input</td><td colspan="3">

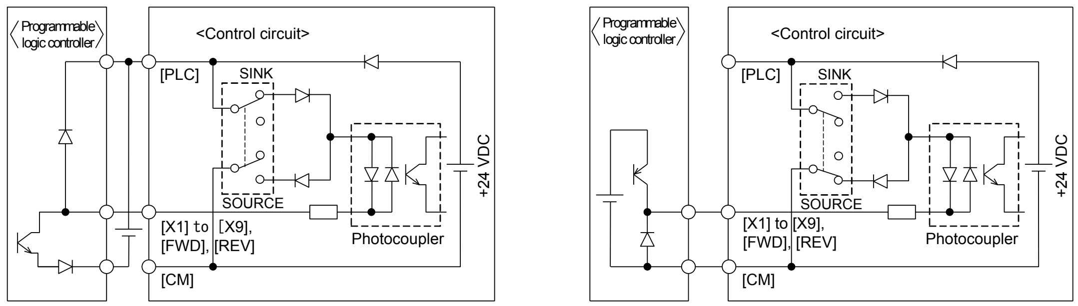
Tip

■ Using a programmable logic controller (PLC) to turn [FWD], [REV], or [X1] to [X9] ON or OFF

Figure 3.3-13 shows two examples of a circuit configuration that uses a programmable logic controller (PLC) to turn control signal input [X1] to [X9], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch is turned to SINK (factory default), whereas in circuit (b) it is turned to SOURCE.

In circuit (a) below, short-circuiting or opening the transistor's open collector circuit in the PLC using an external power supply turns ON or OFF control signal [FWD], [REV], or [X1] to [X9]. When using this type of circuit, observe the following:

- Connect the + node of the external power supply (which should be isolated from the PLC's power) to terminal [PLC] of the inverter.
- Do not connect terminal [CM] of the inverter to the common terminal of the PLC.



(a) With the switch turned to SINK (factory default)

(b) With the switch turned to SOURCE

Figure 3.3-13 Circuit Configuration Using a PLC

For details about the slide switch setting, refer to Section 3.3.3.9 "Setting up the slide switches."

</td></tr>
<tr><td rowspan="2">Analog output</td><td>[Ao1]

[Ao2]

[Ao3]</td><td>Analog output 1

Analog output 2

Analog output 3</td><td>(1) Output of monitor signals with analog voltage 0 to ±10 VDC.
Various signals such as "Detected speed," "Speed setting," and "Torque current command" can be assigned to these terminals by setting Function codes E67 to E71. For details, refer to Chapter 4, Section 4.2 "Function Codes."
(2) Hardware specifications
• Connectable impedance: Min. 3kΩ
• Gain adjustment range: 0.00 to ±100.00 times
Note: For these terminals, select devices having input terminals with a small capacitive load. Large capacitive load may cause the output to oscillate.</td></tr>
<tr><td>[M]</td><td>Analog common</td><td>Common for analog output signals ([Ao1], [Ao2] and [Ao3]).
Electrically isolated from terminals [CM], [CMY] and [PGM].</td></tr>
</table>

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="3">Transistor output</td><td>[Y1]

[Y2]

[Y3]

[Y4]</td><td>Transistor output 1

Transistor output 2

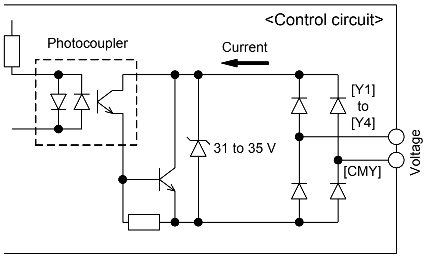
Transistor output 3

Transistor output 4</td><td>

(1) Various signals such as "Inverter running," "Speed valid," and "Speed agreement" can be assigned to these terminals by setting Function codes E15 to E18. For details, refer to Chapter 4, Section 4.2 "Function Codes."

(2) Function code E28 switches the logic value (1/0) for ON/OFF of the terminals between [Y1] to [Y4], and [CMY]. If the logic value for ON between [Y1] to [Y4] and [CMY] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa.

(Transistor output circuit specification)



<table>
<tr><th colspan="2">Item</th><th>Max.</th></tr>
<tr><td rowspan="2">Operation voltage</td><td>ON level</td><td>2 V</td></tr>
<tr><td>OFF level</td><td>27 V</td></tr>
<tr><td colspan="2">Maximum current at ON</td><td>50 mA</td></tr>
<tr><td colspan="2">Leakage current at OFF</td><td>0.1 mA</td></tr>
</table>

Figure 3.3-14 Transistor Output Circuit

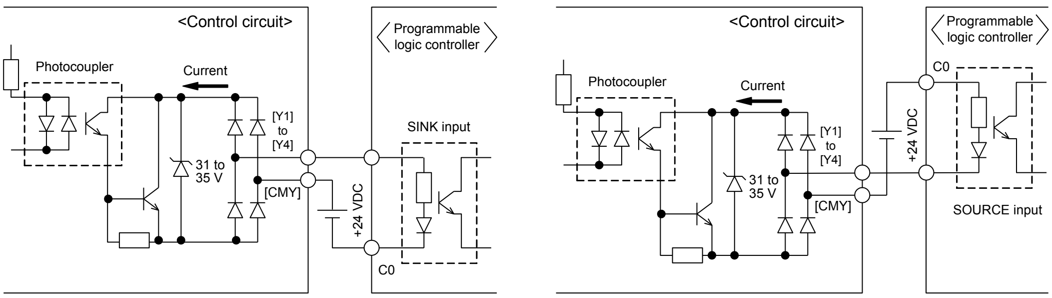
Note
- When a transistor output drives a control relay, connect a surge-absorbing diode across relay's coil terminals.
- When any equipment or device connected to the transistor output needs to be supplied with DC power, feed the power (+24 VDC: allowable range: +22 to +27 VDC, 100 mA max.) through the [PLC] terminal. Short-circuit between the terminals [CMY] and [CM] in this case.

</td></tr>
<tr><td>[CMY]</td><td>Transistor output common</td><td>Common terminal for transistor output signals
Electrically isolated from terminals [CM], [11], [M], and [PGM].</td></tr>
<tr><td colspan="3">

Tip

■ Connecting programmable logic controller (PLC) to terminal [Y1], [Y2], [Y3] or [Y4]

Figure 3.3-15 shows two examples of circuit connection between the transistor output of the inverter's control circuit and a PLC. In example (a), the input circuit of the PLC serves as a SINK for the control circuit output, whereas in example (b), it serves as a SOURCE for the output.



(a) PLC serving as SINK (b) PLC serving as SOURCE

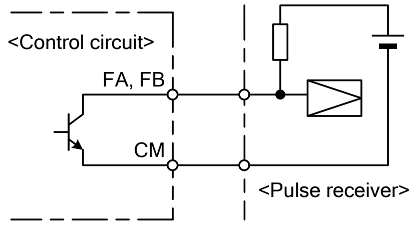
Figure 3.3-15 Connecting PLC to Control Circuit

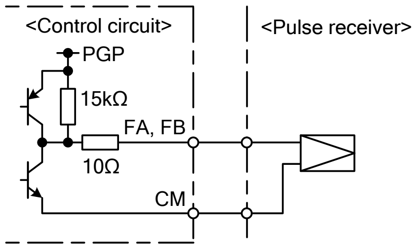
</td></tr>
</table>

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

Classifi-cation	Symbol	Name	Functions
Relay output	[Y5A/C]	General-purpose relay output	(1) Function code E19 selects a general-purpose relay contact output signal usable as well as the function of the transistor output terminal [Y1], [Y2], [Y3] or [Y4]. Contact rating: 250 VAC 0.3 A, cos ϕ = 0.3, 48 VDC, 0.5 A (2) Function code E28 switches the normal/negative logic output applicable to the following two contact output modes: "Active ON" (Terminals [Y5A] and [Y5C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [Y5A] and [Y5C] are opened (non-excited) if the signal is active.)
	[30A/B/C]	Alarm relay output (for any error)	(1) Outputs a contact signal (SPDT) when a protective function has been activated to stop the motor. Contact rating: 250 VAC, 0.3A, cos ϕ = 0.3, 48 VDC, 0.5A (2) Function code F36 switches the normal/negative logic output applicable to the following two contact output modes: "Active ON" (Terminals [30A] and [30C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [30A] and [30C] are opened (non-excited) if the signal is active.)
Communication	[DX+]/ [DX-]	RS-485 communications port (Terminals on control PCB)	Input/output terminals to transmit data through the RS-485 multipoint protocol between the inverter and a computer or other equipment such as a PLC. (For setting of the terminating resistor, refer to Section 3.3.3.9 "Setting up the slide switches.")
	USB connector	USB port (On the keypad)	A USB port connector (mini B) that connects an inverter to a computer. FRENIC-VG Loader (inverter support software*) running on the computer supports editing the function codes, transferring them to the inverter, verifying them, test-running an inverter and monitoring the inverter running status. * FRENIC-VG Loader (free version) is available as an install from the CD-ROM (that comes with the inverter as an accessory) or as a free download from our website at: http://www.fujielectric.com/products/inverter/download/ The free version supports editing, transferring and verifying of function codes and the traceback function.
Speed detection	[PA] [PB]	Pulse generator 2-phase signal input	The PG interface uses a complementary output mode. [PA]: Input terminal for A phase of the pulse generator [PB]: Input terminal B phase of the pulse generator When 12V power supply is in use: H level ≥ 9V, L level ≤ 1.5V When 15V power supply is in use: H level ≥ 12V, L level ≤ 1.5V Input pulse frequency: 100 kHz or below, Duty: 50 ±10% Wiring length (as a guide): 100 m or less (Note) False detection may occur due to noise. Make the wiring length as short as possible and take sufficient noise control measures.
	[PGP]	Pulse generator power supply	Power supply terminal for a pulse generator. The output voltage is switchable between 15V (factory default) and 12V with the output voltage switch SW6 on the control circuit PCB. Output: +15 VDC ±10% or +12 VDC ±10% Maximum current: 270 mA (For output voltage switch SW6, refer to Section 3.3.3.9 "Setting up the slide switches.")
	[PGM]	Common terminal	Common terminal for pulse generator power/signal. Electrically isolated from terminals [11], [M] and [CMY]. Not electrically isolated from terminal [CM], but not equivalent voltage.

Table 3.3-8 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="2">Speed detection</td><td>[FA]
[FB]</td><td>Pulse generator output</td><td>(1) This outputs pulse generator signals with frequency divided to 1/n (where, n is programmable with Function code E29).
(2) Switchable between open collector and complementary (equivalent to the voltage on the [PGP] terminal) transistor outputs.
Factory default: Open collector
(For switching, refer to Section 3.3.3.9 "Setting up the slide switches.")
Open collector


<table>
<tr><th colspan="2">Items</th><th>Max.</th></tr>
<tr><td rowspan="2">Operating voltage</td><td>ON level</td><td>2 V</td></tr>
<tr><td>OFF level</td><td>Indefinite (depends on the receiver side)</td></tr>
<tr><td colspan="2">Operating load current at ON</td><td>15 mA</td></tr>
<tr><td colspan="2">Rated voltage</td><td>15 V</td></tr>
</table>
Complementary


<table>
<tr><th colspan="2">Items</th><th>Min.</th><th>Max.</th></tr>
<tr><td rowspan="2">Operating voltage</td><td>High level</td><td>PGP-3V</td><td>-</td></tr>
<tr><td>Low level</td><td>-</td><td>2 V</td></tr>
<tr><td colspan="2">Operating current at ON</td><td>-</td><td>20 mA</td></tr>
<tr><td colspan="2">Allowable leakage current at OFF</td><td>-</td><td>0.5 mA</td></tr>
</table>
Figure 3.3-16 Pulse Output Circuit</td></tr>
<tr><td>[CM]</td><td>Pulse generator output common</td><td>Common terminal for pulse generator output [FA] and [FB].</td></tr>
<tr><td rowspan="2">Temperature detection</td><td>[TH1]</td><td>NTC/PTC thermistor connection</td><td>Monitors the motor temperature with NTC or PTC thermistor.
For a PTC thermistor, the motor overheat protection level can be specified with Function code E32.</td></tr>
<tr><td>[THC]</td><td>Common</td><td>Common terminal for NTC and PTC thermistors.
Electrically isolated from terminals [CM], [PGM], and [CMY]</td></tr>
</table>

■ Wiring for control circuit terminals

For FRN75VG1□-2□, FRN90VG1□-2□ and FRN132VG1□-4□ to FRN630VG1□-4□

(1) As shown in Figure 3.3-17, route the control circuit wires along the left side panel to the outside of the inverter.

(2) Secure those wires to the wiring support, using a cable tie (e.g., Insulok) with 3.8 mm or less in width and 1.5 mm or less in thickness.

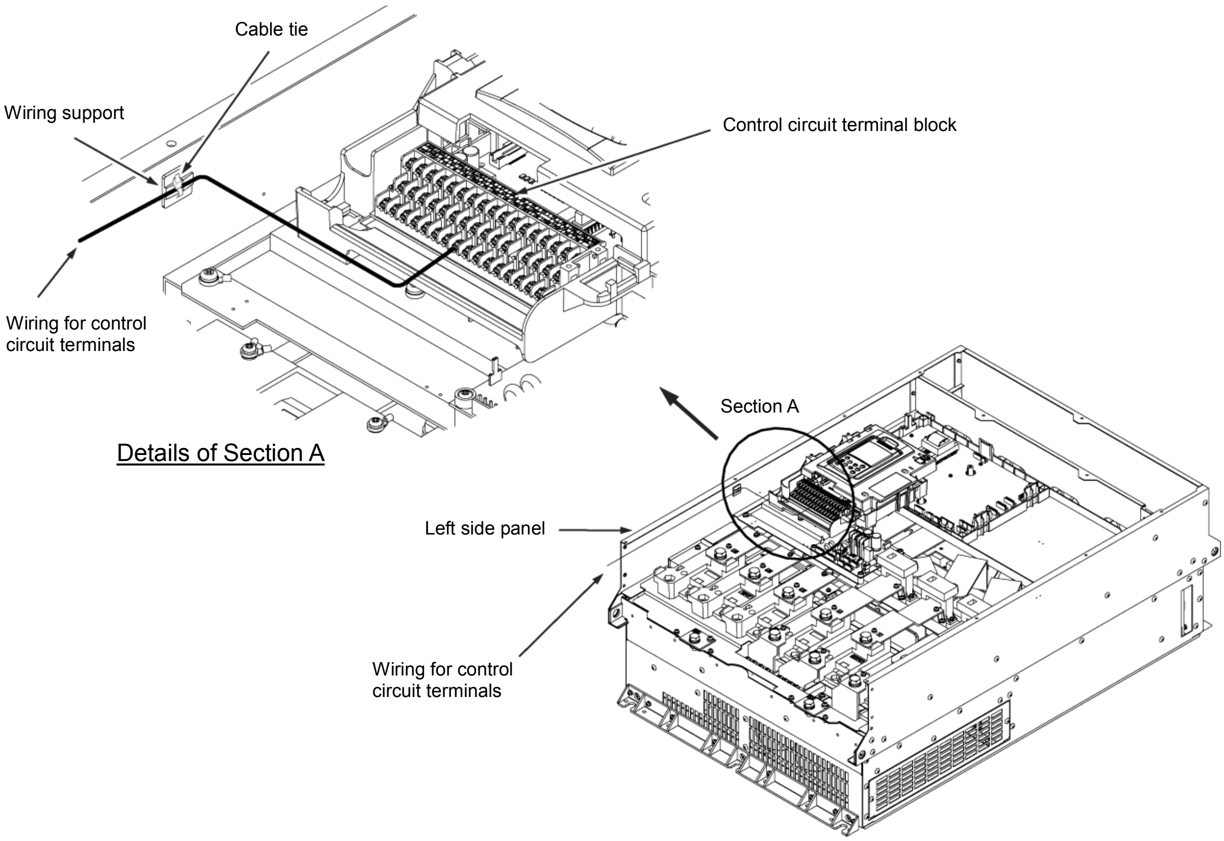


Figure 3.3-17 Wiring Route and Fixing Position for the Control Circuit Wires

Note
- Route the wiring of the control circuit terminals as far from the wiring of the main circuit as possible. Otherwise electric noise may cause malfunctions.
- Fix the control circuit wires with a cable tie inside the inverter to keep them away from the live parts of the main circuit (such as the terminal block of the main circuit).

3.3.3.9 Setting up the slide switches

⚠WARNING⚠

Before changing the switches or touching the control circuit terminal symbol plate, **turn OFF the power and wait at least five minutes for inverters of 22 kW or below, or at least ten minutes for those of 30 kW or above**. Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P(+) and N(-) has dropped to the safe level (+25 VDC or below).

An electric shock may result if this warning is not heeded as there may be some residual electric charge in the DC bus capacitor even after the power has been turned OFF.

Switching the slide switches located on the control PCB allows you to customize the operation mode of the analog output terminals, digital I/O terminals, and communications ports. The locations of those switches are shown in Figure 3.3-18 "Location of the Slide Switches on the Control PCB."

To access the slide switches, remove the front cover so that you can see the control PCB. For inverters with a capacity of 30 kW or above, open also the keypad enclosure.

📖 For details on how to remove the front cover and how to open and close the keypad enclosure, refer to Section 3.3.3.1 "Removing and mounting the front cover and the wiring guide."

Table 3.3-9 lists function of each slide switch.

Table 3.3-9 Function of Each Slide Switch

<table>
<tr><th>Switch</th><th>Function</th></tr>
<tr><td>SW1</td><td>Switches the service mode of the digital input terminals between SINK and SOURCE.
▪ This switches the input mode of digital input terminals [X1] to [X9], [FWD] and [REV] to be used as the SINK or SOURCE mode.
▪ Factory default: SINK</td></tr>
<tr><td>SW2</td><td>Reserved for particular manufacturers.</td></tr>
<tr><td>SW3</td><td>Switches the input mode of the analog input terminal [Ai2] between voltage and current.<table><tr><th>Input form</th><th>SW3</th></tr><tr><td>Voltage input (Factory default)</td><td>V position</td></tr><tr><td>Current input</td><td>I position</td></tr></table></td></tr>
<tr><td>SW4</td><td>Switches the terminating resistor of RS-485 communications port 2 on the terminal block ON and OFF.
▪ If the inverter is connected to the RS-485 communications network as a terminating device, turn SW4 to ON.</td></tr>
<tr><td>SW5</td><td>Reserved for particular manufacturers.</td></tr>
<tr><td>SW6</td><td>Switches the output voltage of terminal [PGP] between 12 V and 15 V.
Select the voltage level that matches the power voltage of the pulse generator to be connected.<table><tr><th>Output voltage</th><th>SW6</th></tr><tr><td>12 V</td><td>12 V</td></tr><tr><td>15 V (Factory default)</td><td>15 V</td></tr></table></td></tr>
<tr><td>SW7
SW8</td><td>Switch the output mode of terminals [FA] and [FB] between open collector output and complementary output.<table><tr><th>Output form</th><th>SW7
(Terminal [FA])</th><th>SW8
(Terminal [FB])</th></tr><tr><td>Open collector output (Factory default)</td><td>1</td><td>1</td></tr><tr><td>Complementary output</td><td>2</td><td>2</td></tr></table></td></tr>
</table>

Figure 3.3-18 shows the location of slide switches on the control PCB for the input/output terminal configuration.

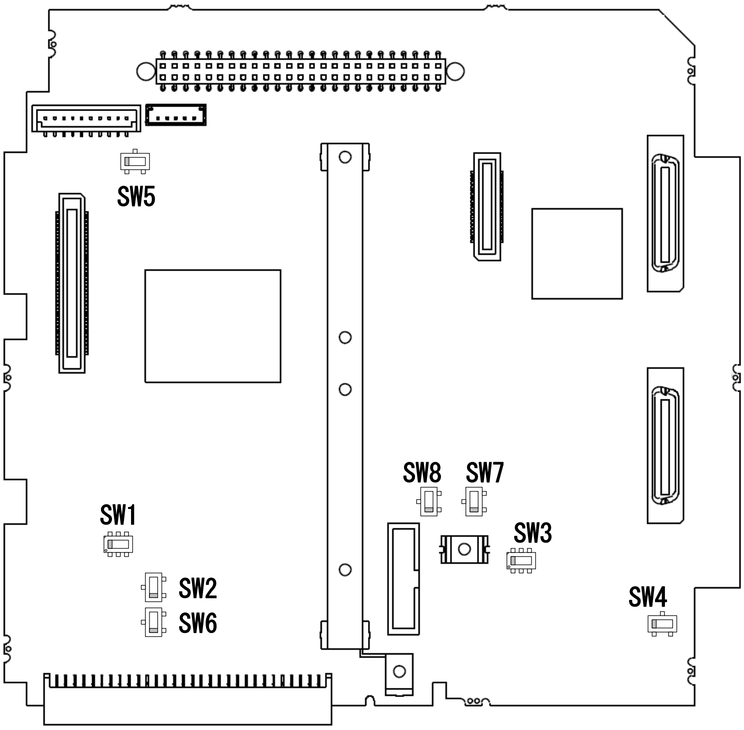


Figure 3.3-18 Location of the Slide Switches on the Control PCB

Switch Configuration and Factory Defaults

	SW1	SW2	SW3	SW4	SW5	SW6	SW7 SW8
Factory default	SINK ←	↓	V ←	OFF ←	←	↓ 15V	↓ 1
---	→ SOURCE		→ I	→ ON		12V ↑	2 ↑

Note To move a switch slider, use a tool with a narrow tip (e.g., a tip of tweezers). Be careful not to touch other electronic parts, etc. If the slider is in an ambiguous position, the circuit is unclear whether it is turned ON or OFF and the digital input remains in an undefined state. Be sure to place the slider so that it contacts either side of the switch.

SW2 and SW5 are reserved for particular manufacturers. Do not access them.

3.3.4 Mounting and connecting a keypad

3.3.4.1 Parts required for connection

To mount a keypad on a place other than an inverter, the parts listed below are needed.

Parts name	Model	Remarks
Extension cable (Note 1)	CB-5S, CB-3S and CB-1S	3 types available in length of 5 m, 3 m, and 1 m.
Fixing screw	M3 × □ (Note 2)	Two screws needed. (To be provided by the customer)

(Note 1) When using an off-the-shelf LAN cable, use a 10BASE-T/100BASE-TX straight type cable compliant with US ANSI/TIA/EIA-568A Category 5. (20 m or less)

Recommended LAN cable

Manufacturer: Sanwa Supply Inc.

Model: KB-10T5-01K (1 m)

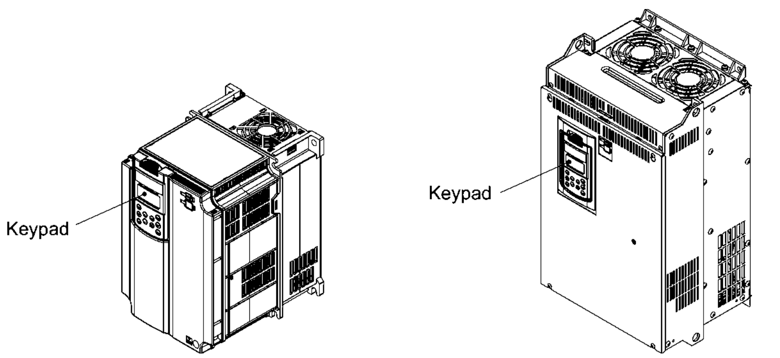
KB-STP-01K: (1 m) (Shielded LAN cable to make the inverter compliant with the EMC Directive)

(Note 2) When mounting on a panel wall, use the screws with a length suitable for the wall thickness.

3.3.4.2 Mounting procedure

You can install and/or use the keypad in one of the following three ways:

- ■ Mounting it directly on the inverter (See Figure 3.3-19 (a), (b).)
- ■ Mounting it on the panel (See Figure 3.3-20.)
- ■ Using it remotely in your hand (See Figure 3.3-21.)



(a) FRN15VG1□-2□ (b) FRN37VG1□-2□

Figure 3.3-19 Mounting the Keypad Directly on the Inverter

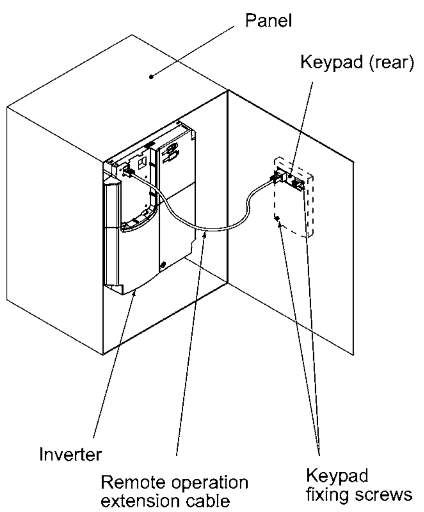


Figure 3.3-20 Mounting the Keypad on the Panel

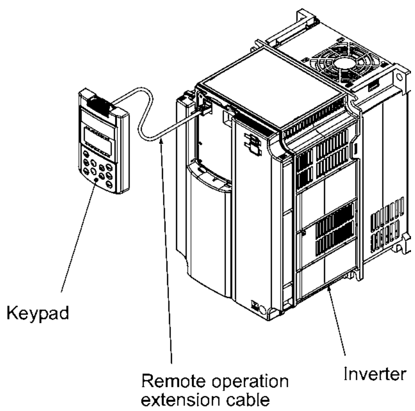


Figure 3.3-21 Using the Keypad Remotely in Your Hand

After completion of wiring, mount the keypad using the following procedure. Make sure that the inverter power is shut down beforehand.

■ **Removing and mounting the keypad from/onto the inverter**

(1) Remove the keypad by pulling it toward you with the hook held down as directed by the arrows in Figure 3.3-22.

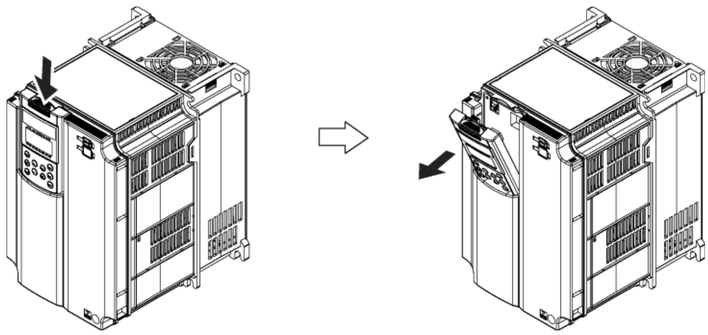


Figure 3.3-22 Removing a Keypad

(2) Put the keypad in the original slot while engaging its bottom latches with the holes (as shown below), and push it onto the case of the inverter (arrow ②) while holding it downward (against the terminal block cover) (arrow ①).

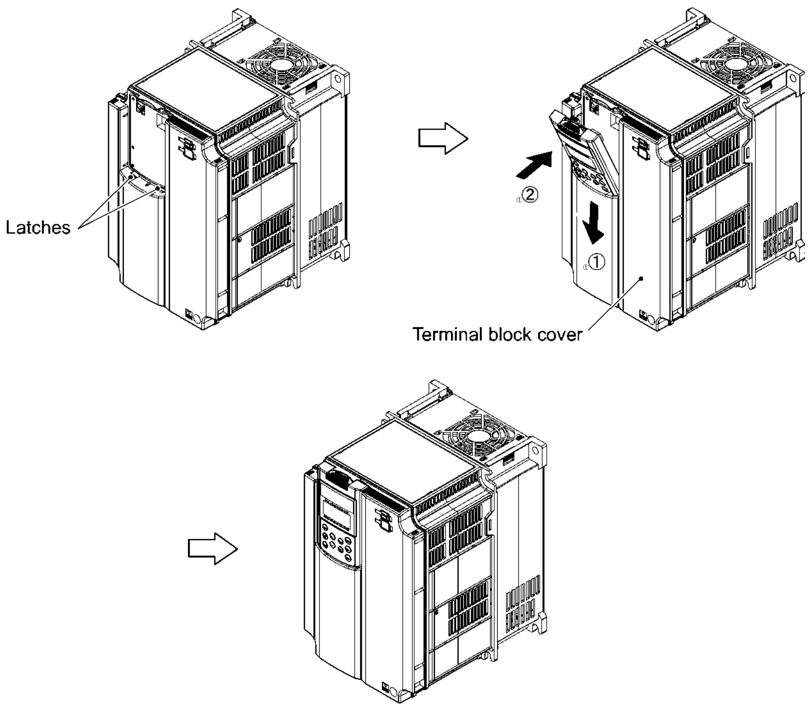


Figure 3.3-23 Mounting the Keypad

■ **Mounting the keypad on the panel**

(1) Cut the panel out for a single square area and perforate two screw holes on the panel wall as shown in Figure 3.3-24.

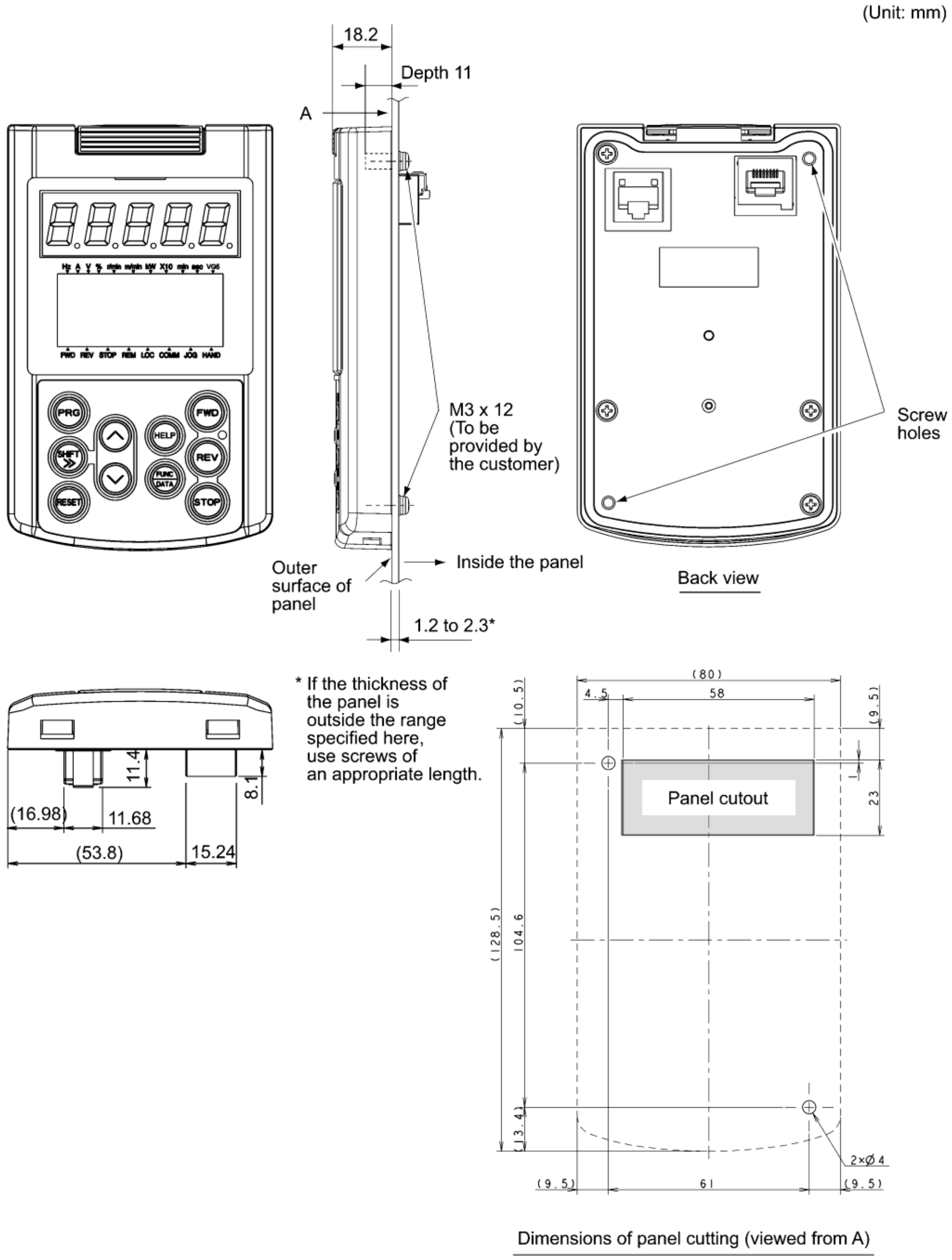


Figure 3.3-24 Location of Screw Holes and Dimension of Panel Cutout

(2) Mount the keypad on the panel wall with 2 screws as shown below. (Recommended tightening torque: 0.7 N•m)

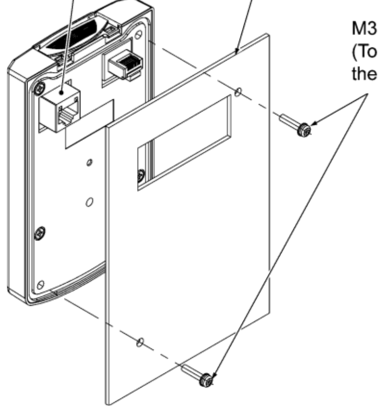


Figure 3.3-25 Mounting the Keypad

(3) Using a remote operation extension cable or a LAN cable, interconnect the keypad and the inverter (insert one end of the cable into the RS-485 port with RJ-45 connector on the keypad and the other end into that on the inverter) (See Figure 3.3-26).

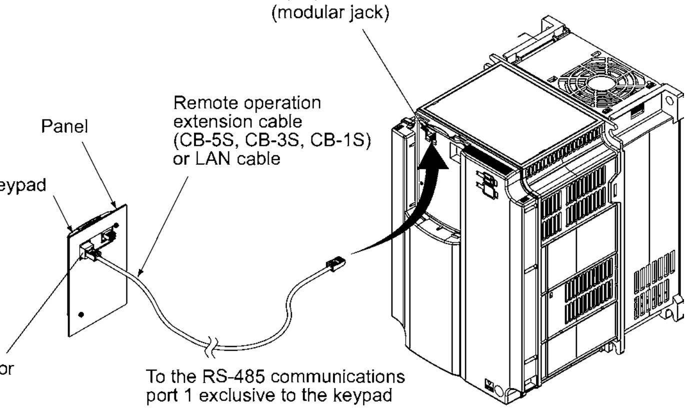


Figure 3.3-26 Connecting the Keypad to the Inverter with Remote Operation Extension Cable or an Off-the-shelf LAN Cable

⚠CAUTION
• The RJ-45 connector on the inverter is exclusive to communication via a touch panel. With the RJ-45 connector, neither RS-485 communication nor connection with FRENIC-VG Loader is possible. • Do not connect the inverter to a LAN port of a computer, Ethernet hub, or telephone line. Doing so may damage the inverter or devices connected. **A fire or accident could occur.**

■ Using the keypad remotely in hand

Follow step (3) of "Mounting the keypad on the panel" above.

3.3.5 USB connectivity

At the right side of the keypad mounting place, a USB port (mini B connector) is provided. To connect a USB cable, open the USB port cover as shown below.

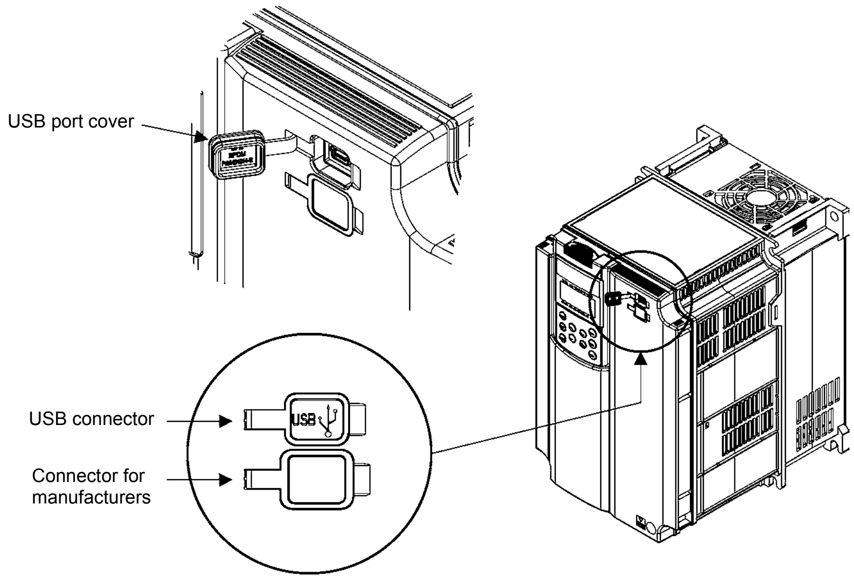


Figure 3.3-27 Connecting a USB Cable

Connecting the inverter to a PC with a USB cable enables remote control from FRENIC-VG Loader. On the PC running FRENIC-VG Loader, it is possible to edit, check and manage the inverter's function code data and monitor the real-time data and the running/alarm status of the inverter.

⚠CAUTION
Connector located beneath the USB connector is provided for particular manufacturers. Do not access it. **Otherwise, a fire or accident could occur.**

3.4 Operation Using the Keypad

3.4.1 Names and functions of keypad components

The keypad allows you to start and stop the motor, view various data including maintenance information and alarm information, configure function codes, monitor I/O signal status, copy data, and calculate the load factor.

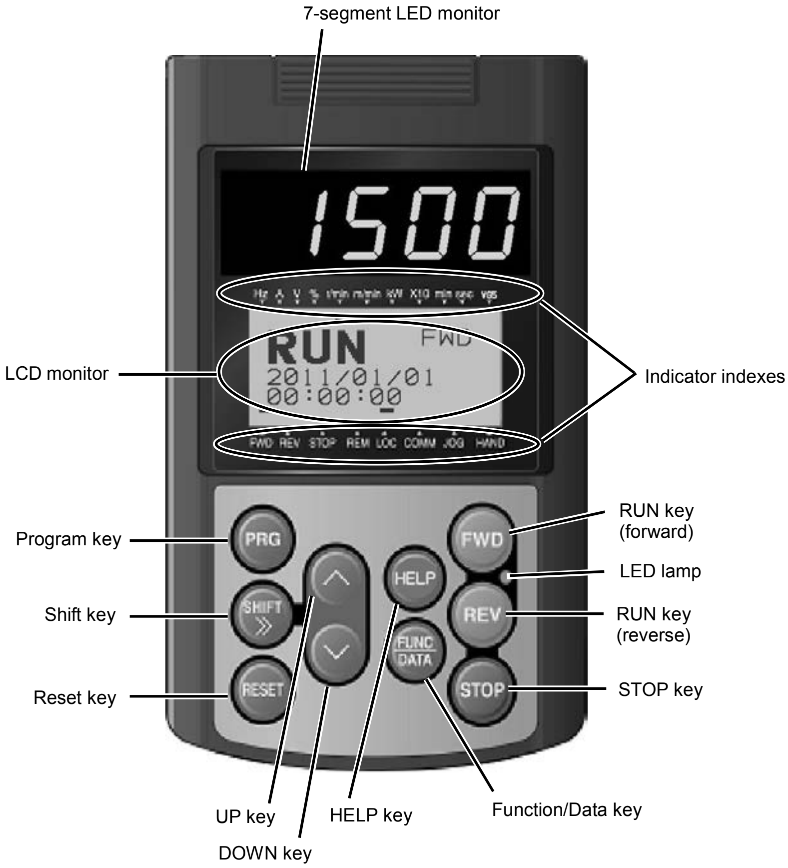
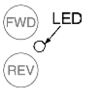
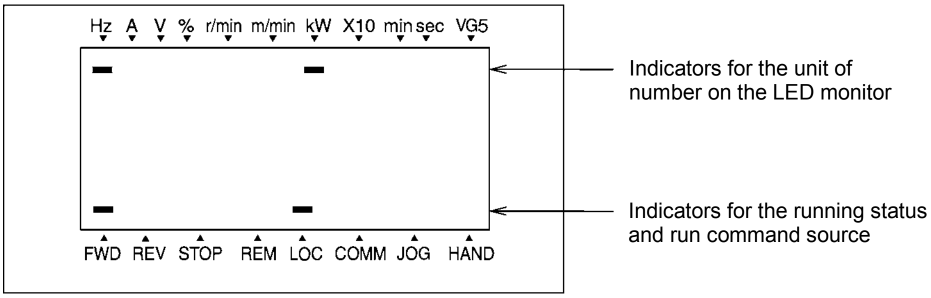


Table 3.4-1 Overview of Keypad Functions

Item	Monitors and Keys	Functions
Monitors		Five-digit, 7-segment LED monitor which displays the following according to the operation modes: ■ In Running mode: Running status information (e.g., detected speed, speed command, and torque command) ■ In Programming mode: Same as above. ■ In Alarm mode: Alarm code, which identifies the cause of alarm when the protective function is activated.
		LCD monitor which displays the following according to the operation modes: ■ In Running mode: Running status information ■ In Programming mode: Menus, function codes and their data ■ In Alarm mode: Alarm information, which identifies the cause of an alarm when the protective function is activated.
	Indicator indexes	In Running mode, these indexes show the unit of the number displayed on the 7-segment LED monitor and the running status information on the LCD monitor. For details, see the next page.
Programming keys	PRG	Switches the operation modes of the inverter.
	SHIFT »	Shifts the cursor to the right for entry of a numerical value.
	RESET	Pressing this key after removing the cause of an alarm switches the inverter to Running mode. This key is used to reset settings or screen transition.
	∧ / ∨	UP and DOWN keys, which are used to select the setting items or change function code data.
	FUNC DATA	Function/Data key, which switches the operation mode as follows: ■ In Running mode: Pressing this key switches the information to be displayed concerning the status of the inverter (detected speed, speed command, torque command, etc.). ■ In Programming mode: Pressing this key displays the function code and establishes the newly entered data. ■ In Alarm mode: Pressing this key displays the details of the problem indicated by the alarm code that has come up on the LED monitor.
	STOP + ∧	This simultaneous keying toggles between the ordinary running mode and jogging mode. The current mode appears on the corresponding indicator.
	STOP + RESET	This simultaneous keying toggles between the remote and local modes. The current mode appears on the corresponding indicator.
	SHIFT » + ∧ / ∨	This simultaneous keying jumps the cursor to the preceding/following function code group (F to M) in selecting a function code.
	SHIFT » + HELP	On the function code data modification screens: This simultaneous keying displays the initial data value. On the running status monitor, I/O checking, and maintenance info. screens: This simultaneous keying holds the displayed data.
Operation keys	FWD	Starts running the motor in the forward rotation.
	REV	Starts running the motor in the reverse rotation.
	STOP	Stops the motor.
	HELP	Switches the screen to the operation guide display prepared for each operation mode or to the menu function guide display.
LED lamp		Lights when the inverter is running.

Details of Indicator Indexes



Type	Item	Description (information, condition, status)
Unit of number on LED monitor	Hz	Output frequency
	A	Output current
	V	Output voltage
	%	Torque command, calculated torque, and load factor
	kW	Input power and motor output
	r/min	Preset and actual (detected) motor speeds
	m/min	Preset and actual line speeds
	X10	Data exceeding 99,999
	min	Not used.
	sec	Not used.
	VG5	Not used.
Running status	FWD	Running in forward rotation
	REV	Running in reverse rotation
	STOP	No output frequency
Run command source	REM	Remote mode (Run command and speed command sources selected by F02 and F01) (In the remote mode, a run command entered via the communications link takes effect. This indicator goes off when H30 = 2 or 3.)
	LOC	Local mode (Run command and speed command sources from the keypad, independent of the setting of F02 and F01.)
	COMM	Via communications link
	JOG	Jogging mode
	HAND	Via keypad This indicator lights also: - in local mode or - in remote mode and when H30 = 0 and F02 = 0

3.4.2 Overview of operation modes

The FRENIC-VG features the following three operation modes.

Table 3.4-2 Operation Modes

Mode	Description
Running Mode	This mode allows you to specify run/stop commands in regular operation. It is also possible to monitor the running status in real time. If a light alarm occurs, the L-AL * appears on the LED monitor.
Programming Mode	This mode allows you to configure function code data and check a variety of information relating to the inverter status and maintenance.
Alarm Mode	If an alarm condition arises, the inverter automatically enters the Alarm mode in which you can view the corresponding alarm code* and its related information on the LED and LCD monitors.

* Alarm code that represents the cause(s) of the alarm(s) that has been triggered by the protective function. For details, refer to Chapter 2, Section 2.5 "Protective Functions."

Figure 3.4-1 shows the status transition of the inverter between these three operation modes.

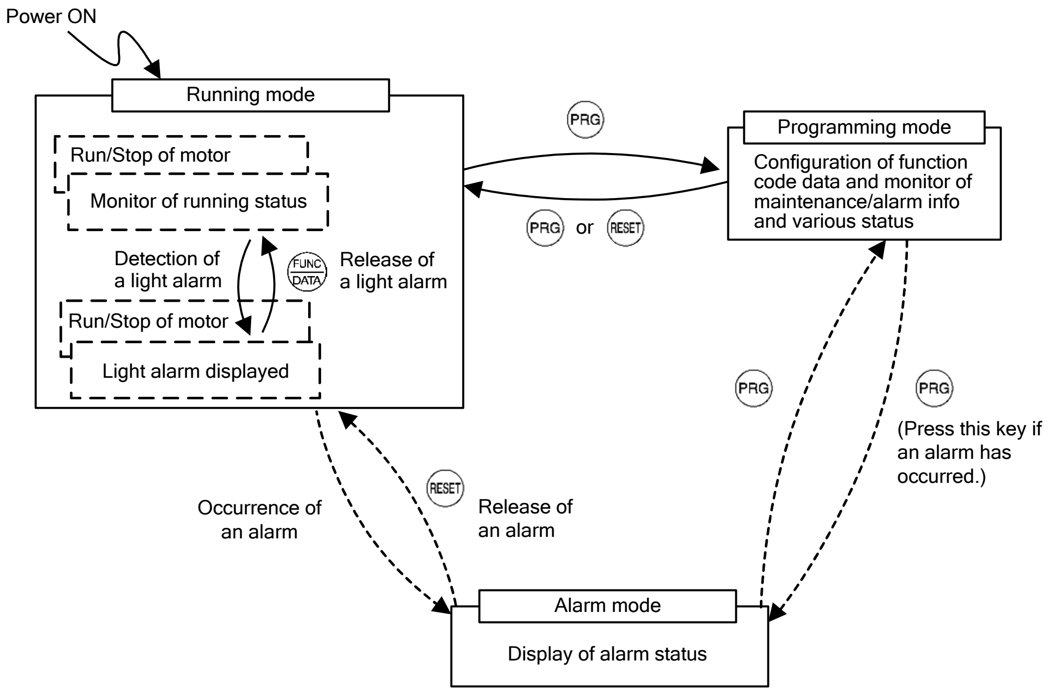


Figure 3.4-1 Status Transition between Operation Modes

3.4.3 Running mode

When the inverter is turned ON, it automatically enters Running mode in which you can:

[1] Configure speed commands,
[2] Run or stop the motor,
[3] Monitor the running status,
[4] Jog (inch) the motor, and
[5] Monitor light alarms.

3.4.3.1 Configuring the speed command

Using ∧ and ∨ keys (F01 = 0 (factory default))

(1) Set function code F01 at "0". This cannot be done when the keypad is in Programming mode or Alarm mode. To enable speed setting using the ∧ and ∨ keys, first switch the keypad to Running mode.

(2) Press the ∧ or ∨ key. The lowest digit on the LED monitor blinks. The 7-segment LED monitor displays the speed command and the LCD monitor displays the related information including the operation guide, as shown below.

(3) Press the ∧ or ∨ key again to change the frequency command. The new setting can be saved into the inverter’s internal memory.

When the speed command source is other than digital setting, the LCD monitor displays the following.

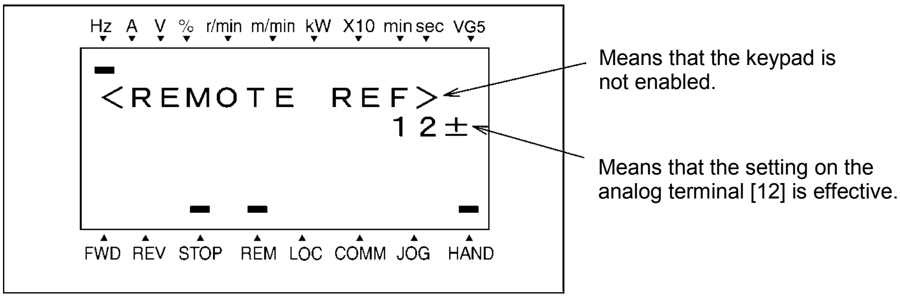


Table 3.4-3 lists the available command sources and their symbols.

Table 3.4-3 Available Command Sources

Symbol	Command source	Symbol	Command source	Symbol	Command source
HAND	Keypad	DIB	DIB card	PID-HAND	PID keypad command
12 ±	Voltage input on terminal [12] (with polarity)	MULTI	Terminal command ***SS8***, ***SS4***, ***SS2***, ***SS1*** ("Select multistep speed")	JOG	Jogging speed
12	Voltage input on terminal [12] (without polarity)	LINK	Terminal command ***LE*** ("Enable communications link") H30: Communications Link Function (Link operation)	LOADER	Inverter support software "FRENIC-VG Loader"
U/D1	UP/DOWN control (Default = 0)	UPAC	UPAC SW1 (Speed command 1): Enable	AI-V	Voltage input on analog input terminal ***N-REFV***
U/D2	UP/DOWN control (Default = Previous value)	PTI	Terminal command ***SYN*** ("Synchronous operation command (pulse train)"): Enable	LOCAL	Keypad in local mode
U/D3	UP/DOWN control (Default = CRP1, 2)	LOCK	Terminal command ***LOCK*** ("Servo-lock command")	AI-C	Current input on analog input terminal ***N-REFC***
DIA	DIA card	PID-AI	PID analog input command Ai		

3.4.3.2 Running or stopping the motor

By factory default, pressing the FWD key starts running the motor in the forward direction and pressing the REV key, in the reverse direction. Pressing the STOP key decelerates the motor to stop. The keypad operation is possible only in Running and Programming modes.

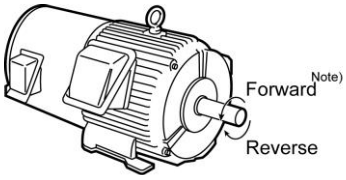


Figure 3.4-2 Rotation Direction of Motor

Note) The rotation direction of IEC-compliant motors is opposite to the one shown above.

■ Displaying the running status on the LCD monitor

(1) When function code F57 (LCD monitor, Item selection) = 0

The LCD monitor displays the current running status, the run command, and the date & time (calendar clock)*. (The upper indicators show the unit of values shown on the LED monitor, and the lower indicators, the running status and run command source.)

* If no backup battery is loaded (option for inverters of 22 kW or below), turning the power OFF resets the calendar clock.

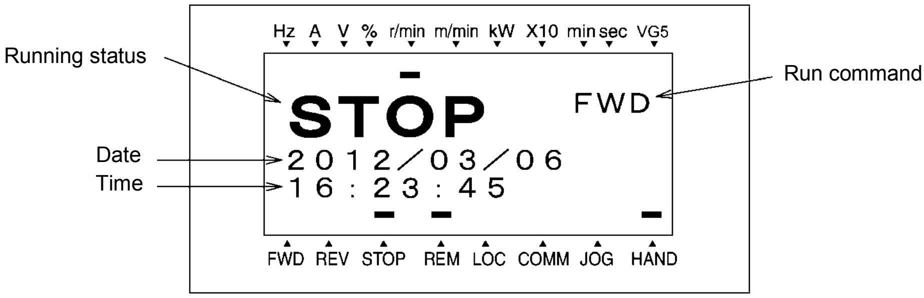


Figure 3.4-3 Display of Running Status

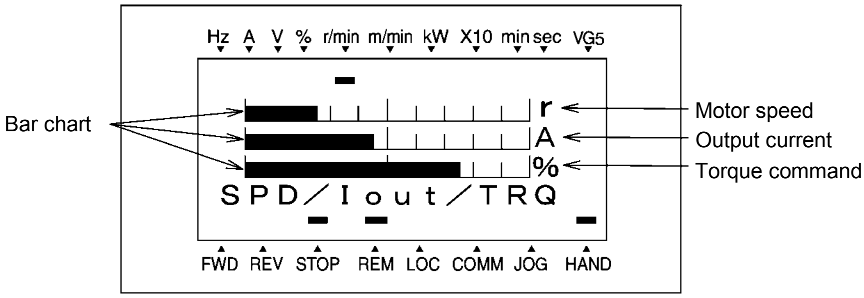
The running status and the run command are displayed as listed below.

Table 3.4-4 Running Status and Run Commands

Running mode display items	Meaning
Running status	RUN: The inverter is running. STOP: No run command is given and the inverter is stopped. JOG: The inverter is jogging.
Run commands	FWD: Run forward command entered. REV: Run reverse command entered. Blank: The inverter is stopped.

(2) <u>When function code F57 (LCD monitor, Item selection) = 1</u>

The LCD monitor displays the motor speed, output current, and torque command in a bar chart. (The upper indicators show the unit of the value shown on the LED monitor, and the lower indicators, the running status and run command source.)



The full scale (maximum value) for each parameter is as follows:

Motor speed: Maximum frequency
Output current: 200% of motor rating
Torque command: 200% of motor rating

Figure 3.4-4 Bar Chart

3.4.3.3 Monitoring the running status on the LED monitor

The items listed below can be monitored on the 7-segment LED monitor. Immediately after the power is turned ON, the monitor item specified by function code F55 is displayed.

Pressing the FUNC/DATA key in Running mode switches between monitor items in the sequence shown in Table 3.4-5.

Table 3.4-5 Monitor Items

Page #	LED monitor: Running	LED monitor: Stopped (F56 = 0) *8	Digital setting mode: Digital speed setting	Digital setting mode: PID command	Unit	Resolution
0	MOTOR SPEED 1 *1	REFERENCE SPEED *1*9	Speed command from keypad	PID command from keypad	r/min	0 to 9999: resolution 1 10000 to 30000: 10
1	REFERENCE SPEED 4 *1				r/min	
2	OUTPUT FREQUENCY				Hz	0.1 to 400.0: resolution 0.1
3	REFERENCE TORQUE CURRENT				%	1%
4	REFERENCE MOTOR TORQUE				%	1%
5	CAL MOTOR TORQUE *2				%	1%
6	MOTOR OUTPUT POWER (kW)				F60 = 0 (kW) F60 = 1 (HP)	0.01 to 99.99: 0.01 100.0 to 999.9: 0.1 1000 or above : 1
7	OUTPUT CURRENT				A	
8	OUTPUT VOLTAGE				V	1 V
9	DC LINK VOLTAGE				V	1 V
10	REFERENCE MAGNETIC FLUX				%	1%
11	CAL MAGNETIC FLUX				%	1%
12	MOTOR TEMPERATURE *3				-	1
13	LOAD SHAFT SPEED *4	LOAD SHAFT SPEED *4	Load speed command from keypad		r/min	1
14	LINE SPEED *4	LINE SPEED *4	Speed command from keypad		m/min	1
15	Ai (12) ADJUSTMENT				%	0.1%
16	Ai (Ai1) ADJUSTMENT				%	0.1%
17	Ai (Ai2) ADJUSTMENT				%	0.1%
18	Ai (Ai3) ADJUSTMENT *5				%	0.1%
19	Ai (Ai4) ADJUSTMENT *5				%	0.1%
20	PID REFERENCE *6				-	0.00 to ±9.99: 0.01 10.0 to ±99.9: 0.1 100 to ±999: 1
21	PID FEEDBACK *6					
22	PID OUTPUT *6					
23	OPTION MONITOR 1 (hex.) *7				in hexadecimal	1
24	OPTION MONITOR 2 (hex.) *7				in hexadecimal	1
25	OPTION MONITOR 3 (dec.) *7				in decimal	1, x 10
26	OPTION MONITOR 4 (dec.) *7				in decimal	1, x 10
27	OPTION MONITOR 5 (dec.) *7				in decimal	1, x 10
28	OPTION MONITOR 6 (dec.) *7				in decimal	1, x 10
29	-				-	-
30	LOAD FACTOR *1				%	1%
31	INPUT POWER				F60 = 0 (kW) F60 = 1 (HP)	0.01 to 99.99: 0.01 100.0 to 999.9: 0.1 1000 or above : 1
32	WATT-HOUR (Display value = Input watt-hour (kWh)/100)				kWh	0.1

*1 Shown as an absolute value.
*2 Under vector control, the inverter outputs the torque value to which the compensation for motor loss (iron loss) is added.
*3 "---" appears when no NTC thermistor is used.
*4 Limited to a maximum of 60,000 in display.
*5 Not shown when no AIO option is mounted.
*6 Not shown when the PID control is disabled.
*7 Shown or not shown, depending upon application. Option monitors 5 and 6 have a sign; option monitors 3 and 4 have not.
*8 For switching the display when the inverter is stopped, refer to the description of function code F56.
*9 For the reference speed monitor to be shown when the inverter is stopped, refer to the block diagram given in Chapter 4, Section 4.1.2 "Speed Command Selection Section."

The LCD monitor (given below) shows information related to the item shown on the LED monitor. The monitor item on the LED monitor can be switched by pressing the (FUNC/DATA) key.

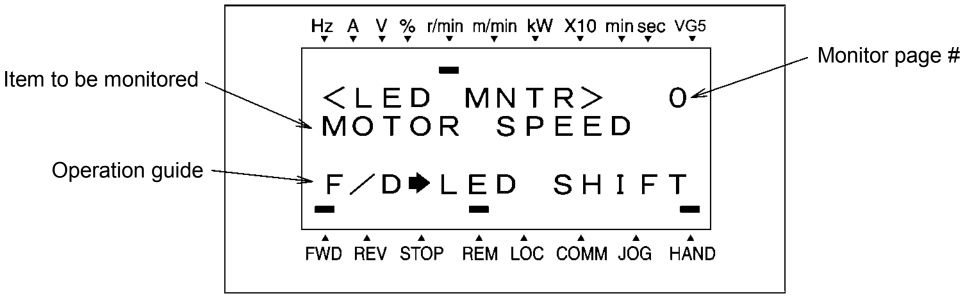


Figure 3.4-5 LCD Monitor Sample Detailed for the LED Monitor Item

3.4.3.4 Jogging (inching) the motor

To start jogging operation, perform the following procedure.

(1) Make the inverter ready to jog with the steps below.

1) Switch the inverter to Running mode.

2) Press the "(STOP) + (∧) keys" simultaneously. The lower indicator above the "JOG" index comes ON.

(2) Jog the motor.

While the (FWD) or (REV) key is held down, the motor continues jogging. Releasing the key decelerates the motor to stop.

(3) Make the inverter exit from the ready-to-jog state and return to the normal operation state.

Press the "(STOP) + (∧) keys" simultaneously. The lower indicator above the "JOG" index goes OFF.

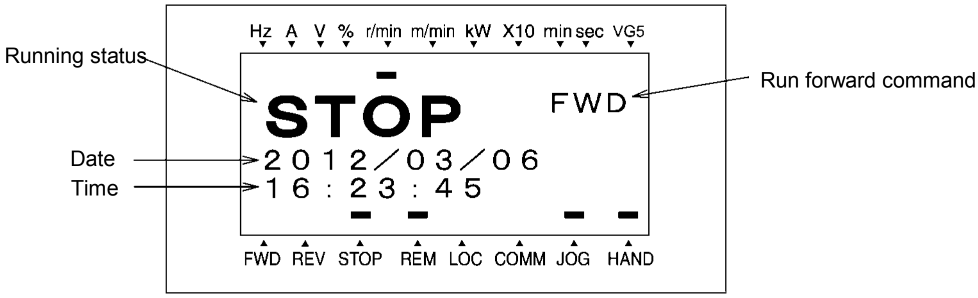


Figure 3.4-6 Display of Jogging Mode

3.4.3.5 Monitoring light alarms

The inverter identifies abnormal states in two categories--Heavy alarm and Light alarm. If the former occurs, the inverter immediately trips; if the latter occurs, the inverter shows the L -AL on the LED monitor and blinks the "L-ALARM" indication in the operation guide area on the LCD monitor but it continues to run without tripping.

Which abnormal states are categorized as a light alarm ("Light alarm" object) should be defined with function codes H106 to H111 beforehand.

Assigning the ***L-ALM*** signal to any one of the general-purpose, digital output terminals with any of function codes E15 to E27 (data = 57) enables the inverter to output the ***L-ALM*** signal on that terminal upon occurrence of a light alarm.

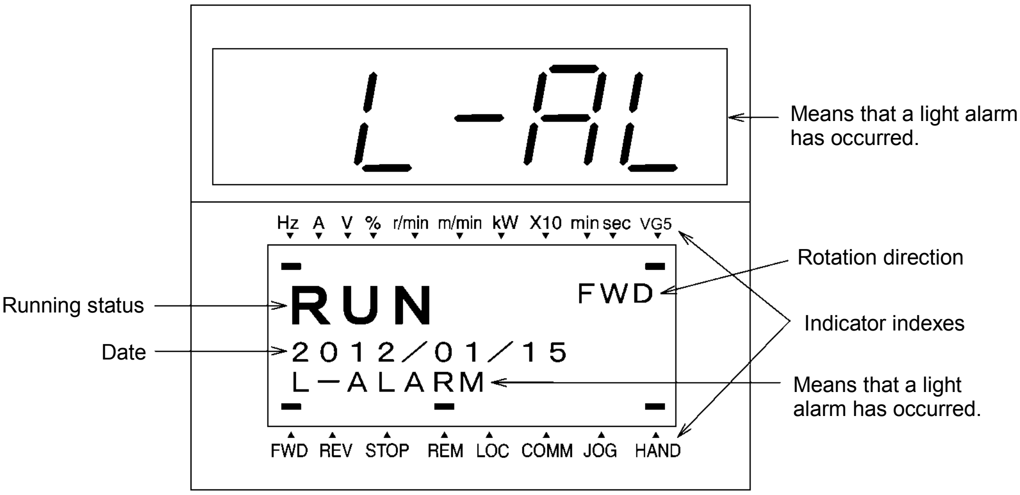


Figure 3.4-7 Display of Light Alarm

For details of the light alarm factors, refer to Chapter 13 "TROUBLESHOOTING."

■ **How to check a light alarm factor**

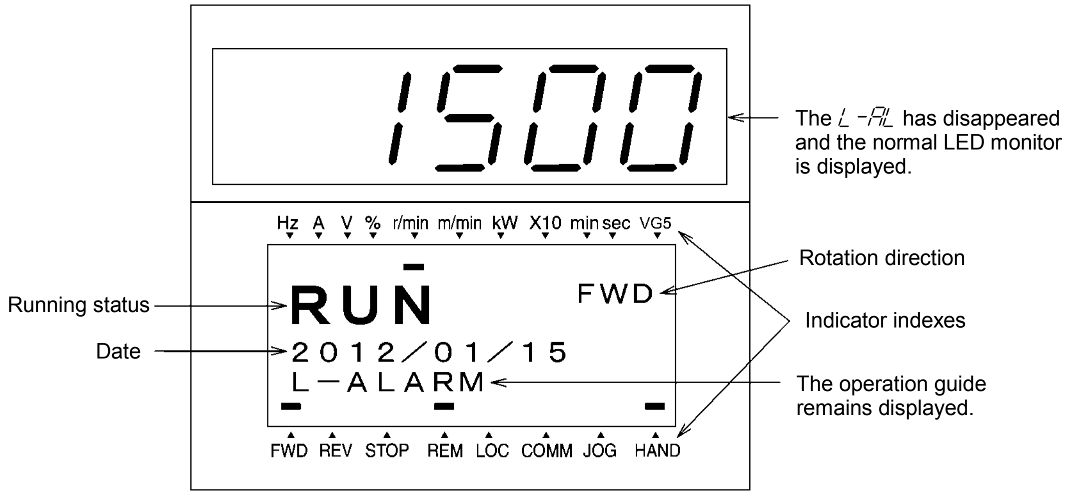
If a light alarm occurs, L -AL appears on the LED monitor. To check the current light alarm factor, switch to Programming mode by pressing the PRG key and select LALM1 on Menu #5 "Maintenance Information." For details of the menu transition of the maintenance information, refer to Section 3.4.4.6 "Reading maintenance information."

It is also possible to check the factors of the last three light alarms by selecting LALM2 (last) to LALM4 (3rd last).

■ How to remove the current light alarm

After checking the current light alarm, to switch the LED monitor from the L-AL indication back to the running status display, press the FUNC/DATA key in Running mode. To reset a light alarm via the communications link, use an alarm reset signal.

If the light alarm factor has been removed, the "L-ALARM" disappears and the ***L-ALM*** output signal turns OFF. If not (e.g. DC fan lock), the L-AL on the LED monitor disappears so that normal monitoring becomes available, but the "L-ALARM" remains displayed on the LCD monitor (as shown below) and the ***L-ALM*** output signal remains ON.



3.4.4 Programming mode

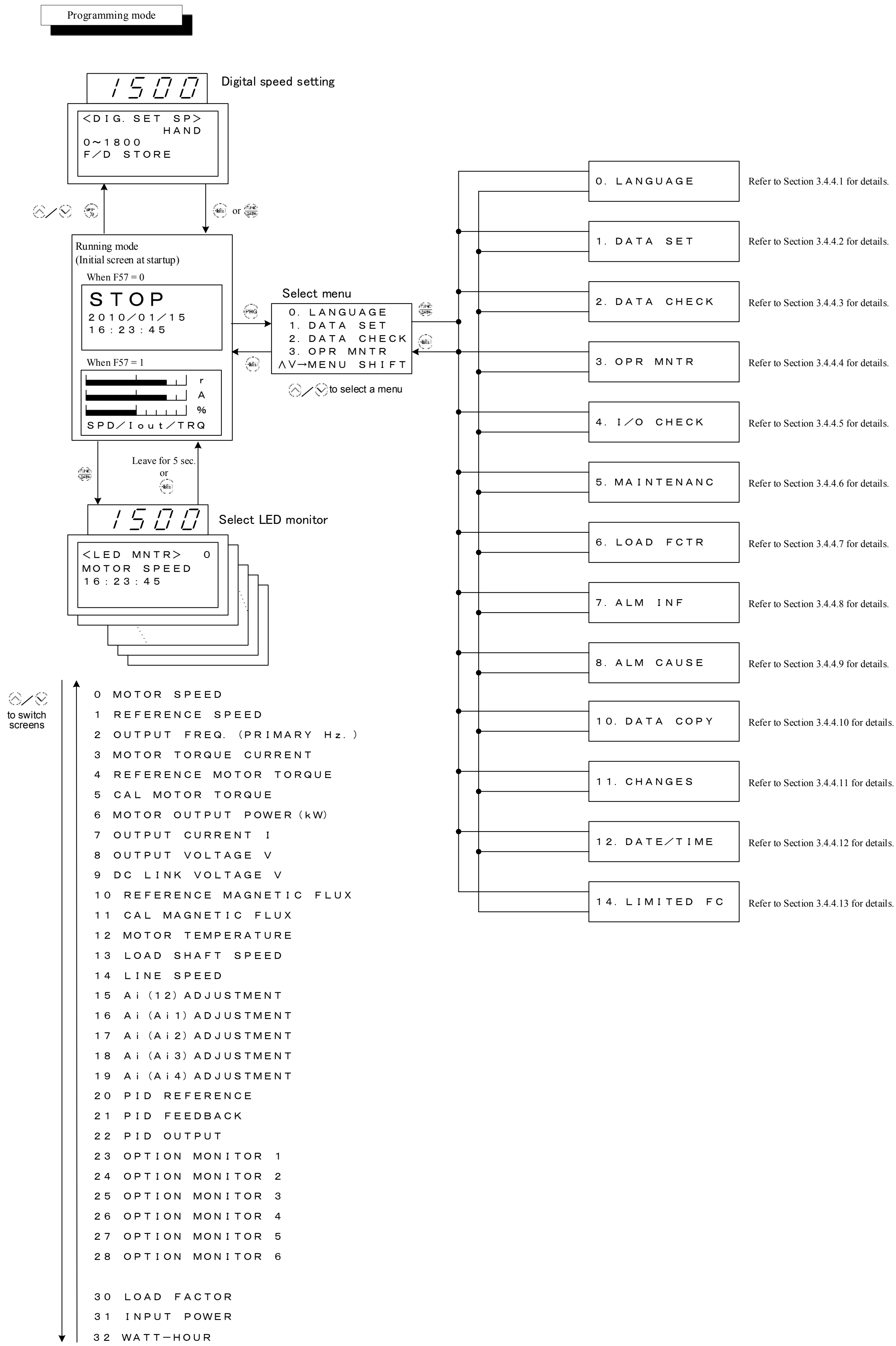
Programming mode allows you to set and check function code data and monitor maintenance information and input/output (I/O) signal status. The functions can be easily selected with a menu-driven system. Table 3.4-6 lists menus available in Programming mode.

Table 3.4-6 Menus Available in Programming Mode

Menu #	Menu	Used to:	Refer to Section:
0	Selecting language (LANGUAGE)	Change the display language on the LCD monitor.	3.4.4.1
1	Configuring function codes (DATA SET)	Display and change the data of the function code selected.	3.4.4.2
2	Checking function code data (DATA CHECK)	Display a function code and its data on the same screen. Also this menu is used to change the function code data or check whether the data has been changed from the factory default.	3.4.4.3
3	Monitoring the running status (OPR MNTR)	Display the running information required for maintenance or test running.	3.4.4.4
4	Checking I/O signal status (I/O CHECK)	Display external interface information.	3.4.4.5
5	Reading maintenance information (MAINTENANCE)	Display maintenance information including cumulative run time.	3.4.4.6
6	Measuring load factor (LOAD FCTR)	Measure the maximum output current, average output current, and average braking power.	3.4.4.7
7	Reading alarm information *1 (ALM INF)	Display recent four alarm codes. Also this menu is used to view the information on the running status at the time the alarm occurred.	3.4.4.8
8	Viewing causes of alarm (ALM CAUSE)	Display the cause of the alarm.	3.4.4.9
9	Reading communications information (COMM INFO)	Not supported.	-
10	Copying data (DATA COPY)	Read or write function code data, as well as verifying it.	3.4.4.10
11	Checking changed function codes (CHANGES)	Display only the function code data that has been changed from the factory default.	3.4.4.11
12	Setting the calendar clock (DATE/TIME)	Display/hide the date and time and adjust the display format and data.	3.4.4.12
13	Compatibility with conventional inverter models (FORMER INV)	Not supported.	-
14	Limiting function codes to be displayed (LIMITED FC)	• Select whether to display all function codes or limited ones (selected in Loader). • Cancel the directory structure of function codes.	3.4.4.13

*1 Alarm information will not be saved when only the auxiliary power input for the control circuit is turned on.

The screen transition and hierarchy structure in Running and Programming modes are shown below.



* If the screen system is password-protected, no menu can be selected until you enter the password.

■ Menu screen

Pressing the (PRG) key in Running mode calls up the menu screen.

Select the target menu by moving the cursor (flashing rectangle) with ∧/∨ key.

■ Configuring function code data

Figure 3.4-8 shows the LCD screen transition for Menu #0 "DATA SET."

A hierarchy exists among those screens that are shifted in the order of "Menu screen," "List of function code groups," and "List of function codes."

On the modification screen of the target function code, you can modify or check its data.

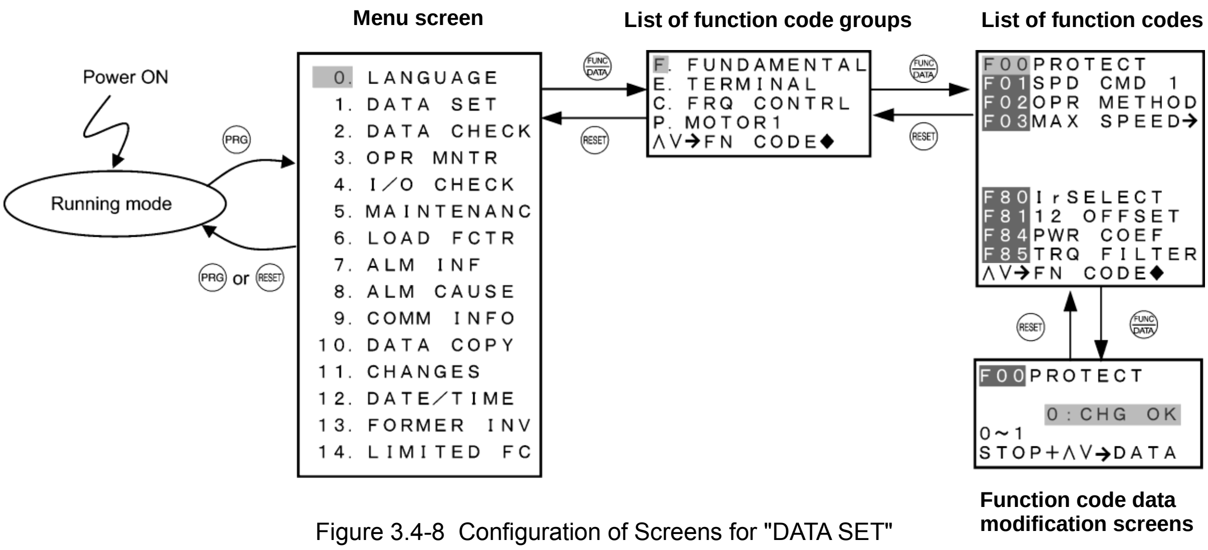
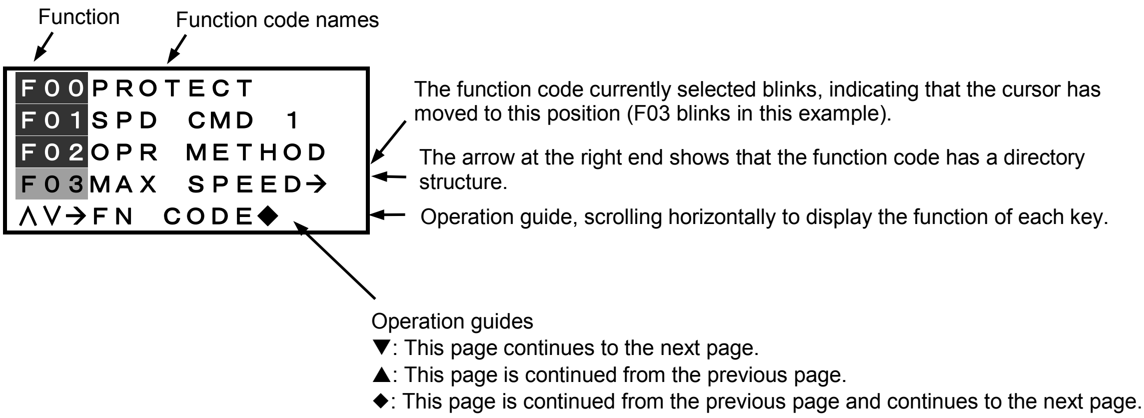


Figure 3.4-8 Configuration of Screens for "DATA SET"

■ Screen samples for changing function code data

The "list of function codes" shows function codes, their names, and operation guides.



The "function code data modification screen" shows the function code, its name, its data (before and after change), allowable entry range, and operation guides.

<Before change>

```
F03MAX  SPEED

     1500r/m
50~30000
∧∨→DATA  ADJUST
```

Function code # and name
*: Function code that has been changed from factory default
Data
Allowable entry range
Operation guide

<Changing data>

```
F03MAX  SPEED
     1500
     1200r/m
50~30000
∧∨→DATA  ADJUST
```

Data before change
Data being changed

Figure 3.4-9 Screen Samples for Changing Function Code Data

Simultaneous keying of "SHIFT + HELP keys" switches the lower portion of the screen from the allowable entry range to the factory default. The same simultaneous keying switches it back to the allowable entry range.

A function code consists of an alphabet denoting a function code group and numerals.

Table 3.4-7 Function Code List

Function Code Group	Function	Description
F codes (Fundamental functions)	Fundamental functions	Functions to be used for basic motor running
E codes (Extension terminal functions)	Terminal functions	Functions concerning the selection of operation of the control circuit terminals; Functions concerning the display on the LED monitor
C codes (Control functions of frequency)	Control functions	Functions associated with speed settings
P codes (Motor 1 parameters)	Motor 1 parameters	Functions for configuring characteristics parameters (such as capacity) of the 1st motor
H codes (High performance functions)	High-level functions	Highly added-value functions; Functions for sophisticated control
A codes (Motor 2, 3 parameters)	Motor 2 parameters Motor 3 parameters	Functions for configuring characteristics parameters (such as capacity) of the 2nd or 3rd motor
o codes (Option functions)	Optional functions	Functions concerning optional features (The o codes are displayed only when the corresponding option is mounted on the inverter.)
L codes (Lift functions)	Vertical carrier machine functions	Functions to be used for vertical carrier machines
U codes (User functions)	User-defined functions	Functions to be used for UPAC option cards, etc.
SF code (Safety functions)	Safety functions	Functions concerning the safety card OPC-VG1-SAFE
S codes (Command functions)	Command data	These function codes can be modified via the integrated RS-485 interface or filedbus options (e.g., T-Link, SX-bus). The S fields are write-only and the M fields, read-only.
M codes (Monitor functions)	Monitor data	

■ **Function codes requiring simultaneous keying**

To modify the data for function code F00 (Data protection), H01 (Auto-tuning), H02 (Save All function), H03 (Data initialization), H142 (Mock alarm), L01 (Password data 1) or L02 (Password data 2), simultaneous keying of "STOP + ∧ keys" or "STOP + ∨ keys" is required.

■ **Changing, validating, and saving function code data when the invert is running**

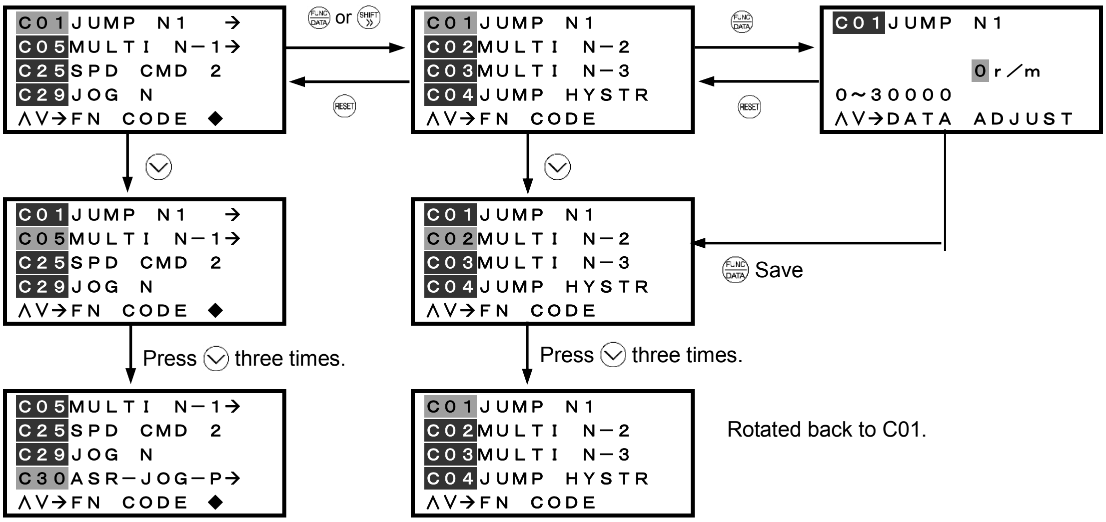
Some function codes can be modified while the inverter is running, whereas others cannot. Further, depending on the function code, modifications may or may not become effective immediately. For details, refer to the "Change when running" column in Chapter 4, Section 4.2.3.

■ **Keypad directory structure**

The keypad has a directory structure that includes the related function codes in a directory to make it easy to select a target function code from many function codes.

For example, function codes C01 to C04 are all related with the mechanical resonance point of the load and treated as the same function so that C02 to C04 are not located in the parent directory. At the right of C01, "→" appears indicating that C01 has a child directory. To access the child directory, move the cursor to that function code using the ∧ and ∨ keys and then press the FUNC/DATA or SHIFT key.

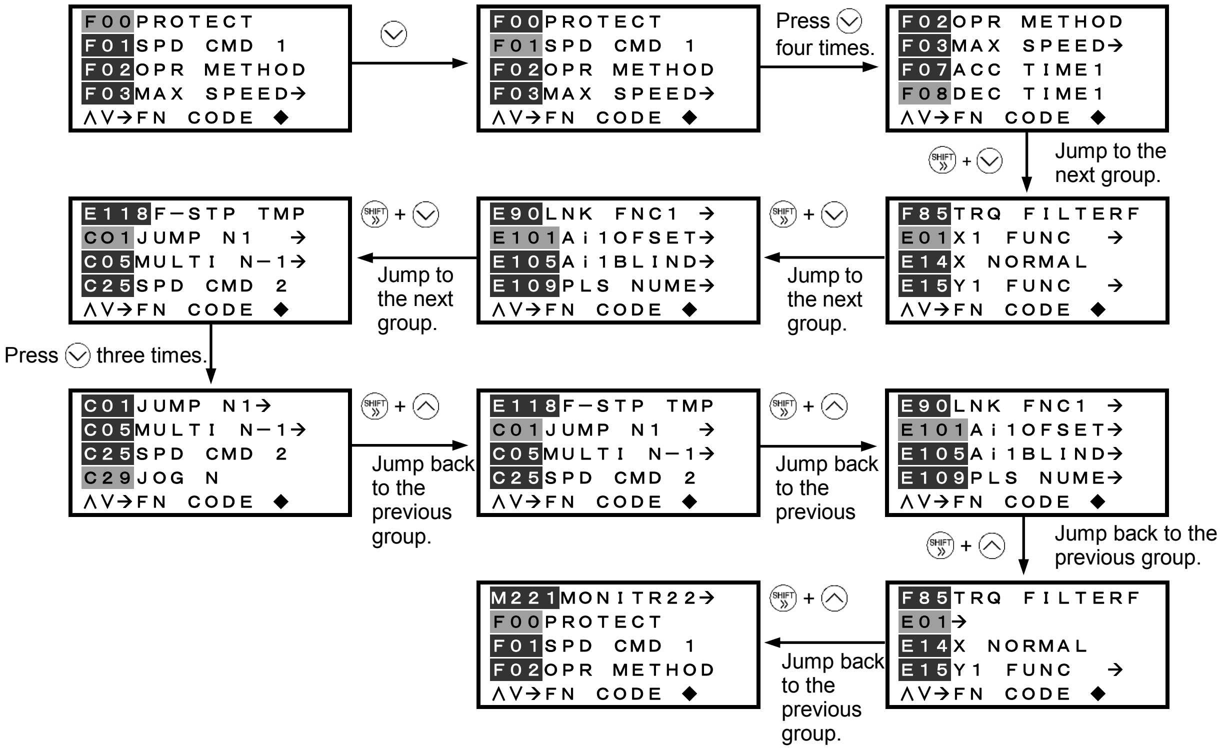
An example of selecting a function code with a child directory



■ **Jumping by function code group**

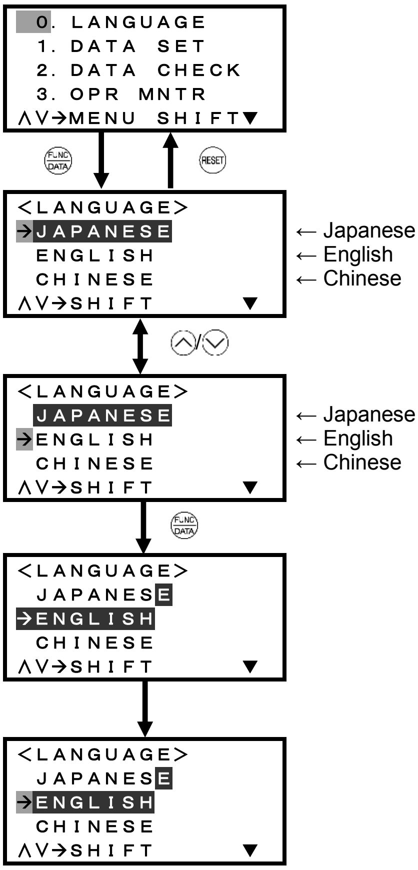
To call up a function code in a different group (E to M), press the SHIFT and ∧ keys or SHIFT and ∨ keys simultaneously to jump to the previous or next function code group.

In the case of a function code group having 100 or more function codes, this function jumps function codes in units of 100. (For example, F00 ⇒ E01 ⇒ E101 ⇒ • • •)



3.4.4.1 Selecting language -- Menu #0 "LANGUAGE"

Menu #0 "LANGUAGE" in Programming mode is used to select the display language from a choice of four languages (English, Japanese, Chinese and Korean) on the LCD monitor.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.

Move the cursor at the left of the screen to "0. LANGUAGE" using the ∧ and ∨ keys. Then press the FUNC/DATA key to switch to the language selection screen.

Move the pointer → to the desired language using the ∧ and ∨ keys.

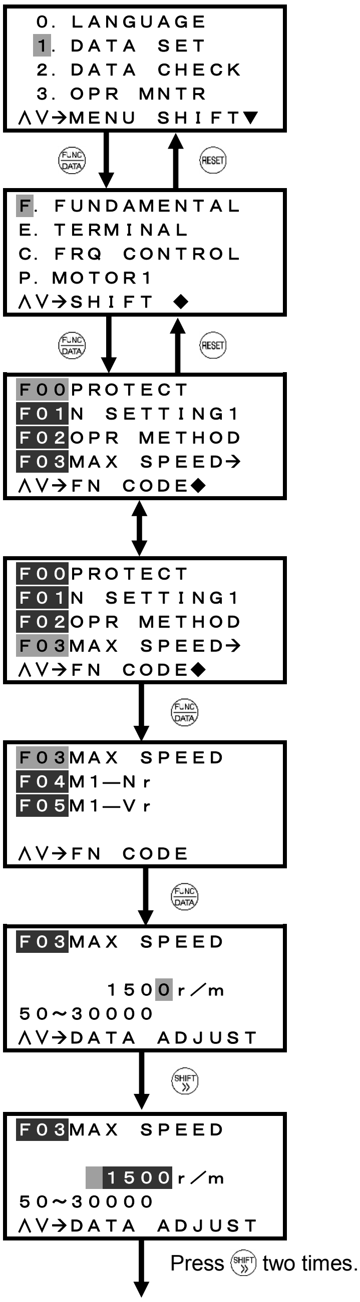
Press FUNC/DATA key to establish the selected language.

After a second, the screen automatically switches back to the submenu.

3.4.4.2 Configuring function codes -- Menu #1 "DATA SET"

Menu #1 "DATA SET" in Programming mode is used to configure function codes.

This section gives a description of the basic key operation, following the example of the data changing flow shown below. This example shows how to change F03 data (M1 maximum speed) from 1500 r/min to 1200 r/min.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "1. DATA SET" using the ∧ and ∨ keys. Then press the FUNC/DATA key to switch to the function code configuration screen.

Function code groups (F, E, C, P…) appear.
Move the cursor to the desired function code group using the ∧ and ∨ keys.

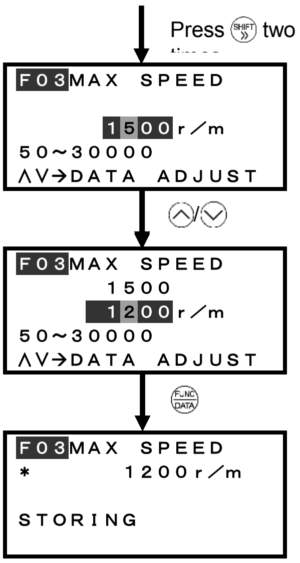
Move the cursor to the desired function code using the ∧ and ∨ keys.
At the right of F03, "→" appears indicating that F03 has a child directory. To access the child directory, move the cursor to that function code using the ∧ and ∨ keys and then press the FUNC/DATA or SHIFT key.

Press the FUNC/DATA key to move to the lower directory.

Press the FUNC/DATA key to establish the desired function code.

Press the SHIFT key to move the cursor from the units place to the ten-thousands place.

Press the SHIFT key to move the cursor from the ten-thousands place to the hundreds place.



Change the function code data using the ∧ and ∨ keys.
(In this example, change from 1500 r/min to 1200 r/min.)

Press the FUNC/DATA key to establish the function code data.

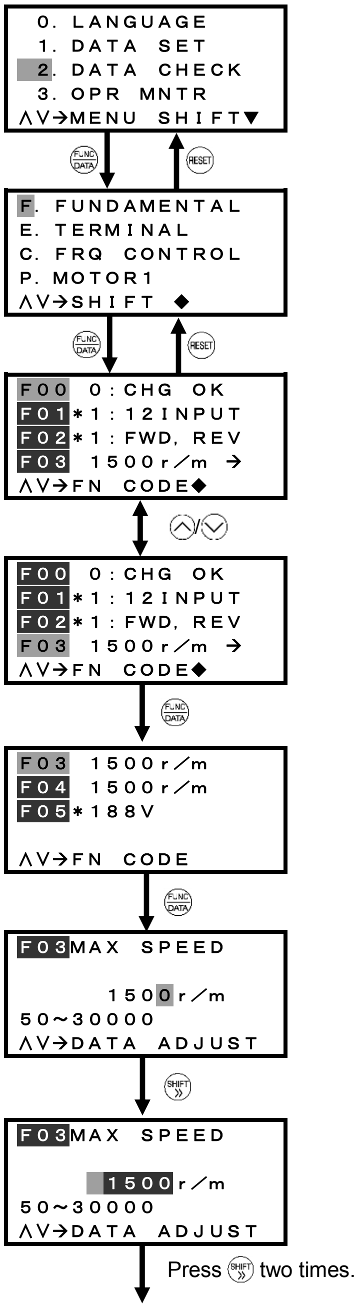
3.4.4.3 Checking function code data -- Menu #2 "DATA CHECK"

Menu #2 "DATA CHECK" in Programming mode is used to check function codes (together with their data) that have been changed. The function codes whose data have been changed from factory defaults are marked with *.

This section gives a description of the basic key operation, following the example of the data checking flow shown below. This example shows how to change F03 data (M1 maximum speed) from 1500 r/min to 1200 r/min.

In any of the following cases, change of function code data will be saved only into the volatile memory (RAM) and not be saved into the non-volatile memory. Such data is displayed with white letters on black background.

- After tuning, the All Save function is not performed (H02 ≠ 1).
- After changing function code data via the communications link, the All Save function is not specified (H02 ≠ 1).
- When terminal command ***LU-CCL*** ("Cancel undervoltage alarm") on any X terminal is enabled, function code data is changed.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "2. DATA CHECK" using the ∧ and ∨ keys. Then press the FUNC/DATA key to switch to the function code configuration screen.

Function code groups (F, E, C, P…) appear.
Move the cursor to the desired function code group using the ∧ and ∨ keys.

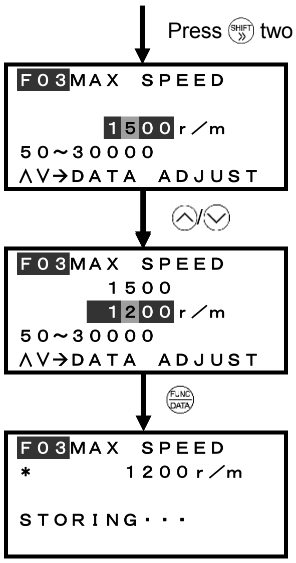
The function codes whose data has been changed from factory defaults are marked with an asterisk (*).

Move the cursor to the desired function code using the ∧ and ∨ keys.
At the right of F03, → appears indicating that F03 has a child directory. To access the child directory, move the cursor to that function code using the ∧ and ∨ keys and then press the FUNC/DATA or SHIFT key.

Press the FUNC/DATA key to move to the lower directory.

Press FUNC/DATA key to establish the desired function code.

Press the SHIFT key to move the changeable digit place (blinking), then change the function code data using the ∧ and ∨ keys.



Press key to establish the function code data.

3.4.4.4 Monitoring the running status -- Menu #3 "OPR MNTR"

Menu #3 "OPR MNTR" in Programming mode is used to check the running status during maintenance and test running.

Simultaneous keying of the (SHIFT) + (HELP) keys holds the displayed data. The same simultaneous keying again reverts to the normal display. When the display is in the hold state, the "DATA HOLD" is shown at the bottom of the screen.

```
0. LANGUAGE
1. DATA SET
2. DATA CHECK
3. OPR MNTR
∧∨→MENU SHIFT▼
```

To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "3. OPR MNTR" using the (∧) and (∨) keys. Then press the (FUNC DATA) key.

(FUNC DATA) ↓ ↑ (RESET)

```
N*=xxxxx.xr/m
N =xxxxx.xr/m
f* =xxxx.xHz
TRQ=xxxx.x%
∧∨→PAGE SHIFT 1
```

← Reference speed
← Motor speed
← Output frequency
← Reference motor torque

↕ (∧)/(∨)

```
TMP =   ±xxx℃
Iout=xxx.xxA
Vout=   xxxV
FLX*=   xxx%
∧∨→PAGE SHIFT 2
```

← Motor temperature ("---" appears when no NTC thermistor is used.)
← Output current
← Output voltage
← Reference magnetic flux

↕ (∧)/(∨)

```
(1)  (2)  (3)
(4)  (5)
(6)  (7)  (8)  (9)
(10) (11)
∧∨→PAGE SHIFT 3
```

(1) Current rating (2) Speed command source (3) PID control
(4) Motor selected (5) Drive control
(6) Run command (7) Current limit (8) Undervoltage/Voltage limit (9) Torque limit
(10) Run command source (11) Cause of trip

* For details, refer to Table 3.4-8.

↕ (∧)/(∨)

```
N  =xxxx.xr/m
LOD=xxxx.xr/m
LIN=xxxx.xm/m
SY-d= xxx
∧∨→PAGE SHIFT 4
```

← Motor speed
← Load shaft speed
← Line speed detection value
← Deviation in SY synchronous operation (This page is available soon.)

↕ (∧)/(∨)

```
SV =xxx.x
PV =xxx.x
MV =xxx.x
INTNL N-REF
∧∨→PAGE SHIFT 5
```

← PID command value
← PID feedback amount
← PID output value
← (12) PID command source (13) PID output destination
* For details, refer to Table 3.4-8.

↕ (∧)/(∨)

```
P  =xxx.xp
E  =xxx.xp
dP =xxx.xp
MODE:
∧∨→PAGE SHIFT 6
```

← Current position pulse for position control (This page is available soon.)
← Target position pulse for position control
← Current deviation pulse for position control
← Position control status

↕ (∧)/(∨)

```
P4  =××××××××p
E4  =××××××××p
dp4=××××××××p
MODE:
∧∨→PAGE SHIFT 7
```

← 4-multiplied, current position pulse for position control (This page is available soon.)
← 4-multiplied, target position pulse for position control
← 4-multiplied, current deviation pulse for position control
← Position control status

```
ETI1=      ×××%
ETI2=      ×××%
ETI3=      ×××%

∧∨→PAGE SHIFT 8
```

← Remaining allowance for M1 motor overload (When it counts down to 0%, OL1 alarm is issued.)
← Remaining allowance for M2 motor overload (When it counts down to 0%, OL2 alarm is issued.)
← Remaining allowance for M3 motor overload (When it counts down to 0%, OL3 alarm is issued.)

Table 3.4-8 Running Status Items

	Symbol	Item	Description
(1)	HD	Current rating	HD (High Duty) mode selected (F80 = 0, 2)
	MD		MD (Medium Duty) mode selected (F80 = 3)
	LD		LD (Low Duty) mode selected (F80 = 1)
(2)	HAND	Speed command source	Keypad
	12±		Voltage input on terminal [12] (with polarity)
	12		Voltage input on terminal [12] (without polarity)
	U/D1		UP/DOWN control (Default = 0)
	U/D2		UP/DOWN control (Default = Previous value)
	U/D3		UP/DOWN control (Default = CPR1, 2)
	MULTI		Terminal command ***SS8***, ***SS4***, ***SS2***, ***SS1*** ("Select multistep speed")
	LINK		Terminal command ***LE*** ("Enable communications link via RS-485 or fieldbus") H30: Communications Link Function (Mode selection)
	PTI		Terminal command ***SYC*** ("Synchronization command") enabled
	LOCK		Terminal command ***LOCK*** ("Servo-lock command")
	JOG		Jogging speed
	LDR		"FRENIC-VG Loader"
	AI-V		Voltage input on analog input terminal AI-V
	AI-C		Current input on analog input terminal AI-C
	LOCAL		Keypad in local mode
(3)	----	PID control	PID control disabled
	PID		PID control enabled
(4)	M1	Motor selected	Motor 1 selected
	M2		Motor 2 selected
	M3		Motor 3 selected
(5)	PG_V	Drive control	Vector control with speed sensor
	SENS_LES		Vector control without speed sensor
	EMU		Simulation mode
	PMPG		Vector control for PMSM with speed sensor
	V/F		V/f control for IM
	MW_PGV_M		Vector control for IM with speed sensor (Multiplex master)
	MW_PGV_S		Vector control for IM with speed sensor (Multiplex slave)
	MW_LES_M		Vector control for IM without speed sensor (Multiplex master)
	MW_LES_S		Vector control for IM without speed sensor (Multiplex slave)
(6)	----	Run command	Both Run forward and Run reverse commands being OFF or ON
	FWD		Run forward command
	REV		Run reverse command
(7)	----	Current limit	No current limit
	IL		Current limiting
(8)	----	Undervoltage Voltage limit	Neither undervoltage nor voltage limited
	LU		Undervoltage detected
	VL		Voltage limited
(9)	----	Torque limit	No torque limit
	TL		Torque limiting
(10)	HAND	Run command source	Keypad (F02 = 0)
	TERM		External signals to terminals [FWD] and [REV] (F02 = 1)
	COMM		Via communications link
	LOCAL		Keypad in Local mode
(11)	----	Cause of trip	No cause of trip
	STP1		Input on STOP1 terminal
	STP2		Input on STOP2 terminal
	STP3		Input on STOP3 terminal
	BX		Coast to a stop
(12)	INTL	PID command source	Internal speed command
	AI		Analog input
	LINK		Communications link
	KP-ON		Terminal command ***KP/PID*** ON ("Cancel PID control")
(13)	----	PID output usage	PID output disabled
	T-LIM		Torque limiter
	T-REF		Torque command
	N-REF		Speed command
	N-AUX		Auxiliary speed (e.g., dancer control)

3.4.4.5 Checking I/O signal status -- Menu #4 "I/O CHECK"

Menu #4 "I/O CHECK" in Programming mode is used to check the I/O states of digital and analog signals during maintenance or test running.

Simultaneous keying of the [SHIFT] + [HELP] keys holds the displayed data. The same simultaneous keying again reverts to the normal display. When the display is in the hold state, the "DATA HOLD" is shown at the bottom of the screen.

```
1. DATA SET
2. DATA CHECK
3. OPR MNTR
4. I/O CHECK
ΛV→MENU SHIFT▼
```

To display this menu screen, press the [PRG] key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "4. I/O CHECK" using the [∧] and [∨] keys. Then press the [FUNC/DATA] key.

[FUNC/DATA] ↓ ↑ [RESET]

```
REM  □X2 □X6
□FWD □X3 □X7
□REV □X4 □X8
□X1  □X5 □X9
ΛV→PAGE SHIFT 1
```

Digital input signals at the control circuit terminal block
□: Signal OFF, ■: Signal ON

Normal open/close settings of X terminals specified by function code E14 are reflected to these signals.

↕ [∧]/[∨]

```
REM
□EN1
□EN2

ΛV→PAGE SHIFT 2
```

Digital input signals at the control circuit terminal block
□: Signal OFF, ■: Signal ON

↕ [∧]/[∨]

```
COMM □X2 □X6
□FWD □X3 □X7
□REV □X4 □X8
□X1  □X5 □X9
ΛV→PAGE SHIFT 3
```

Digital input signals via communications link
□: Signal OFF, ■: Signal ON

↕ [∧]/[∨]

```
□Y1   □Y5A
□Y2
□Y3
□Y4
ΛV→PAGE SHIFT 4
```

Output signals from transistors at the control circuit terminal block
□: Signal OFF, ■: Signal ON

↕ [∧]/[∨]

Analog input signals at the control circuit terminal block

```
12  =±××. ×V
Ai1=±××. ×V
Ai2=±××. ×V

ΛV→PAGE SHIFT 5
```

← Analog input signal (12)
← Analog input signal (Ai1)
← Analog input signal (Ai2) (voltage/current)
The unit of Ai2 can be switched between V and mA by function code E50.
When E50 ≠ 26, the unit is V and when E50 = 26, mA.

↕ [∧]/[∨]

Analog output signals at the control circuit terminal block

```
AO1=±××. ×V
AO2=±××. ×V
AO3=±××. ×V

ΛV→PAGE SHIFT 6
```

← Analog output signal (Ao1)
← Analog output signal (Ao2)
← Analog output signal (Ao3)

↕ [∧]/[∨]

```
□FWD□BRK□IL
□REV□NUV□ACC
□EXT□TL □DEC
□INT□VL □ALM
ΛV→PAGE SHIFT 7
```

← This screen is used to check the inverter running status.
□: Signal OFF,
■: Signal ON

FWD: Forward operation
REV: Reverse operation
EXT: Pre-exciting
INT: Inverter shut off
BRK: Braking

NUV: DC link bus voltage established
TL: Torque limiting
VL: Voltage limiting
IL: Current limiting

ACC: Accelerating
DEC: Decelerating
ALM: Alarm output (for any fault)

↕ [∧]/[∨]

```
□PARA1□M1□JOG
□PARA2□M2
□PARA3□M3
□PARA4
∧∨→PAGE SHIFT 8
```

← Indicates currently effective sets.
□: Signal OFF,
■: Signal ON

PARA1: ASR1 being selected M1: Motor 1 selected JOG: Jogging mode
PARA2: ASR2 being selected M2: Motor 2 selected
PARA3: ASR3 being selected M3: Motor 3 selected
PARA4: ASR4 being selected

```
OPTION
A:(1)
B:(2)
C:(3)
∧∨→PAGE SHIFT 9
```

← Indicates the mounting status of the control options.

For the display content of (1) to (3), refer to the instruction manual of the corresponding option.

```
OPTION
D:(4)
E:(5)
F:(6)
∧∨→PAGE SHIFT 10
```

← Indicates the mounting status of the control options.

For the display content of (4) to (6), refer to the instruction manual of the corresponding option.

```
Ai3=±××.×V
Ai4=±××.×V
AO4=±××.×V
AO5=±××.×V
∧∨→PAGE SHIFT 14
```

← Indicates the I/O status of the AIO option.
(This page appears by mounting the AIO option card OPC-VG1-AIO.)

AIO I/O status 1 (Ai3) "0.0" when no AIO is connected
AIO I/O status 2 (Ai4) "0.0" when no AIO is connected
AIO I/O status 3 (Ao4)
AIO I/O status 4 (Ao5)

```
SD =±×××××P/s
LD =±×××××P/s
PR =±×××××P/s
PD =±×××××P/s
∧∨→PAGE SHIFT 15
```

← Indicates the PG signal input on the inverter.

[1] Input info of inverter PG signal: This appears when no PG (SD) is connected.
Input info of PG (SD) signal: This appears when a PG (SD) is mounted.
[2] Input info of PG (LD) signal: "---" appears when no PG (LD) is connected.
[3] Input info of PG (PR) signal: "---" appears when no PG (PR) is connected.
[4] Input info of PG (PD) signal: "---" appears when no PG (PD) is connected.

```
R□×11 C□×11
 □×12  □×12
 □×13  □×13
 □×14  □×14
∧∨→PAGE SHIFT 16
```

← Indicates the input status of the DIOA option.
□: Signal OFF,
■: Signal ON

```
□Y11 □Y15
□Y12 □Y16
□Y13 □Y17
□Y14 □Y18
∧∨→PAGE SHIFT 17
```

← Indicates the output status of the DIOA option.
□: Signal OFF, ■: Signal ON

```
□DIA □BCD □BIN
A =×××××
□DIB □BCD □BIN
B =×××××
∧∨→PAGE SHIFT 18
```

← Indicates the input status of the DIA option.
□: Signal OFF,
■: Signal ON

(This page appears by mounting the DI option card OPC-VG1-DI.)

The input statuses of the DIA and DIB options are shown in either of the following formats.
Bin format: 0 to FFFF
BCD format: 0 to 65535

```
X□21□25□29□33
□22□26□30□34
□23□27□31□35
□24□28□32□36
∧∨→PAGE SHIFT 19
```

← Indicates the input status of the DIOB option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the DIO option card OPC-VG1-DIO and turning SW2 to the DIOB position.)

```
□Y21 □Y25 □Y29
□Y22 □Y26 □Y30
□Y23 □Y27
□Y24 □Y28
∧∨→PAGE SHIFT 20
```

←Indicates the output status of the DIOB option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the DIO option card OPC-VG1-DIO and turning SW2 to the DIOB position.)

```
□ST1 □ST2 □RE
□SL1 □SL2
□SB+ □SB−
□BF1 □BF2
∧∨→PAGE SHIFT 21
```

← Indicates the I/O status of the SAFE option.
□: Signal OFF, ■: Signal ON
(This page appears by mounting the optional functional safety card OPC-VG1-SAFE.)

3.4.4.6 Reading maintenance information -- Menu #5 "MAINTENANCE"

Menu #5 "MAINTENANCE" in Programming mode shows information necessary for performing maintenance on the inverter.

Simultaneous keying of the (SHIFT) + (HELP) keys holds the displayed data. The same simultaneous keying again reverts to the normal display. When the display is in the hold state, the "DATA HOLD" is shown at the bottom of the screen.

```
 2. DATA CHECK
 3. OPR MNTR
 4. I/O CHECK
 5. MAINTENANCE
∧∨→MENU  SHIFT◆
```

To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "5. MAINTENANCE" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

(FUNC/DATA) ↓ ↑ (RESET)

```
TIME=  ×××××h
EDC  =    ×××V
TMPI=     ×××℃
TMPF=     ×××℃
∧∨→PAGE  SHIFT 1
```

- ← Cumulative run time
- ← DC link bus voltage
- ← Max. temperature inside the inverter (Refreshed every one hour.)
- ← Max. temperature of heat sink (Refreshed every one hour.)

↕ (∧)/(∨)

```
Imax=××.××A
CAP  =   ×××%


∧∨→PAGE  SHIFT 2
```

- ← Max. effective current (within an hour)
- ← Main capacitor capacity

↕ (∧)/(∨)

```
TCAP=×××××h
     (87600h)
TFAN=×××××h
     (87600h)
∧∨→PAGE  SHIFT 3
```

- ← Cumulative run time of capacitors on the printed circuit board (Refreshed every 10 hours)
- ← Estimated remaining life of the capacitor on the printed circuit board (fixed)
- ← Cumulative run time of the cooling fan (Refreshed every 10 hours)
- ← Estimated remaining life of the cooling fan (fixed)

↕ (∧)/(∨)

```
NRK= (1)
NRR= (2)      (5)
NRO= (3)      (6)
NRL= (4)      (7)
∧∨→PAGE  SHIFT 4
```

- ← (1) Number of communication retries for keypad
- ← (2) Number of communication retries, (5) Latest error code for RS-485 (See Table 3.4-9.)
- ← (3) Number of communication retries, (6) Latest error code for T-Link/CC-Link/SX-bus
- ← (4) Number of communication retries, (See Table 3.4-10.)
- (7) Latest error code for high-speed serial communication dedicated terminal block (Available soon)

↕ (∧)/(∨)

```
MAIN=H1××××
MTR  =H2××××
KP   =K  ××××

∧∨→PAGE  SHIFT 5
```

- ← ROM version of main control CPU (MAIN)
- ← ROM version of motor control CPU (MTR)
- ← ROM version of keypad (KP)

↕ (∧)/(∨)

```
OP_A  =Q1××××
OP_B  =Q1××××
OP_D  =Q3××××

∧∨→PAGE  SHIFT 6
```

- ← ROM version of 8-bit digital option CPU (OP1)
- ← ROM version of 8-bit digital option CPU (OP2)
- ← ROM version of 16-bit digital option CPU

"----" when no option is mounted.

↕ (∧)/(∨)

```
OP_C  =Q2××××
OP_E  =Q4××××
      =Q5××××

∧∨→PAGE  SHIFT 7
```

- ← ROM version (Not used.)
- ← ROM version of optional functional safety card CPU-S1
- ← ROM version of optional functional safety card CPU-S2

"----" when no option is mounted.

↕ (∧)/(∨)

```
Wh   =××××××kWh     ← Input watt-hour
PD  =    ××××       ← Input watt-hour data
REMN=×××××          ← Remaining startup times before the next maintenance
REMT=××××0h         ← Remaining time before the next maintenance
∧∨→PAGE SHIFT 8
```

↕ ⊙/⊙

```
TNPIM=    ×××℃      ← Temperature inside the inverter (real-time value)
TNPFM=    ×××℃      ← Temperature of heat sink (real-time value)
CAPEH=××××0h        ← Lifetime of DC link bus capacitor (elapsed hours) (Refreshed every 10 hours)
CAPRH=××××0h        ← Lifetime of DC link bus capacitor (remaining hours) (Refreshed every 10 hours)
∧∨→PAGE SHIFT 9
```

↕ ⊙/⊙

```
NST1  =×××××        ← Number of startups 1 (1st motor)
NST2  =×××××        ← Number of startups 2 (2nd motor)
NST3  =×××××        ← Number of startups 3 (3rd motor)

∧∨→PAGE SHIFT 10
```

These counters work when H82 ≠ 0.

↕ ⊙/⊙

```
MTIM1=××××0h        ← Cumulative run time (1st motor)  (Refreshed every 10 hours)
MTIM2=××××0h        ← Cumulative run time (2nd motor)  (Refreshed every 10 hours)
MTIM3=××××0h        ← Cumulative run time (3rd motor)  (Refreshed every 10 hours)

∧∨→PAGE SHIFT 11
```

↕ ⊙/⊙

```
LALM1=×××           ← Light alarm (1) -- Latest
LALM2=×××           ← Light alarm (2) -- Last
LALM3=×××           ← Light alarm (3) -- 2nd last
LALM4=×××           ← Light alarm (4) -- 3rd last
∧∨→PAGE SHIFT 15
```

*Shutting down the power clears light alarm history.

Table 3.4-9 List of RS-485 Error Codes

Display #	Data for function code M26 Values in parentheses are in hexadecimal.	Error content
--	0 (0H)	No error
01	74 (4AH)	Format error
	75 (4BH)	Command error
02	78 (4EH)	Function code error
03	80 (50H)	Data error
04	71 (47H)	Checksum error, CRC error
05	72 (48H)	Parity error
06	73 (49H)	Overrun error, framing error
07	76 (4CH)	Communications link priority error
	79 (4FH)	Write-protected
	81 (51H)	Error during writing

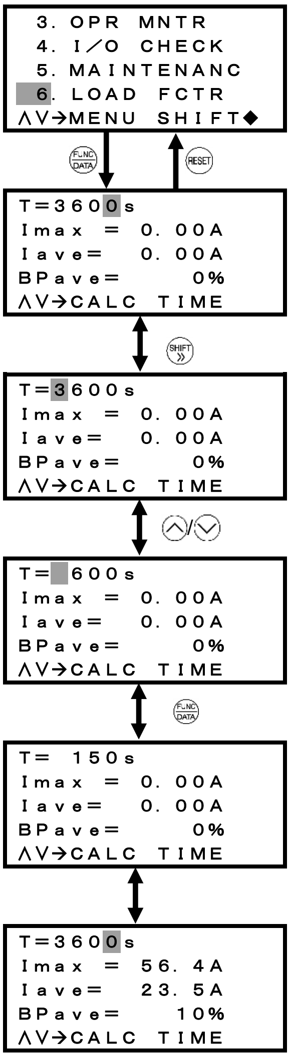
Table 3.4-10 List of Bus Error Codes

The following display numbers are shown as a bus error code.

Display #	Upper digits (T-Link)	Upper digits (CC-Link)	Lower digits (SX-bus)
--	No error	No error	No error
1	Light alarm: Noise		Light alarm: Communications data error
2	Heavy alarm: Wire break, Hardware defective, Mounting failure	Light alarm (CC-Link error)	Heavy alarm 1: Wire break
3		Heavy alarm (option error)	Heavy alarm 2: Hardware defective, Mounting failure

3.4.4.7 Measuring load factor -- Menu #6 "LOAD FCTR"

Menu #6 "LOAD FCTR" in Programming mode is used to measure the maximum output current, the average output current, and the average braking power.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "6. LOAD FCTR" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

← Measurement period

Change the measurement period using the SHIFT, ∧ and ∨ keys.

← Measurement period (600 seconds)

Press the FUNC/DATA key to start measurement.

← Indicates the remaining measurement period. When this value comes to zero, measurement is completed.

← Reverts to the initial value.
← Maximum current
← Average current
← Average braking power (motor rated output/100%)

3.4.4.8 Reading alarm information -- Menu #7 "ALM INF"

Menu #7 "ALM INF" in Programming mode shows the past four alarm codes and the related alarm information on the current inverter conditions detected when the alarm occurred.

```
 4. I/O CHECK
 5. MAINTENANCE
 6. LOAD FCTR
 7. ALM INF
∧∨→MENU SHIFT◆
```

To display this menu screen, press the PRG key in Running mode to switch to Programming mode.

Move the cursor (flashing rectangle) at the left of the screen to "7. ALM INF" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

(FUNC/DATA ↓ / RESET ↑)

```
0/1= (1) (5) (9)
 -1= (2) (6) (10)
 -2= (3) (7) (11)
 -3= (4) (8) (12)
∧∨→HISTORY SHIF
```

← (1) Latest alarm code (5) Latest alarm, ID (9) Latest alarm, no. of occurrences (always 1)
← (2) 1st last alarm code (6) 1st last alarm, ID (10) 1st last alarm, no. of occurrences
← (3) 2nd last alarm code (7) 2nd last alarm, ID (11) 2nd last alarm, no. of occurrences
← (4) 3rd last alarm code (8) 3rd last alarm, ID (12) 3rd last alarm, no. of occurrences
Alarm ID: Blank (Alarm caused by the inverter), O (Alarm caused by multiplex system or other inverters)

Use the ∧ and ∨ keys to select the desired alarm.

(∧/∨)

```
0/1= (1) (5) (9)
 -1= (2) (6) (10)
 -2= (3) (7) (11)
 -3= (4) (8) (12)
∧∨→HISTORY SHIF
```

Press the FUNC/DATA key to establish the selected alarm.

(FUNC/DATA)

```
OCCURRED AT
2011/01/01
00:00:00

∧∨→PAGE SHIFT 1
```

← Date when an alarm occurred
← Time when an alarm occurred
Note: To record accurate date and time, it is necessary to mount a memory backup battery (Option for inverters of up to 22 kW, Included as standard for those of 30 kW or above) and adjust the date and time.

(∧/∨)

```
RESET AT
2011/01/01
00:00:10

∧∨→PAGE SHIFT 2
```

← Date when an alarm was removed
← Time when an alarm was removed
Note: To record accurate date and time, it is necessary to mount a memory backup battery (Option for inverters of up to 22 kW, Included as standard for those of 30 kW or above) and adjust the date and time.

(∧/∨)

```
N*=×××××.×r/m
N =×××××.×r/m
f* =  ×××.×Hz
TRQ=     ×××%
∧∨→PAGE SHIFT 3
```

← Speed setting 4 upon the occurrence of alarm
← Detected speed 1 upon the occurrence of alarm
← Reference output frequency upon the occurrence of alarm
← Reference torque upon the occurrence of alarm

The value is rounded to the first decimal place. If the absolute value of the detected speed is 10,000 or larger, the value is rounded to an integer.

(∧/∨)

```
TMP =   ±×××℃
Iout=×××.××A
Vout=    ×××V
FLX*=    ×××%
∧∨→PAGE SHIFT 4
```

← Motor temperature upon the occurrence of alarm ("---" appears when no NTC is mounted)
← Detected output current upon the occurrence of alarm
← Detected output voltage upon the occurrence of alarm
← Reference magnetic-flux value upon the occurrence of alarm

(∧/∨)

```
TIME= ×××××h
Mout= ×××.×kW
TMPIM=    ×××℃
TMPFM=    ×××℃
∧∨→PAGE SHIFT 5
```

← Cumulative operation hours upon the occurrence of alarm
← Reference motor output (in kW or HP) upon the occurrence of alarm *
← Inverter inside air temperature upon the occurrence of alarm (real-time value)
← Heat sink temperature upon the occurrence of alarm (real-time value)
* kW or HP can be selected with code F60.

(∧/∨)

```
EDC = ×××V



∧∨→PAGE SHIFT 6
```

← DC link bus voltage at the time of an alarm

```
NRK=×××××
NRR=×××××
NRO=×××××
NRL=×××××
∧∨→PAGE SHIFT 7
```

← No. of communication retries at the time of an alarm for keypad
← No. of communication retries at the time of an alarm for RS-485
← No. of communication retries at the time of an alarm for T-Link/CC-Link/SX-bus
← No. of communication retries at the time of an alarm for high-speed serial communication dedicated terminal block

```
REM  □X2 □X6
□FWD □X3 □X7
□REV □X4 □X8
□X1  □X5 □X9
∧∨→PAGE SHIFT 8
```

(Terminal block)
□: Signal OFF, ■: Signal ON

```
REM
□EN1
□EN2

∧∨→PAGE SHIFT 9
```

(Terminal block)
□: Signal OFF, ■: Signal ON

```
COMM □X2 □X6
□FWD □X3 □X7
□REV □X4 □X8
□X1  □X5 □X9
∧∨→PAGE SHIFT 10
```

(Via communications link)
□: Signal OFF, ■: Signal ON

```
□Y1  □Y5A
□Y2
□Y3
□Y4
∧∨→PAGE SHIFT 11
```

□: Signal OFF, ■: Signal ON

```
□FWD□BRK□IL
□REV□NUV□ACC
□EXT□TL □DEC
□INT□VL □ALM
∧∨→PAGE SHIFT 12
```

□: Signal OFF, ■: Signal ON

FWD: Forward operation
REV: Reverse operation
EXT: Pre-exciting
INT: Inverter shut off
BRK: Braking
NUV: DC link bus voltage established (ready for operation)
TL: Torque limiting
VL: Voltage limiting
IL: Current limiting
ACC: Accelerating
DEC: Decelerating
ALM: Alarm output (for any fault)

```
R□X11 C□X11
 □X12  □X12
 □X13  □X13
 □X14  □X14
∧∨→PAGE SHIFT 13
```

(Shown only when DIO option is mounted)
□: Signal OFF, ■: Signal ON
(R: Terminal block, C: Via communications link)

```
□Y11 □Y15
□Y12 □Y16
□Y13 □Y17
□Y14 □Y18
∧∨→PAGE SHIFT 14
```

(Shown only when DIO option is mounted)
□: Signal OFF, ■: Signal ON

```
5= (1)
4= (2)
3= (3)
2= (4)
∧∨→PAGE SHIFT 16
```

← Multiple alarms 5 ((1) = Alarm code)
← Multiple alarms 4 ((2) = Alarm code)
← Multiple alarms 3 ((3) = Alarm code)
← Multiple alarms 2 ((4) = Alarm code)

```
(1)  (2)  (3)
(4)  (5)
(6)  (7)  (8)  (9)
(10)  (11)
∧∨→PAGE SHIFT 19
```

(1) Current rating (2) Speed command source (3) PID control
(4) Motor selected (5) Drive control
(6) Run command (7) Current limit (8) Undervoltage/Voltage limit (9) Torque limit
(10) Run command source (11) Cause of trip
* For details, refer to Table 3.4-8.

```
NST1 =xxxxx
NST2 =xxxxx
NST3 =xxxxx

∧∨→PAGE SHIFT 20
```

← Number of startups 1 (1st motor)
← Number of startups 2 (2nd motor)
← Number of startups 3 (3rd motor)

```
TRQI=xx. xx%
TRO =xx. xx%
TROI=xx. xx%
P    =xxxxxkW
∧∨→PAGE SHIFT 21
```

← Reference torque current at the time of an alarm
← Calculated torque at the time of an alarm
← Calculated torque current at the time of an alarm
← Input power at the time of an alarm

```
□ST1 □ST2 □RE
□SL1 □SL2
□SB+ □SB-
□BF1 □BF2
∧∨→PAGE SHIFT 22
```

← Indicates the I/O status of the SAFE option.
□: Signal OFF, ■: Signal ON

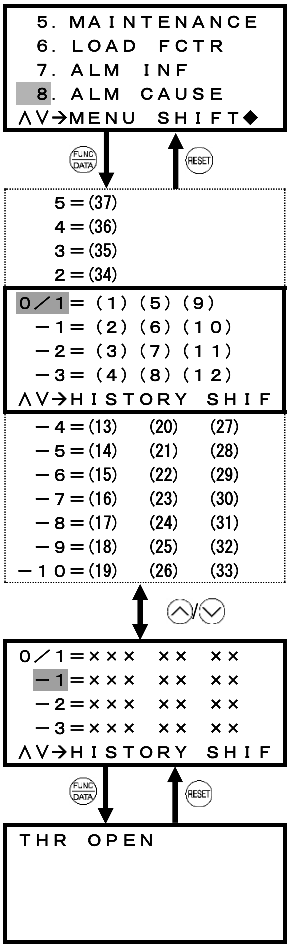
```
SUB=xxxx
AL=xxx AL=xxx
AL=xxx AL=xxx

∧∨→PAGE SHIFT 23
```

← Alarm sub-code (for manufacturers)*
← Alarm whose cause is not removed yet (for the latest alarm only)

* (In multiplex systems, the alarm sub-code appears only at the station where an alarm has occurred.)

3.4.4.9 Viewing causes of alarm -- Menu #8 "ALM CAUSE"

Menu #8 "ALM CAUSE" in Programming mode shows the past four alarm codes and the related alarm information on the current inverter conditions detected when the alarm occurred.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "8. ALM CAUSE" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

← (37) Multiple alarms, 4th
← (36) Multiple alarms, 3rd
← (35) Multiple alarms, 2nd
← (34) Multiple alarms, 1st

← (1) Latest alarm code	(5) Latest alarm, ID	(9) Latest alarm, no. of occurrences (always 1)
← (2) 1st last alarm code	(6) 1st last alarm, ID	(10) 1st last alarm, no. of occurrences
← (3) 2nd last alarm code	(7) 2nd last alarm, ID	(11) 2nd last alarm, no. of occurrences
← (4) 3rd last alarm code	(8) 3rd last alarm, ID	(12) 3rd last alarm, no. of occurrences
← (13) 4th last alarm code	(20) 4th last alarm, ID	(27) 4th last alarm, no. of occurrences
← (14) 5th last alarm code	(21) 5th last alarm, ID	(28) 5th last alarm, no. of occurrences
← (15) 6th last alarm code	(22) 6th last alarm, ID	(29) 6th last alarm, no. of occurrences
← (16) 7th last alarm code	(23) 7th last alarm, ID	(30) 7th last alarm, no. of occurrences
← (17) 8th last alarm code	(24) 8th last alarm, ID	(31) 8th last alarm, no. of occurrences
← (18) 9th last alarm code	(25) 9th last alarm, ID	(32) 9th last alarm, no. of occurrences
← (19) 10th last alarm code	(26) 10th last alarm, ID	(33) 10th last alarm, no. of occurrences

Use the ∧ and ∨ keys to select the desired alarm and press the FUNC/DATA key to establish the selected alarm.

← Indicates cause of the alarm selected from alarm history
Shown at the left is the OH2 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.

< Alarm ID Details >

Display	Function
Blank	Ordinary alarm
O	Alarm caused by other inverters

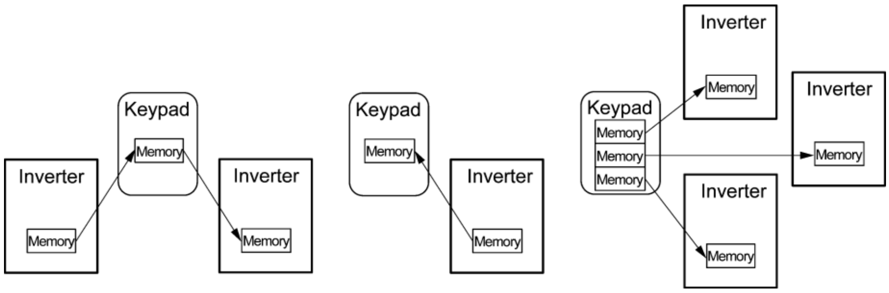
3.4.4.10 Copying data -- Menu #10 "DATA COPY"

Menu #10 "DATA COPY" in Programming mode provides "Read," "Write," and "Verify" functions, enabling the following applications. The keypad can hold three sets of function code data in its internal memory to use for three different inverters.

(a) Reading function code data already configured in an inverter and then writing that function code data altogether into another inverter.

(b) Copying the function code data saved in the inverter memory into the keypad memory for backup.

(c) Saving function code data in the keypad as master data for data management; that is, saving more than one set of function code data in the keypad and writing a set of data suited to the machinery into the target inverter.



(a) Copy (b) Backup (c) Data management

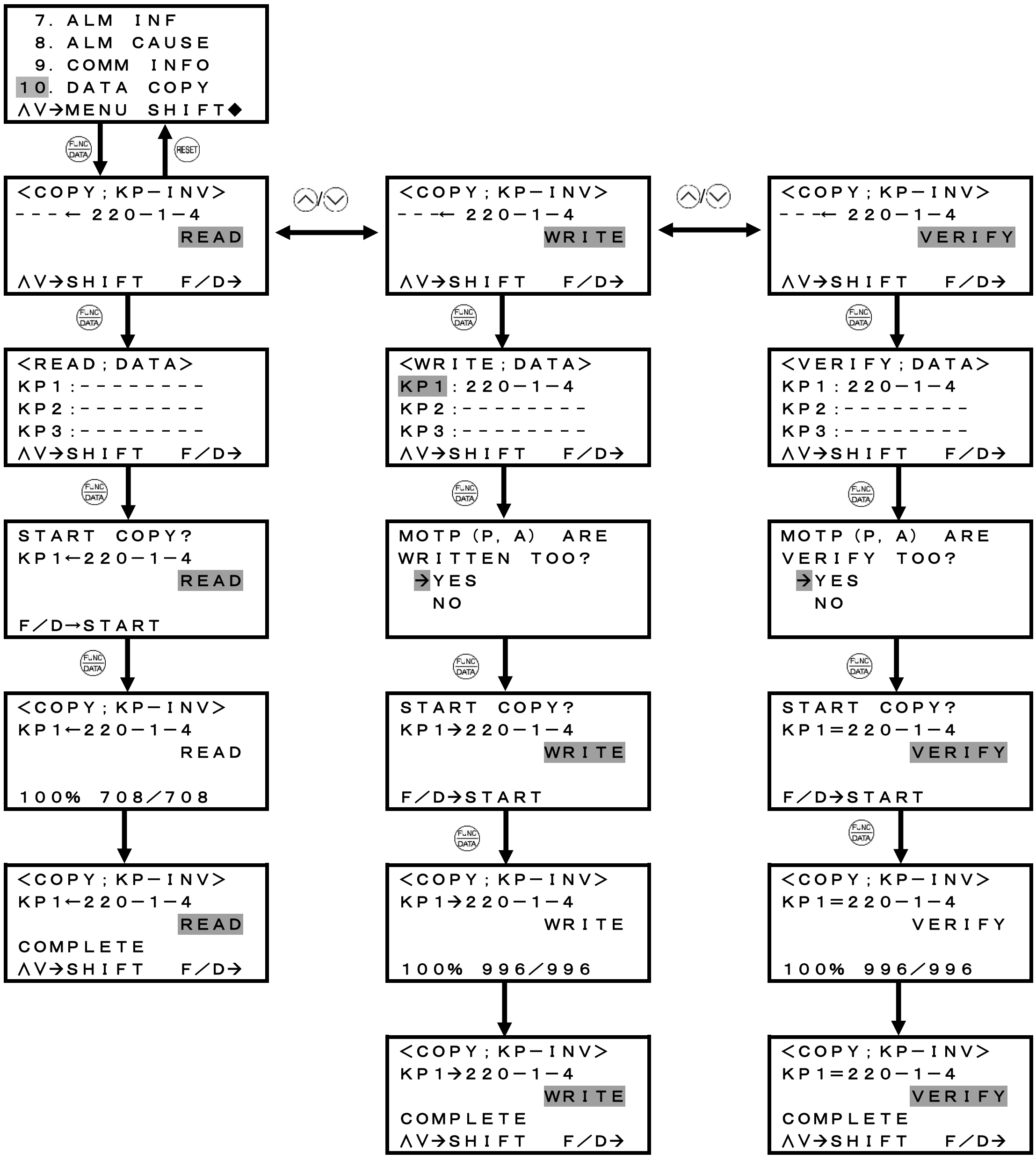
Table 3.4-11 details the data copying functions.

Table 3.4-11 List of Data Copying Functions

Operation	Description
Read: Read data	Reads out function code data from the inverter memory and stores it into the keypad memory.
Write: Write data	Writes the data held in the selected area of the keypad memory into the target inverter memory.
Verify: Verify data	Verifies the data held in the keypad memory against that in the inverter memory.

To display this menu screen, press the (PRG) key in Running mode to switch to Programming mode. Move the cursor (flashing rectangle) at the left of the screen to "10. DATA COPY" using the (∧) and (∨) keys. Then press the (FUNC/DATA) key.

Use the (∧) and (∨) keys to select ""Read," "Write," or "Verify."



Error Processing in Menu #10 "DATA COPY"

When the inverter is running or the data protection is enabled, attempting data copying causes the inverter to automatically stop its output. Take necessary measures, referring to the error processing given below.

1) Data change not allowed during running

If you attempt to perform a write operation when the inverter is running or to start running the inverter during a write operation, then an error occurs with the message shown at right.

Stop the inverter, press the (RESET) key, and perform a write operation again.

Attempted to write during running

```
<COPY;KP-INV>
---    →400-1-4
          WRITE
CANNOT WRITE
```

To cancel, press (RESET), (PRG).

2) Choice impossible/Inverter type mismatch

When the data area is empty ("- - - -" shown) on the data selection screen of the keypad in a write or verify operation, pressing the (FUNC/DATA) key causes an error with the message shown at right.

When there is a mismatch of inverter type information (inverter type and voltage series, etc.), pressing the (FUNC/DATA) calls up the confirmation screen asking whether to continue processing or not.

No data stored

```
<WRITE;DATA>
KP1:----------
KP2:045-1-2
KP3:350-1-4
CANNOT SELECT
```

Inverter type info mismatch

```
UNMATCH TYPE
WRITTEN TOO ?
  ⇒YES
    NO
```

To cancel, press (RESET), (PRG)

3) Verify error

If there is a mismatch between the data stored in the keypad memory and the one in the inverter memory, then the "ERROR" and the function code number appear and the inverter temporarily halts data checking.

To continue the subsequent data checking, press the (FUNC/DATA) key; to terminate it, press the (RESET) key.

Data discrepancy

```
<COPY;KP-INV>
KP1=400-1-4
          VERIFY
ERROR:E12
  11%    75/677
```

To continue, press (FUNC/DATA).
To terminate, press (RESET), (PRG).

4) Data protection enabled

If the copy destination inverter is data-protected (F00 = 1), the message appears as shown at right.

To perform a write operation, change the F00 setting to enable data modification.

Data protection enabled with F00

```
<COPY;KP-INV>
KP1=400-1-4
          WRITE
ERROR:F01
DATA PRTCTD
```

To cancel, press (RESET), (PRG).

5) When the ***WE-KP*** terminal command ("Enable data change with keypad") is assigned to a digital input terminal (function code data = 19) and it is OFF, the message appears as shown at right.

Turn the ***WE-KP*** ON and perform a write operation again.

Data change with keypad is disabled

```
<COPY;KP-INV>
KP1=400-1-4
          WRITE
ERROR:F01
NO SIGNAL(WE)
```

To cancel, press (RESET), (PRG).

6) [FWD]/[REV] terminal being ON

If the ready-to-run signal is OFF (e.g., only auxiliary power supply) and the [FWD]/[REV] terminal is ON via a contact, then the message appears as shown at right.

Open the [FWD]/[REV] terminal and perform a write operation again.

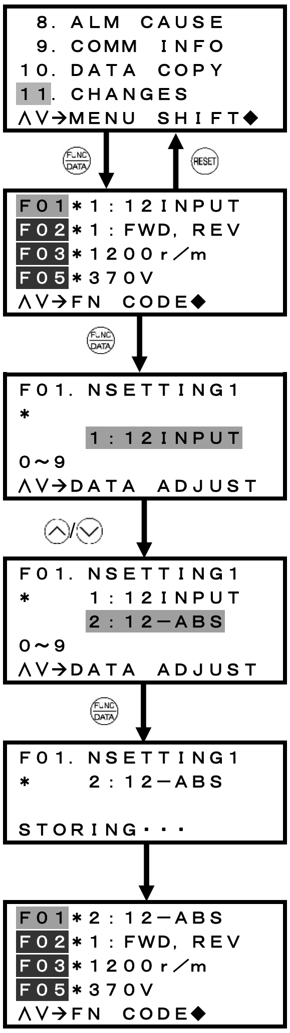
[FWD]/[REV] terminal being ON

```
<COPY;KP-INV>
KP1=400-1-4
          WRITE
ERROR:F01
FWD/REV ON
```

RTo cancel, press (RESET), (PRG).

3.4.4.11 Checking changed function codes -- Menu #11 "CHANGES"

Menu #11 "CHANGES" in Programming mode shows only the function codes whose data has been changed from the factory defaults.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "11. CHANGES" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

The function codes whose data has been changed from factory defaults are marked with an asterisk (*).

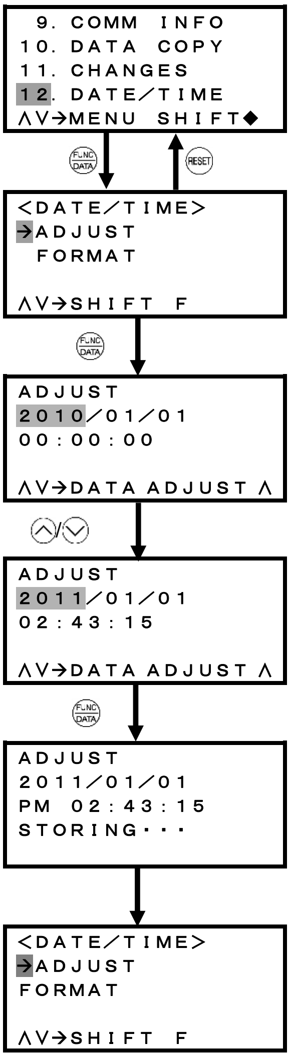
Just as in Section 3.4.4.2, "Configuring function codes--Menu #1 "DATA SET," the function code data can be modified.

3.4.4.12 Setting the calendar clock -- Menu #12 "DATE/TIME"

Menu #12 "DATE/TIME" in Programming mode is used to select the format of the calendar clock to be displayed in the operation guide line in Running mode and set the date and time.

⚠CAUTION
After mounting a memory backup battery (option for inverters of 22 kW or below, included as standard for those of 33 kW or above), set the date and time. When a memory backup battery is not mounted, the calendar clock does not work correctly.

1) Setting the date and time



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.

Move the cursor (flashing rectangle) at the left of the screen to "12. DATA/TIME" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

Press FUNC/DATA key to establish the desired menu.

Use the SHIFT key to move the cursor to the desired item.

Change the date and time using the ∧ and ∨ keys.

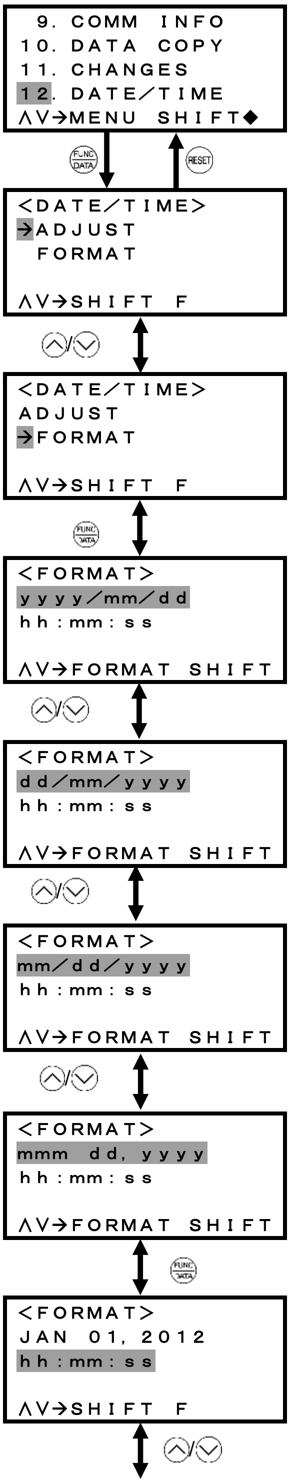
If the relationship between the changed year, month, day, and time is invalid, "CANNOT SET" appears when the FUNC/DATA key is pressed.

After a second, the screen automatically switches back to the submenu.

Tip: The calendar clock can also be set with FRENIC-VG Loader. For details, refer to the FRENIC-VG Loader Instruction Manual.

Chap. 3 PREPARATION AND TEST RUN

2) Selecting the display format



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "12. DATA/TIME" using the ∧ and ∨ keys. Then press the FUNC DATA key.

Press FUNC DATA key to establish the desired menu.

Move the pointer → using the ∧ and ∨ keys to the desired menu.

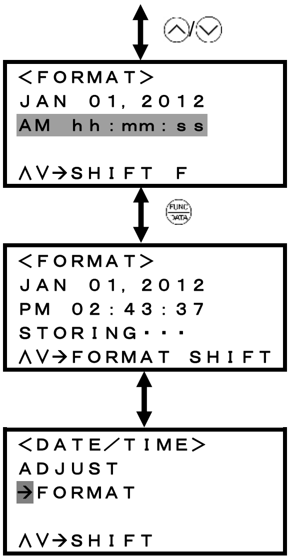
Press FUNC DATA key to establish the desired menu.

Change the date format data using the ∧ and ∨ keys.

<List of date formats>

yyyy/mm/dd	Year/Month/Date
dd/mm/yyyy	Date/Month/Year
mm/dd/yyyy	Month/Date/Year
mmm dd, yyyy	Month Date, Year
<OFF>	No display

Press FUNC DATA key to establish the newly specified date format.



Change the time format data using the ∧ and ∨ keys.

<List of time formats>

hh:mm:ss	0-24 hour: minutes: seconds
hh:mm:ss AM	0-12 hour: minutes: seconds AM/PM
AM hh:mm:ss	AM/PM 0-12 hour: minutes: seconds
<OFF>	No display

Press FUNC/DATA key to establish the newly specified time format.

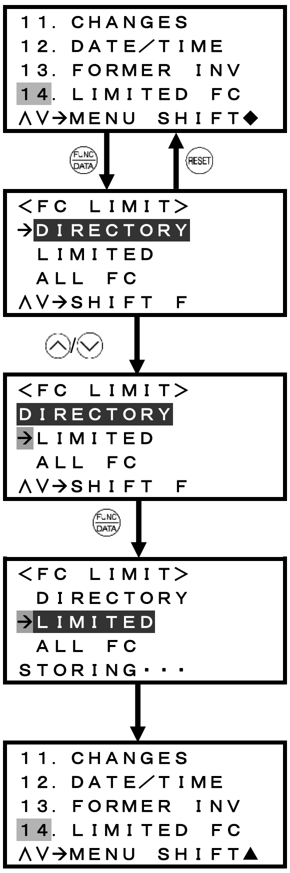
After a second, the screen automatically switches back to the submenu.

3.4.4.13 Limiting function codes to be displayed -- Menu #14 "LIMITED FC"

Menu #14 "LIMITED FC" in Programming mode is used to display/hide the directory and select whether to display all function codes or limited ones selected in Loader.

For details, refer to the "Function code edit" section in the FRENIC-VG Loader Instruction Manual.

Shown below is an example of selecting limited ones.



To display this menu screen, press the PRG key in Running mode to switch to Programming mode.
Move the cursor (flashing rectangle) at the left of the screen to "14. LIMITED FC" using the ∧ and ∨ keys. Then press the FUNC/DATA key.

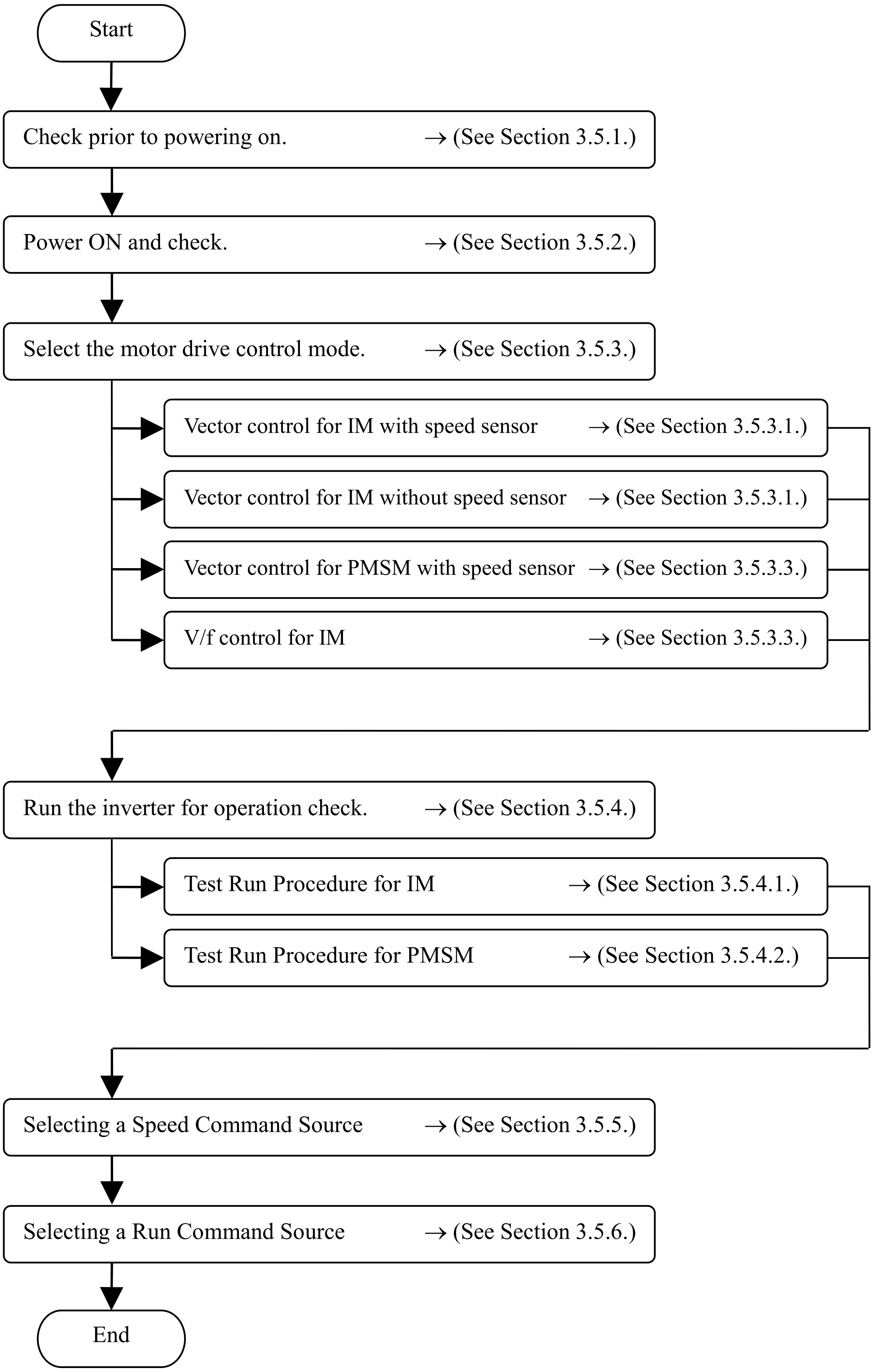
Move the pointer → using the ∧ and ∨ keys to the desired menu.

Press FUNC/DATA key to select "LIMITED."

After a second, the screen automatically switches back to the submenu.

3.5 Test Run Procedure

Make a test run of the motor using the flowchart given below.



3.5.1 Checking prior to powering On

Check the following before powering on the inverter.

(1) Check the wiring to the inverter input terminals L1/R, L2/S and L3/T and output terminals U, V, and W. Also check that the grounding wires are connected to the grounding terminals (⏚G) correctly. (See Figure 3.5-1.)

⚠WARNING

- Never connect power supply wires to the inverter output terminals U, V, and W. Doing so and turning the power ON breaks the inverter.
- Be sure to connect the grounding wires of the inverter and the motor to the ground electrodes.

Otherwise, an electric shock could occur.

(2) Check the control circuit terminals and main circuit terminals for short circuits or ground faults.

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

(4) Check that the motor is separated from mechanical equipment.

(5) Make sure that all switches of devices connected to the inverter are turned OFF. Powering on the inverter with any of those switches being ON may cause an unexpected motor operation.

(6) Check that safety measures are taken against runaway of the equipment, e.g., a defense to prevent people from access to the equipment.

(7) Check that a power factor correction DC reactor (DCR) is connected to terminals P1 and P(+).

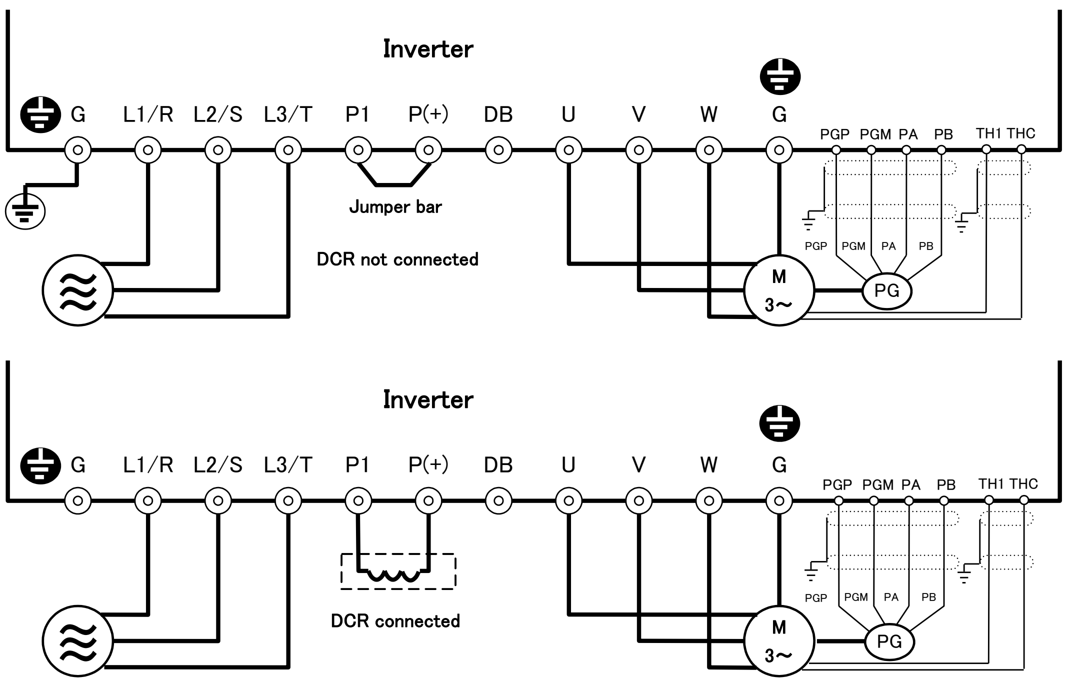
(Inverters of 75 kW or above and LD-mode inverters of 55 kW are provided together with a DCR as standard. Be sure to connect the DCR to the inverter.)

(8) Check that the PG (pulse generator) wiring is correct.

⚠CAUTION

Wrong wiring may break the PG..

If the inverter is powered on with wrong wiring, disconnect the PG signal wires from the inverter, keep only the PG powered on via the PGP and PGM, and then check that each signal is correctly output with an oscilloscope or recorder.



Note: In principle, the shielded sheath of wires should be connected to ground. If the inverter is significantly affected by external induction noise, however, connection to the common terminal (PGM, THC) may be effective to suppress the influence of noise.

Figure 3.5-1 Connection of Main Circuit Terminals (Vector dedicated motor connected)

3.5.2 Powering ON and checking

⚠WARNING
• Be sure to mount the front cover before turning the power ON. Do not remove the cover when the inverter power is ON. • Do not operate switches with wet hands. **Otherwise, an electric shock could occur.**

Turn the power ON and check the following points. The following is a case when no function code data is changed from the factory defaults.

(1) Check that the LED monitor displays 0 (indicating that the reference speed is 0 r/min) that is blinking. (See Figure 3.5-2.)
If the LED monitor displays any number except 0, press ∧ / ∨ key to set 0.

(2) Check that the built-in cooling fans rotate.

Figure 3.5-2 Display of the LED Monitor at Power-on

3.5.2.1 Checking the input state of PG (pulse generator) signals

Before proceeding to a test run of the inverter, rotate the motor shaft and check the digital input state of PG (pulse generator) signals on the screen shown below.

To call up the screen, switch the inverter operation mode from the Running mode to the Programming mode, select Menu #4 "I/O CHECK" on the menu screen, and select page 15 (shown below) using the ∧/∨ keys.

For detailed operation procedure, refer to Section 3.4.4.5.

```
SD  =±×××××P/s   ← PG (SD) signal input info (inverter or option)*
LD  =±×××××P/s   ← PG (LD) signal input info (option)
PR  =±×××××P/s   ← PG (PR) signal input info (option)
PD  =±×××××P/s   ← PG (PD) signal input info (option)
∧∨→PAGE  SHIF 15
```

* When a PG (SD) option is mounted, the PG (SD) signal input info appears; when it is not, the inverter PG signal input info appears.

3.5.2.2 Mounting direction of a PG (pulse generator) and PG signals

The forward rotational direction of the dedicated motor (MVK type) is CCW when viewed from the motor output shaft as shown in Figure 3.5-3.

During rotation in the forward direction, the PG output pulse forms a forward rotation signal (B phase advanced by 90 degrees) shown in Figure 3.5-4, and during rotation in the reverse direction, a reverse rotation signal (A phase advanced by 90 degrees).

In the case of motors other than the dedicated one, for example, to mount an external PG, directly connect it to the motor, using a coupling, etc.

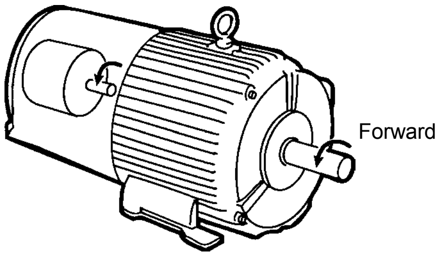


Figure 3.5-3 Forward Rotational Direction of Motor and PG

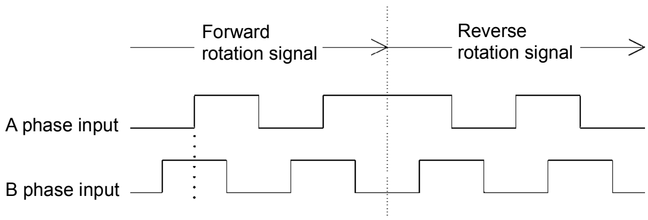


Figure 3.5-4 PG (Pulse Generator) Signal

3.5.3 Selecting a desired motor drive control

The FRENIC-VG supports the following motor drive controls.

Data for P01	M1 drive control	Speed feedback	Speed control	Refer to:
0	Vector control for IM with speed sensor	Yes	Speed control with automatic speed regulator (ASR)	Section 3.5.3.1
1	Vector control for IM without speed sensor	Estimated speed		Section 3.5.3.2
2	Simulation mode	Yes		Chapter 4, Section 4.3.4 "P codes"
3	Vector control for PMSM with speed sensor	Yes		Section 3.5.3.3
5	V/f control for IM	No	Frequency control	Section 3.5.3.4

3.5.3.1 Vector control for IM with speed sensor

Under vector control, the inverter detects the motor's rotational position and speed according to PG feedback signals and uses them for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector.

The desired response can be obtained by adjusting the control constants (PI constants) with the speed regulator (PI controller).

This control enables the speed control with higher accuracy and quicker response than the vector control without speed sensor.

(A recommended motor for this control is a Fuji VG motor exclusively designed for vector control.)

Note Vector control regulating the motor current requires some voltage margin between the voltage that the inverter can output and the induced voltage of the motor. Usually a general-purpose motor is so designed that the voltage matches the commercial power. Under the control, therefore, it is necessary to suppress the motor terminal voltage to the lower level in order to secure the voltage margin required.

However, driving the motor with the motor terminal voltage suppressed to the lower level cannot generate the rated torque even if the rated current originally specified for the motor is applied. To ensure the rated torque, it is necessary to review the rated current. (This also applies to vector control without speed sensor.)

■ **For Fuji VG motor exclusively designed for vector control**

Configure the function codes as listed below. The machinery design values (maximum speed, acceleration time, and deceleration time) should match your machinery ones.

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	Motor to be applied	Motor to be applied
P28 A30 A130	M1 PG Pulse Resolution M2 PG Pulse Resolution M3 PG Pulse Resolution	1024	1024
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	1: NTC thermistor	1: NTC thermistor
F03	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

■ For motors except Fuji VG motor

To use motors except a Fuji VG motor when their motor parameters to be set to function codes are known, perform auto-tuning to automatically configure them.

Configure the function codes as listed below according to the motor ratings and your machinery design values (maximum speed, acceleration time, and deceleration time). The motor ratings are printed on the motor's nameplate. For your machinery design values, ask system designers about them.

After configuring the function codes, perform motor parameter auto-tuning (H01 = 3 or 4).

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P28 A30 A130	M1 Pulse Resolution M2 Pulse Resolution M3 Pulse Resolution	Match the specifications of the PG to be used.	1024
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	0: No thermistor	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P03	M1 Rated Capacity		Capacity of nominal applied motors
A02 A102	M2 Rated Capacity M3 Rated Capacity		0.00 kW
P04	M1 Rated Current		Rated current of nominal applied motors
A03 A103	M2 Rated Current M3 Rated Current		0.01 A
P05 A07 A107	M1 Poles M2 Poles M3 Poles		4 poles
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

📖 For the motor parameter auto-tuning procedure (H01 = 3 or 4), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	3: Auto tuning with motor stopped 4: Auto tuning with motor rotating	0: Disable

Note Performing motor parameter auto-tuning (H01 = 3 or 4) automatically changes the data of function codes P06 through P11 and P15 through P21 for M1, A08 through A13 and A17 through A23 for M2, and A108 through A113 and A117 through A123 for M3. Be careful with this data change.

After tuning, be sure to perform the Save All function (H02 = 1) to save the tuned data into the inverter (writing into the nonvolatile memory).

3.5.3.2 Vector control for IM without speed sensor

Under this control, the inverter estimates the motor speed based on the inverter's output voltage and current to use the estimated speed for speed control. In addition, it controls the motor current and motor torque with quick response and high accuracy under vector control. No PG (pulse generator) is required.

The desired response can be obtained by adjusting the control constants (PI constants) and using the speed regulator (PI controller).

Applying "vector control without speed sensor" requires auto-tuning regardless of the motor type. (Even driving a Fuji VG motor exclusively designed for vector control requires auto-tuning.)

Configure the function codes as listed below according to the motor ratings and your machinery design values (maximum speed, acceleration time, and deceleration time). The motor ratings are printed on the motor's nameplate. For your machinery design values, ask system designers about them.

■ **For Fuji VG motor exclusively designed for vector control**

Configure the function codes as listed below and perform motor parameter auto-tuning (H01 = 2)

🕮 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P30 A31 A131	M1 PG Pulse Resolution M2 PG Pulse Resolution M3 PG Pulse Resolution	1: NTC thermistor	1: NTC thermistor
F03 A06 A106	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed		5.00 s
F08	Acceleration Time 1 **(Note)**		5.00 s

🕮 For the motor parameter auto-tuning procedure (H01 = 2), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	2: Auto-tuning (R1, Lσ)	0: Disable

Note: Performing motor parameter auto-tuning (H01 = 2) automatically changes the data of function codes P06 and P07 for M1, A08 and A09 for M2, and A108 and A109 for M3. Be careful with this data change.

After tuning, be sure to perform the Save All function (H02 = 1) to save the tuned data into the inverter (writing into the nonvolatile memory).

■ For motors except Fuji VG motor

Configure the function codes as listed below and perform motor parameter auto-tuning (H01 = 3 or 4)

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	0: Vector control for IM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	0: No thermistor	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P03	M1 Rated Capacity		Capacity of nominal applied motors
A02 A102	M2 Rated Capacity M3 Rated Capacity		0.00 kW
P04	M1 Rated Current		Rated current of nominal applied motors
A03 A103	M2 Rated Current M3 Rated Current		0.01 A
P05 A07 A107	M1 Poles M2 Poles M3 Poles		4 poles
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

📖 For the motor parameter auto-tuning procedure (H01 = 3 or 4), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	3: Auto tuning with motor stopped 4: Auto tuning with motor rotating	0: Disable

Note Performing motor parameter auto-tuning (H01 = 3 or 4) automatically changes the data of function codes P06 through P11 and P15 through P21 for M1, A08 through A13 and A17 through A23 for M2, and A108 through A113 and A117 through A123 for M3. Be careful with this data change.

After tuning, be sure to perform the Save All function (H02 = 1) to save the tuned data into the inverter (writing into the nonvolatile memory).

3.5.3.3 Vector control for PMSM with speed sensor and magnetic pole position sensor

Under this control, the inverter detects the motor's rotational position, speed and magnetic pole position according to feedback signals sent from the speed sensor and magnetic pole position sensor for speed control. In addition, it decomposes the motor drive current into the exciting and torque current components, and controls each of components in vector.

The desired response can be obtained by adjusting the control constants (PI constants) with the speed regulator (PI controller).

(A recommended motor for this control is Fuji GNF2 series exclusively designed for vector control.)

■ **For Fuji GNF2 motor exclusively designed for vector control**

Configure the function codes as listed below. The machinery design values (maximum speed, acceleration time, and deceleration time) should match your machinery ones. For details, contact your Fuji Electric representative.

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET." For details, refer to Chapter 4, Section 4.3 "Details of Function Codes."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	3: Vector control for PMSM with speed sensor	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
o10 A60 A160	M1 Magnetic Pole Position Sensor Offset M2 Magnetic Pole Position Sensor Offset M3 Magnetic Pole Position Sensor Offset	0.0 to 359.9 (0.0° to 359.9° CCW) These function codes are used to adjust the magnetic pole position. Refer to Section 3.5.4.2 "Test run procedure for permanent magnet synchronous motor (PMSM), [3] Setting the magnetic pole position offset value."	0.0
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration Time 1 **(Note)**		5.00 s
F08	Deceleration Time 1 **(Note)**		5.00 s

Note: Since vector control for a Fuji GNF2 motor with speed sensor uses motor parameters, the following conditions should be satisfied; otherwise, full control performance may not be obtained.

- A single motor should be connected per inverter.
- Motor parameters are properly configured.

Table 3.5-1 PMSM (GNF2) Function Code Table 1

Motor Type	Motor Capacity	Rated Voltage	Rated Current	Num. of poles	Rated Speed	Maximum Speed	F03 (A06) (A106)	F04 (A05) (A105)	F05 (A04) (A104)	F40	F44	P01 (A01) (A101)	P02	P03 (A02) (A102)	P04 (A03) (A103)	P05 (A07) (A107)	P06 (A08) (A108)	P07 (A09) (A109)	P08 (A10) (A110)	P09 (A11) (A111)	P10 (A12) (A112)	P11 (A13) (A113)	P12 (A14) (A114)	P13 (A15) (A115)	P14 (A16) (A116)	P15 (A17) (A117)	P16 (A18) (A118)	P17 (A19) (A119)	P18 (A20) (A120)	P19 (A21) (A121)	P20 (A22) (A122)	P21 (A23) (A123)
GNF2114A	5.5	185	20	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	5.50	20.00	6	4.02	45.57	9.76	14.96	0.001	0.001	5.45	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	164
GNF2115A	7.5	185	29	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	7.50	29.00	6	4.76	51.21	14.30	19.94	0.001	0.001	5.33	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	164
GNF2117A	11	185	42	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	11.00	42.00	6	4.44	59.11	21.62	29.39	0.001	0.001	4.55	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	160
GNF2118A	15	185	57	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	15.00	57.00	6	4.03	45.01	26.38	41.74	0.001	0.001	4.67	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	157
GNF2136A	18.5	180	71	6	1500	2000	2000	1500	180	3	150	3	P-OTHER	18.50	71.00	6	2.99	51.83	38.21	47.86	0.001	0.001	4.32	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	161
GNF2137A	22	185	82	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	22.00	82.00	6	2.93	37.62	34.95	62.56	0.001	0.001	4.09	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	160
GNF2139A	30	180	113	6	1500	2000	2000	1500	180	3	150	3	P-OTHER	30.00	113.0	6	2.94	41.50	55.27	83.16	0.001	0.001	4.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	157
GNF2165A	37	185	140	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	37.00	140.0	6	2.76	51.88	80.41	90.78	0.001	0.001	2.97	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	152
GNF2167A	45	185	165	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	45.00	165.0	6	2.28	45.11	94.10	112.6	0.001	0.001	3.10	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	151
GNF2185A	55	185	200	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	55.00	200.0	6	2.47	47.65	122.1	126.6	0.001	0.001	3.27	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	162
GNF2187A	75	185	270	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	75.00	270.0	6	2.12	45.27	161.8	176.4	0.001	0.001	3.20	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	160
GNF2207A	90	185	316	6	1500	2000	2000	1500	185	3	150	3	P-OTHER	90.00	316.0	6	1.99	43.92	205.7	195.1	0.001	0.001	2.67	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	165
GNF2114A	5.5	370	10	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	5.50	10.00	6	4.02	45.57	4.88	7.48	0.001	0.001	5.45	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	328
GNF2115A	7.5	370	15	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	7.50	15.00	6	4.93	52.97	7.15	9.97	0.001	0.001	5.33	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	328
GNF2117A	11	370	21	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	11.00	21.00	6	4.44	59.11	10.81	14.70	0.001	0.001	4.55	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	320
GNF2118A	15	370	29	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	15.00	29.00	6	4.10	45.80	13.09	20.90	0.001	0.001	4.67	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	314
GNF2136A	18.5	360	36	6	1500	2000	2000	1500	360	3	150	3	P-OTHER	18.50	36.00	6	3.03	52.56	19.11	23.93	0.001	0.001	4.32	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	322
GNF2137A	22	370	41	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	22.00	41.00	6	2.93	37.62	17.48	31.28	0.001	0.001	4.09	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	320
GNF2139A	30	360	57	6	1500	2000	2000	1500	360	3	150	3	P-OTHER	30.00	57.00	6	2.96	41.87	27.18	41.75	0.001	0.001	4.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	314
GNF2165A	37	370	70	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	37.00	70.0	6	2.75	51.88	40.20	45.39	0.001	0.001	2.97	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	304
GNF2167A	45	370	83	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	45.00	83.00	6	2.30	45.38	47.05	56.30	0.001	0.001	3.11	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	302
GNF2185A	55	370	100	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	55.00	100.0	6	2.47	47.65	61.33	62.46	0.001	0.001	3.27	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	324
GNF2187A	75	370	135	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	75.00	135.0	6	2.12	45.27	80.90	88.18	0.001	0.001	3.20	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	321
GNF2207A	90	370	158	6	1500	2000	2000	1500	370	3	150	3	P-OTHER	90.00	158.0	6	1.99	43.92	102.8	97.55	0.001	0.001	2.67	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.001	338

Table 3.5-1 PMSM (GNF2) Function Code Table 2

Motor Type	Motor Capacity	Rated Voltage	P22 (A24) (A124)	P23 (A25) (A125)	P24 (A26) (A126)	P25 (A27) (A127)	P26 (A28) (A128)	P27 (A29) (A129)	P28 (A30) (A130)	P30 (A31) (A131)	P33 (A53) (A153)	P42 (A62) (A162)	P43 (A63) (A163)	P44 (A64) (A164)	P45 (A65) (A165)	P46 (A66) (A166)	P47 (A67) (A167)	P48 (A68) (A168)	P49 (A69) (A169)	P50 (A70) (A170)	P51 (A71) (A171)	H51 (H52) (H127)	H104	H160 (H170) (H180)	H161 (H171) (H181)	H162 (H172) (H182)	H163 (H173) (H183)	H164 (H174) (H184)	o09 (A59) (A159)	o11 (A61) (A161)
GNF2114A	5.5	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	50.0	0.90	0.85	−0.170	0.050	−3.00	−3.00	−0.150	0.018	1110	0	80	1.0	80	0	1	2.258
GNF2115A	7.5	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	72.5	1.00	0.88	−0.120	−0.120	0.00	−3.00	−0.200	0.021	1110	0	80	1.0	80	0	1	2.204
GNF2117A	11	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	105.0	1.00	1.15	−0.100	−0.250	−2.00	−3.00	−0.170	0.027	1110	0	80	1.0	80	0	1	2.009
GNF2118A	15	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	98.3	142.5	0.95	0.95	−0.100	−0.100	−0.50	−2.50	−0.200	0.036	1110	0	80	1.0	80	0	1	2.397
GNF2136A	18.5	180	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	180	95.0	100.0	177.5	0.95	0.95	−0.120	−0.200	−2.00	−3.00	−0.200	0.065	1110	0	80	1.0	80	0	1	2.242
GNF2137A	22	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	205.0	0.90	0.90	−0.200	−0.300	0.00	−3.00	−0.200	0.070	1110	0	80	1.0	80	0	1	2.548
GNF2139A	30	180	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	180	95.0	99.9	282.5	0.90	0.90	−0.150	−0.150	−1.00	−2.00	−0.200	0.090	1110	0	80	1.0	80	0	1	2.494
GNF2165A	37	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	350.0	1.02	1.00	−0.100	−0.100	−2.00	−3.00	−0.200	0.153	1110	0	80	1.0	80	0	1	2.595
GNF2167A	45	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	98.8	412.5	0.93	0.93	−0.170	−0.140	0.00	−2.00	−0.200	0.191	1110	0	80	1.0	80	0	1	2.770
GNF2185A	55	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	500.0	0.95	1.00	−0.100	−0.100	−3.00	−4.00	−0.200	0.350	1110	0	80	1.0	80	0	1	2.792
GNF2187A	75	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	98.1	675.0	0.97	0.95	−0.150	−0.150	0.00	−3.50	−0.200	0.467	1110	0	80	1.0	80	0	1	2.816
GNF2207A	90	185	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	185	95.0	100.0	790.0	1.00	1.10	−0.050	−0.030	0.00	−3.00	−0.200	0.805	1110	0	80	1.0	80	0	1	2.929
GNF2114A	5.5	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	25.0	0.90	0.85	−0.170	0.050	−3.00	−3.00	−0.150	0.018	1110	0	80	1.0	80	0	1	2.258
GNF2115A	7.5	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	36.3	1.00	0.88	−0.120	−0.120	0.00	−3.00	−0.200	0.021	1110	0	80	1.0	80	0	1	2.204
GNF2117A	11	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	52.5	1.00	1.15	−0.100	−0.250	−2.00	−3.00	−0.170	0.027	1110	0	80	1.0	80	0	1	2.009
GNF2118A	15	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	98.3	71.3	0.95	0.95	−0.100	−0.100	−0.50	−2.50	−0.200	0.036	1110	0	80	1.0	80	0	1	2.397
GNF2136A	18.5	360	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	360	95.0	100.0	88.8	0.95	0.95	−0.120	−0.200	−2.00	−3.00	−0.200	0.065	1110	0	80	1.0	80	0	1	2.242
GNF2137A	22	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	102.5	0.90	0.90	−0.200	−0.300	0.00	−3.00	−0.200	0.070	1110	0	80	1.0	80	0	1	2.548
GNF2139A	30	360	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	360	95.0	99.9	141.3	0.90	0.90	−0.150	−0.150	−1.00	−2.00	−0.200	0.090	1110	0	80	1.0	80	0	1	2.494
GNF2165A	37	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	175.0	1.02	1.00	−0.100	−0.100	−2.00	−3.00	−0.200	0.153	1110	0	80	1.0	80	0	1	2.595
GNF2167A	45	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	98.8	206.2	0.93	0.93	−0.170	−0.140	0.00	−2.00	−0.200	0.191	1110	0	80	1.0	80	0	1	2.776
GNF2185A	55	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	250.0	0.95	1.00	−0.100	−0.100	−3.00	−4.00	−0.200	0.350	1110	0	80	1.0	80	0	1	2.792
GNF2187A	75	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	98.1	337.5	0.97	0.95	−0.150	−0.150	0.00	−3.50	−0.200	0.467	1110	0	80	1.0	80	0	1	2.816
GNF2207A	90	370	1.100	1.000	1.000	0.000	2.0	1.0	1024	1	370	95.0	100.0	395.0	1.00	1.10	−0.050	−0.030	0.00	−3.00	−0.200	0.805	1110	0	80	1.0	80	0	1	2.929

3.5.3.4 V/f control for IM

Under this control, the inverter drives a motor with the voltage and frequency according to the V/f pattern specified by function codes.

■ **For Fuji VG motor exclusively designed for vector control**

Configure the function codes as listed below. The machinery design values (maximum speed, acceleration time, and deceleration time) should match your machinery ones.

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	5: V/f control for IM	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	Motor to be applied	Motor to be applied
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	1: NTC thermistor (Specify the thermistor as needed.)	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P33	M1 Maximum Output Voltage		Three-phase 200 V class series: 200 (V) Thee-phase 400 V class series: 400 (V)
A53 A153	M2 Maximum Output Voltage M3 Maximum Output Voltage		80 V
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration time 1 **(Note)**		5.00 s
F08	Deceleration time 1 **(Note)**		5.00 s
P35 A55 A155	M1 Torque Boost M2 Torque Boost M3 Torque Boost	2.0 (For constant torque load) **(Note)** In applications requiring a starting torque, adjust the torque boost (P35, A55, A155) within the range from 2.0 to 20.0.)	0.0 (Auto torque boost)

■ **For motors except Fuji VG motor**

Configure the function codes as listed below according to the motor ratings and your machinery design values (maximum speed, acceleration time, and deceleration time). The motor ratings are printed on the motor's nameplate. For your machinery design values, ask system designers about them.

In applications requiring a starting torque, adjust the torque boost (P35, A55, A155) within the range from 2.0 to 20.0, or perform motor parameter auto-tuning (H01 = 2) and then set the torque boost (P31, A55, A155) to 0.0 (auto torque boost).

📖 For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

Function code	Name	Function code data	Factory default
P01 A01	M1 Drive Control M2 Drive Control	5: V/f control for IM	0: Vector control for IM with speed sensor
A101	M3 Drive Control		5: V/f control for IM
P02	M1 Selection	37: Others (No modification is required for M2 or M3.)	Motor to be applied
P30 A31 A131	M1 Thermistor Type M2 Thermistor Type M3 Thermistor Type	0: No thermistor	1: NTC thermistor
F04 A05 A105	M1 Rated Speed M2 Rated Speed M3 Rated Speed	Motor ratings (printed on the nameplate of the motor)	1500 r/min
F05	M1 Rated Voltage		Rated voltage of nominal applied motors
A04 A104	M2 Rated Voltage M3 Rated Voltage		80 V
P33	M1 Maximum Output Voltage		Three-phase 200 V class series: 200 (V) Thee-phase 400 V class series: 400 (V)
A53 A153	M2 Maximum Output Voltage M3 Maximum Output Voltage		80 V
P03	M1 Rated Capacity		Capacity of nominal applied motors
A02 A102	M2 Rated Capacity M3 Rated Capacity		0.00 kW
P04	M1 Rated Current		Rated current of nominal applied motors
A03 A103	M2 Rated Current M3 Rated Current		0.01 A
P05 A07 A107	M1 Poles M2 Poles M3 Poles		4 poles
F03 A06 A106	M1 Maximum Speed M2 Maximum Speed M3 Maximum Speed	Machinery design values **(Note)** For a test-driving of the motor, increase values so that they are longer than your machinery design values. If the specified time is short, the inverter may not run the motor properly.	1500 r/min
F07	Acceleration time 1 **(Note)**		5.00 s
F08	Deceleration time 1 **(Note)**		5.00 s
P35 A55 A155	M1 Torque Boost M2 Torque Boost M3 Torque Boost	2.0 (For constant torque load)	0.0 (Auto torque boost)
P06	M1 %R1	To use the auto torque boost function (P35, A55, A155 = 0.0), be sure to perform motor parameter auto-tuning (H01 =2).	Depends on the rated capacity.
A08 A108	M2 %R1 M3 %R1		0.00%
P07	M1 %X		Depends on the rated capacity.
A09 A109	M2 %X M3 %X		0.00%

For the motor parameter auto-tuning procedure (H01 = 2), refer to Chapter 4, Section 4.3.5 "H Codes."

Function code	Name	Function code data	Factory default
H01	Tuning Selection	2: Auto-tuning (R1, Lσ)	0: Disable

Note: Performing motor parameter auto-tuning (H01 = 2) automatically changes the data of function codes P06 and P07 for M1, A08 and A09 for M2, and A108 and A109 for M3. Be careful with this data change.

After tuning, be sure to perform the Save All function (H02 = 1) to save the tuned data into the inverter (writing into the nonvolatile memory).

3.5.4 Running the inverter for operation check

⚠WARNING

- If the user configures the function codes without completely understanding this Instruction Manual and the FRENIC-VG User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine.
- When making a test run with a permanent magnet synchronous motor (PMSM), be sure to observe the test run procedure given in Section 3.5.4.2. If wiring between the inverter and motor or PG wiring is wrong, or the magnetic pole position offset is improper, the motor may run out of control.

An accident or injuries may result.

After completion of preparations for a test run as described above, start running the inverter for motor operation check using the following procedure.

⚠CAUTION

If any abnormality is found in the inverter or motor, immediately stop operation and investigate the cause referring to Chapter 13, "TROUBLESHOOTING."

3.5.4.1 Test run procedure for induction motor (IM)

(1) Turn the power ON and check that the reference speed is 0 r/min and it is blinking on the LED monitor.

(2) Set a low reference speed such as 100 r/min, using ∧ / ∨ keys. (Check that the speed is blinking on the LED monitor.)

(3) To run the motor in the forward direction, press the FWD key; to run it in the reverse direction, press the REV key. (Check that the speed is lit on the LED monitor.)

(4) Press the STOP key to stop the motor.

< Check points during a test run >

- Check that the motor is running in the forward direction when it is driven with the FWD key.
- Check that the motor is running in the reverse direction when it is driven with the REV key.
- Check for smooth rotation without motor humming or excessive vibration.
- Check for smooth acceleration and deceleration.

When no abnormality is found, press the FWD or REV key again to start driving the motor, then increase the reference speed using ∧ / ∨ keys. Check the above points again.

3.5.4.2 Test run procedure for permanent magnet synchronous motor (PMSM)

[1] Before proceeding with a test run

This section provides a test run procedure for the configuration consisting of the FRENIC-VG, the interface card for PMPG drive (OPC-VG1-PMPG), and a PMSM using a UVW phase detection PG (including GNF2 motor).

For a test run using a PMSM, it is recommended that the motor be disconnected from the equipment for testing it by itself. If it is impossible to drive the motor by itself due to the equipment, however, make a test run under the conditions that cause no problems even if the motor runs continuously in one direction (forward or reverse).

[2] Preparation for a test run

(1) Before turning the inverter power ON, make checking given in Section 3.5.1 "Checking prior to powering On."

(2) Check that wiring of the encoder (PG) is correct.

(For the connection diagram, refer to Chapter 2, Section 2.3.1.2 "In combination with a dedicated PMSM (GNF2 type).")

⚠CAUTION
Wrong wiring may break the PG.. If the inverter is powered on with wrong wiring, disconnect the PG signal wires from the inverter, keep only the PG powered on via the PGP and PGM, and then check that each signal is correctly output with an oscilloscope or recorder.

(3) Turn the power ON, make a note of the current configuration of all function codes, and then change the function code data as listed in Table 3.5-2.

(4) Check that the magnetic pole position offset (o10) is set to the previously specified value or adjusted value.

Replacing the motor or encoder requires adjustment of the magnetic pole position offset again.

Table 3.5-2 Configuration for Test Run of PMSM

Function code	Name	Current configuration before test run (Values given below are factory defaults)		Configuration for test run	
F01	Speed Command N1	0	The current configuration of function codes differs depending upon the equipment specifications. Make a note of the current configuration and then change the function code data as shown at the right.	0	0: Enable the ∧ and ∨ keys on the keypad (Digital speed setting)
F02	Operation Method	0		0	0: Enable the FWD, REV and STOP keys on the keypad to run or stop the motor.
F03	Maximum Speed M1	1500 r/min		750 r/min	Set about half of the current value (before test run).
F40	Torque Limiter Mode 1	0 (Disable)		3	3: Torque current limit
F44	Torque Limiter Level 1	150%		10%	If motor power wires or encoder wires are wrongly connected, the motor may run out of control, breaking the equipment. To suppress abrupt acceleration at the time of runaway, decrease the torque limiter level.
E45	Speed Disagreement Alarm	00 (Disable)		01	Speed disagreement alarm: Enable Power supply phase loss detection: Disable

Note 1: If the moment of inertia of the coupled equipment is large, the motor may not run at a test run. If it happens, adjust the torque limiter level 1 properly.

Note 2: After a test run, revert the function code data to the previous values.

[3] Setting the magnetic pole position offset value

⚠CAUTION

Be sure to adjust the magnetic pole position offset value (see below for the adjustment procedure):

- when the inverter runs for the first time after purchase
- after replacement of a motor, PG or inverter

Running the inverter with the magnetic pole position offset value (o10, A60, A160) not adjusted or with the position deviated greatly from the true value could run the motor in the opposite direction or out of control in the worst case.

An accident or injuries could occur.

When driving a PMSM for the first time, be sure to set the magnetic pole position offset value to the inverter with the following function code(s) beforehand.

M1: Function code o10
M2: Function code A60
M3: Function code A160

Select the adjustment procedure from the following three depending on the situation.

(1) When the magnetic pole position offset value is printed on the label attached to the motor

GNF2 motors have a magnetic pole position label on the motor power line (U phase) on which the magnetic pole position offset value is printed. See Figure 3.5-5. Set the value to the function code (o10, A60, A160).

As shown in Figure 3.5-6, there are two types of magnetic pole position labels.

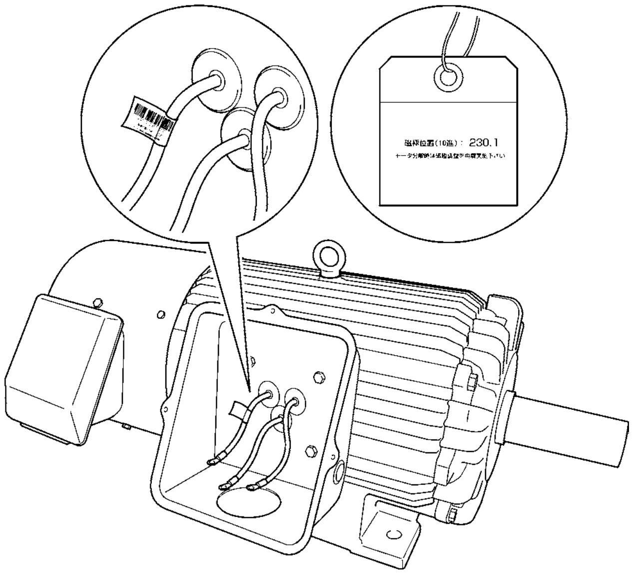


Figure 3.5-5 Magnetic Pole Position Offset Label Attaching Position Example

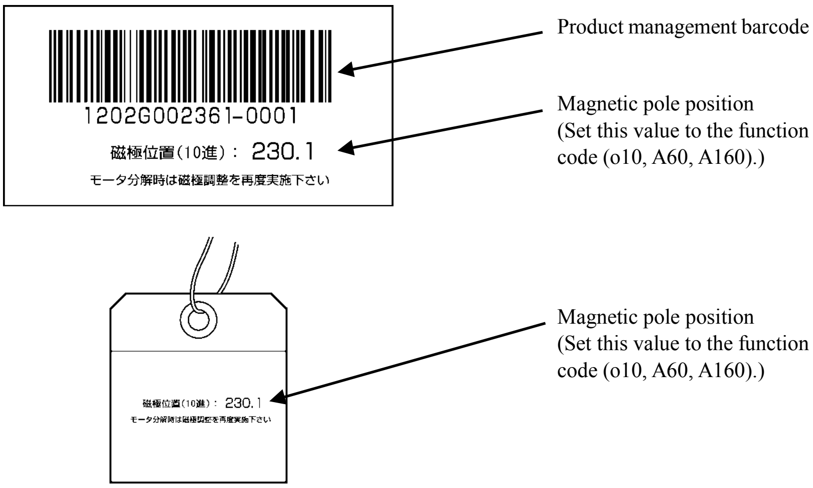


Figure 3.5-6 Magnetic Pole Position Offset Labels

Note: Once a pulse generator (PG) is removed from the motor, it is necessary to adjust the magnetic pole position offset value.

(2) Automatic adjustment of the magnetic pole position offset value

When you mount a PG on the motor or replace the PG at the site for motors having no magnetic pole position offset label, perform automatic adjustment with the tuning function (H71 = 5).

Upon normal end of tuning, the magnetic pole position offset data is automatically saved into function code o10 (Magnetic pole position offset).

Requisites for tuning the magnetic pole position offset

① Running the motor does not bring the machinery into dangerous situations.

② There is no load fluctuation at the machinery and the motor rotation is stabilized.

If any of the above conditions is not satisfied, separate the motor from the machinery and perform the magnetic pole position offset tuning.

③ Automatic adjustment of the magnetic pole position offset value can apply only to the absolute UVW encoders (o09 = 1).

For encoders other than the absolute UVW ones, perform manual adjustment given in item (3) later.

Tuning procedure

① Before starting tuning, configure the following function codes.
P01 = 3 (Select PMSM)
o09 = 1 (Select absolute UVW encoders)
F02 = 0 (Select keypad for operation)

② Set H71 to "5" (Select magnetic pole position offset tuning).
(The H71 data can be changed by simultaneous keying of STOP + ∧ / ∨ keys.)

③ Press the FWD key to start tuning.

④ Upon completion of tuning, the data of H71 automatically reverts to "0."

⑤ The tuning result is saved into o10.

Note: When motor 2 (M2) or motor 3 (M3) is selected, use the following functions in tuning as listed below.

Motor 1 (M1)	Motor 2 (M2)	Motor 3 (M3)
P01	A01	A101
o09	A59	A159
o10	A60	A160

Function codes applied for adjustment

The following function codes are applied for adjustment in tuning. Usually, their factory default values should be retained.

- H161 (M1 pull-in current command)
- H171 (M2 pull-in current command)
- H181 (M3 pull-in current command)

Setting range: 10 to 200(%), Factory default: 80(%)
(Assuming the setting of P04 (M1 rated current) as 100%)

Note: If the motor sticks to the stop state, increasing the current value preset to the above function codes may resolve the problem.

- H162 (M1 pull-in frequency)
- H172 (M2 pull-in frequency)
- H182 (M3 pull-in frequency)

Setting range: 0.1 to 10.0 (Hz), Factory default: 1.0 (Hz)

Note: If the motor vibrates abnormally, decreasing the frequency value preset to the above function codes may resolve the problem.

Tuning Errors

If tuning fails, check the configuration of the function codes and wiring according to the instructions given below.

① The "NOT EXECUTE" appears on the keypad.

When M1 is selected, P02 ≠ 37 (OTHER).
⇒ Set P02 to "37."

The JOG mode is selected. (The JOG indicator on the keypad is lit.)
⇒ Cancel the JOG mode by simultaneous keying of (STOP) + (∧) keys.
⇒ Turn the digital input ***JOG*** OFF (if ON).

② Alarm Er-6 occurs.

P01 ≠ 3, o09 ≠ 1, or H160 ≠ 0.
⇒ Set P01 to "3," o09 to "1," or H160 to "0."

Any of the digital inputs ***BX***, ***STOP1***, ***STOP2***, and ***STOP3*** is ON.
Either one of the functional safety input terminals [EN1] and [EN2] is OFF.
⇒ Turn ***BX***, ***STOP1***, ***STOP2***, and ***STOP3*** OFF and turn [EN1] and [EN2] ON; otherwise, turning cannot start.

③ Alarm Er-7 occurs.

A phase loss may have occurred in connection between the inverter and motor.
⇒ Correct the connection between the inverter and motor.

Brake applies to the motor.

⇒ During tuning, be sure to enable the motor to rotate.

The motor cannot rotate. The motor is vibrating abnormally.

⇒ For motor 1: Adjust the settings of H161 (M1 pull-in current command) and H162 (M1 pull-in frequency).

⇒ For motor 2: Adjust the settings of H171 (M2 pull-in current command) and H172 (M2 pull-in frequency).

⇒ For motor 3: Adjust the settings of H181 (M3 pull-in current command) and H182 (M3 pull-in frequency).

④ Alarm PG occurs.

The PG wiring may be wrong.

⇒ Correct the PG wiring.

⚠WARNING

Starting magnetic pole position offset tuning rotates the motor. Before starting tuning, be sure to check that running the motor does not cause any dangerous situation.

An accident or injuries could occur.

(3) Manual adjustment of the magnetic pole position offset value

If magnetic pole position offset tuning cannot be used, adjust the offset value manually according to the instructions given below.

Configuring function code data beforehand

- E69 (Terminal [Ao1] function) = 26 (U phase voltage)
- E70 (Terminal [Ao2] function) = 39 (Magnetic pole position signal ***SMP***)
- E84 (Ao1-Ao5 filter setting) = 0.000 s (Cancel filter)

Adjustment procedure

Rotate the motor shaft by hand to check that the positional relationship between the waveforms on Ao1 and Ao2 is as shown below. If the waveforms are greatly misaligned, adjust the data of function code o10 to align the waveforms as shown below.

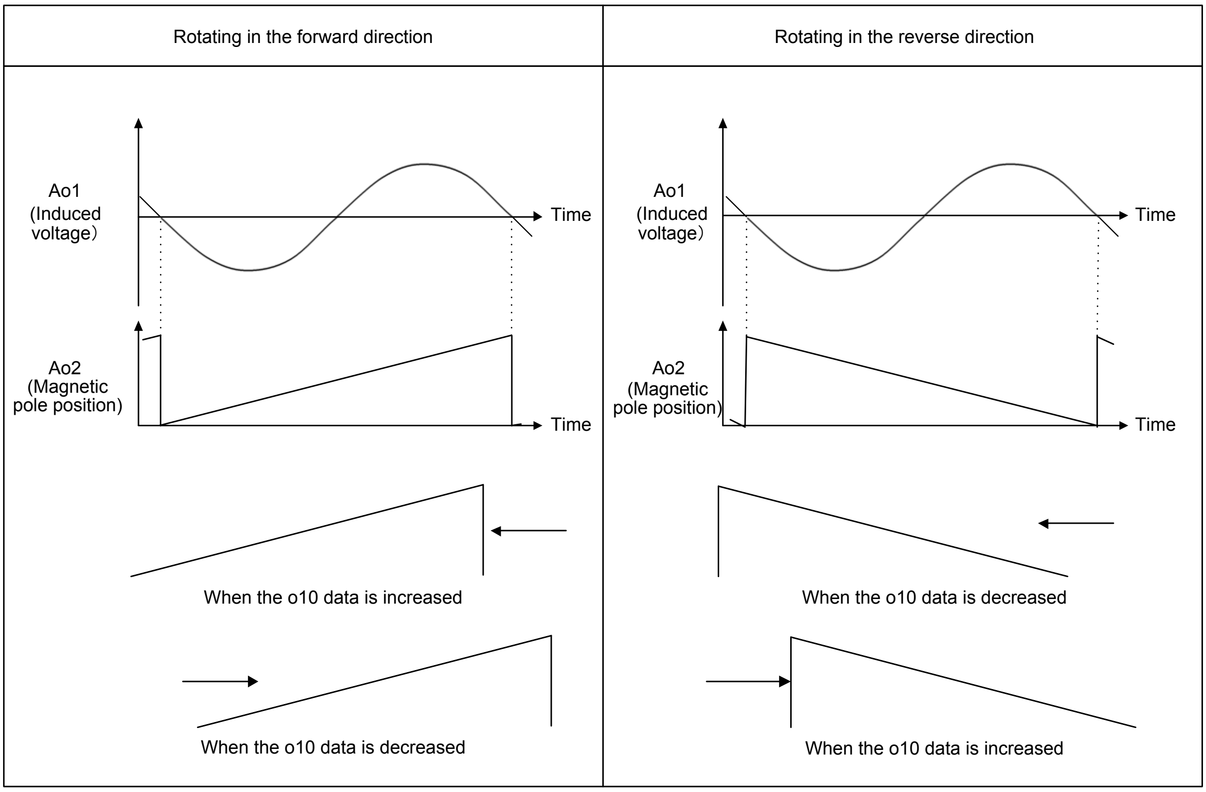


Figure 3.5-7 Adjustment of Magnetic Pole Position

Note: If a PG alarm occurs during adjustment, the PG connection may be wrong. Check the PG wiring.

[4] Test run

(1) Turn the power ON and check that the reference speed is 0 r/min and it is blinking on the LED monitor.

(2) Set a low reference speed such as 100 r/min, using ∧ / ∨ keys. (Check that the speed is blinking on the LED monitor.)

(3) Set the maximum speed (F03) to 750 r/min.

(4) Shift the LCD monitor to Menu #3 "OPR MNTR" to show the speed (N∗, N).

```
N∗=×××××.×r/m
N =×××××.×r/m
f∗ =××××.×Hz
TRQ=××××.×%
∧∨→PAGE SHIFT 1
```

(5) To run the motor in the forward direction, press the (FWD) key; to run it in the reverse direction, press the (REV) key.

Check that:

- The speed on the LED monitor comes ON instead of blinking
- The motor accelerates up to the specified speed.
- There is no abnormal discrepancy between the reference speed (*N) and the detected speed (N) shown on the LCD monitor.

(6) Press the (STOP) key to stop the motor.

(7) If no alarm occurs or no problem is found in motor running, increase the speed with the ∧ / ∨ keys.

(8) Turn the run command OFF.

< Check points during a test run >

- Check that the motor is running in the forward direction when it is driven with the (FWD) key.
- Check that the motor is running in the reverse direction when it is driven with the (REV) key.
- Check for smooth rotation without motor humming or excessive vibration.
- Check for smooth acceleration and deceleration.

When no abnormality is found, press the (FWD) or (REV) key again to start driving the motor, then increase the reference speed using ∧ / ∨ keys. Check the above points during a test run.

[5] Troubleshooting for motor abnormality

If any of the following abnormalities is found during a test run, follow the troubleshooting procedure in Table 3.5-3.

- Turning the inverter ON triggers a P9 alarm.
- Entering a run command triggers a P9 or Er-9 alarm.
- Entering a run command does not run the motor or increase the speed.

Table 3.5-3 Troubleshooting for Motor Abnormality

Possible Causes	What to Check and Suggested Measures
(1) Setting of torque limiter level 1 too small relative to the load.	Check the setting of the torque limiter level 1 (F44). ➔ Increase the F44 data in increments of 5%.
(2) Wrong wiring between the inverter and motor.	Check the wiring between the inverter and motor. ➔ Correct the wiring.
(3) Wrong PG wiring.	Check the wiring of the PG. ➔ Correct the wiring.
(4) PMSM magnetic pole position not matched.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160), referring to "■ Adjusting the magnetic pole position" in Section 3.5.3.3.

3.5.5 Selecting a speed command source

A speed command source is the keypad (⌃ / ⌄ keys) by factory default. This section provides the speed command setting procedures using the speed command sources of the keypad, external potentiometer, and speed selection terminal commands.

3.5.5.1 Setting up a speed command from the keypad

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F01	Speed Command Source N1	0: Keypad (⌃ / ⌄ keys)	0

Note
- When the inverter is in Programming or Alarm mode, speed command setting with ⌃ / ⌄ keys is disabled. To enable it, switch to Running mode.
- If any of higher priority speed command sources (multistep speed commands and speed commands via communications link) is specified, the inverter may run at an unexpected speed.

(2) Press the ⌃ / ⌄ key to display the current speed command on the LED monitor. The least significant digit blinks.

(3) To change the speed command, press the ⌃ / ⌄ key again.

When you start specifying the speed command with the ⌃ / ⌄ key, the least significant digit on the display blinks; that it, the cursor lies in the least significant digit. Holding down the ⌃ / ⌄ key changes data in the least significant digit and generates a carry, while the cursor remains in the least significant digit.

(4) To save the new setting into the inverter's memory, press the FUNC/DATA key.

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

3.5.5.2 Setting up a speed command with an external potentiometer

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F01	Speed Command Source N1	1: Analog voltage input to terminal [12] (0 to ±10 V)	0

(2) Connect an external potentiometer to terminals [11] through [13] of the inverter.

(3) Rotate the external potentiometer to apply voltage to terminal [12] for a speed command input.

For precautions in wiring, refer to Section 3.3 "Mounting and Wiring the Inverter."

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

3.5.5.3 Setting up a speed command with multistep speed selection

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
E01 to E14	Terminal [X1] to [X14] Functions	0, 1, 2, 3: Multistep speed 1 to 15 (0: ***SS1***, 1: ***SS2***, 2: ***SS4***, 3: ***SS8***)	0
C05 to C19	Multistep speed 1 to 15	0 to 30000 r/min, 0.00 to 100.00%, or 0.0 to 999.9 m/m	0

Terminals [X11] to [X14] are available only when an optional OPC-VG1-DIOA is mounted.

Assign signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** to four out of digital input terminals [X1] to [X14] by four out of function codes E01 to E14 (data = 0, 1, 2 and 3). Specify multistep speed commands with C05 to C19.

Turning digital signals ***SS1***, ***SS2***, ***SS4*** and ***SS8*** ON/OFF selectively switches the multistep speed commands specified beforehand.

Combination of input signals				Selected speed command	
3 ***SS8***	2 ***SS4***	1 ***SS2***	0 ***SS1***		
OFF	OFF	OFF	ON	C05 (Multistep speed 1)	Function codes C05 to C19 Data setting range: 0 to 30000 r/min or 0.00 to 100.00% or 0.0 to 999.9 m/m
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 N-14/CREP1	
ON	ON	ON	ON	C19 N-15/CREP2	

(2) Connect a multistep speed switch to an X terminal and [CM].

(3) Turn the multistep speed switch ON (short-circuit). The combination of those input signals switches a multistep speed command.

For precautions in wiring, refer to Section 3.3 "Mounting and Wiring the Inverter."

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

Note: Enabling a multistep speed command with a multistep speed switch (ON between X terminal and [CM]) disables the speed command source N1 specified by F01.

3.5.6 Selecting a run command source

A run command source is the keypad (FWD / REV / STOP keys) by factory default.

3.5.6.1 Setting up a run command from the keypad

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F02	Operation Method	0: Keypad (FWD / REV / STOP keys)	0: Keypad (FWD / REV / STOP keys)

(2) Press the FWD key to run the motor in the forward direction. Press the STOP key to stop it.

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

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

3.5.6.2 Setting up a run command with digital input signals (terminals [FWD] and [REV])

Follow the procedure given below.

(1) Configure the function codes as listed below.

Function code	Name	Function code data	Factory default
F02	Operation Method	1: External digital input signal	0: Keypad (FWD / REV / STOP keys)

Note If terminal [FWD] and [REV] are ON, the F02 data cannot be changed. First turn those terminals OFF and then change the F02 data.

(2) Connect the run forward switch between terminals [FWD] and [CM] and the run reverse switch between [REV] and [CM].

Note Make sure that the SINK/SOURCE slide switch (SW1) is turned to the SINK position. If SW1 is in the SOURCE position, the inverter cannot run the motor.

(3) Turn the run forward switch or run reverse switch ON (short-circuit) to run the motor in the forward or reverse direction, respectively.

For precautions in wiring, refer to Section 3.3 "Mounting and Wiring the Inverter."

For details on how to modify the function code data, see Section 3.4.4.2 "Configuring function codes -- Menu #1 "DATA SET."

FRENIC- VG

4

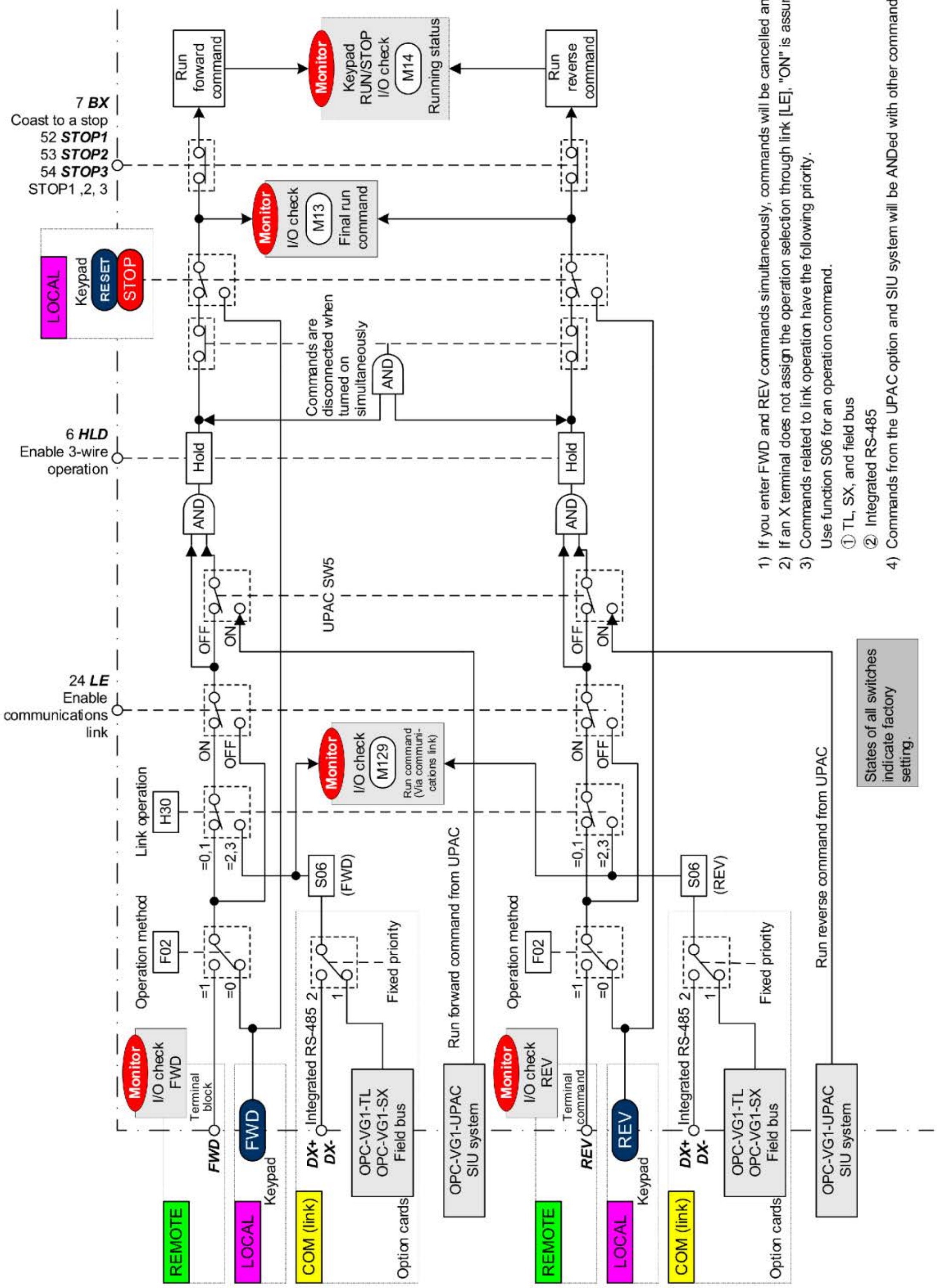
Chapter 4
CONTROL AND OPERATION

This chapter provides the main block diagrams for the control logic of the FRENIC-VG series of inverters. It also contains overview tables of function codes and details of function codes.

Contents

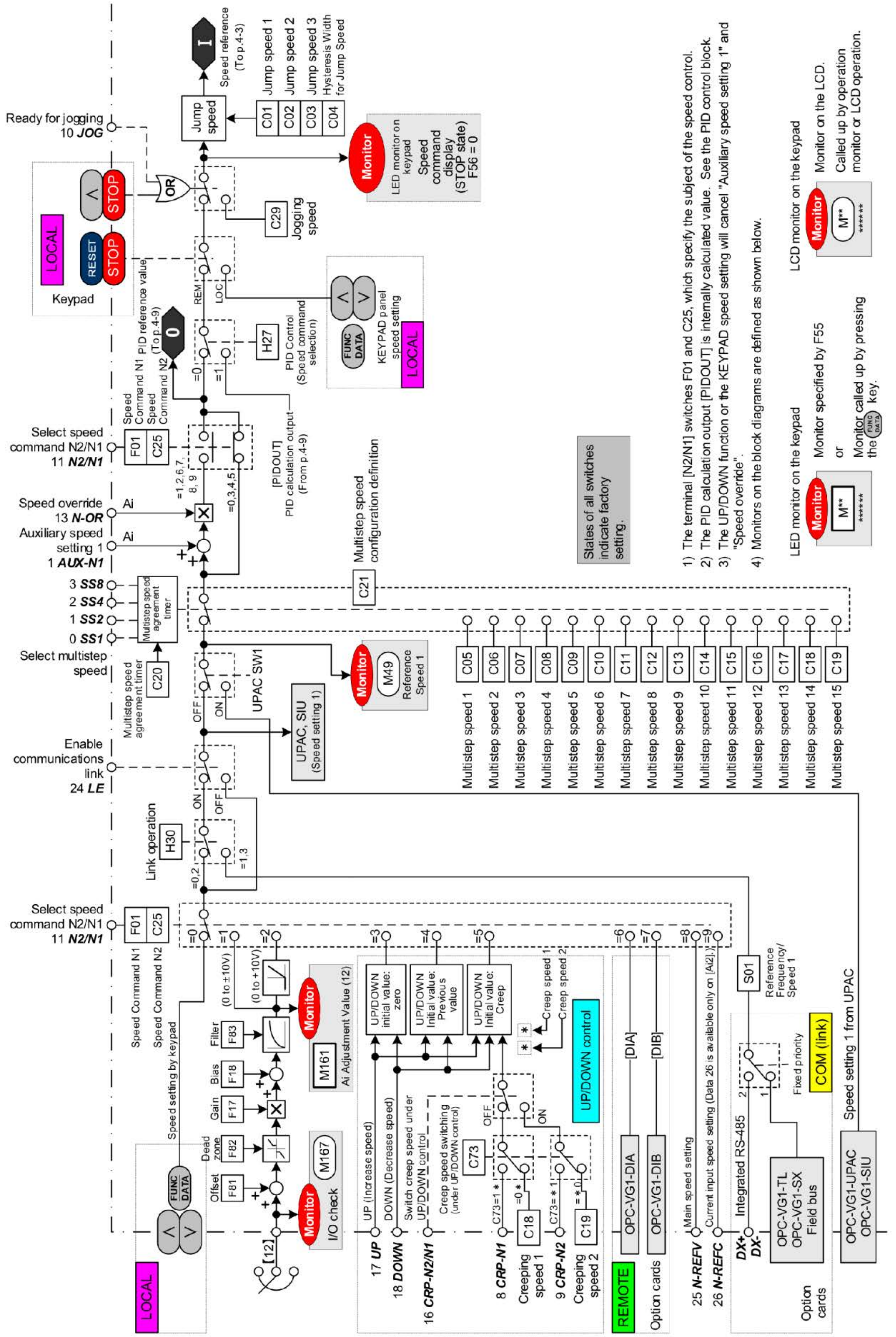
4.1 Block Diagrams for Control Logic

4.1.1 Operation Command

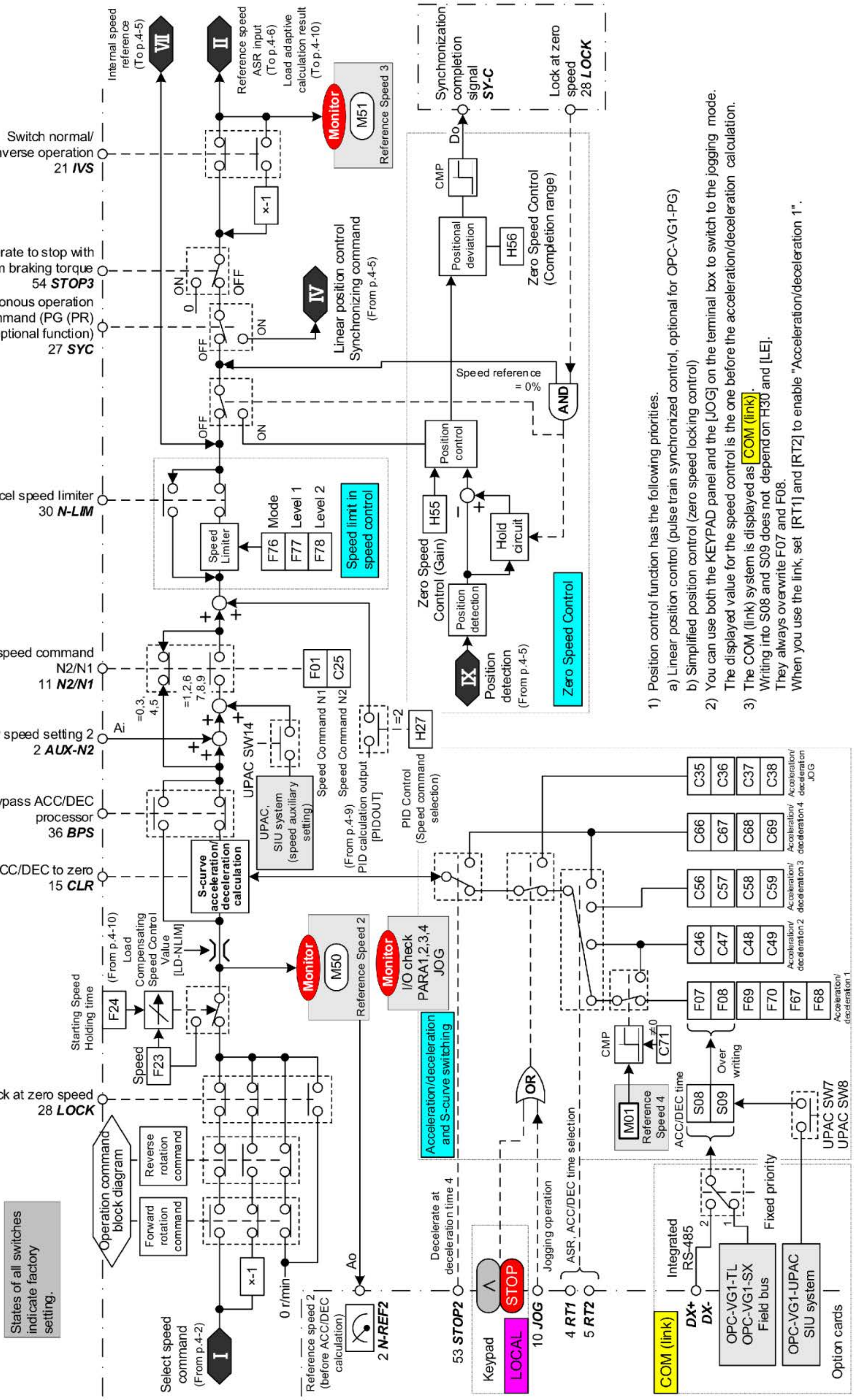


1) If you enter FWD and REV commands simultaneously, commands will be cancelled and the motor will decelerate to stop.
2) If an X terminal does not assign the operation selection through link [LE], "ON" is assumed to it.
3) Commands related to link operation have the following priority.
Use function S06 for an operation command.
① TL, SX, and field bus
② Integrated RS-485
4) Commands from the UPAC option and SIU system will be ANDed with other commands.

4.1.2 Speed Command Selection Section



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



1) Position control function has the following priorities.
   a) Linear position control (pulse train synchronized control, optional for OPC-VG1-PG)
   b) Simplified position control (zero speed locking control)
2) 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.
3) 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".

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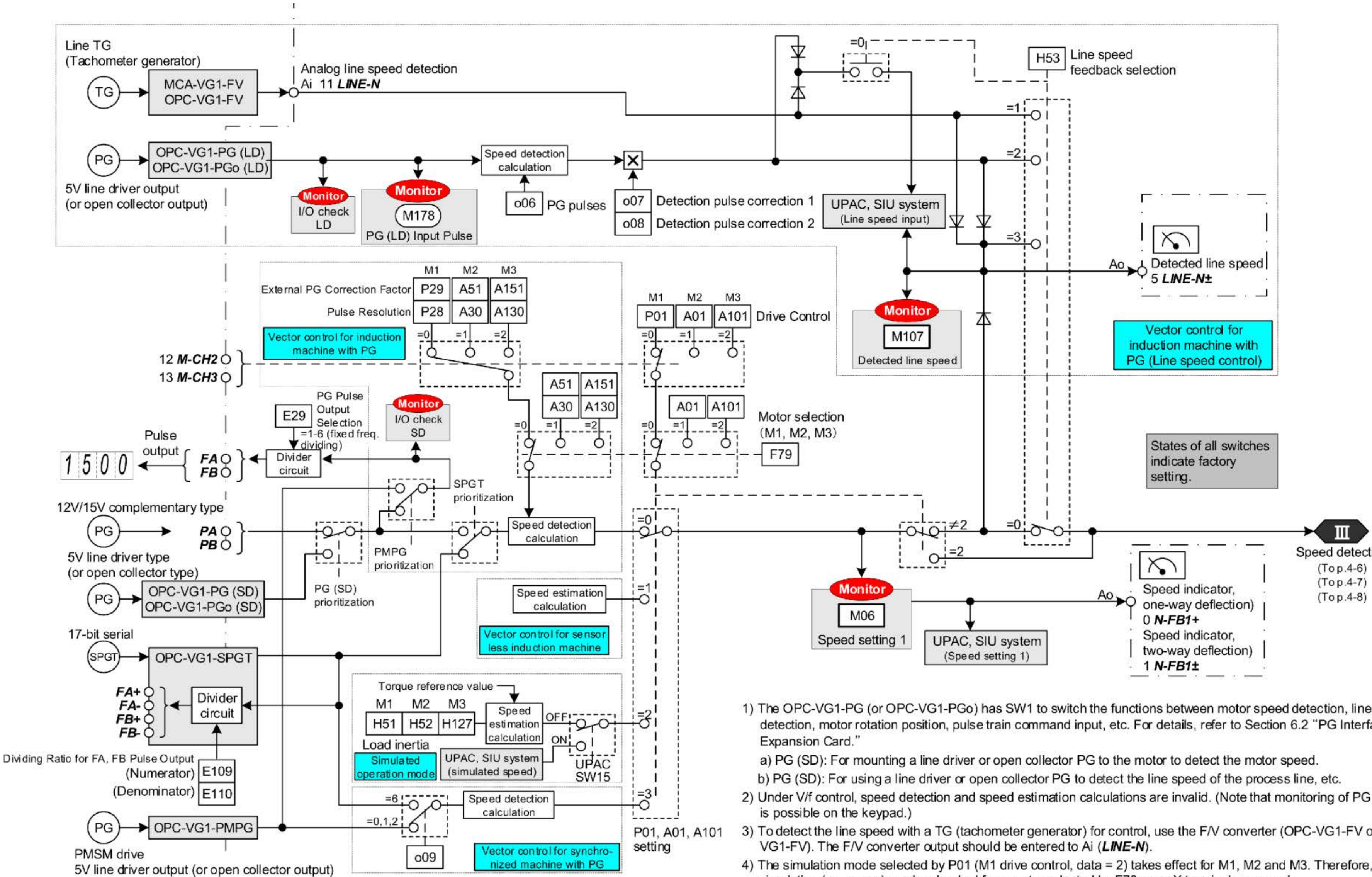
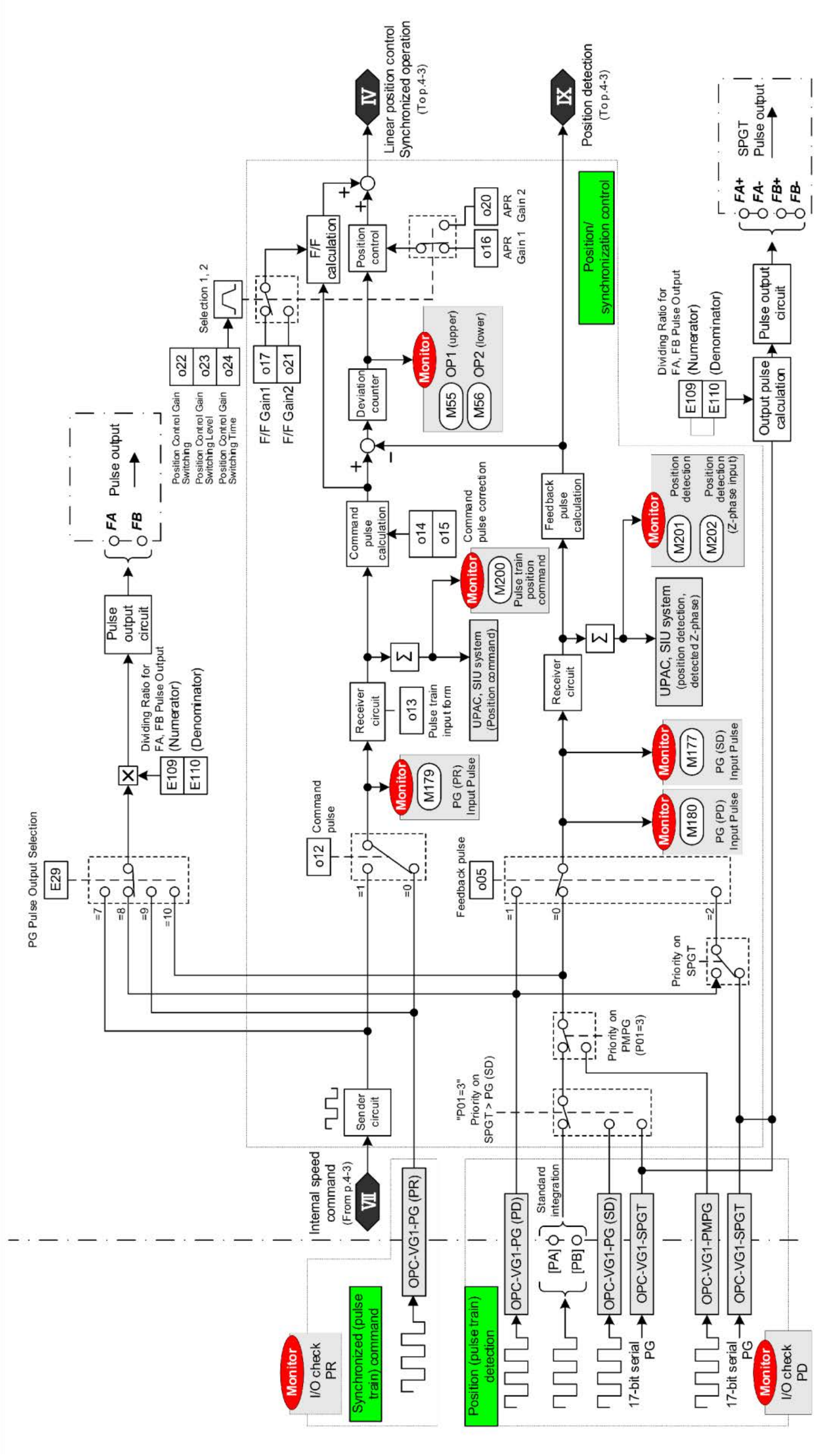
4.1.4 Motor Speed/Line Speed Detection



1) The OPC-VG1-PG (or OPC-VG1-PGo) has SW1 to switch the functions between motor speed detection, line speed detection, motor rotation position, pulse train command input, etc. For details, refer to Section 6.2 "PG Interface Expansion Card."
   a) PG (SD): For mounting a line driver or open collector PG to the motor to detect the motor speed.
   b) PG (SD): For using a line driver or open collector PG to detect the line speed of the process line, etc.
2) Under V/f control, speed detection and speed estimation calculations are invalid. (Note that monitoring of PG pulses is possible on the keypad.)
3) To detect the line speed with a TG (tachometer generator) for control, use the F/V converter (OPC-VG1-FV or MCA-VG1-FV). The F/V converter output should be entered to Ai (***LINE-N***).
4) The simulation mode selected by P01 (M1 drive control, data = 2) takes effect for M1, M2 and M3. Therefore, simulation (sequence) can be checked for a motor selected by F79 or an X terminal command.

4.1.5 Pulse Train Command Input Section and Position Detection Section



1) The OPC-VG1-PG (or OPC-VG1-PGo) has SW1 to switch the functions between motor speed detection, line speed detection, motor rotation position, pulse train command input, etc. For details, refer to Section 6.2 "PG Interface Expansion Card."

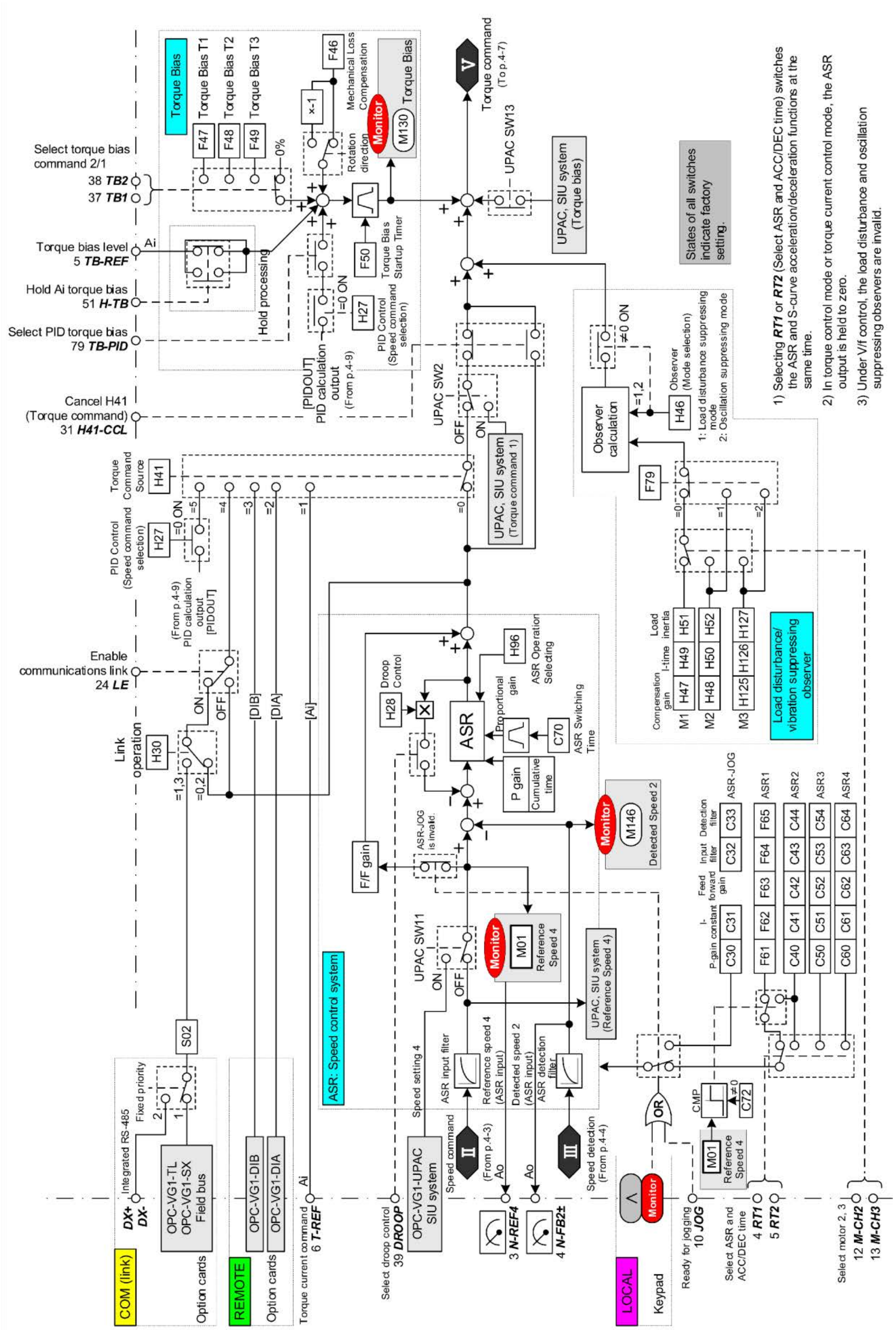
a) PG (PR): For synchronous operation with pulse train command input of line driver or open collector encoder signals.

b) PG (PD): For positioning (orientation) control with pulse train command input of line driver or open collector encoder signals.

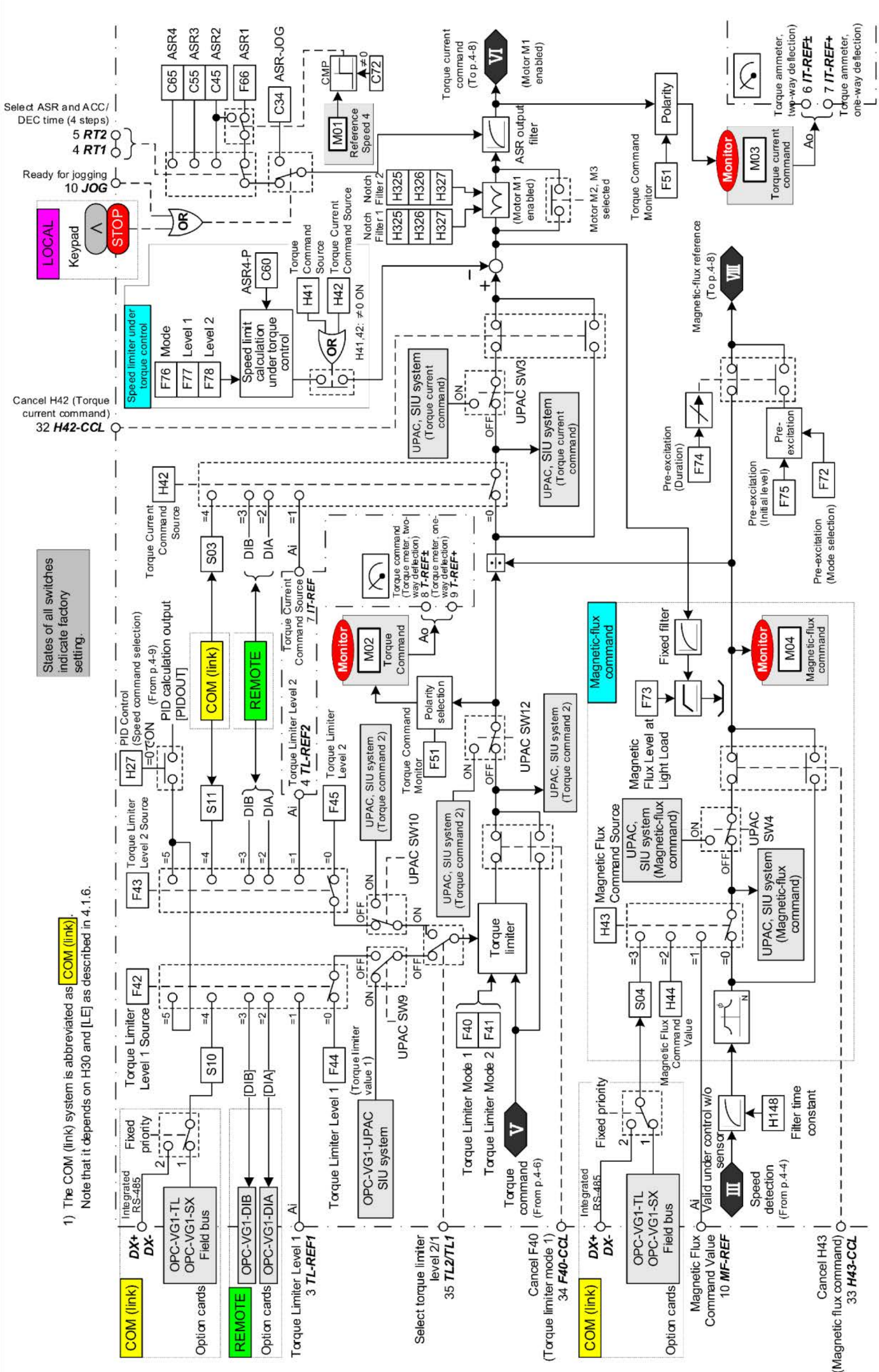
2) As output through terminals [FA] and [FB], one of the following four items can be selected: pulse command value, converted pulse of internal speed command, detected pulse value, and detected motor speed.

States of all switches indicate factory setting.

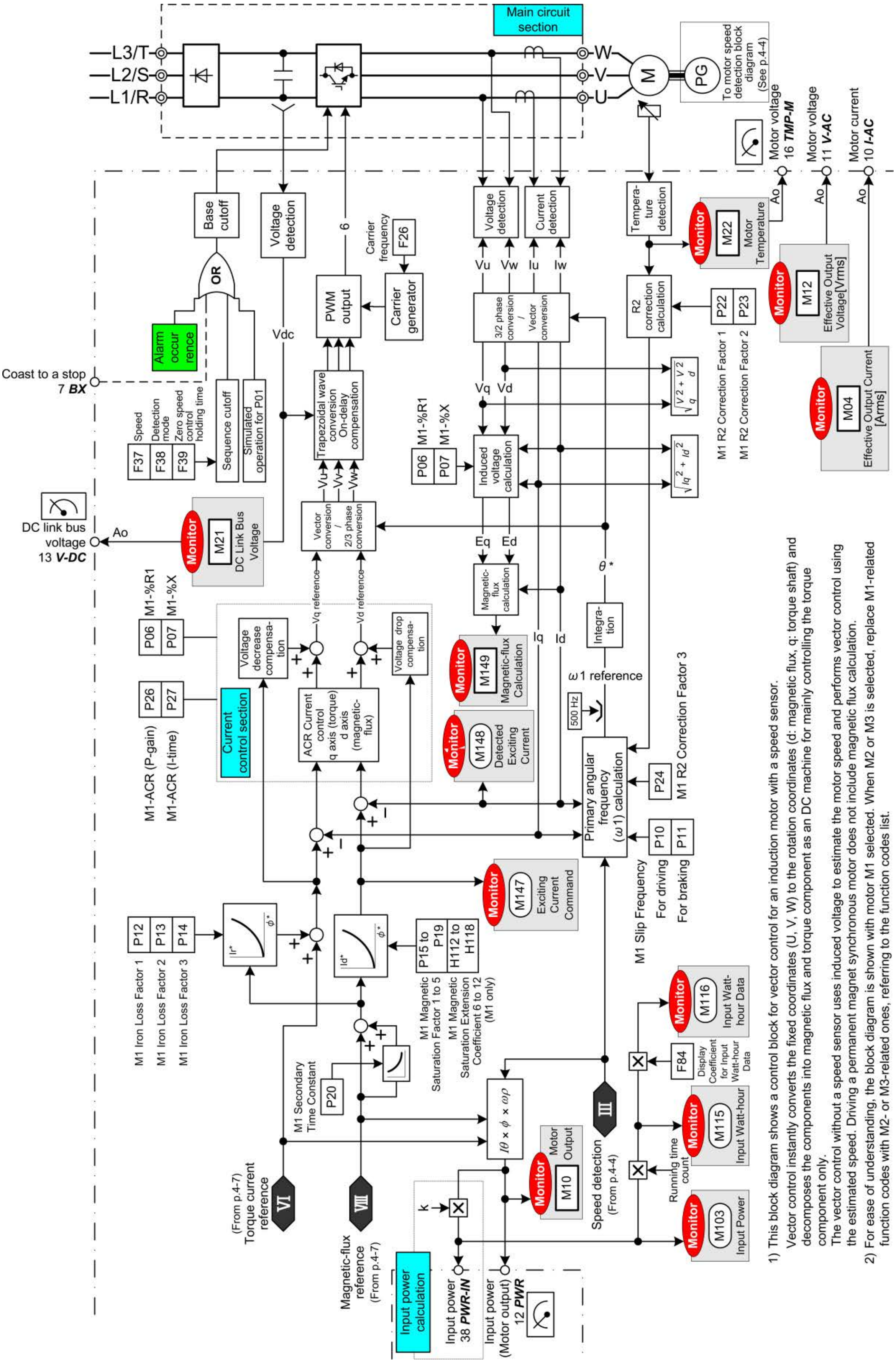
4.1.6 Speed Control (ASR) and Torque Command Section



4.1.7 Torque Limit, Torque Current Command, and Magnetic-flux Command Section



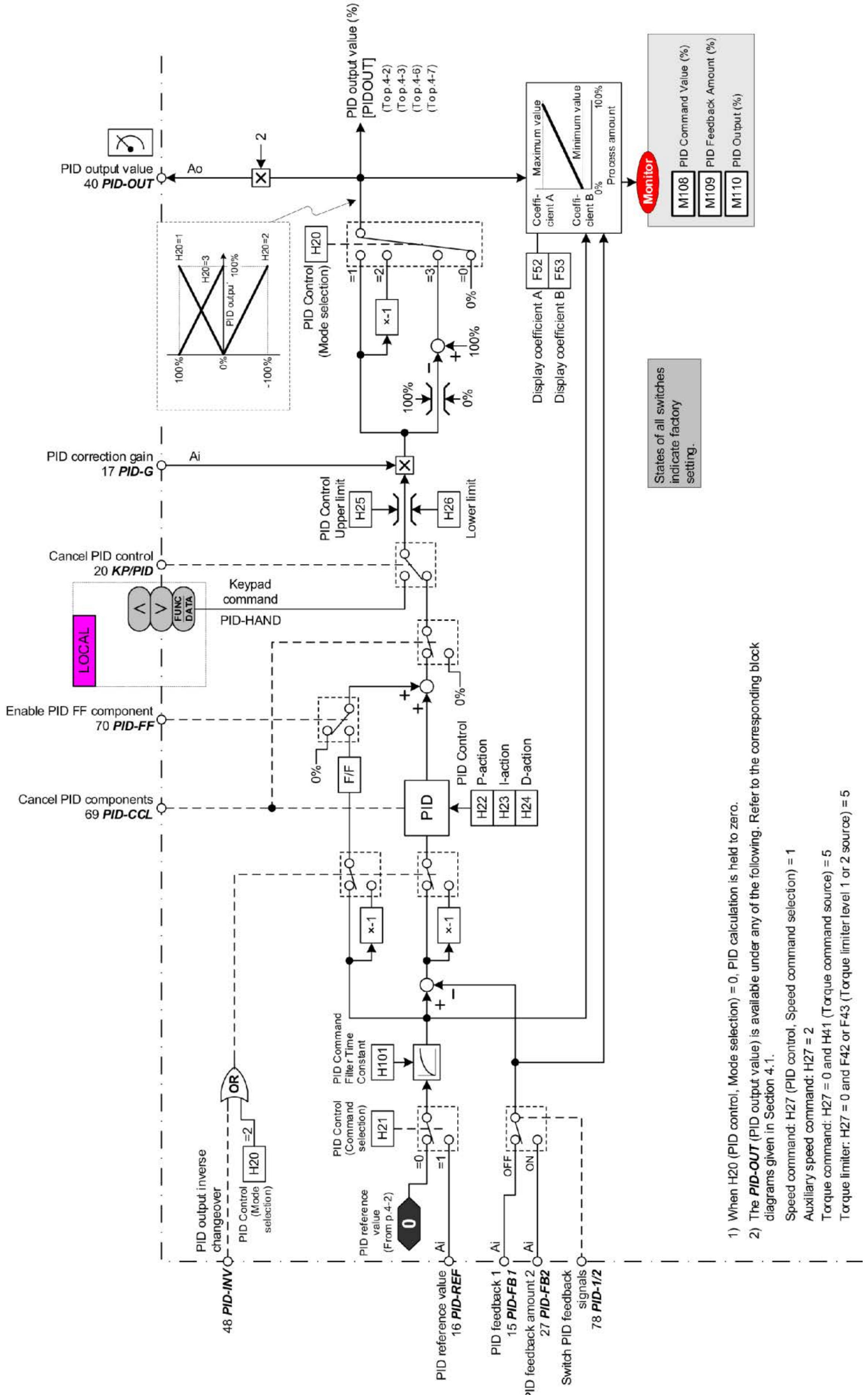
4.1.8 Current Control and Vector Control Section



1) This block diagram shows a control block for vector control for an induction motor with a speed sensor.
Vector control instantly converts the fixed coordinates (U, V, W) to the rotation coordinates (d: magnetic flux, q: torque shaft) and decomposes the components into magnetic flux and torque component as an DC machine for mainly controlling the torque component only.
The vector control without a speed sensor uses induced voltage to estimate the motor speed and performs vector control using the estimated speed. Driving a permanent magnet synchronous motor does not include magnetic flux calculation.

2) For ease of understanding, the block diagram is shown with motor M1 selected. When M2 or M3 is selected, replace M1-related function codes with M2- or M3-related ones, referring to the function codes list.

4.1.9 PID Calculation Section

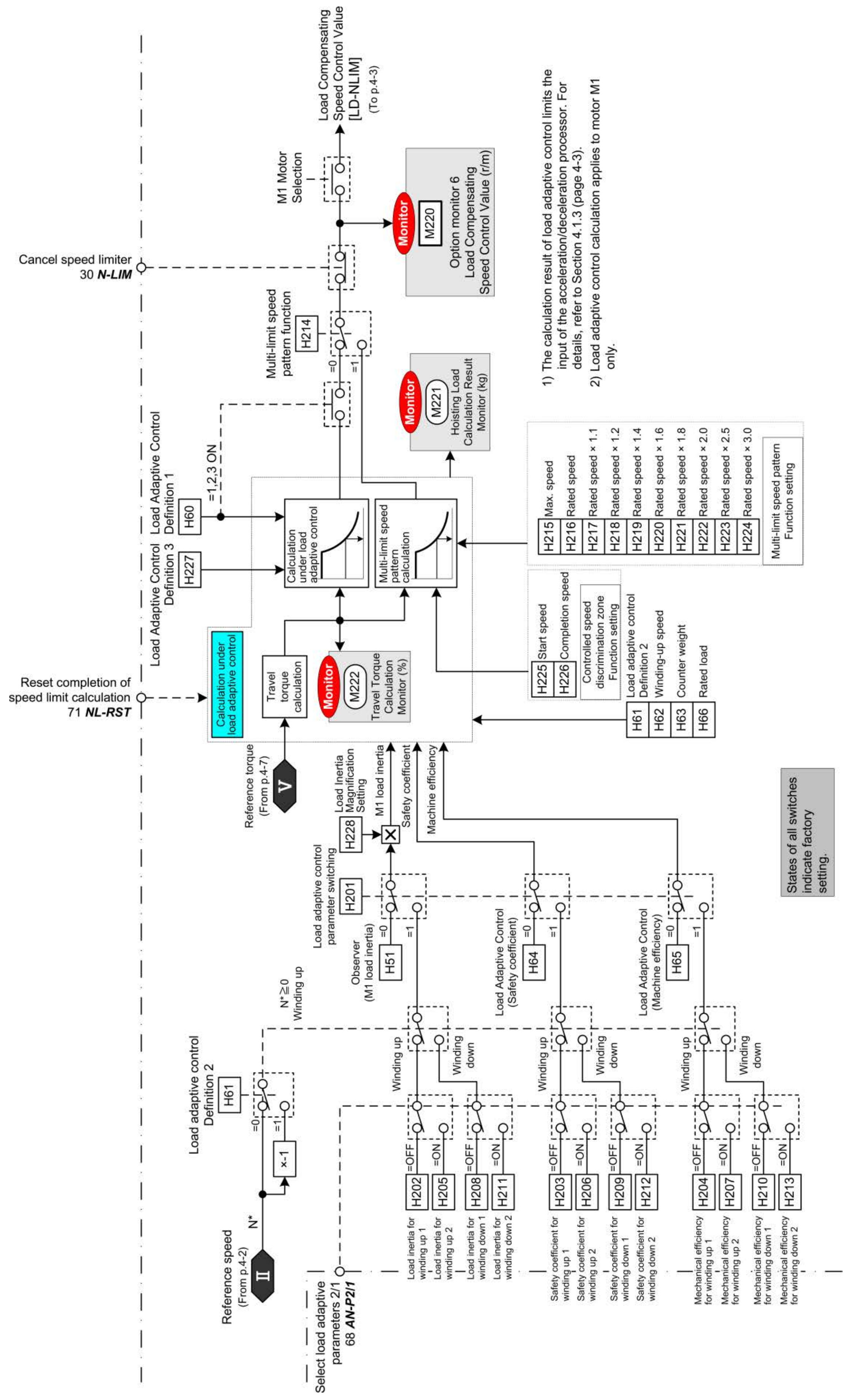


1) When H20 (PID control, Mode selection) = 0, PID calculation is held to zero.

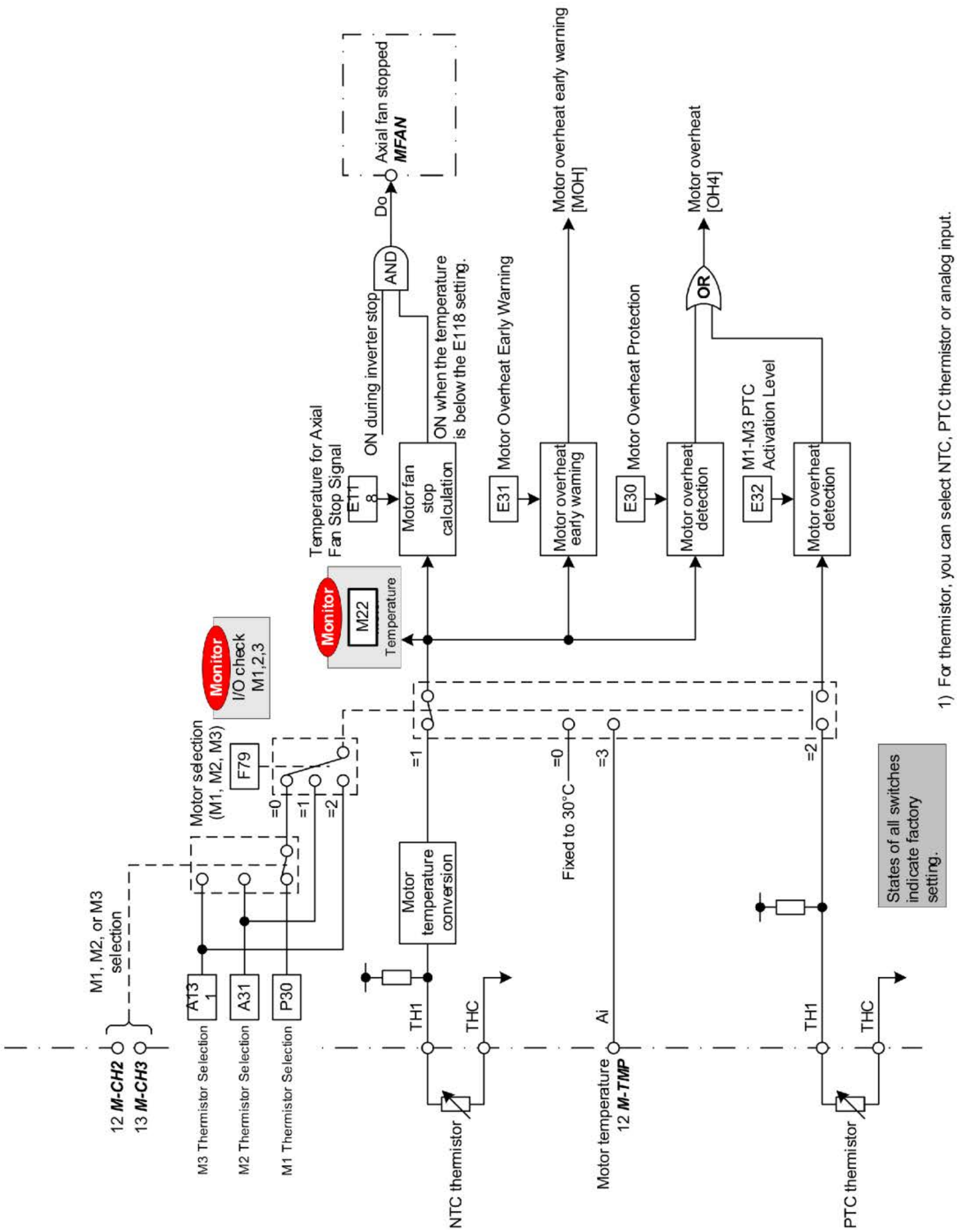
2) The ***PID-OUT*** (PID output value) is available under any of the following. Refer to the corresponding block diagrams given in Section 4.1.

Speed command: H27 (PID control, Speed command selection) = 1
Auxiliary speed command: H27 = 2
Torque command: H27 = 0 and H41 (Torque command source) = 5
Torque limiter: H27 = 0 and F42 or F43 (Torque limiter level 1 or 2 source) = 5

4.1.10 Load Adaptive Control Section



4.1.11 Motor Temperature Detection Section



1) 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.

2) The motor temperature monitor displays only when an NTC thermistor is connected or Ai [M-TMP] is input. When a PTC thermistor is connected, "--" appears.

3) 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 4.1.8 "Current control and vector control section".

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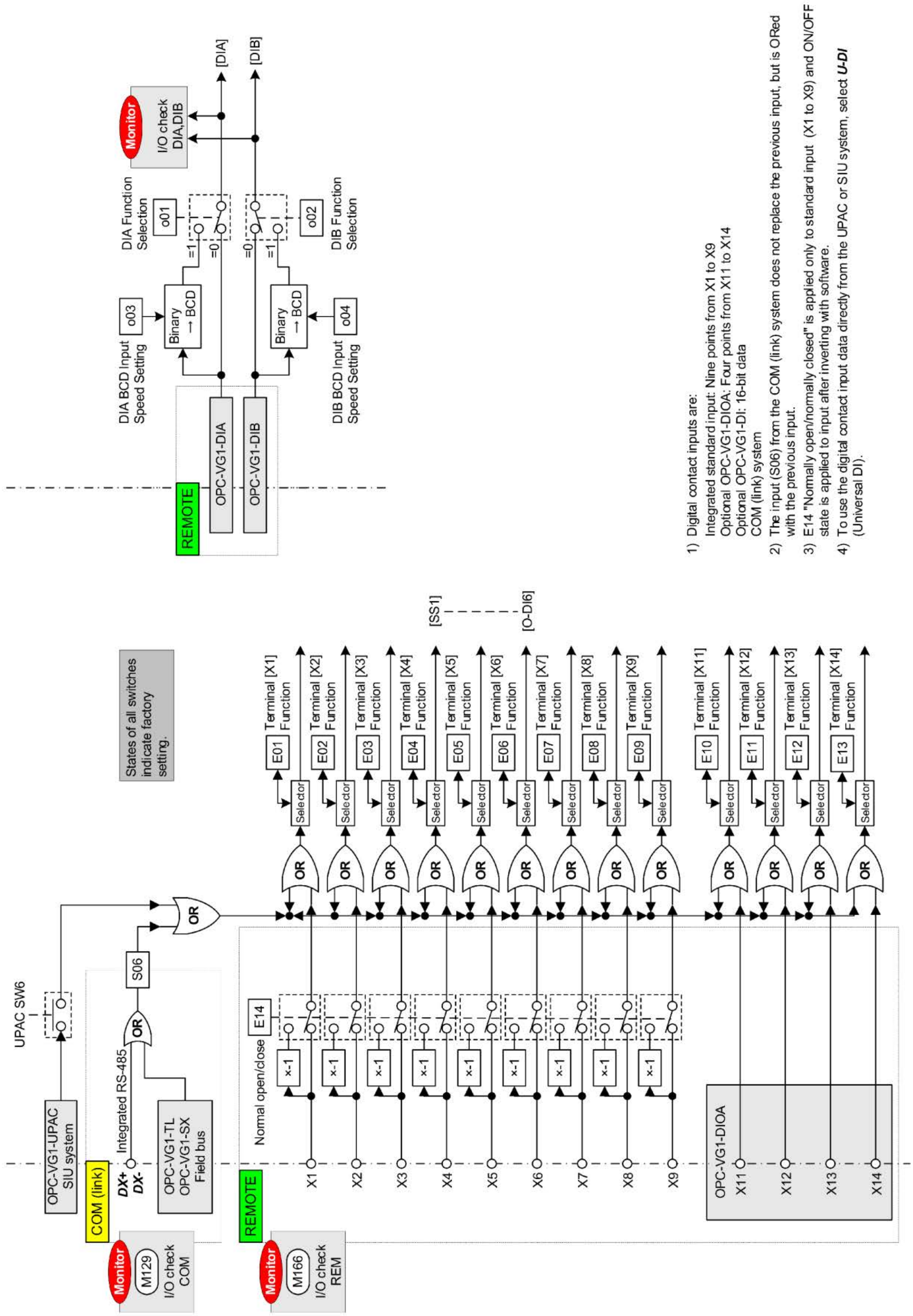
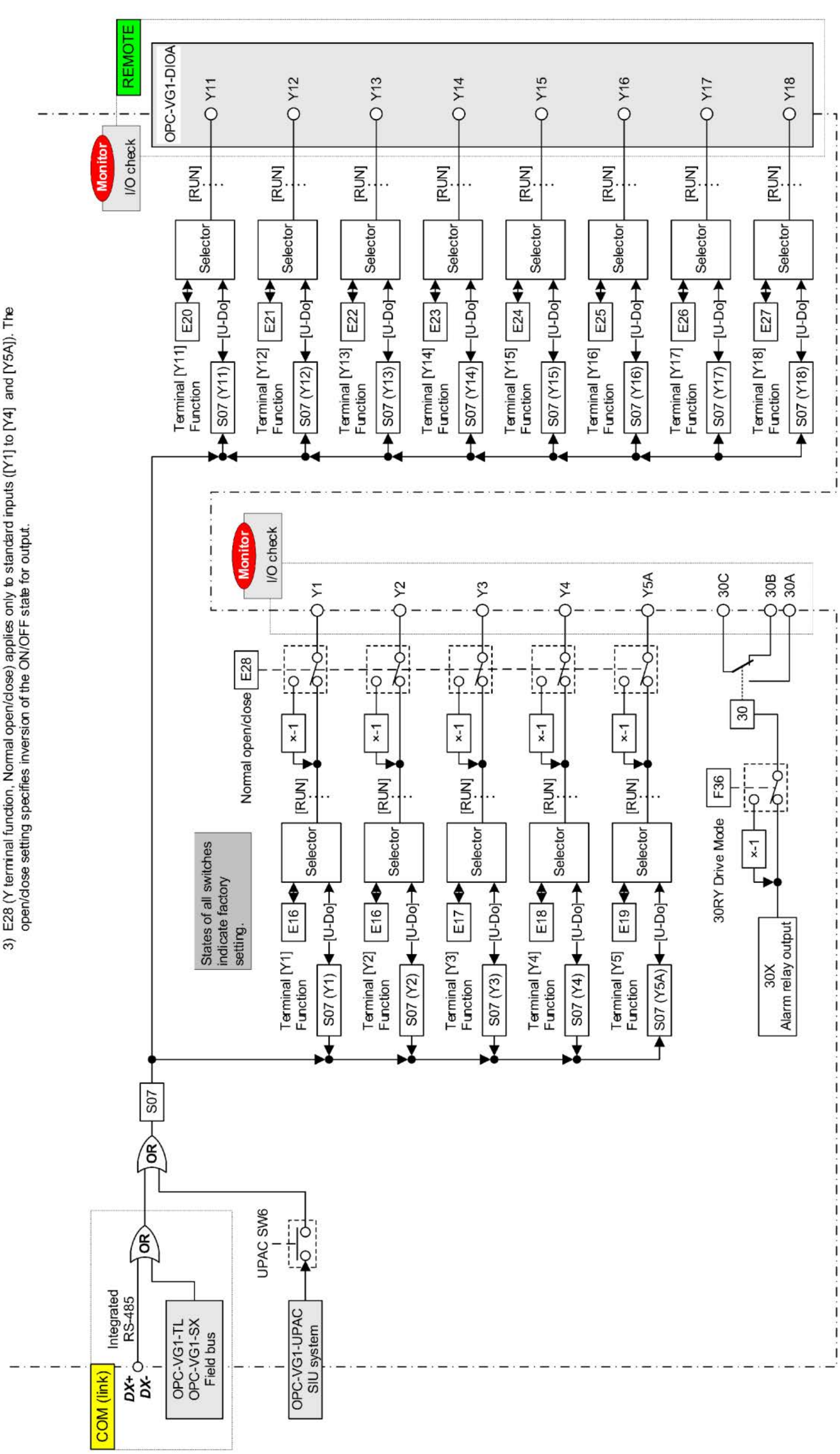
4.1.12 Function Selection Digital Input



4.1.13 Function Selection Digital Output/Fault Output

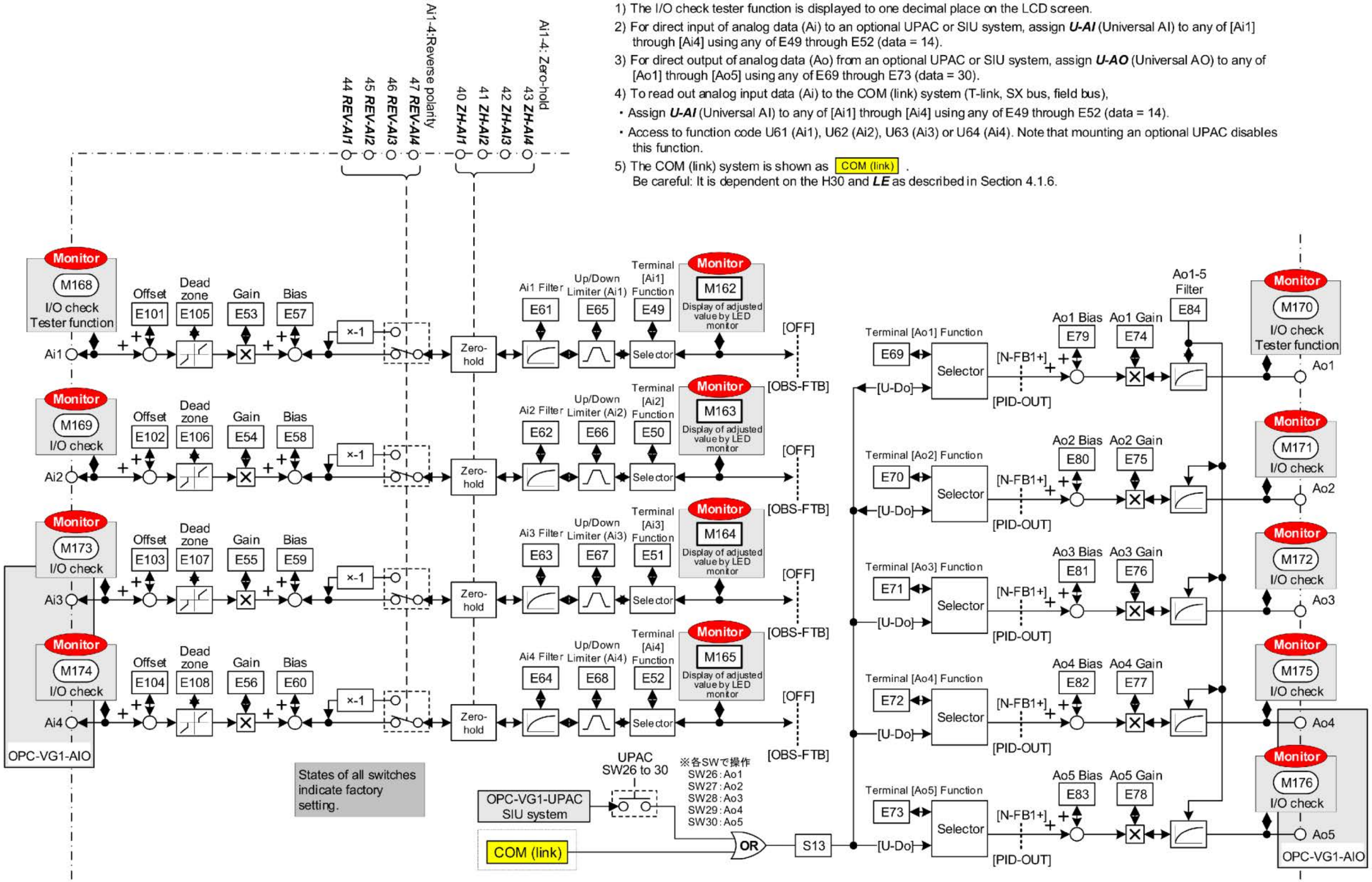
1) Five standard digital outputs via [Y1] to [Y4] and [Y5A] (relay) are available. Up to eight digital outputs via [Y11] to [Y18] on the optional OPC-VG1-DIOA can be added.
2) For direct digital output (related function code S07) from the COM (link) system, UPAC or SIU system, assign ***U-DO*** (Universal DO) to any of [Y2] through [Y18] using any of E16 through E27 (data = 25).
3) E28 (Y terminal function, Normal open/close) applies only to standard inputs ([Y1] to [Y4] and [Y5A]). The open/close setting specifies inversion of the ON/OFF state for output.



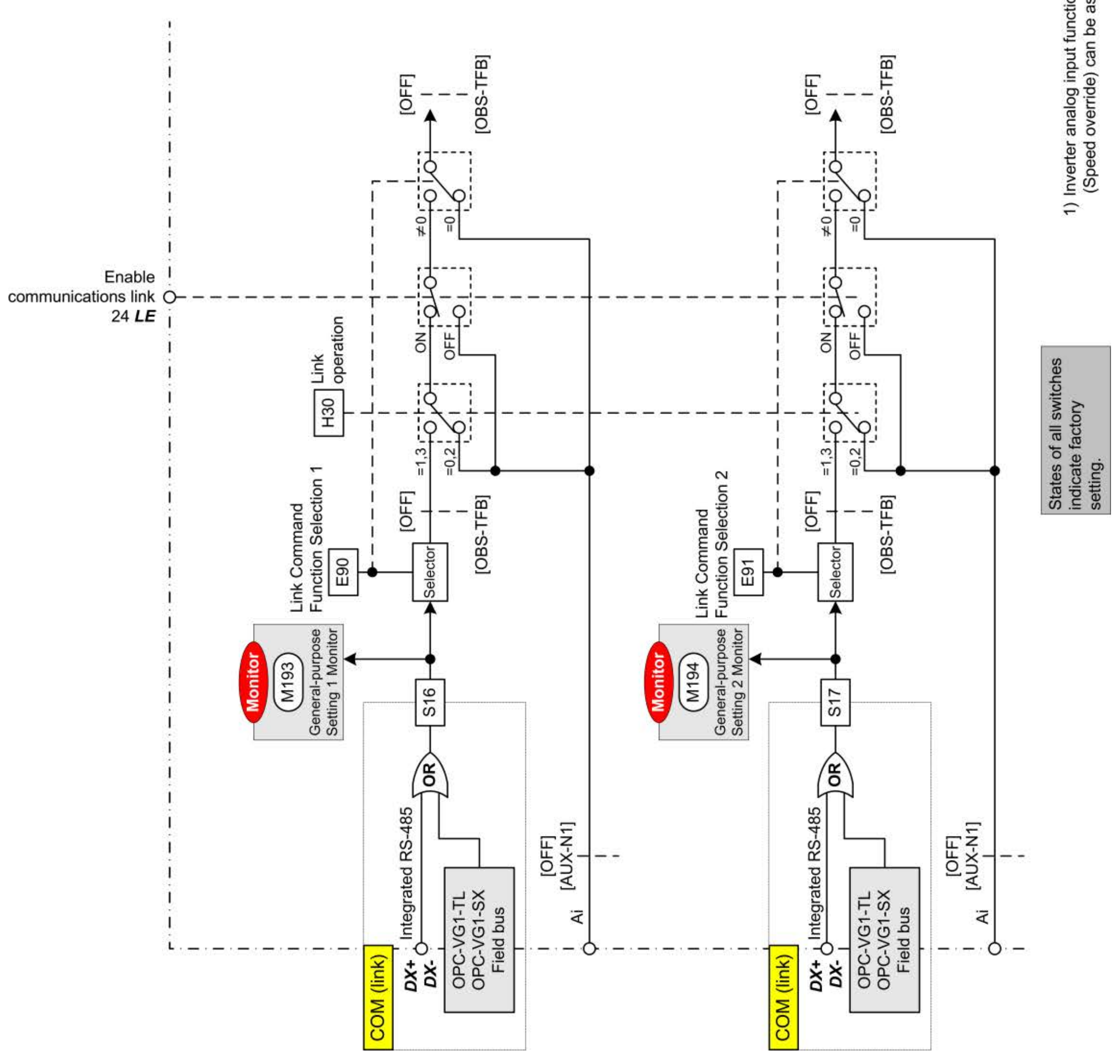
4.1.14 Function Selection Analog Input/Output

1) The I/O check tester function is displayed to one decimal place on the LCD screen.
2) For direct input of analog data (Ai) to an optional UPAC or SIU system, assign ***U-AI*** (Universal AI) to any of [Ai1] through [Ai4] using any of E49 through E52 (data = 14).
3) For direct output of analog data (Ao) from an optional UPAC or SIU system, assign ***U-AO*** (Universal AO) to any of [Ao1] through [Ao5] using any of E69 through E73 (data = 30).
4) To read out analog input data (Ai) to the COM (link) system (T-link, SX bus, field bus),
- Assign ***U-AI*** (Universal AI) to any of [Ai1] through [Ai4] using any of E49 through E52 (data = 14).
- Access to function code U61 (Ai1), U62 (Ai2), U63 (Ai3) or U64 (Ai4). Note that mounting an optional UPAC disables this function.

5) The COM (link) system is shown as COM (link) .
Be careful: It is dependent on the H30 and ***LE*** as described in Section 4.1.6.

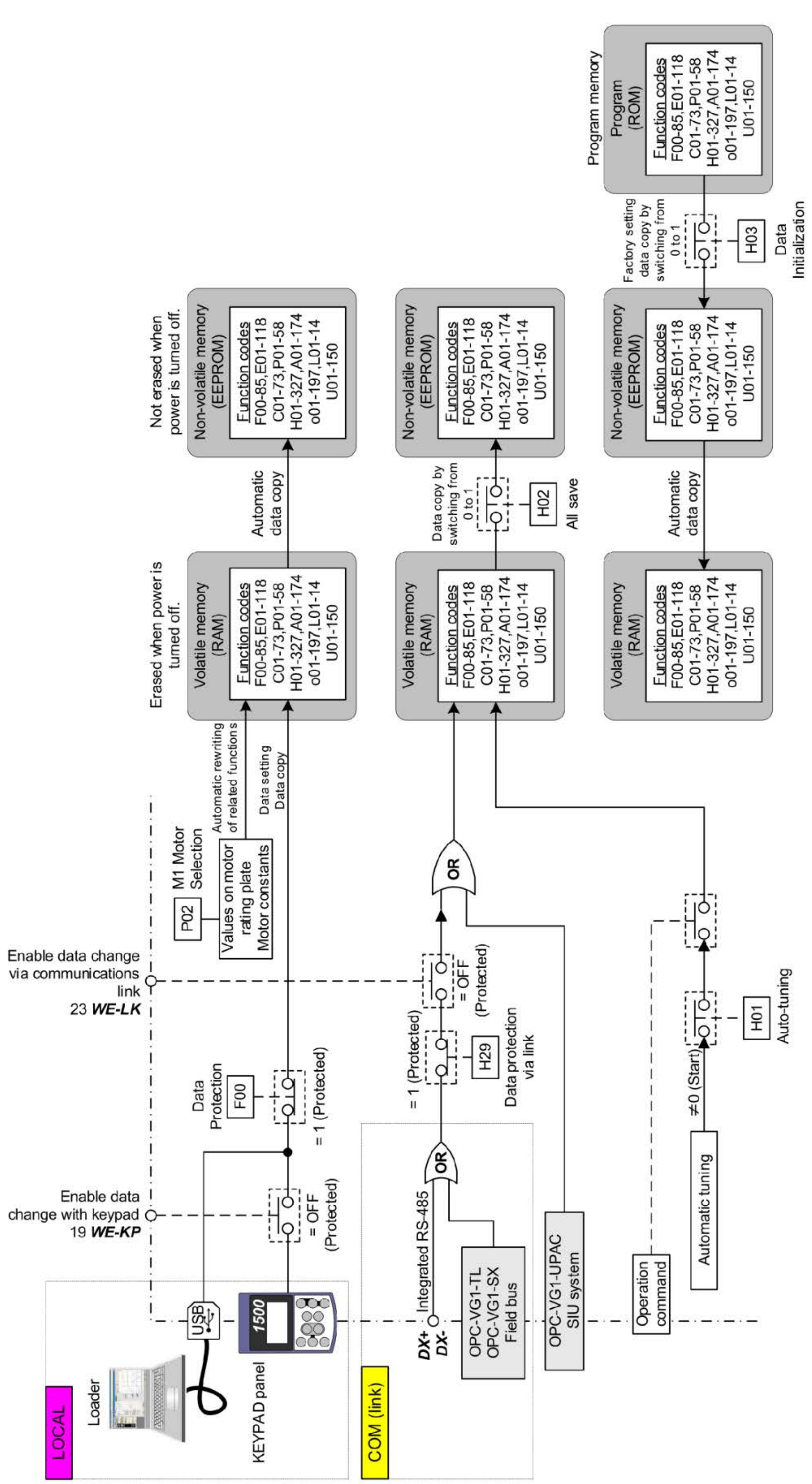


4.1.15 Link Command Function Selection



1) Inverter analog input functions such as ***AUX-N1*** (Auxiliary speed setting 1) and ***N-OR*** (Speed override) can be assigned from the COM (link) for use.

4.1.16 Enabling to Write to/Recording Function Codes

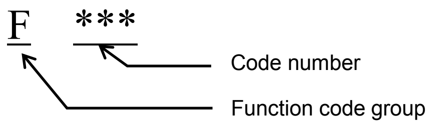


States of all switches indicate factory setting.

1) Later writing has always priority. Data written last is maintained and previous data is deleted on writing.
2) The all save and initialization procedures take about 2s. You cannot change data in this period.
3) When you have not assigned the [WE-KP] or the [WE-LK] to X functions, they are assumed as "ON".
4) You cannot enable or disable to write data from the UPAC, SIU system.
5) 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.
6) 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.
7) You cannot use the COM (link) to change the function code P02.

4.2 Function Code Tables

4.2.1 Function Code Groups and Function Codes



Function code group		Function codes	Remarks	
Fundamental functions	**F** codes	F00 to F85		
Extension terminal functions	**E** codes	E01 to E118		
			E51, E52	For the OPC-VG1-AIO option.
			E55, E56	
			E59, E60	
			E63, E64	
			E67, E68	
			E72, E73	
			E77, E78	
			E82, E83	
			E103, E104	
			E107, E108	
Control functions	**C** codes	C01 to C73		
Motor 1 Parameters	**P** codes	P01 to P51	For M1.	
High performance function	**H** codes	H01 to H228		
Alternative motor parameters	**A** codes	A01 to A171	For M2 and M3.	
option functions	**o** codes	o01 to o197	o01 to o04	For the OPC-VG1-DIA, DIB option.
			o05	For the OPC-VG1-PG (PD) option.
			o06 to o08	For the OPC-VG1-PG (LD) option.
			o09 to o11	For the OPC-VG1-PMPG option.
			o12 to o19	For the OPC-VG1-PG (PR) option.
			o30 to o32	For communications options. (e.g., OPC-VG1-TL, OPC-VG1-CCL).
			o33, o34, o50	For the high-speed serial communication terminal block OPC-VG1-TBSI.
			o38 to o40	For the OPC-VG1-UPAC option.
			o101 to o197	For communications options.
Lift functions	**L** codes	L01 to L15		
User functions	**U** codes	U01 to U64	For the UPAC option.	
		U101 to U150	For manufacturers.	
SaFety functions	**SF** codes	SF00 to SF31	For the functional safety card option. 📖 For details, refer to the Functional Safety Card Instruction Manual (INR-SI47-1541).	
Serial communication functions	**S** codes	S01 to S17	Commands	Accessible via the communications link (T-Link, RS-485, SX-bus, ESX-bus and fieldbus), and via the UPAC.
Monitoring functions	**M** codes	M01 to M222	Data monitor	Accessible in local mode (keypad), via the communications link (T-Link, RS-485, SX-bus, ESX-bus and fieldbus), and via the UPAC.

4.2.2 About the Contents of Column Headers in Function Code Tables

Column Headers		Description
Function code		Function code group and code number
Communications address	485 No.	Address to be used to refer to or change function code data using a communications option. Available for all communications options except OPC-VG1-TL.
	Link No.	Address to be used to refer to or change function code data using a communications option (OPC-VG1-TL, OPC-VG1-SX, etc.). Blank link number fields mean that the corresponding function codes cannot be accessed via a field option.
Name		Name assigned to a function code.
Dir.		Number of subdirectories in the keypad directory structure. 0: Parent directory having no subdirectories 1: Subdirectory 2 or more: Parent directory having the specified number of subdirectories
Data setting range		Allowable data setting range and definition of each data.
Change when running		Indicates whether the function code data can be changed or not when the inverter is running. Y: Possible, N: Impossible
Default setting		Data preset by factory default. If data is changed from the factory default, it is displayed with an asterisk (*) on the keypad. Using function code H03 reverts changed function code data to the default values.
Data copying		Indicates whether or not the function code data can be copied when you copy the data stored in the keypad memory of a source inverter to other destination inverters.
Initialization		Indicates whether or not the function code data can be initialized to the default value by function code H03 (Data initialization). Y: Possible, N: Impossible
Format type		Indicates a format type to be used to refer to or change function code data via the communications link.
Drive control (Availability)		Indicates whether or not the function code is available to the individual drive controls. Y: Available, N: Not available Drive controls: VC w/ PG: Vector control for induction motor (IM) with speed sensor VC w/o PG: Vector control for induction motor (IM) without speed sensor V/f: V/f control for induction motor (IM) VC for PMSM: Vector control for permanent magnet synchronous motor (PMSM) with speed sensor

4.2.3 Function Code Tables

■ F codes (Fundamental Functions)

Function code	Communications address: 485 No.	Communications address: Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
F00	0h	50h	Data Protection	0	0 or 1 0: Enable data change 1: Protect data This write-protects data from the keypad. H29 defines write-protect from the communications link (T-link, RS-485, etc.)	N	0	N	Y	40	Y	Y	Y	Y	
F01	1h	h	Speed Command N1	0	0 to 9 0: Keypad (∧/∨ keys) 1: Analog input to terminal [12](0 to ±10V) 2: Analog input to terminal [12](0 to +10V) 3: ***UP/DOWN*** control (Initial speed = 0) 4: ***UP/DOWN*** control (Initial speed = Last value) 5: ***UP/DOWN*** control (Initial speed = Creep speed 1 or 2) 6: DIA card input 7: DIB card input 8: ***N-REFV*** input to terminal [Ai1] 9: ***N-REFC*** input to terminal [Ai2] F01 defines the command source that specifies a speed command.	N	0	Y	Y	41	Y	Y	Y	Y	
F02	2h	h	Operation Method	0	0 or 1 0: Keypad (FWD/REV/STOP keys) (Local mode) 1: External signals to terminals ***FWD***/***REV*** (Remote mode) F02 defines a run command source	N	0	Y	Y	42	Y	Y	Y	Y	
F03	3h	51h	Maximum Speed M1	3	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
F04	4h	52h	Rated Speed M1	1	50 to 30000 r/min	N	*	Y	N	0	Y	Y	Y	Y	
F05	5h	53h	Rated Voltage M1	1	80 to 999 V	N	*	Y	N	0	Y	Y	Y	Y	
F07	7h	54h	Acceleration Time 1	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
F08	8h	55h	Deceleration Time 1	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
F10	Ah	56h	M1 Electronic Thermal Overload Protection (Select motor characteristics)	3	0 to 2 0: Disable (For a VG-dedicated motor) 1: Enable (For a general-purpose motor with shaft-driven cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan)	Y	0	Y	N	85	Y	Y	Y	Y	
F11	Bh	57h	(Detection level)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	*	Y	N	13	Y	Y	Y	Y	
F12	Ch	58h	(Thermal time constant)	1	0.5 to 75.0 min	Y	*	Y	N	2	Y	Y	Y	Y	
F14	Eh	h	Restart Mode after Momentary Power Failure (Mode selection)	0	0 to 5 0: No restart (Trip immediately, with alarm LU) 1: No restart (Trip after recovery from power failure, with alarm LU) 2: No restart (Trip after decelerate-to-stop, with alarm LU) 3: Restart (Continue to run) 4: Restart at the frequency at which the power failure occurred 5: Restart at the starting frequency	Y	0	Y	Y	0	Y	Y	Y	Y	
F17	11h	h	Gain (for terminal [12] input)	0	0.0 to 200.0% Ratio to analog speed setting on terminal [12]. Limited to ±110% of the maximum speed.	Y	100.0	Y	Y	2	Y	Y	Y	Y	
F18	12h	h	Bias (for terminal [12] input)	0	-30000 to 30000 r/min Bias to analog speed setting on terminal [12]. Limited to ±110% of the maximum speed	Y	0	Y	Y	5	Y	Y	Y	Y	
F20	14h	59h	DC Braking (Braking starting speed)	3	0 to 3600 r/min	Y	0	Y	Y	0	Y	Y	Y	N	
F21	15h	5Ah	(Braking level)	1	0 to 100%	Y	0	Y	Y	16	Y	Y	Y	N	
F22	16h	5Bh	(Braking time)	1	0.0 to 30.0 s 0.0: Disable 0.1 to 30.0 s	Y	0.0	Y	Y	2	Y	Y	Y	N	

*Depending upon the inverter's capacity.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F23	17h	5Ch	Starting Speed (Speed)	0	0.0 to 150.0 r/min Limited in order not to lower to 0.1 Hz or below (under vector control w/o speed sensor and V/f control). Use F23 for assuring the torque at startup.	N	0.0	Y	Y	2	Y	Y	Y	Y	
F24	18h	5Dh	(Holding time)	0	0.00 to 10.00 s	N	0.00	Y	Y	3	Y	Y	Y	Y	
F26	1Ah	5Eh	Motor Sound (Carrier frequency)	0	2 to 15 kHz 2: 2 kHz 3: 3 kHz 4: 4 kHz 5: 5 kHz 6: 6 kHz 7: 7 kHz 8, 9: 8 kHz 10, 11: 10 kHz 12, 13, 14: 12 kHz 15: 15 kHz This controls the carrier frequency to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, to suppress the resonance with the machinery, and to decrease a leakage current from the output circuit wirings.	N	8 for 55 kW or below 7 for 75 kW or above	Y	Y	10	Y	Y	Y	Y	
F36	24h	h	30RY Drive Mode	0	0 or 1 0: Excite relay (30) when an alarm occurs 1: Excite relay (30) when the inverter power is normally established	N	0	Y	Y	43	Y	Y	Y	Y	
F37	25h	60h	Stop Speed (Speed)	3	0.0 to 150.0 r/min Limited in order not to lower to 0.1 Hz or below (under vector control w/o speed sensor and V/f control).	N	10.0	Y	Y	2	Y	Y	Y	Y	
F38	26h	61h	(Detection mode)	1	0 or 1 0: Detected speed 1: Reference speed Fixed at "1" under V/f control	N	0	Y	Y	90	Y	N	N	Y	
F39	27h	62h	(Zero speed control holding time)	1	0.00 to 10.00 s Applies to when timing the application of the mechanical brake.	N	0.50	Y	Y	3	Y	N	N	Y	
F40	28h	63h	Torque Limiter Mode 1	12	0 to 3 0: Disable limiter 1: Enable torque limiter 2: Enable power limiter 3: Enable torque current limiter	N	0	Y	Y	44	Y	Y	N	Y	
F41	29h	64h	Torque Limiter Mode 2	1	0 to 3 0: Level 1 to all four quadrants 1: Level 1 to driving, Level 2 to braking 2: Level 1 to upper limit, Level 2 to lower limit 3: Level 1/Level 2 (switchable) to all four quadrants Levels 1 and 2 are specified by the source defined by F42 and F43, respectively.	N	0	Y	Y	45	Y	Y	Y	Y	
F42	2Ah	65h	Torque Limiter Level 1 Source	1	0 to 5 0: Function code F44 1: ***TL-REF1*** input to terminal [Ai] 2: DIA card 3: DIB card 4: Communications link 5: PID output	N	0	Y	Y	46	Y	Y	Y	Y	
F43	2Bh	66h	Torque Limiter Level 2 Source	1	0 to 5 0: Function code F45 1: ***TL-REF1*** input to terminal [Ai] 2: DIA card 3: DIB card 4: Communications link 5: PID output	N	0	Y	Y	47	Y	Y	Y	Y	
F44	2Ch	67h	Torque Limiter Level 1	1	-300 to 300%	Y	150	Y	Y	5	Y	Y	Y	Y	
F45	2Dh	68h	Torque Limiter Level 2	1	-300 to 300%	Y	10	Y	Y	5	Y	Y	Y	Y	
F46	2Eh	69h	Mechanical Loss Compensation	1	-300.00 to 300.00%	Y	0.00	Y	Y	7	Y	Y	N	Y	
F47	2Fh	6Ah	Torque Bias T1	1	-300.00 to 300.00% Torque biases T1 to T3 are switchable with DI.	Y	0.00	Y	Y	7	Y	Y	N	Y	
F48	30h	h	Torque Bias T2	1	-300.00 to 300.00%	Y	0.00	Y	Y	7	Y	Y	N	Y	
F49	31h	h	Torque Bias T3	1	-300.00 to 300.00%	Y	0.00	Y	Y	7	Y	Y	N	Y	
F50	32h	h	Torque Bias Startup Timer	1	0.00 to 1.00 s F50 specifies the time required for generating 300% torque.	Y	0.00	Y	Y	3	Y	Y	N	Y	
F51	33h	FBh	Torque Command Monitor (Polarity)	1	0 or 1 0: Torque polarity 1: + for driving, - for braking F51 specifies the polarity of torque related data output (e.g., Ao monitor, LED monitor, and LCD monitor).	Y	0	Y	Y	48	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F52	34h	h	LED Monitor (Display coefficient A)	8	-999.00 to 999.00 F52 specifies the conversion coefficient for displaying the load shaft speed and line speed on the LED monitor. Display value = Motor speed x (0.01 to 200.00) Only the setting range from 0.01 to 200.00 takes effect. The specification out of the range is limited.	Y	1.00	Y	Y	12	Y	Y	Y	Y	
F53	35h	h	(Display coefficient B)	1	-999.00 to 999.00 Display coefficient A: Maximum value Display coefficient B: Minimum value F52 and F53 specify the conversion coefficients for displaying the PID command, PID feedback amount, and PID output (process command). Display value = (Command or feedback value) x (Display coefficient A - B) + B	Y	1.00	Y	Y	12	Y	Y	Y	Y	
F54	36h	h	LED Monitor (Display filter)	1	0.0 to 5.0 s	Y	0.2	Y	Y	2	Y	Y	Y	Y	
F55	37h	h	(Item selection)	1	00 to 32	Y	0	Y	Y	49					
					00: Detected speed 1 or Reference speed (r/min) (switchable with F56)						Y	Y	N	Y	
					01: Reference speed 4 (ASR input) (r/min)						Y	Y	Y	Y	
					02: Output frequency (after slip compensation) (Hz)						Y	Y	Y	Y	
					03: Reference torque current (%)						Y	Y	N	Y	
					04: Reference torque (%)						Y	Y	N	Y	
					05: Calculated torque (%)						Y	Y	Y	Y	
					06: Power consumption (Motor output) (kW or HP, switchable with F60)						Y	Y	Y	Y	
					07: Output current (A)						Y	Y	Y	Y	
					08: Output voltage (V)						Y	Y	Y	Y	
					09: DC link bus voltage (V)						Y	Y	Y	Y	
					10: Magnetic flux command (%)						Y	Y	N	N	
					11: Calculated magnetic flux (%)						Y	Y	N	N	
					12: Motor temperature (℃) (When no NTC thermistor is used, "---" appears.)						Y	Y	Y	Y	
					13: Load shaft speed (r/min) (Detected or commanded, switchable with F56)						Y	Y	N	Y	
					14: Line speed (m/min) (Detected or commanded, switchable with F56)						Y	Y	Y	Y	
					15: Ai adjustment value on [12] (%)						Y	Y	Y	Y	
					16: Ai adjustment value on [Ai1] (%)						Y	Y	Y	Y	
					17: Ai adjustment value on [Ai2] (%)						Y	Y	Y	Y	
					18: Ai adjustment value on [Ai3] (%)						Y	Y	Y	Y	
					19: Ai adjustment value on [Ai4] (%)						Y	Y	Y	Y	
					The following data will be hidden depending upon the mode or options. 20: PID command (%)						Y	Y	Y	Y	
					21: PID feedback amount (%)						Y	Y	Y	Y	
					22: PID output (%)						Y	Y	Y	Y	
					23: Option monitor 1 (HEX)						Y	Y	Y	Y	
					24: Option monitor 2 (HEX)						Y	Y	Y	Y	
					25: Option monitor 3 (DEC)						Y	Y	Y	Y	
					26: Option monitor 4 (DEC)						Y	Y	Y	Y	
					27: Option monitor 5 (DEC)						Y	Y	Y	Y	
					28: Option monitor 6 (DEC)						Y	Y	Y	Y	
					29: -						Y	Y	Y	Y	
					30: Load factor (%)						Y	Y	Y	Y	
					31: Input power (kW or HP, switchable with F60)						Y	Y	Y	Y	
					32: Input watt-hour (x 100 kWh)						Y	Y	Y	Y	
F56	38h	h	(Display when stopped)	1	0 or 1 0: Reference speed 1: Detected speed F56 switches the display data between the reference speed and detected one when the motor stops. It applies to the speed (F55 = 0), the load shaft speed (F55 = 13), and the line speed (F55 = 14).	Y	0	Y	Y	50	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F57	39h	h	LCD Monitor (Item selection)	1	0 or 1 0: Running status, rotation direction and operation guide 1: Bar charts for detected speed 1, current and reference torque F57 switches the Running mode screen.	Y	0	Y	Y	51	Y	Y	Y	Y	
F58	3Ah	h	(Language selection)	1	0 to 7 0: Japanese 1: English 2-5: - 6: Chinese 7: Korean	Y	0	Y	N	52	Y	Y	Y	Y	
F59	3Bh		(Contrast control)	1	0 (Low) to 10 (High)	Y	5	Y	Y	0	Y	Y	Y	Y	
F60	3Ch		Output Unit (HP/kW)	0	0 or 1 0: kW 1: HP F60 switches the display unit between kW and HP on the LED monitor and LCD monitor for the power consumption (F55 = 6) and input power (F55 = 31). It also switches the display table between kW and HP for motor 1 selection (P02).	Y	0	Y	Y	53	Y	Y	Y	Y	
F61	3Dh	6Bh	ASR1 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
F62	3Eh	6Ch	(Integral constant)	1	0.000 to 10.000 s P control when F62 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
F63	3Fh	6Dh	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
F64	40h	6Eh	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
F65	41h	6Fh	(Detection filter)	1	0.000 to 0.100 s F65 specifies a time constant of the first order delay filter for detected speed.	Y	0.005	Y	Y	4	Y	Y	N	Y	
F66	42h	70h	(Output filter)	1	0.000 to 0.100 s F66 specifies a time constant of the first order delay filter for torque command.	N	0.002	Y	Y	4	Y	Y	N	Y	
F67	43h	71h	S-curve Acceleration 1 (Start)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F68	44h	72h	(End)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F69	45h	73h	S-curve Deceleration 1 (Start)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F70	46h	74h	(End)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
F72	48h	h	Pre-excitation Mode	4	0 or 1 0: Cause pre-excitation at the time of startup (Pre-excitation continues for the duration specified by F74.) 1: Cause pre-excitation at the time of startup and stop. (Pre-excitation continues for the duration specified by F74 or until the magnetic flux command reaches the detection level specified by E48, whichever is earlier.)	N	0	Y	Y	230	Y	Y	N	N	
F73	49h	h	Magnetic Flux Level at Light Load	1	10 to 100%	Y	100	Y	Y	16	Y	N	N	N	
F74	4Ah	75h	Pre-excitation (Duration)	1	0.0 to 10.0 s Turning a run command (FWD, REV) ON automatically continues pre-excitation for the duration specified by F74.	N	0.0	Y	Y	2	Y	Y	N	N	
F75	4Bh	76h	(Initial level)	1	100 to 400%	N	100	Y	Y	0	Y	Y	N	N	
F76	4Ch	h	Speed Limiter (Mode)	3	0 to 3 0: Level 1 for forward rotation, Level 2 for reverse rotation 1: Level 1 for both forward and reverse rotations 2: Level 1 for upper limit, Level 2 for lower limit 3: Level 1 for forward rotation, Level 2 for reverse rotation (Terminal [12] input added as a bias)	N	0	Y	Y	91	Y	Y	Y	Y	
F77	4Dh	4Fh	(Level 1)	1	-110.0 to 110.0%	Y	100.0	Y	Y	6	Y	Y	Y	Y	
F78	4Eh	FEh	(Level 2)	1	-110.0 to 110.0%	Y	100.0	Y	Y	6	Y	Y	Y	Y	
F79	4Fh	77h	Motor Selection (M1, M2, M3)	0	0 to 2 0: Select M1 (Note that switching of contacts by X terminal functions has priority over this function code setting.) 1: Select M2 (X terminal functions disabled) 2: Select M3 (X terminal functions disabled) Select a motor to be used from M1, M2 and M3.	N	0	Y	N	54	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
F80	50h	h	Switching between HD, MD and LD Drive Modes	0	0 to 3 0, 2: HD (High duty mode, overload capability 150%-1 min./200%-3 sec.) 1: LD (Low duty mode, overload capability 120%-1 min.) 3: MD (Medium duty mode, overload capability 150%-1 min.) F80 switches the drive mode between the HD, MD and LD.	N	0	Y	N	56	Y	Y	Y	Y	
F81	51h	h	Offset for Speed Setting on Terminal [12]	3	-30000 to 30000 r/min F81 specifies the offset for analog speed input on terminal [12].	Y	0	Y	Y	5	Y	Y	Y	Y	
F82 ***1**	52h	h	Dead Zone for Speed Setting on Terminal [12]	1	0.0 to 150.0 r/min F82 specifies the dead zone speed for analog speed input on terminal [12] to limit the speed setting value within the range of ±F82 data to 0 r/min.	Y	0	Y	Y	2	Y	Y	Y	Y	
F83	53h	h	Filter for Speed Setting on Terminal [12]	1	0.000 to 5.000 s	Y	0.005	Y	Y	4	Y	Y	Y	Y	
F84	54h	h	Display Coefficient for Input Watt-hour Data	0	0.000 to 9999 F84 specifies a display coefficient for displaying the input watt-hour data (M116). M116 = F84 x M115 (Input watt-hour, kWh) Specification of 0.000 clears the input watt-hour data.	Y	0.010	Y	Y	101	Y	Y	Y	Y	
F85	55h	h	Display Filter for Calculated Torque	0	0.000 to 1.000 s F85 specifies a display filter for calculated torque output for monitoring (LED monitor and LCD monitor).	Y	0.100	Y	Y	4	Y	Y	Y	Y	

*1 Available in the ROM version H1/2 0019 or later.

■ E codes (Extension Terminal Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
E01	101h	78h	Terminal [X1] Function	13	00 to 79	N	0	Y	Y	57					
					00, 01, 02, 03: Select multistep speed (1 to 15 steps) 00: ***SS1***, 01: ***SS2***, 02: ***SS4***, 03: ***SS8***						Y	Y	Y	Y	
					4,5: Select ASR and ACC/DEC time (4 steps) 4: ***RT1***, 5: ***RT2***						Y	Y	Y	Y	
					6: Enable 3-wire operation ***HLD***						Y	Y	Y	Y	
					7: Coast to a stop ***BX***						Y	Y	Y	Y	
					8: Reset alarm ***RST***						Y	Y	Y	Y	
					9: Enable external alarm trip ***THR***						Y	Y	Y	Y	
					10: Ready for jogging ***JOG***						Y	Y	Y	Y	
					11: Select speed command N2/N1 ***N2/N1***						Y	Y	Y	Y	
					12: Select motor 2 ***M-CH2***						Y	Y	Y	Y	
					13: Select motor 3 ***M-CH3***						Y	Y	Y	Y	
					14: Enable DC braking ***DCBRK***						Y	Y	Y	N	
					15: Clear ACC/DEC to zero ***CLR***						Y	Y	Y	Y	
					16: Switch creep speed under UP/DOWN control ***CRP-N2/N1***						Y	Y	Y	Y	
					17: UP (Increase speed) ***UP***						Y	Y	Y	Y	
					18: DOWN (Decrease speed) ***DOWN***						Y	Y	Y	Y	
					19: Enable data change with keypad ***WE-KP***						Y	Y	Y	Y	
					20: Cancel PID control ***KP/PID***						Y	Y	Y	Y	
					21: Switch normal/inverse operation ***IVS***						Y	Y	Y	Y	
					22: Interlock (52-2) ***IL***						Y	Y	Y	Y	
					23: Enable data change via communications link ***WE-LK***						Y	Y	Y	Y	
					24: Enable communications link ***LE***						Y	Y	Y	Y	
					25: Universal DI ***U-DI***						Y	Y	Y	Y	
					26: Enable auto search for idling motor speed at starting ***STM***						Y	Y	Y	Y	
					27: Synchronous operation command (PG (PR) optional function) ***SYC***						Y	N	N	Y	
					28: Lock at zero speed ***LOCK***						Y	N	N	Y	
					29: Pre-excitation ***EXITE***						Y	Y	N	N	
					30: Cancel speed limiter ***N-LIM*** (Related codes: F76, F77, F78)						Y	Y	Y	Y	
					31: Cancel H41 (Torque command) ***H41-CCL***						Y	Y	N	Y	
					32: Cancel H42 (Torque current command) ***H42-CCL***						Y	Y	N	Y	
					33: Cancel H43 (Magnetic flux command) ***H43-CCL***						Y	N	N	N	
					34: Cancel F40 (Torque limiter mode 1) ***F40-CCL***						Y	Y	N	Y	
					35: Select torque limiter level 2/1 ***TL2/TL1***						Y	Y	Y	Y	
					36: Bypass ACC/DEC processor ***BPS***						Y	Y	Y	Y	
					37, 38: Select torque bias command 37: ***TB1***, 38: ***TB2***						Y	Y	N	Y	
					39: Select droop control ***DROOP***						Y	Y	N	Y	
					40: Zero-hold Ai1 ***ZH-AI1***						Y	Y	Y	Y	
					41: Zero-hold Ai2 ***ZH-AI2***						Y	Y	Y	Y	
					42: Zero-hold Ai3 (AIO optional function) ***ZH-AI3***						Y	Y	Y	Y	
					43: Zero-hold Ai4 (AIO optional function) ***ZH-AI4***						Y	Y	Y	Y	
					44: Reverse Ai1 polarity ***REV-AI1***						Y	Y	Y	Y	
					45: Reverse Ai2 polarity ***REV-AI2***						Y	Y	Y	Y	
					46: Reverse Ai3 polarity (AIO optional function) ***REV-AI3***						Y	Y	Y	Y	
					47: Reverse Ai4 polarity (AIO optional function) ***REV-AI4***						Y	Y	Y	Y	
					48: Inverse PID output ***PID-INV***						Y	Y	Y	Y	
					49: Cancel PG alarm ***PG-CCL***						Y	N	N	Y	
					50: Cancel undervoltage alarm ***LU-CCL***						Y	Y	Y	Y	
					51: Hold Ai torque bias ***H-TB***						Y	Y	N	Y	
					52: STOP1 ***STOP1*** (Decelerate to stop with normal deceleration time)						Y	Y	Y	Y	
					53: STOP2 ***STOP2*** (Decelerate to stop with deceleration time 4)						Y	Y	Y	Y	
					54: STOP3 ***STOP3*** (Decelerate to stop with max. braking torque, ignoring the deceleration time setting)						Y	Y	Y	Y	
					55: Latch DIA data (DIA optional function) ***DIA***						Y	Y	Y	Y	
					56: Latch DIB data (DIB optional function) ***DIB***						Y	Y	Y	Y	

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
E01	101h	78h	Terminal [X1] Function	13	57: Cancel multiplex system ***MT-CCL***						Y	N	Y	N	
					58-67: Custom Di1-Di10 ***C-DI1*** to ***C-DI10***						Y	Y	Y	Y	
					68: Select load adaptive parameters 2/1 (Available soon) ***AN-P2/1***						Y	N	N	Y	
					69: Cancel PID components ***PID-CCL***						Y	Y	Y	Y	
					70: Enable PID FF component ***PID-FF***						Y	Y	Y	Y	
					71: Reset completion of speed limit calculation (Available soon) ***NL-RST***						Y	N	N	Y	
					72: Toggle signal 1 ***TGL1***						Y	Y	Y	Y	
					73: Toggle signal 2 ***TGL2***						Y	Y	Y	Y	
					74: Cause external mock alarm ***FTB***						Y	Y	Y	Y	
					75: Cancel NTC thermistor alarm ***NTC-CCL***						Y	Y	Y	Y	
					76: Cancel lifetime alarm signal ***LF-CCL***						Y	Y	Y	Y	
					77: --						-	-	-	-	
					78: Switch PID feedback signals ***PID-1/2***						Y	Y	Y	Y	
					79: Select PID torque bias ***TB-PID***						Y	Y	N	Y	
E02	102h	79h	Terminal [X2] Function	1	0 to 79 (See Terminal [X1] Function.)	N	1	Y	Y	57	Y	Y	Y	Y	
E03	103h	7Ah	Terminal [X3] Function	1	0 to 79 (See Terminal [X1] Function.)	N	2	Y	Y	57	Y	Y	Y	Y	
E04	104h	7Bh	Terminal [X4] Function	1	0 to 79 (See Terminal [X1] Function.)	N	3	Y	Y	57	Y	Y	Y	Y	
E05	105h	7Ch	Terminal [X5] Function	1	0 to 79 (See Terminal [X1] Function.)	N	4	Y	Y	57	Y	Y	Y	Y	
E06	106h	7Dh	Terminal [X6] Function	1	0 to 79 (See Terminal [X1] Function.)	N	5	Y	Y	57	Y	Y	Y	Y	
E07	107h	7Eh	Terminal [X7] Function	1	0 to 79 (See Terminal [X1] Function.)	N	7	Y	Y	57	Y	Y	Y	Y	
E08	108h	7Fh	Terminal [X8] Function	1	0 to 79 (See Terminal [X1] Function.)	N	8	Y	Y	57	Y	Y	Y	Y	
E09	109h	80h	Terminal [X9] Function	1	0 to 79 (See Terminal [X1] Function.)	N	9	Y	Y	57	Y	Y	Y	Y	
E10	10Ah	81h	Terminal [X11] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E11	10Bh	82h	Terminal [X12] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E12	10Ch	83h	Terminal [X13] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E13	10Dh	84h	Terminal [X14] Function	1	0 to 79 (See Terminal [X1] Function.)	N	25	Y	Y	57	Y	Y	Y	Y	
E14	10Eh	h	X Terminal Function (Normal open/close)	0	0000 to 01FF 0: Normal open 1: Normal close E14 specifies whether to open or close the contact for terminals [X1] to [X9].	N	0000	Y	Y	35	Y	Y	Y	Y	
E15	10Fh	85h	Terminal [Y1] Function	13	00 to 84	N	1	Y	Y	58					
					00: Inverter running ***RUN***						Y	Y	Y	Y	
					01: Speed valid ***N-EX***						Y	Y	Y	Y	
					02: Speed agreement 1 ***N-AG1***						Y	Y	N	Y	
					03: Speed arrival signal ***N-AR***						Y	Y	Y	Y	
					04: Speed detected 1 ***N-DT1***						Y	Y	Y	Y	
					05: Speed detected 2 ***N-DT2***						Y	Y	Y	Y	
					06: Speed detected 3 ***N-DT3***						Y	Y	Y	Y	
					07: Undervoltage detected (Inverter stopped) ***LU***						Y	Y	Y	Y	
					08: Torque polarity detected (braking/driving) ***B/D***						Y	Y	N	Y	
					09: Torque limiting ***TL***						Y	Y	Y	Y	
					10: Torque detected 1 ***T-DT1***						Y	Y	Y	Y	
					11: Torque detected 2 ***T-DT2***						Y	Y	Y	Y	
					12: Keypad operation enabled ***KP***						Y	Y	Y	Y	
					13: Inverter stopped ***STOP***						Y	Y	Y	Y	
					14: Inverter ready to run ***RDY***						Y	Y	Y	Y	
					15: Magnetic flux detected ***MF-DT***						Y	Y	N	N	
					16: Motor M2 selected ***SW-M2***						Y	Y	Y	Y	
					17: Motor M3 selected ***SW-M3***						Y	Y	Y	Y	
					18: Brake release signal ***BRK***						Y	Y	N	Y	
					19: Alarm content 1 ***AL1***						Y	Y	Y	Y	
					20: Alarm content 2 ***AL2***						Y	Y	Y	Y	
					21: Alarm content 4 ***AL4***						Y	Y	Y	Y	
					22: Alarm content 8 ***AL8***						Y	Y	Y	Y	
					23: Cooling fan in operation ***FAN***						Y	Y	Y	Y	
					24: Resetting ***TRY***						Y	Y	Y	Y	
					25: Universal DO ***U-DO***						Y	Y	Y	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
E15	10Fh	85h	Terminal [Y1] Function	13	26: Heat sink overheat early warning ***INV-OH***						Y	Y	Y	Y	
					27: Synchronization completion signal ***SY-C***						Y	N	N	N	
					28: Lifetime alarm ***LIFE***						Y	Y	Y	Y	
					29: Under acceleration ***U-ACC***						Y	Y	Y	Y	
					30: Under deceleration ***U-DEC***						Y	Y	Y	Y	
					31: Inverter overload early warning ***INV-OL***						Y	Y	Y	Y	
					32: Motor overheat early warning ***M-OH***						Y	Y	Y	Y	
					33: Motor overload early warning ***M-OL***						Y	Y	Y	Y	
					34: DB overload early warning ***DB-OL***						Y	Y	N	Y	
					35: Link transmission error ***LK-ERR***						Y	Y	Y	Y	
					36: In limiting under load adaptive control ***ANL***						Y	N	N	Y	
					37: In calculation under load adaptive control ***ANC***						Y	N	N	Y	
					38: Analog torque bias being held ***TBH***						Y	Y	N	Y	
					39 to 48: Custom Do1-Do10 ***C-DO1*** to ***C-DO10***						Y	Y	Y	Y	
					49: -						-	-	-	-	
					51: Multiplex system communications link being established ***MTS***						Y	N	Y	N	
					52: Answerback to cancellation of multiplex system ***MEC-AB***						Y	N	Y	N	
					53: Multiplex system master selected ***MSS***						Y	N	Y	N	
					54: Multiplex system local station failure ***AL-SF***						Y	N	Y	N	
					55: Stopped due to communications link error ***LES***						Y	Y	Y	Y	
					56: Alarm output (for any alarm) ***ALM***						Y	Y	Y	Y	
					57: Light alarm ***L-ALM***						Y	Y	Y	Y	
					58: Maintenance timer ***MNT***						Y	Y	Y	Y	
					59: Braking transistor broken ***DBAL***						Y	Y	Y	Y	
					60: DC fan locked ***DCFL***						Y	Y	Y	Y	
					61: Speed agreement 2 ***N-AG2***						Y	Y	N	Y	
					62: Speed agreement 3 ***N-AG3***						Y	Y	N	Y	
					63: Axial fan stopped ***MFAN***						Y	Y	Y	Y	
					64: Arbitrarily assigned RDY ***AS-RDY*** (***1**)						-	-	-	-	
					65: -						-	-	-	-	
					66: Answerback to droop control enabled ***DSAB***						Y	Y	N	Y	
					67: Answerback to cancellation of torque command/torque current command (***H41-CCL***/***H42-CCL***) ***TCL-C***						Y	Y	N	Y	
					68: Answerback to cancellation of torque limiter mode 1 (F40-CCL) ***F40-AB***						Y	Y	N	Y	
					71: 73 ON command ***PRT-73***						Y	Y	Y	Y	
					72: Turn ON Y-terminal test output ***Y-ON***						Y	Y	Y	Y	
					73: Turn OFF Y-terminal test output ***Y-OFF***						Y	Y	Y	Y	
					74: --						-	-	-	-	
					75: System clock battery lifetime expired ***BATT***						Y	Y	Y	Y	
					76: --						-	-	-	-	
					77: SPGT battery warning ***SPGT-B*** (Available soon)						Y	Y	Y	Y	
					78: --						-	-	-	-	
					79: --						-	-	-	-	
					80: EN terminal detection circuit failure ***DECF***						Y	Y	Y	Y	
					81: EN terminal OFF ***ENOFF***						Y	Y	Y	Y	
			***2** (80 to 84)		82: Safety function in progress ***SF-RUN***						Y	Y	Y	Y	
					83: --						-	-	-	-	
					84: STO under testing ***SF-TST***						Y	Y	Y	Y	
E16	110h	86h	Terminal [Y2] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	2	Y	Y	58	Y	Y	Y	Y	
E17	111h	87h	Terminal [Y3] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	3	Y	Y	58	Y	Y	Y	Y	
E18	112h	88h	Terminal [Y4] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	4	Y	Y	58	Y	Y	Y	Y	
E19	113h	89h	Terminal [Y5] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	14	Y	Y	58	Y	Y	Y	Y	

*1 Availble in the ROM version H1/2 02□□, which supports PROFINET-IRT.

*2 Available in the ROM version H1/2 0020 or later.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E20	114h	8Ah	Terminal [Y11] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E21	115h	8Bh	Terminal [Y12] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E22	116h	8Ch	Terminal [Y13] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E23	117h	8Dh	Terminal [Y14] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E24	118h	8Eh	Terminal [Y15] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E25	119h	8Fh	Terminal [Y16] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E26	11Ah	90h	Terminal [Y17] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E27	11Bh	91h	Terminal [Y18] Function	1	0 to 75 (See Terminal [Y1] Function.)	N	26	Y	Y	58	Y	Y	Y	Y	
E28	11Ch	h	Y Terminal Function (Normal open/close)	0	0000 to 001F 0: Normal open 1: Normal close	N	0000	Y	Y	36	Y	Y	Y	Y	
E29	11Dh	92h	PG Pulse Output Selection	0	0 to 10 0: No dividing 1: 1/2 2: 1/4 3: 1/8 4: 1/16 5: 1/32 6: 1/64 0 to 6: Internal PG input is divided before output. 7: Internal speed command: Pulse oscillation mode 8: PG (PD): Detected pulse input oscillation mode 9: PG (PR): Pulse command input oscillation mode 10: Integrated PG, PG (SD): Detected speed pulse input oscillation mode 7 to 10: Input pulse is arbitrarily divided before output. (AB 90° phase difference signal)	N	0	Y	Y	92	Y	N	N	Y	
E30	11Eh	h	Motor Overheat Protection (Temperature)	8	50 to 200°C	Y	150	Y	Y	0	Y	Y	Y	Y	
E31	11Fh	h	Motor Overheat Early Warning (Temperature)	1	50 to 200°C	Y	75	Y	Y	0	Y	Y	Y	Y	
E32	120h	CDh	M1-M3 PTC Activation Level	1	0.00 to 5.00 V The PTC is activated if the input voltage of the PTC terminal exceeds this activation level when the PTC thermistor is selected (P30/A31/A131 = 2).	N	1.60	Y	Y	3	Y	Y	Y	Y	
E33	121h	h	Inverter Overload Early Warning	1	25 to 100%	Y	90	Y	Y	0	Y	Y	Y	Y	
E34	122h	h	Motor Overload Early Warning	1	25 to 100%	Y	90	Y	Y	0	Y	Y	Y	Y	
E35	123h	h	DB Overload Protection	1	0 to 100% E35 specifies %ED of the braking resistor relative to the inverter capacity. When E35 = 0, the overload protection function (dbH) is disabled.	Y	0	Y	Y	0	Y	Y	N	Y	
E36	124h	h	DB Overload Early Warning	1	0 to 100%	Y	80	Y	Y	0	Y	Y	N	Y	
E37	125h	h	DB Thermal Time Constant	1	0 to 1000 s	Y	300	Y	Y	0	Y	Y	N	Y	
E38	126h	93h	Speed Detection Mode	8	000 to 111 Detection mode of 0xE39/E40/E41 0: Detected speed 1: Reference speed Under V/f control, only the specified reference speed is valid.	Y	000	Y	Y	9	Y	Y	N	Y	
E39	127h	94h	Speed Detection Level 1	1	0 to 30000 r/min If ***N-FB1±*** (Detected speed 1) or ***N-REF4*** (Reference speed 4) exceeds this speed detection level 1, the inverter issues the detection signal.	Y	1500	Y	Y	0	Y	Y	Y	Y	
E40	128h	95h	Speed Detection Level 2	1	-30000 to 30000 r/min	Y	1500	Y	Y	5	Y	Y	Y	Y	
E41	129h	96h	Speed Detection Level 3	1	-30000 to 30000 r/min	Y	1500	Y	Y	5	Y	Y	Y	Y	
E42	12Ah	97h	Speed Arrival (Detection width)	1	1.0 to 20.0% If the detected speed comes within the range of ***N-REF2*** (Reference speed 2) ± this detection width, the inverter issues the detection signal.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E43	12Bh	98h	Speed Agreement (Detection width)	1	1.0 to 20.0% If ***N-FB2±*** (Detected speed 2) is within the range of ***N-REF4*** (Reference speed 4) ± this detection width, the inverter issues the detection signal.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E44	12Ch	99h	(Off-delay timer)	1	0.000 to 5.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
E45	12Dh	9Ah	Speed Disagreement Alarm/ Phase Loss Detection Level	1	00 to 21 Units place: Speed disagreement alarm (Er9) 0: Disable 1: Enable Tenths place: Power supply phase loss detection (Lin) 0: Standard level 1: For particular manufacturers. 2: Cancel	N	00	Y	Y	9	Y	Y	N	Y	
E46	12Eh	9Bh	Torque Detection Level 1	3	0 to 300% Calculated value under V/f control. If the torque command exceeds this setting, the inverter issues the detection signal.	Y	30	Y	Y	16	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	VC w/o PG	V/f	VC for PMSM	Remarks
E47	12Fh	9Ch	Torque Detection Level 2	1	0 to 300%	Y	30	Y	Y	16	Y	Y	Y	Y	
E48	130h	9Dh	Magnetic Flux Detection Level	1	10 to 100% If the magnetic flux value calculated exceeds this setting, the inverter issues the detection signal.	N	100	Y	Y	16	Y	Y	N	N	
E49	131h	h	Terminal [Ai1] Function	4	00 to 27	N	0	Y	Y	59					
					00: Shut down input signal ***OFF*** -						Y	Y	Y	Y	
					01: Auxiliary speed setting 1 ***AUX-N1*** ±10V/±Nmax						Y	Y	Y	Y	
					02: Auxiliary speed setting 2 ***AUX-N2*** ±10V/±Nmax						Y	Y	Y	Y	
					03: Torque limiter level 1 ***TL-REF1*** ±10V/±150%						Y	Y	Y	Y	
					04: Torque limiter level 2 ***TL-REF2*** ±10V/±150%						Y	Y	Y	Y	
					05: Torque bias ***TB-REF*** ±10V/±150%						Y	Y	N	Y	
					06: Torque command ***T-REF*** ±10V/±150%						Y	Y	N	Y	
					07: Torque current command ***IT-REF*** ±10V/±150%						Y	Y	N	Y	
					08: Creep speed 1 for UP/DOWN control ***CRP-N1*** ±10V/±Nmax						Y	Y	Y	Y	
					09: Creep speed 2 for UP/DOWN control ***CRP-N2*** ±10V/±Nmax						Y	Y	Y	Y	
					10: Magnetic flux reference ***MF-REF*** ＋10V/＋100%						Y	N	N	N	
					11: Detect line speed ***LINE-N*** ±10V/±Nmax						Y	Y	Y	Y	
					12: Motor temperature ***M-TMP*** ＋10V/200°C						Y	Y	Y	Y	
					13: Speed override ***N-OR*** ±10V/±50%						Y	Y	Y	Y	
					14: Universal Ai ***U-AI*** ±10V/±4000(h)						Y	Y	Y	Y	
					15: PID feedback 1 ***PID-FB1*** ±10V/±20000(d)						Y	Y	Y	Y	
					16: PID reference value ***PID-REF*** ±10V/±20000(d)						Y	Y	Y	Y	
					17: PID correction gain ***PID-G*** ±10V/±4000(h)						Y	Y	Y	Y	
					18 to 24: Custom Ai1 to Ai7 ***C-AI1*** to ***C-AI7***						Y	Y	Y	Y	
					25: Main speed setting ***N-REFV*** ±10V/±Nmax						Y	Y	Y	Y	
					26: Current input speed setting (4-20 mADC) ***N-REFC*** ±10V/±Nmax (Data 26 is available only on [Ai2].)						Y	Y	Y	Y	
					27: PID feedback amount 2 ***PID-FB2*** ±10V/±20000 (d)						Y	Y	Y	Y	
E50	132h	h	Terminal [Ai2] Function	1	0 to 27 (Refer to Terminal [Ai1] Function.)	N	0	Y	Y	59	Y	Y	Y	Y	
E51	133h	h	Terminal [Ai3] Function	1	0 to 27 (Refer to Terminal [Ai1] Function.) (Data 26 is available only on [Ai2].)	N	0	Y	Y	59	Y	Y	Y	Y	
E52	134h	h	Terminal [Ai4] Function	1	0 to 27 (Refer to Terminal [Ai1] Function.) (Data 26 is available only on [Ai2].)	N	0	Y	Y	59	Y	Y	Y	Y	
E53	135h	h	Ai1 Gain	4	-10.000 to 10.000 times	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E54	136h	h	Ai2 Gain	1	-10.000 to 10.000 times	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E55	137h	h	Ai3 Gain	1	-10.000 to 10.000 times (Displays if AIO option is mounted)	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E56	138h	h	Ai4 Gain	1	-10.000 to 10.000 times (Displays if AIO option is mounted)	Y	1.000	Y	Y	8	Y	Y	Y	Y	
E57	139h	h	Ai1 Bias	4	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E58	13Ah	h	Ai2 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E59	13Bh	h	Ai3 Bias	1	-100.0 to 100.0% (Displays if AIO option is mounted)	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E60	13Ch	h	Ai4 Bias	1	-100.0 to 100.0% (Displays if AIO option is mounted)	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E61	13Dh	h	Ai1 Filter	4	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E62	13Eh	h	Ai2 Filter	1	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E63	13Fh	h	Ai3 Filter	1	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E64	140h	h	Ai4 Filter	1	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E65	141h	h	Up/Down Limiter (Ai1)	4	0.00 to 60.00 s E65 specifies the duration required when the inverter internal data changes from 0 V to 10 V if the voltage on terminal [Ai1] changes from 0 V to 10 V.	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E66	142h	h	Up/Down Limiter (Ai2)	1	0.00 to 60.00 s	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E67	143h	h	Up/Down Limiter (Ai3)	1	0.00 to 60.00 s	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E68	144h	h	Up/Down Limiter (Ai4)	1	0.00 to 60.00 s	Y	0.00	Y	Y	3	Y	Y	Y	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E69	145h	h	Terminal [Ao1] Function	5	00 to 40	Y	1	Y	Y	60					
					00: Detected speed 1 (Speed indicator, one-way deflection) ***N-FB1+*** ±Nmax/10V						Y	Y	N	Y	
					01: Detected speed 1 (Speed indicator, two-way deflection) ***N-FB1±*** ±Nmax/±10V						Y	Y	N	Y	
					02: Reference speed 2 (before ACC/DEC processing) ***N-REF2*** ±Nmax/±10V						Y	Y	Y	Y	
					03: Reference speed 4 (ASR input) ***N-REF4*** ±Nmax/±10V						Y	Y	Y	Y	
					04: Detected speed 2 (ASR input) ***N-FB2±*** ±Nmax/±10V						Y	Y	N	Y	
					05: Detected line speed ***LINE-N±*** ±Nmax/±10V						Y	Y	Y	Y	
					06: Torque current command (Torque ammeter, one-way deflection) ***IT-REF±*** ±150%/±10V						Y	Y	N	Y	
					07: Torque current command (Torque ammeter, two-way deflection) ***IT-REF+*** ±150%/10V						Y	Y	N	Y	
					08: Torque command (Torque meter, two-way deflection) ***T-REF±*** ±150%/±10V						Y	Y	N	Y	
					09: Torque command (Torque meter, one-way deflection) ***T-REF+*** ±150%/10V						Y	Y	N	Y	
					10: Motor current ***I-AC*** 200%/10V						Y	Y	Y	Y	
					11: Motor voltage ***V-AC*** 200%/10V						Y	Y	Y	Y	
					12: Input power (Motor output) ***PWR*** 200%/10V						Y	Y	Y	Y	
					13: DC link bus voltage ***V-DC*** 800V/10V						Y	Y	Y	Y	
					14: +10V test voltage output ***P10*** +10 VDC equivalent						Y	Y	Y	Y	
					15: -10V test voltage output ***N10*** -10 VDC equivalent						Y	Y	Y	Y	
					16: Motor temperature ***TMP-M*** ±200°C/±10V						Y	Y	Y	Y	
					30: Universal AO ***U-AO*** -						Y	Y	Y	Y	
					31-37: Custom Ao1-Ao7 ***C-AO1*** to ***C-AO7***						Y	Y	Y	Y	
					38: Input power ***PWR-IN*** 200%/10V						Y	Y	Y	Y	
					39: Magnetic pole position signal ***SMP*** TOP/5V						N	N	N	Y	
					40: PID output value ***PID-OUT*** ±200%/±10V						Y	Y	Y	Y	
E70	146h	h	Terminal [Ao2] Function	1	0 to 40 (Refer to Terminal [Ao1] function.)	Y	6	Y	Y	60	Y	Y	Y	Y	
E71	147h	h	Terminal [Ao3] Function	1	0 to 40 (Refer to Terminal [Ao1]1 function.)	Y	3	Y	Y	60	Y	Y	Y	Y	
E72	148h	h	Terminal [Ao4] Function	1	0 to 40 (Refer to Terminal [Ao1] function.)	Y	0	Y	Y	60	Y	Y	Y	Y	
E73	149h	h	Terminal [Ao5] Function	1	0 to 40 (Refer to Terminal [Ao1] function.)	Y	0	Y	Y	60	Y	Y	Y	Y	
E74	14Ah	h	Ao1 Gain	5	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E75	14Bh	h	Ao2 Gain	1	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E76	14Ch	h	Ao3 Gain	1	-100.00 to 100.00 times	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E77	14Dh	h	Ao4 Gain	1	-100.00 to 100.00 times (Displays if AIO option is mounted)	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E78	14Eh	h	Ao5 Gain	1	-100.00 to 100.00 times (Displays if AIO option is mounted)	Y	1.00	Y	Y	7	Y	Y	Y	Y	
E79	14Fh	h	Ao1 Bias	5	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E80	150h	h	Ao2 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E81	151h	h	Ao3 Bias	1	-100.0 to 100.0%	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E82	152h	h	Ao4 Bias	1	-100.0 to 100.0% (Displays if AIO option is mounted)	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E83	153h	h	Ao5 Bias	1	-100.0 to 100.0% (Displays if AIO option is mounted)	Y	0.0	Y	Y	6	Y	Y	Y	Y	
E84	154h	h	Ao1-Ao5 Filter	0	0.000 to 0.500 s	Y	0.010	Y	Y	4	Y	Y	Y	Y	
E90	15Ah	h	Link Command Function Selection 1 (Available soon)	2	00 to 13	Y	0	Y	Y	231					
					00: Shut down input signal ***OFF***						Y	Y	Y	Y	
					01: Auxiliary speed setting 1 ***AUX-N1***						Y	Y	Y	Y	
					02: Auxiliary speed setting 2 ***AUX-N2***						Y	Y	Y	Y	
					03: Torque bias level ***TB-REF***						Y	Y	N	Y	
					04: Creep speed 1 for UP/DOWN control ***CRP-N1***						Y	Y	Y	Y	
					05: Creep speed 2 for UP/DOWN control ***CRP-N2***						Y	Y	Y	Y	
					06: Detect line speed ***LINE-N***						Y	Y	Y	Y	
					07: Motor temperature ***M-TMP***						Y	Y	Y	Y	
					08: Speed override ***N-OR***						Y	Y	Y	Y	
					09: PID feedback amount 1 ***PID-FB1***						Y	Y	Y	Y	
					10: PID command amount ***PID-REF***						Y	Y	Y	Y	
					11: PID correction gain ***PID-G***						Y	Y	Y	Y	
					12: PID feedback amount 2 ***PID-FB2***						Y	Y	Y	Y	
					13: Observer torque FB ***OBS-TFB***						Y	Y	N	Y	

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
E91	15Bh	h	Link Command Function Selection 2 (Available soon)	1	00 to 12 When E91 ≠ 0 (OFF), analog setting via the communications link (S17) has priority over Ai input specified by Ai function selection. (Refer to the Link Command Function Selection 1.)	Y	0	Y	Y	231	Y	Y	Y	Y	
E101	1E01h	h	Ai1 Offset	4	-100.00 to 100.00%	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E102	1E02h	h	Ai2 Offset	1	-100.00 to 100.00%	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E103	1E03h	h	Ai3 Offset	1	-100.00 to 100.00% (Displays if AIO option is mounted)	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E104	1E04h	h	Ai4 Offset	1	-100.00 to 100.00% (Displays if AIO option is mounted)	Y	0.00	Y	Y	7	Y	Y	Y	Y	
E105	1E05h	h	Ai1 Dead Zone	4	0.00 to 10.00% Limits all command values except input values to 0 V.	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E106	1E06h	h	Ai2 Dead Zone	1	0.00 to 10.00%	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E107	1E07h	h	Ai3 Dead Zone	1	0.00 to 10.00% (Displays if AIO option is mounted)	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E108	1E08h	h	Ai4 Dead Zone	1	0.00 to 10.00% (Displays if AIO option is mounted)	Y	0.00	Y	Y	3	Y	Y	Y	Y	
E109	1E09h	h	Dividing Ratio for FA, FB Pulse Output (Numerator)	2	1 to 65535 Specifies the numerator of the dividing ratio for FA and FB pulse output.	N	1000	Y	Y	0	Y	N	N	Y	
E110	1E0Ah	h	(Denominator)	1	1 to 65535 Specifies the denominator of the dividing ratio for FA and FB pulse output.	N	1000	Y	Y	0	Y	N	N	Y	
E114	1E0Eh	h	Speed Agreement 2 (Detection width)	4	1.0 to 20.0% If ***N-FB2±*** (Detected speed 2) is within the range of ***N-REF4*** (Reference speed 4) ± this detection width, the inverter issues the speed agreement signal ***N-AG2***.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E115	1E0Fh	h	(Off-delay timer)	1	0.000 to 5.000 s Specifies the off-delay timer of the speed agreement signal ***N-AG2***.	Y	0.100	Y	Y	4	Y	Y	N	Y	
E116	1E10h	h	Speed Agreement 3 (Detection width)	1	1.0 to 20.0% If ***N-FB2±*** (Detected speed 2) is within the range of ***N-REF4*** (Reference speed 4) ± this detection width, the inverter issues the speed agreement signal ***N-AG3***.	Y	3.0	Y	Y	2	Y	Y	N	Y	
E117	1E11h	h	(Off-delay timer)	1	0.000 to 5.000 s Specifies the off-delay timer of the speed agreement signal ***N-AG3***.	Y	0.100	Y	Y	4	Y	Y	N	Y	
E118	1E12h	h	Temperature for Axial Fan Stop Signal	0	0 to 200°C If the NTC detection temperature of the motor having an NTC thermistor drops below this setting, the inverter turns ON the axial fan stopped signal ***MFAN***.	Y	0	Y	Y	0	Y	Y	Y	Y	

■ C codes (Control Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
C01	201h	h	Jump Speed 1	4	0 to 30000 r/min Enables the inverter to jump over a point on the reference speed in order to skip a resonance point of the driven machinery (load) and the motor speed. Up to three different jump points can be specified.	Y	0	Y	Y	0	Y	Y	Y	Y	
C02	202h	h	Jump Speed 2	1	0 to 30000 r/min	Y	0	Y	Y	0	Y	Y	Y	Y	
C03	203h	h	Jump Speed 3	1	0 to 30000 r/min	Y	0	Y	Y	0	Y	Y	Y	Y	
C04	204h	h	Hysteresis Width for Jump Speed	1	0 to 1000 r/min	Y	0	Y	Y	0	Y	Y	Y	Y	
C05	205h	9Eh	Multistep Speed 1	17	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21) Multistep speeds 1 to 15 can be switched by turning terminal commands ***SS1***, ***SS2***, ***SS4*** and ***SS8*** ON/OFF.	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C06	206h	9Fh	Multistep Speed 2	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C07	207h	A0h	Multistep Speed 3	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C08	208h	A1h	Multistep Speed 4	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C09	209h	A2h	Multistep Speed 5	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C10	20Ah	A3h	Multistep Speed 6	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C11	20Bh	A4h	Multistep Speed 7	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C12	20Ch	h	Multistep Speed 8	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C13	20Dh	h	Multistep Speed 9	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C14	20Eh	h	Multistep Speed 10	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C15	20Fh	h	Multistep Speed 11	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C16	210h	h	Multistep Speed 12	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C17	211h	h	Multistep Speed 13	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C18	212h	h	Multistep Speed 14/ Creeping Speed 1	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21) C18 and C19 apply also to the creep speed under UP/DOWN control.	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C19	213h	h	Multistep Speed 15/ Creeping Speed 2	1	0 to 30000 r/min / 0.00 to 100.00% / 0.0 to 999.9 m/min (Switchable by C21)	Y	0/0.00/ 0.0	Y	Y	0	Y	Y	Y	Y	
C20	214h	h	Multistep Speed Agreement Timer	1	0.000 to 0.100 s When ***SS1***, ***SS2***, ***SS4*** and ***SS8*** are kept at the same status for the duration specified by this function code, the inverter switches the reference speed.	Y	0.000	Y	Y	4	Y	Y	Y	Y	
C21	215h	h	Multistep Speed Configuration Definition	1	0 to 2 0: 0 to 30000 r/min 1: 0.00 to 100.00% 2: 0.0 to 999.9 m/min Defines the unit of multistep speed specified by C05 to C19. When C21 = 1, the percentage of the maximum speed (F03/A06/A106) of the selected motor applies.	N	0	Y	Y	93	Y	Y	Y	Y	
C25	219h	h	Speed Command N2	0	0 to 9 0: Keypad (∧/∨ keys) 1: Analog input to terminal [12](0 to ±10V) 2: Analog input to terminal [12](0 to +10V) 3: ***UP/DOWN*** control (Initial speed = 0) 4: ***UP/DOWN*** control (Initial speed = Last value) 5: ***UP/DOWN*** control (Initial speed = Creep speed 1, 2) 6: DIA card input 7: DIB card input 8: N-REFV input to terminal [Ai1] 9: N-REFC input to terminal [Ai2] The speed command specified by this function code takes effect when X terminal command ***N2/N1*** is turned ON.	N	0	Y	Y	41	Y	Y	Y	Y	
C29	21Dh	h	Jogging Speed	0	0 to 30000 r/min Specifies the speed to be applied when the motor jogs.	Y	50	Y	Y	0	Y	Y	Y	Y	
C30	21Eh	h	ASR-JOG (P-gain)	9	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C31	21Fh	h	(I-constant)	1	0.000 to 10.000 s P control when C31 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
C32	220h	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C33	221h	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C34	222h	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C35	223h	h	Acceleration Time for Jogging	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C36	224h	h	Deceleration Time for Jogging	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C37	225h	h	S-curve JOG (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C38	226h	h	S-curve JOG (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C40	228h	h	ASR2 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C41	229h	h	(I-constant)	1	0.000 to 10.000 s P control when C41 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
C42	22Ah	h	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
C43	22Bh	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C44	22Ch	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C45	22Dh	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C46	22Eh	h	Acceleration Time 2	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C47	22Fh	h	Deceleration Time 2	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C48	230h	h	S-curve 2 (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C49	231h	h	S-curve 2 (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C50	232h	h	ASR3 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C51	233h	h	(I-constant)	1	0.000 to 10.000 s P control when C41 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
C52	234h	h	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
C53	235h	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C54	236h	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C55	237h	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C56	238h	h	Acceleration Time 3	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C57	239h	h	Deceleration Time 3	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C58	23Ah	h	S-curve 3 (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C59	23Bh	h	S-curve 3 (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C60	23Ch	h	ASR4 (P-gain)	10	0.1 to 500.0 times	Y	10.0	Y	Y	2	Y	Y	N	Y	
C61	23Dh	h	(I-gain)	1	0.000 to 10.000 s P control when C41 = 0.000	Y	0.200	Y	Y	4	Y	Y	N	Y	
C62	23Eh	h	(Feedforward gain)	1	0.000 to 9.999 s	Y	0.000	Y	Y	4	Y	Y	N	Y	
C63	23Fh	h	(Input filter)	1	0.000 to 5.000 s	Y	0.040	Y	Y	4	Y	Y	Y	Y	
C64	240h	h	(Detection filter)	1	0.000 to 0.100 s	Y	0.005	Y	Y	4	Y	Y	N	Y	
C65	241h	h	(Output filter)	1	0.000 to 0.100 s	N	0.002	Y	Y	4	Y	Y	N	Y	
C66	242h	h	Acceleration Time 4	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C67	243h	h	Deceleration Time 4	1	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	Y	5.00	Y	Y	13	Y	Y	Y	Y	
C68	244h	h	S-curve 4 (Start side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C69	245h	h	S-curve 4 (End side)	1	0 to 50%	Y	0	Y	Y	0	Y	Y	Y	Y	
C70	246h	h	ASR Switching Time	0	0.00 to 2.55 s	Y	1.00	Y	Y	3	Y	Y	N	Y	
C71	247h	A5h	ACC/DEC Switching Speed	0	0.00 to 100.00%	Y	0.00	Y	Y	3	Y	Y	Y	Y	
C72	248h	A6h	ASR Switching Time	0	0.00 to 100.00%	Y	0.00	Y	Y	3	Y	Y	N	Y	
C73	249h	h	Creep Speed Switching (under UP/DOWN control)	0	00 to 11 (Creep Speed 1)(Creep Speed 2) 0: Function code setting (C18, C19) 1: Analog input (***CRP1***, ***CRP2***)	N	00	Y	Y	9	Y	Y	Y	Y	

■ P codes (Motor Parameter Functions M1)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
P01	301h	h	M1 Drive Control	0	0 to 5 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor 2: Simulation mode 3: Vector control for PMSM with speed sensor 4: -- 5: V/f control for IM	N	0	Y	N	55	Y	Y	Y	Y	
P02	302h	h	M1 Motor Selection	26	00 to 50 Display (kW, HP) changes by setting F60. 00 to 35: Settings for VG-dedicated motors Data at F04, F05, and P03 to P27 are automatically set and write-protected. 36: P-OTHER (P-OTR on the keypad) Data at F04, F05, and P03 to P27 are write-protected and cannot be overwritten. 37: OTHER Data at F04, F05, and P03 to P27 are write-protected and cannot be overwritten. 38 to 50: Settings for the motor only for FRENIC-VG (8-series) Data at F04, F05, and P03 to P27 are automatically set and write-protected. For the relationship between the setting data and the motor type, refer to "List of Applicable Motors" in Section 4.3.4, P02 codes.	N	*	Y	N	82	Y	Y	Y	Y	
P03	303h	A7h	M1 Rated Capacity	1	For inverters of 400 kW or below 0.00 to 500.00 kW when F60 = 0 0.00 to 600.00 HP when F60 = 1 For inverters of 500 kW or above 0.00 to 1200 kW when F60 = 0 0.00 to 1600 HP when F60 = 1 For multiwinding motors, set the motor capacity per wiring.	N	*	Y	N	3 13	Y	Y	Y	Y	
P04	304h	A8h	M1 Rated Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	N	*	Y	N	13	Y	Y	Y	Y	
P05	305h	A9h	M1 Number of Poles	1	2 to 100 poles	N	4	Y	N	1	Y	Y	Y	Y	
P06	306h	AAh	M1 %R1	1	0.00 to 30.00%	Y	*	Y	N	3	Y	Y	Y	Y	
P07	307h	ABh	M1 %X	1	0.00 to 200.00%	Y	*	Y	N	3	Y	Y	Y	Y	
P08	308h	ACh	M1 Exciting Current/Magnetic Flux Weakening Current (-Id)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	*	Y	N	13	Y	Y	Y	Y	
P09	309h	ADh	M1 Torque Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	*	Y	N	13	Y	Y	N	Y	
P10	30Ah	AEh	M1 Slip Frequency (For driving)	1	0.001 to 10.000 Hz	Y	*	Y	N	4	Y	Y	N	N	
P11	30Bh	AFh	(For braking)	1	0.001 to 10.000 Hz	Y	*	Y	N	4	Y	Y	N	N	
P12	30Ch	B0h	M1 Iron Loss Factor 1	1	0.00 to 10.00%	Y	*	Y	N	3	Y	Y	N	Y	
P13	30Dh	B1h	M1 Iron Loss Factor 2	1	0.00 to 10.00%	Y	*	Y	N	3	Y	Y	N	Y	
P14	30Eh	B2h	M1 Iron Loss Factor 3	1	0.00 to 10.00%	Y	*	Y	N	3	Y	Y	N	Y	
P15	30Fh	B3h	M1 Magnetic Saturation Factor 1	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 93.75%	Y	*	Y	N	2	Y	Y	N	N	
P16	310h	B4h	M1 Magnetic Saturation Factor 2	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 87.5%	Y	*	Y	N	2	Y	Y	N	N	
P17	311h	B5h	M1 Magnetic Saturation Factor 3	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 75%	Y	*	Y	N	2	Y	Y	N	N	
P18	312h	B6h	M1 Magnetic Saturation Factor 4	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 62.5%	Y	*	Y	N	2	Y	Y	N	N	
P19	313h	B7h	M1 Magnetic Saturation Factor 5	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 50%	Y	*	Y	N	2	Y	Y	N	N	
P20	314h	B8h	M1 Secondary Time Constant	1	0.001 to 9.999 s	Y	*	Y	N	4	Y	Y	N	N	
P21	315h	B9h	M1 Induced Voltage Factor	1	0 to 999 V	Y	*	Y	N	0	Y	Y	N	Y	
P22	316h	BAh	M1 R2 Correction Factor 1	1	0.500 to 5.000	Y	*	Y	N	4	Y	Y	N	Y	
P23	317h	BBh	M1 R2 Correction Factor 2	1	0.500 to 5.000	Y	*	Y	N	4	Y	Y	N	N	
P24	318h	BCh	M1 R2 Correction Factor 3	1	0.010 to 5.000	Y	*	Y	N	4	Y	Y	N	N	
P25	319h	BDh	M1 Exciting Current Correction Factor	1	0.000 to 5.000	Y	*	Y	N	4	Y	Y	N	N	
P26	31Ah	BEh	M1 ACR (P-gain)	1	0.1 to 20.0	Y	1.0	Y	N	2	Y	Y	N	Y	
P27	31Bh	BFh	(I-time)	1	0.1 to 100.0 ms	Y	1.0	Y	N	2	Y	Y	N	Y	

*Depending upon the inverter's capacity.

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
P28	31Ch	C0h	M1 Pulse Resolution	0	100 to 60000	N	1024	Y	N	0	Y	N	N	Y	
P29	31Dh	D6h	M1 External PG Correction Factor	0	0000 to 4FFF	N	4000	Y	N	9	Y	N	N	N	
P30	31Eh	C1h	M1 Thermistor Selection	0	0 to 3 0: No thermistor 1: NTC thermistor 2: PTC thermistor 3: Ai (***M-TMP***) The protection level of the motor protective functions should be specified by E30 to E32.	N	1	Y	N	84	Y	Y	Y	Y	
P32	320h	h	M1 Online Auto-tuning	0	0 or 1 0: Disable 1: Enable Enabling this auto-tuning activates the compensation function for the resistance change caused by the temperature rise of the motor running.	Y	0	Y	N	0	Y	Y	N	N	
P33	321h	h	M1 Maximum Output Voltage/ Maximum Voltage Limit	0	80 to 999 V	Y	220/ 440	Y	N	0	N	N	Y	Y	
P34	322h	h	M1 Slip Compensation	3	-20.000 to 5.000 Hz	Y	0.000	Y	N	8	N	N	Y	N	
P35	323h	h	M1 Torque Boost	1	0.0 to 20.0 Exclusive to V/f control. 0.0: Auto torque boost (for constant torque load) 0.1 to 0.9: For variable torque load 1.0 to 1.9: For proportional torque load 2.0 to 20.0: For constant torque load	Y	0.0	Y	N	2	N	N	Y	N	
P36	324h	h	M1 Output Current Fluctuation Damping Gain	1	0.00 to 1.00	Y	0.20	Y	N	3	N	N	Y	N	
P42	32Ah	h	M1 q-axis Inductance Magnetic Saturation Coefficient	10	0 to 100%	Y	100.0	Y	N	0	N	N	N	Y	
P43	32Bh	h	M1 Magnetic Flux Limiting Value	1	50.0 to 150.0%	Y	*	Y	N	2	N	N	N	Y	
P44	32Ch	h	M1 Overcurrent Protection Level	1	0.00: Disable 0.01 to 99.99 A 100.0 to 999.9 A 1000 o 5000 A Specifies the allowable current value to prevent the permanent magnet of a PMSM from getting demagnetized. If the current exceeding this setting flows, an overcurrent alarm (OC) occurs.	N	0.00	Y	N	13	N	N	N	Y	
P45	32Dh	h	M1 Torque Correction Gain 1	1	0.00 to 10.00	Y	*	Y	N	3	N	N	N	Y	
P46	32Eh	h	M1 Torque Correction Gain 2	1	0.00 to 10.00	Y	*	Y	N	3	N	N	N	Y	
P47	32Fh	h	M1 Torque Correction Gain 3	1	-1.000 to 1.000	Y	*	Y	N	8	N	N	N	Y	
P48	330h	h	M1 Torque Correction Gain 4	1	-1.000 to 1.000	Y	*	Y	N	8	N	N	N	Y	
P49	331h	h	M1 Torque Correction Gain 5	1	-50.00 to 50.00	Y	*	Y	N	7	N	N	N	Y	
P50	332h	h	M1 Torque Correction Gain 6	1	-50.00 to 50.00	Y	*	Y	N	7	N	N	N	Y	
P51	333h	h	M1 Torque Correction Gain 7	1	-1.000 to 1.000	Y	*	Y	N	8	N	N	N	Y	

*Depending upon the inverter's capacity.

■ H codes (High Performance Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H01	401h	h	Auto-tuning	0	0 to 4 0: Disable	N	0	N	N	61	Y	Y	Y	Y	
					1: ASR auto-tuning (Available soon)						Y	Y	N	Y	
					2: Motor parameter auto-tuning (R1, Lσ)						Y	Y	Y	N	
					3: Auto-tuning with the motor stopped						Y	Y	Y	N	
					4: Auto-tuning with the motor running						Y	Y	Y	N	
					Upon completion of auto-tuning, the H01 data automatically reverts to "0." To save the tuned data, perform the Save all function (H02).										
H02	402h	Eh	Save All Function	0	0 or 1 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 RS-458, etc.), the data goes out when the power supply of the inverter is turned off. This function must operate when preservation is necessary. After writing the data, this function's data code automatically returns to 0.	Y	0	N	N	11	Y	Y	Y	Y	
H03	403h	h	Data Initialization	0	0 or 1 Setting H03 to "1" reverts the function code data modified by the customer to the factory defaults. Initialization targets include all fields of F, E, C, H, o, L and U codes except motor parameter fields (P, A), F04, F05, F10 to F12, and F58. Upon completion of the initialization, the H03 data automatically reverts to "0."	N	0	N	N	11	Y	Y	Y	Y	
H04	404h	h	Auto-reset (Times)	0	0 to 10 0: Disable 1 to 10 times The auto-resetting signal can be output to the output terminal.	N	0	Y	Y	0	Y	Y	Y	Y	
H05	405h	H	Auto-reset (Reset interval)	0	0.01 to 20.00 s	N	5.00	Y	Y	3	Y	Y	Y	Y	
H06	406h	h	Cooling Fan ON/OFF Control	0	0 or 1 0: Disable 1: Enable This control detects the temperature of the heat sink in the inverter unit and turns the cooling fan ON/OFF automatically. It is possible to output the ***FAN*** (Cooling fan in operation) signal in conjunction with this function.	N	0	Y	Y	68	Y	Y	Y	Y	
H08	408h	h	Rev. Phase Sequence Lock	0	0 or 1 0: Disable 1: Enable	Y	0	Y	Y	68	Y	N	N	Y	
H09	409h	C2h	Starting Mode (Auto search)	0	0 to 2 0: Disable 1: Enable (At restart after momentary power failure) 2: Enable Auto search detects the idling motor speed at starting and drives the motor at the same speed without stopping it.	Y	2	Y	Y	0	N	Y	Y	N	
H10	40Ah	C3h	Energy-saving Operation	0	0 or 1 0: Disable 1: Enable	N	0	Y	Y	68	Y	N	N	N	
H11	40Bh	h	Automatic Operation OFF Function	0	0 to 4 0: Decelerate to stop when FWD-CM or REV-CM is opened 1: The inverter is turned off below the stop speed even for ON between FWD-CM and REV-CM. 2: Coast to stop when FWD-CM or REV-CM is opened 3: Decelerate to stop using ASR when FWD-CM or REV-CM is opened (under torque control) 4: Coast to stop when FWD-CM or REV-CM is opened (under torque control)	Y	0	Y	Y	0	Y	Y	Y	Y	
H13	40Dh	C4h	Restart Mode after Momentary Power Failure (Wait time)	5	0.1 to 5.0 s	N	0.5	Y	Y	2	Y	Y	Y	Y	
H14	40Eh	h	(Decrease rate in speed)	1	1 to 3600 r/min/s	Y	500	Y	Y	0	N	N	Y	N	
H15	40Fh	h	(Continuous running level)	1	3-phase 200 V: 200 to 300 V 3-phase 400 V: 400 to 600 V This setting applies when F14 = 2 (Trip after recovery from power failure) or F14 = 3 (Continue to run).	Y	235/ 470	Y	Y	0	Y	Y	Y	Y	
H16	410h	h	(Run command self-hold setting)	1	0 or 1 0: Setting made by H17 1: Maximum time (The inverter self-holds the run command while the control power supply in the inverter is established or until the DC link bus voltage comes to almost "0.")	N	1	Y	Y	94	Y	Y	Y	Y	
H17	411h	h	(Run command self-hold time)	1	0.0 to 30.0 s	N	30.0	Y	Y	2	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H19	413h	C5h	Active Drive	0	0 or 1 0: Disable 1: Enable Under vector control, this function automatically limits the output torque to avoid an overload trip, etc.	N	0	Y	Y	68	Y	Y	Y	Y	
H20	414h	C6h	PID Control (Mode selection)	8	0 to 3 0: Inactive 1: Active 2: Inverse action 1 3: Inverse action 2	N	0	Y	Y	69	Y	Y	Y	Y	
H21	415h	C7h	(Command selection)	1	0 or 1 0: Keypad or input to terminal [12] 1: Analog input ***PID-REF***	Y	0	Y	Y	70	Y	Y	Y	Y	
H22	416h	C9h	(P-action)	1	0.000 to 10.000 times	Y	1.000	Y	Y	4	Y	Y	Y	Y	
H23	417h	CAh	(I-action)	1	0.00 to 100.00 s	Y	1.00	Y	Y	3	Y	Y	Y	Y	
H24	418h	CBh	(D-action)	1	0.000 to 10.000 s	Y	0.000	Y	Y	4	Y	Y	Y	Y	
H25	419h	C8h	(Upper limit)	1	-300 to 300%	N	100	Y	Y	5	Y	Y	Y	Y	
H26	41Ah	CCh	(Lower limit)	1	-300 to 300%	N	-100	Y	Y	5	Y	Y	Y	Y	
H27	41Bh	CEh	(Speed command selection)	1	0 to 2 0: Disable 1: Select PID 2: Select auxiliary speed	N	0	Y	Y	95	Y	Y	Y	Y	
H28	41Ch	CFh	Droop Control	0	0.0 to 25.0%	Y	0.0	Y	Y	2	Y	Y	N	Y	
H29	41Dh	h	Communications Link Function (Data protection via link)	2	0 or 1 0: Writable to function code fields 1: Write-protect function code fields Setting H29 to "1" protects function code data from getting changed mistakenly via the link (T-Link, RS-485, etc.). Via the link, data can be written to the "function code fields" (given above) or "command data fields" (S fields). The S fields are defined by H30.	Y	0	Y	Y	40	Y	Y	Y	Y	
H30	41Eh	D0h	(Link operation)	1	0 to 3 Monitor / Command data / Run command (FWD, REV) 0: Y N N 1: Y Y N 2: Y N Y 3: Y Y Y	Y	0	Y	Y	72	Y	Y	Y	Y	
H31	41Fh	h	RS-485 Communication (Station address)	10	0 to 255 Broadcast: (0: RTU), (99: Fuji) Address: 1 to 255 Specify the station address of RS-485.	N	1	Y	N	0	Y	Y	Y	Y	
H32	420h	h	(Error processing)	1	0 to 3 0: Immediately trip with Er5 1: Trip with Er5 after running for the period specified by timer H33. 2: Trip with Er5 if a communications error persists exceeding the period specified by timer H33. 3: Continue to run	Y	3	Y	Y	73	Y	Y	Y	Y	
H33	421h	h	(Timer)	1	0.01 to 20.00 s	Y	2.00	Y	Y	3	Y	Y	Y	Y	
H34	422h	h	(Baud rate)	1	0 to 4 0: 38400 bps 1: 19200 bps 2: 9600 bps 3: 4800 bps 4: 2400 bps	Y	0	Y	N	74	Y	Y	Y	Y	
H35	423h	h	(Data length)	1	0 or 1 0: 8 bits 1: 7 bits	Y	0	Y	N	75	Y	Y	Y	Y	
H36	424h	h	(Parity check)	1	0 to 2 0: None 1: Even parity 2: Odd parity	Y	1	Y	N	76	Y	Y	Y	Y	
H37	425h	h	(Stop bits)	1	0 or 1 0: 2 bits 1: 1 bit	Y	1	Y	N	77	Y	Y	Y	Y	
H38	426h	h	(Communications line break time)	1	0.0 to 60.0 s 0.0: Disable detection 0.1 to 60.0: Enable detection	Y	60.0	Y	Y	2	Y	Y	Y	Y	
H39	427h	h	(Response interval)	1	0.00 to 1.00 s	Y	0.01	Y	Y	3	Y	Y	Y	Y	
H40	428h	h	(Protocol selection)	1	0 to 2 0: Fuji general-purpose inverter protocol 1: SX protocol (Loader protocol) 2: Modbus RTU protocol To use FRENIC-VG Loader, set H40 to "1."	N	1	Y	N	78	Y	Y	Y	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
H41	429h	D1h	Torque Command Source	4	0 to 5 0: Internal ASR output 1: Ai terminal input ***T-REF*** 2: DIA card 3: DIB card 4: Communications link 5: PID	N	0	Y	Y	64	Y	Y	N	Y	
H42	42Ah	D2h	Torque Current Command Source	1	0 to 4 0: Internal ASR output 1: Ai terminal input ***IT-REF*** 2: DIA card 3: DIB card 4: Communications link	N	0	Y	Y	65	Y	Y	N	Y	
H43	42Bh	D3h	Magnetic Flux Command Source	1	0 to 3 0: Internal calculation 1: Ai terminal input ***MF-REF*** 2: Function code H44 3: Communications link	N	0	Y	Y	66	Y	N	N	N	
H44	42Ch	D4h	Magnetic Flux Command Value	1	10 to 100%	N	100	Y	Y	16	Y	N	N	N	
H46	42Eh	D7h	Observer (Mode selection)	7	0 to 2 0: Disable 1: Enable (Load disturbance observer) 2: Enable (Oscillation suppressing observer)	N	0	Y	Y	79	Y	Y	N	Y	
H47	42Fh	D8h	(M1 compensation gain)	1	0.00 to 1.00 times	Y	0.00	Y	Y	3	Y	Y	N	Y	
H48	430h	h	(M2 compensation gain)	1	0.00 to 1.00 times	Y	0.00	Y	Y	3	Y	Y	N	Y	
H49	431h	D9h	(M1 I-time)	1	0.005 to 1.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
H50	432h	h	(M2 I-time)	1	0.005 to 1.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
H51	433h	DAh	(M1 load inertia)	1	0.001 to 50.000 kg•m^2 The magnification is switchable by H228.	Y	*	Y	N	4	Y	Y	N	Y	
H52	434h	h	(M2 load inertia)	1	0.001 to 50.000 kg•m^2 The magnification is switchable by H228.	Y	0.001	Y	N	4	Y	Y	N	Y	
H53	435h	D5h	Line Speed Feedback Selection	0	0 to 3 0: Disable line speed (Integrated PG enabled) Note that Ai input or PG (LD) should be high level-select in UPAC. 1: Detect analog line speed (AI-LINE) 2: Detect digital line speed (PG(LD)) 3: High level selected signal (Select high level of motor speed and line speed.)	Y	0	Y	Y	67	Y	Y	Y	Y	
H55	437h	h	Zero Speed Control (Gain)	2	0 to 100 times For details, refer to X terminal command ***LOCK*** assigned by any of E01 to E13.	Y	5	Y	Y	0	Y	N	N	Y	
H56	438h	h	(Completion range)	1	0 to 100 pulses	Y	100	Y	Y	0	Y	N	N	Y	
H57	439h	h	Overvoltage Suppression	2	0 or 1 0: Disable 1: Enable	N	0	Y	Y	68	Y	Y	Y	Y	
H58	43Ah	h	Overcurrent Suppression	1	0 or 1 0: Disable 1: Enable	N	0	Y	Y	68	Y	Y	Y	Y	
H60	43Ch	h	Load Adaptive Control (Definition 1)	7	0 to 3 0: Disable 1: Method 1 2: Method 2 3: Method 3	N	0	Y	Y	80	Y	N	N	Y	
H61	43Dh	h	(Definition 2)	1	0 or 1 0: Winding up in forward rotation 1: Winding down in forward rotation	N	0	Y	Y	81	Y	N	N	Y	
H62	43Eh	h	(Winding-up speed)	1	0.0 to 999.9 m/min	N	0.0	Y	Y	2	Y	N	N	Y	
H63	43Fh	h	(Counter weight)	1	0.00 to 600.00 t	N	0.00	Y	Y	3	Y	N	N	Y	
H64	440h	h	(Safety coefficient)	1	0.50 to 1.20	N	1.00	Y	Y	3	Y	N	N	Y	
H65	441h	h	(Machine efficiency)	1	0.500 to 1.000	N	0.500	Y	Y	4	Y	N	N	Y	
H66	442h	h	(Rated load)	1	0.00 to 600.00 t	N	0.00	Y	Y	3	Y	N	N	Y	
H68	444h	h	Alarm Data Deletion	0	0 or 1 Setting H68 to "1" deletes all of the alarm history, alarm causes and alarm information held in the inverter memory. After that, the H68 data automatically reverts to "0."	Y	0	N	N	11	Y	Y	Y	Y	
H70	446h	h	Reserved 1	2	0 to 9999 Reserved. (Do not access this function code.)	N	0	Y	N	0	Y	Y	N	Y	
H71	447h	h	Reserved 2	1	0 to 10 5: Magnetic pole position offset tuning When you mount a PG on the motor or replace the PG at the site for motors having no magnetic pole position offset label, perform automatic adjustment with the tuning function (H71 = 5)	N	0	N	N	62	Y	Y	Y	Y	
H74	44Ah	h	PG Detection Circuit Self-diagnosis	0	0 or 1 0: Disable 1: Enable This function performs self-diagnosis of the speed detection circuit by pulse generator signals (PA, PB).	N	0	Y	Y	225	Y	Y	N	Y	

*Depending upon the inverter's capacity.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H75	44Bh	h	Phase Sequence Configuration of Main Circuit Output Wires	0	0 or 1 0: Positive phase U-V-W 1: Negative phase U-W-V Switches the phase sequence of the inverter main circuit.	N	0	Y	Y	197	Y	Y	Y	Y	
H76	44Ch	h	Main Power Down Detection	0	0 or 1 0: Disable 1: Enable Enable this function to enable the AC power monitor. Disable this function when DC power is supplied, e.g., connecting with a power regenerative converter.	Y	0	Y	Y	0	Y	Y	Y	Y	
H77	44Dh	h	Cooling Fan ON/OFF Control Continuation Timer	0	0 to 600 s Specifies the condition of the cooling fan ON/OFF control by H06.	Y	600	Y	Y	0	Y	Y	Y	Y	
H78	44Eh	h	Initialization of Startup Counter/ Total Run Time	6	0 to 6 0: Disable 1: M1 number of startups 2: M2 number of startups 3: M3 number of startups 4: M1 cumulative run time 5: M2 cumulative run time 6: M3 cumulative run time Initializes the number of startups and cumulative run time.	N	0	N	N	0	Y	Y	Y	Y	
H79	44Fh	h	Initialization of Cumulative Run Time of Cooling Fan	1	0 to 65535 (in units of 10 hours) Initializes the cumulative run time when the cooling fan is replaced. Usually, write "0" after replacement.	N	0	N	N	0	Y	Y	Y	Y	
H80	450h	h	Capacitance Measurement of DC Link Bus Capacitor	1	0 to 32767 When the capacitance measurement is user mode (H104), setting this function code at "0" and shutting down the inverter power starts measuring the initial value of the capacitance and sets the measurement result to this function code.	N	0	N	Y	0	Y	Y	Y	Y	
H81	451h	h	Initialization of Service Life of DC Link Bus Capacitor	1	0 to 65535 (in units of 10 hours) Initializes the elapsed time of the DC link bus capacitor.	N	0	N	Y	0	Y	Y	Y	Y	
H82	452h	h	Startup Count for Maintenance	1	0 to 65535 Specifies the number of startups for performing maintenance of the machinery.	Y	0	N	Y	0	Y	Y	Y	Y	
H83	453h	h	Maintenance Interval	1	0 to 65535 (in units of 10 hours) Specifies the maintenance interval for performing maintenance of the machinery.	Y	8760	N	Y	0	Y	Y	Y	Y	
H84 *1	454h	h	Speed calculation period when extremely low speed (for maker)	0	0.0 to 200.0ms The sampling period setting of the encoder pulse in extremely low speed region. This is a function code for maker. Do not access this function code.	N	0.0	Y	Y	2	Y	N	N	Y	
H85	455h	h	Calendar Clock (Year/month)	4	0000 to FFFF Upper two digits: Year, Lower two digits: Month	Y	0001	N	Y	143	Y	Y	Y	Y	
H86	456h	h	(Day/hour)	1	0000 to FFFF Upper two digits: Date, Lower two digits: Time	Y	0100	N	Y	144	Y	Y	Y	Y	
H87	457h	h	(Minute/second)	1	0000 to FFFF Upper two digits: Minute, Lower two digits: Second	Y	0000	N	Y	145	Y	Y	Y	Y	
H88	458h	h	(Setting up clock)	1	0 or 1 0: Disable 1: Write the current date and time Setting H88 to "1" sets up the calendar clock in accordance with the settings of H85 to H87. After that, the H88 data automatically reverts to "0."	Y	0	N	N	11	Y	Y	Y	Y	
H90	45Ah	h	Overspeed Alarm Detection Level	0	100 to 160%	Y	120	Y	Y	0	Y	Y	N	Y	
H96 *1	460h	h	ASR operation selecting	0	o to 3 0: P priority (VG1) 1: I priority (compatible with VM5) 2: P priority (compatible with VM5) 3: For maker (Do not select this)	N	0	Y	Y	201	Y	Y	N	Y	
H101	1F01h	h	PID Command Filter Time Constant	0	0 to 5000 ms Specifies the time constant of the PID command filter (after switched by H21).	Y	0	Y	Y	0	Y	Y	Y	Y	

*1 Available in the ROM version H1/2 0067 or later

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
H103	1F03h	h	Protective/Maintenance Function Selection 1	9	0000 to 1111 Selects the protective functions individually. (0: Disable, 1: Enable) Thousands digit: Start delay (LOC) Hundreds digit: Ground fault (EF) Tenths digit: Output phase loss (OPL) Units digit: Braking transistor broken (dbA)	Y	0101	Y	Y	9	Y	Y	Y	Y	
H104	1F04h	h	Protective/Maintenance Function Selection 2	1	0000 to 1111 Selects the protective/maintenance functions individually. (0: Disable, 1: Enable) Thousands digit: PG wire break alarm (PG) Hundreds digit: Lower the carrier frequency Tenths digit: Judge the life of DC link bus capacitor Units digit: Select life judgment threshold of DC link bus capacitor (0: Factory default level, 1: User setup level)	Y	1110	Y	Y	9	Y	Y	Y	Y	
H105	1F05h	h	Protective/Maintenance Function Selection 3	1	0000 to 1111 Selects the protective/maintenance functions individually. (0: Disable, 1: Enable) Thousands digit: -- Hundreds digit: Speed disaccord alarm Er9 operation 1 ***1** Tenths digit: Speed disaccord alarm Er9 operation 2 ***1** Units digit: Save the integrated value of motor electronic thermal	Y	0000	Y	Y	9	Y	Y	Y	Y	
H106	1F06h	h	Light Alarm Object Definition 1	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: OH4 "Motor overheat" Hundreds digit: OL1 - OL3 "Motor 1 to 3 overload" Tenths digit: nrb "NTC thermistor wire break error" Units digit: OH2 "External alarm"	N	0000	Y	Y	9	Y	Y	Y	Y	
H107	1F07h	h	Light Alarm Object Definition 2	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: Er5 "RS-485 communications error" Hundreds digit: Er4 "Network error" Tenths digit: Reserved Units digit: Ar-F "Toggle abnormality error"	N	0000	Y	Y	9	Y	Y	Y	Y	
H108	1F08h	h	Light Alarm Object Definition 3	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: Err "Mock alarm" Hundreds digit: dFA "DC fan locked" Tenths digit: Er9 "Speed mismatch" LoC "Start delay" Units digit: Ar-E "E-SX bus tact synchronization error"	N	0000	Y	Y	9	Y	Y	Y	Y	
H109	1F09h	h	Light Alarm Object Definition 4	1	0000 to 1111 (0: Heavy alarm (Err), 1: Light alarm (L-AL)) Thousands digit: Reserved Hundreds digit: Reserved Tenths digit: Reserved Units digit: Reserved	N	0000	Y	Y	9	Y	Y	Y	Y	
H110	1F0Ah	h	Light Alarm Object Definition 5	1	0000 to 1111 (0: Cancel light alarm, 1: Light alarm (L-AL)) Thousands digit: nOH "Motor overheat early warning" nOL "Motor overload early warning" Hundreds digit: bAT "Battery life expired" Tenths digit: LiF "Life time early warning" Units digit: OH/OL "Heat sink overheat early warning / overload early warning"	N	0000	Y	Y	9	Y	Y	Y	Y	
H111	1F0Bh	h	Light Alarm Object Definition 6	1	0 or 1 0: Disable (L-AL not shown) 1: Enable (L-AL shown) Specified whether or not to display L-AL on the LED monitor when a light alarm occurs.	N	1	Y	Y	68	Y	Y	Y	Y	
H112	1F0Ch	h	M1 Magnetic Saturation Extension Coefficient 6	7	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 43.75%.	Y	43.8	Y	N	2	Y	N	N	N	
H113	1F0Dh	h	M1 Magnetic Saturation Extension Coefficient 7	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 37.5%.	Y	37.5	Y	N	2	Y	N	N	N	
H114	1F0Eh	h	M1 Magnetic Saturation Extension Coefficient 8	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 31.25%.	Y	31.3	Y	N	2	Y	N	N	N	
H115	1F0Fh	h	M1 Magnetic Saturation Extension Coefficient 9	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 25%.	Y	25.0	Y	N	2	Y	N	N	N	
H116	1F10h	h	M1 Magnetic Saturation Extension Coefficient 10	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 18.75%.	Y	18.8	Y	N	2	Y	N	N	N	

***1** Available in the ROM version H1/2 0067 or later

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H117	1F11h	h	M1 Magnetic Saturation Extension Coefficient 11	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 12.5%.	Y	12.5	Y	N	2	Y	N	N	N	
H118	1F12h	h	M1 Magnetic Saturation Extension Coefficient 12	1	0.0 to 100.0% Compensation factor for exciting current when the magnetic flux command is 6.25%.	Y	6.3	Y	N	2	Y	N	N	N	
H125	1F19h	h	Observer (M3 compensation gain)	1	0.00 to 1.00 times	Y	0.00	Y	Y	3	Y	Y	N	Y	
H126	1F1Ah	h	(M3 integral time)	1	0.005 to 1.000 s	Y	0.100	Y	Y	4	Y	Y	N	Y	
H127	1F1Bh	h	(M3 load inertia)	1	0.001 to 50.000 kg•m^2 The magnification is switchable by H228.	Y	0.001	Y	Y	4	Y	Y	N	Y	
H134	1F22h	h	Speed Drop Detection Delay Timer	5	0.000 to 10.000 s	N	0.000	Y	Y	4	N	Y	N	N	
H135	1F23h	h	Speed Command Detection Level (FWD)	1	0.0 to 150.0 r/min	N	0.0	Y	Y	2	N	Y	N	N	
H136	1F24h	h	(REV)	1	0.0 to 150.0 r/min	N	0.0	Y	Y	2	N	Y	N	N	
H137	1F25h	h	Speed Drop Detection Level	1	0.0 to 150.0 r/min	N	0.0	Y	Y	2	N	Y	N	N	
H138	1F26h	h	Speed Command Detection Delay Timer	1	0.000 to 10.000 s	N	0.000	Y	Y	4	N	Y	N	N	
H140	1F28h	h	Start Delay Detection (Detection level)	1	0.0 to 300.0%	Y	150.0	Y	Y	2	Y	Y	N	Y	
H141	1F29h	h	(Detection timer)	1	0.000 to 10.000 s	Y	1.000	Y	Y	0	Y	Y	N	Y	
H142	1F2Ah	h	Mock Alarm	0	0 or 1 0: Disable 1: Cause a mock alarm When H108 does not define a mock alarm as a light alarm, a heavy alarm (Err) occurs; when it defines a mock alarm as a light alarm, a light alarm (L-AL) occurs. Holding down the (STOP) and (FUNC/DATA) keys simultaneously for three seconds also causes a mock alarm.	Y	0	N	N	11	Y	Y	Y	Y	
H144	1F2Ch	h	Toggle Data Error Timer	0	0.01 to 20.00 s H144 specifies the toggle data error detection time.	Y	0.10	Y	Y	3	Y	Y	Y	Y	
H145	1F2Dh	h	Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency selection)	3	0 to 3 0: Disable 1: Enable for FWD unipolar operation 2: Enable for REV unipolar operation 3: Enable for FWD/REV bipolar operation	N	0	Y	Y	202	N	Y	N	N	
H146	1F2Eh	h	(Lower limit frequency, FWD)	1	0.000 to 10.000 Hz	N	0.000	Y	Y	4	N	Y	N	N	
H147	1F2Fh	h	(Lower limit frequency, REV)	1	0.000 to 10.000 Hz	N	0.000	Y	Y	4	N	Y	N	N	
H148	1F30h	h	Estimated Primary Frequency Filter	0	0 to 100 ms Increase this setting if the speed fluctuation is large under vector control without speed sensor.	N	0	Y	Y	0	N	Y	N	N	
H149	1F31h	h	Machine Runaway Detection Speed Setting	0	0.0 to 20.0% 0.0: Disable 0.1 to 20.0% Assuming the maximum speed as 100%.	N	0.0	Y	Y	2	Y	Y	N	Y	
H160	1F3Ch	h	M1 Initial Magnetic Pole Position Detection Mode	3	0 to 3 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor) 1-3: -	N	0	Y	N	0	N	N	N	Y	
H161	1F3Dh	h	M1 Pull-in Current Command	1	10 to 200% 100%/Motor rated current	N	80	Y	N	0	N	N	N	Y	
H162	1F3Eh	h	M1 Pull-in Frequency	1	0.1 to 10.0 Hz	N	1.0	Y	N	2	N	N	N	Y	
H170	1F46h	h	M2 Initial Magnetic Pole Position Detection Mode	3	0 to 3 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor) 1-3: -	N	0	Y	N	0	N	N	N	Y	
H171	1F47h	h	M2 Pull-in Current Command	1	10 to 200% 100%/Motor rated current	N	80	Y	N	0	N	N	N	Y	
H172	1F48h	h	M2 Pull-in Frequency	1	0.1 to 10.0 Hz	N	1.0	Y	N	2	N	N	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H180	1F50h	h	M3 Initial Magnetic Pole Position Detection Mode	8	0 to 3 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor) 1-3: -	N	0	Y	N	0	N	N	N	Y	
H181	1F51h	h	M3 Pull-in Current Command	1	10 to 200% 100%/Motor rated current	N	80	Y	N	0	N	N	N	Y	
H182	1F52h	h	M3 Pull-in Frequency	1	0.1 to 10.0 Hz	N	1.0	Y	N	2	N	N	N	Y	
H201	2001h	h	Load Adaptive Control (Load adaptive control parameter switching) (Available soon)	13	0 or 1 0: Enable H51/H64/H65, Disable H202-H213 1: Disable H51/H64/H65, Enable H202-H213	N	0	Y	Y	0	Y	N	N	Y	
H202	2002h	h	(Load inertia for winding up 1) (Available soon)	1	0.001 to 50.000 kg•m^2 Applies to winding-up operation when ***AN-P2/1*** is OFF. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H203	2003h	h	(Safety coefficient for winding up 1) (Available soon)	1	0.50 to 1.20 Applies to winding-up operation when ***AN-P2/1*** is OFF.	N	1.00	Y	Y	3	Y	N	N	Y	
H204	2004h	h	(Mechanical efficiency for winding up 1) (Available soon)	1	0.500 to 1.000 Applies to winding-up operation when ***AN-P2/1*** is OFF.	N	0.500	Y	Y	4	Y	N	N	Y	
H205	2005h	h	(Load inertia for winding up 2) (Available soon)	1	0.001 to 50.000 kg•m^2 Applies to winding-up operation when ***AN-P2/1*** is ON. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H206	2006h	h	(Safety coefficient for winding up 2) (Available soon)	1	0.50 to 1.20 Applies to winding-up operation when ***AN-P2/1*** is ON.	N	1.00	Y	Y	3	Y	N	N	Y	
H207	2007h	h	(Mechanical efficiency for winding up 2) (Available soon)	1	0.500 to 1.000 Applies to winding-up operation when ***AN-P2/1*** is ON.	N	0.500	Y	Y	4	Y	N	N	Y	
H208	2008h	h	(Load inertia for winding down 1) (Available soon)	1	0.001 to 50.000 kg•m^2 Applies to winding-down operation when ***AN-P2/1*** is OFF. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H209	2009h	h	(Safety coefficient for winding down 1) (Available soon)	1	0.50 to 1.20 Applies to winding-down operation when ***AN-P2/1*** is OFF.	N	1.00	Y	Y	3	Y	N	N	Y	
H210	200Ah	h	(Mechanical efficiency for winding down 1) (Available soon)	1	0.500 to 1.000 Applies to winding-down operation when ***AN-P2/1*** is OFF.	N	0.500	Y	Y	4	Y	N	N	Y	
H211	200Bh	h	(Load inertia for winding down 2) (Available soon)	1	0.001 to 50.000 kg•m^2 Applies to winding-down operation when ***AN-P2/1*** is ON. The magnification is switchable by H228.	N	0.001	Y	Y	4	Y	N	N	Y	
H212	200Ch	h	(Safety coefficient for winding down 2) (Available soon)	1	0.50 to 1.20 Applies to winding-down operation when ***AN-P2/1*** is ON.	N	1.00	Y	Y	3	Y	N	N	Y	
H213	200Dh	h	(Mechanical efficiency for winding down 2) (Available soon)	1	0.500 to 1.000 Applies to winding-down operation when ***AN-P2/1*** is ON.	N	0.500	Y	Y	4	Y	N	N	Y	
H214	200Eh	h	(Multi-limit speed pattern function) (Available soon)	14	0 or 1 0: Enable H60, Disable H215-H224 1: Disable H60, Enable H215-H224	N	0	Y	Y	0	Y	N	N	Y	
H215	200Fh	h	(Multi-limit speed pattern at max. speed) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the maximum speed.	N	50.0	Y	Y	2	Y	N	N	Y	
H216	2010h	h	(Multi-limit speed pattern at rated speed) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed.	N	100.0	Y	Y	2	Y	N	N	Y	
H217	2011h	h	(Multi-limit speed pattern at rated speed x 1.1) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.1.	N	90.9	Y	Y	2	Y	N	N	Y	
H218	2012h	h	(Multi-limit speed pattern at rated speed x 1.2) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.2.	N	83.3	Y	Y	2	Y	N	N	Y	
H219	2013h	h	(Multi-limit speed pattern at rated speed x 1.4) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.4.	N	71.4	Y	Y	2	Y	N	N	Y	
H220	2014h	h	(Multi-limit speed pattern at rated speed x 1.6) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.6.	N	62.5	Y	Y	2	Y	N	N	Y	
H221	2015h	h	(Multi-limit speed pattern at rated speed x 1.8) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*1.8.	N	55.5	Y	Y	2	Y	N	N	Y	
H222	2016h	h	(Multi-limit speed pattern at rated speed x 2.0) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*2.0.	N	50.0	Y	Y	2	Y	N	N	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
H223	2017h	h	(Multi-limit speed pattern at rated speed x 2.5) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*2.5.	N	40.0	Y	Y	2	Y	N	N	Y	
H224	2018h	h	(Multi-limit speed pattern at rated speed x 3.0) (Available soon)	1	0.1 to 100.0% Specifies the torque level at the rated speed*3.0.	N	33.3	Y	Y	2	Y	N	N	Y	
H225	2019h	h	(Limit speed discrimination zone, Start speed) (Available soon)	1	0.1 to 100.0% Specifies the starting speed of the discrimination zone. The rated speed is assumed as 100%.	N	75.0	Y	Y	2	Y	N	N	Y	
H226	201Ah	h	(Limit speed discrimination zone, Completion speed) (Available soon)	1	0.1 to 100.0% Specifies the end speed of the discrimination zone. The rated speed is assumed as 100%.	N	93.7	Y	Y	2	Y	N	N	Y	
H227	201Bh	h	(Function definition 3) (Available soon)	1	0 to 2 0: Calculate the limit speed for winding-up and winding-down individually 1: Drive winding-down operation using the last limited speed result Enable the winding-down limit calculation under specific conditions 2: Drive winding-down operation using the last limited speed result Limit the winding-down speed with the rated speed under specific conditions	N	0	Y	Y	0	Y	N	N	Y	
H228	201Ch	h	Load Inertia Magnification Setting	0	0 to 2 0: 1 time (0.001 to 50.000 kg•m^2) 1: 10 times (0.01 to 500.00 kg•m^2) 2: 100 times (0.1 to 5000.0 kg•m^2) Switches the magnification of the load inertia (H51, H52, H202, H205, H208, H211).	N	630 kW or less: 0 710 kW, or more: 1	Y	Y	193	Y	N	N	Y	
H322	2116h		Notch Filter 1 (Resonance frequency)	6	10 to 2000 Hz	Y	1000	Y	Y	0	Y	Y	N	Y	
H323	2117h		(Attenuation level)	1	0 to 40 dB	Y	0	Y	Y	0	Y	Y	N	Y	
H324	2118h		(Frequency range)	1	0 to 3	Y	2	Y	Y	0	Y	Y	N	Y	
H325	2119h		Notch Filter 2 (Resonance frequency)	1	10 to 2000 Hz	Y	1000	Y	Y	0	Y	Y	N	Y	
H326	211Ah		(Attenuation level)	1	0 to 40 dB	Y	0	Y	Y	0	Y	Y	N	Y	
H327	211Bh		(Frequency range)	1	0 to 3	Y	2	Y	Y	0	Y	Y	N	Y	

■ A codes (Alternative Motor Parameter Functions M2/M3)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
A01	501h	h	M2 Drive Control	29	0 to 5 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor 2: - 3: Vector control for PMSM with speed sensor 4: - 5: V/f control for IM	N	0	Y	N	228	Y	Y	Y	Y	
A02	502h	h	M2 Rated Capacity	1	For inverters of 400 kW or below 0.00 to 500.00 kW when F60 = 0 0.00 to 600.00 HP when F60 = 1 For inverters of 500 kW or above 0.00 to 1200 kW when F60 = 0 0.00 to 1600 HP when F60 = 1 For multiwinding motors, set the motor capacity per wiring.	N	0.00	Y	N	3 13	Y	Y	Y	Y	
A03	503h	h	M2 Rated Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	N	0.01	Y	N	13	Y	Y	Y	Y	
A04	504h	h	M2 Rated Voltage	1	80 to 999 V	N	80	Y	N	0	Y	Y	Y	Y	
A05	505h	h	M2 Rated Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A06	506h	h	M2 Max. Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A07	507h	h	M2 Number of Poles	1	2 to 100 poles	N	4	Y	N	1	Y	Y	Y	Y	
A08	508h	h	M2 %R1	1	0.00 to 30.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A09	509h	h	M2 %X	1	0.00 to 200.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A10	50Ah	h	M2 Exciting Current/Magnetic Flux Weakening Current (-Id)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A11	50Bh	h	M2 Torque Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	N	Y	
A12	50Ch	h	M2 Slip Frequency (For driving)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A13	50Dh	h	(For braking)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A14	50Eh	h	M2 Iron Loss Factor 1	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A15	50Fh	h	M2 Iron Loss Factor 2	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A16	510h	h	M2 Iron Loss Factor 3	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A17	511h	h	M2 Magnetic Saturation Factor 1	1	0.0 to 100.0%	Y	93.8	Y	N	2	Y	Y	N	N	
A18	512h	h	M2 Magnetic Saturation Factor 2	1	0.0 to 100.0%	Y	87.5	Y	N	2	Y	Y	N	N	
A19	513h	h	M2 Magnetic Saturation Factor 3	1	0.0 to 100.0%	Y	75.0	Y	N	2	Y	Y	N	N	
A20	514h	h	M2 Magnetic Saturation Factor 4	1	0.0 to 100.0%	Y	62.5	Y	N	2	Y	Y	N	N	
A21	515h	h	M2 Magnetic Saturation Factor 5	1	0.0 to 100.0%	Y	50.0	Y	N	2	Y	Y	N	N	
A22	516h	h	M2 Secondary Time Constant	1	0.001 to 9.999 s	Y	0.001	Y	N	4	Y	Y	N	N	
A23	517h	h	M2 Induced Voltage Factor	1	0 to 999 V	Y	0	Y	N	0	Y	Y	N	Y	
A24	518h	h	M2 R2 Correction Factor 1	1	0.000 to 5.000	Y	1.000	Y	N	4	Y	Y	N	Y	
A25	519h	h	M2 R2 Correction Factor 2	1	0.000 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A26	51Ah	h	M2 R2 Correction Factor 3	1	0.010 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A27	51Bh	h	M2 Exciting Current Correction Factor	1	0.000 to 5.000	Y	0.000	Y	N	4	Y	Y	N	N	
A28	51Ch	h	M2 ACR (P-gain)	1	0.1 to 20.0	Y	1.0	Y	N	2	Y	Y	N	Y	
A29	51Dh	h	(I-time)	1	0.1 to 100.0 ms	Y	1.0	Y	N	2	Y	Y	N	Y	
A30	51Eh	h	M2 Pulse Resolution	0	100 to 60000	N	1024	Y	N	0	Y	N	N	Y	
A31	51Fh	h	M2 Thermistor Selection	0	0 to 3 0: No thermistor 1: NTC thermistor 2: PTC thermistor 3: Ai (***M-TMP***) The protection level of the motor protective functions should be specified by E30 to E32.	N	1	Y	N	84	Y	Y	Y	Y	
A32	520h	h	M2 Electronic Thermal Overload Protection (Select motor characteristics)	3	0 to 2 0: Disable (For a VG-dedicated motor) 1: Enable (For a general-purpose motor with shaft-driven cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan)	Y	0	Y	N	85	Y	Y	Y	Y	
A33	521h	h	(Detection level)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A34	522h	h	(Thermal time constant)	1	0.5 to 75.0 min	Y	0.5	Y	N	2	Y	Y	Y	Y	
A51	533h	h	M2 External PG Correction Factor	0	0000 to 4FFF	N	4000	Y	N	9	Y	N	N	N	

Function code	Communica-tions address 485 No.	Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	VC w/o PG	V/f	VC for PMSM	Remarks
A52	534h	h	M2 Online Auto-tuning	0	0 or 1 0: Disable 1: Enable	Y	0	Y	N	0	Y	Y	N	N	
A53	535h	h	M2 Maximum Output Voltage/ Maximum Voltage Limit	0	80 to 999 V	Y	80	Y	N	0	N	N	Y	Y	
A54	536h	h	M2 Slip Compensation	3	-20.000 to 5.000 Hz	Y	0.000	Y	N	8	N	N	Y	N	
A55	537h	h	M2 Torque Boost	1	0.0 to 20.0 Exclusive to V/f control. 0.0: Auto torque boost (for constant torque load) 0.1 to 0.9: For variable torque load 1.0 to 1.9: For proportional torque load 2.0 to 20.0: For constant torque load	Y	0.0	Y	N	2	N	N	Y	N	
A56	538h	h	M2 Output Current Fluctuation Damping Gain	1	0.00 to 1.00	Y	0.20	Y	N	3	N	N	Y	N	
A59	53Bh	h	M2 ABS Signal Input Definition	13	0 to 16 Specifies the operation interface to detect the magnetic pole position, in accordance with the encoder specifications. 0: 1 bit (Terminal; F0) Z-phase interface 1: 3 bits (Terminal: F0/F1/F2) U-,V-,W-phase interface 2: 4 bits (Terminal; F0/F1/F2/F3) Gray code interface 3-5: Reserved. 6: SPGT 17-bit serial interface 7-16: Reserved.	N	0	Y	N	0	N	N	N	Y	
A60	53Ch	h	M2 Magnetic Pole Position Offset	1	0.0 to 359.9 (0° to 359.9° CCW) Specifies the offset value for the PG reference position and the actual motor magnetic pole position.	Y	0.0	Y	N	2	N	N	N	Y	
A61	53Dh	h	M2 Salient Pole Ratio (%Xq/%Xd)	1	1.000 to 5.000 Specifies the saliency ratio of PMSM. Setting = Lq/Ld To drive a SPM motor, set 1.000.	N	1.000	Y	N	4	N	N	N	Y	
A62	53Eh	h	M2 q-axis Inductance Magnetic Saturation Coefficient	9	0.0 to 100.0%	Y	100.0	Y	N	2	N	N	N	Y	
A63	53Fh	h	M2 Magnetic Flux Limiting Value	1	50.0 to 150.0%	Y	*	Y	N	2	N	N	N	Y	
A64	540h	h	M2 Overcurrent Protection Level	1	0.00: Disable 0.01 to 99.99 A 100.0 to 999.9 A 1000 to 5000 A Specifies the allowable current value to prevent the permanent magnet of a PMSM from getting demagnetized. If the current exceeding this setting flows, an overcurrent alarm (OC) occurs.	N	*	Y	N	0	N	N	N	Y	
A65	541h	h	M2 Torque Correction Gain 1	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A66	542h	h	M2 Torque Correction Gain 2	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A67	543h	h	M2 Torque Correction Gain 3	1	-1000 to 1000	Y	0.000	Y	N	8	N	N	N	Y	
A68	544h	h	M2 Torque Correction Gain 4	1	-1000 to 1000	Y	0.000	Y	N	8	N	N	N	Y	
A69	545h	h	M2 Torque Correction Gain 5	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A70	546h	h	M2 Torque Correction Gain 6	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A71	546h	h	M2 Torque Correction Gain 7	1	-1000 to 1000	Y	0.000	Y	N	8	N	N	N	Y	
A101	2401h	h	M3 Drive Control	29	0 to 5 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor 2: - 3: Vector control for PMSM with speed sensor 4: - 5: V/f control for IM	N	5	Y	N	228	Y	Y	Y	Y	
A102	2402h	E5h	M3 Rated Capacity	1	For inverters of 400 kW or below 0.00 to 500.00 kW when F60 = 0 0.00 to 600.00 HP when F60 = 1 For inverters of 500 kW or above 0.00 to 1200 kW when F60 = 0 0.00 to 1600 HP when F60 = 1 For multiwinding motors, set the motor capacity per wiring.	N	0.00	Y	N	3 13	Y	Y	Y	Y	
A103	2403h	E6h	M3 Rated Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	N	0.01	Y	N	13	Y	Y	Y	Y	
A104	2404h	E7h	M3 Rated Voltage	1	80 to 999 V	N	80	Y	N	0	Y	Y	Y	Y	

*Depending upon the inverter's capacity.

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
A105	2405h	E9h	M3 Rated Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A106	2406h	EAh	M3 Max. Speed	1	50 to 30000 r/min	N	1500	Y	N	0	Y	Y	Y	Y	
A107	2407h	EBh	M3 Number of Poles	1	2 to 100 poles	N	4	Y	N	1	Y	Y	Y	Y	
A108	2408h	ECh	M3 %R1	1	0.00 to 30.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A109	2409h	EDh	M3 %X	1	0.00 to 200.00%	Y	0.00	Y	N	3	Y	Y	Y	Y	
A110	240Ah	EEh	M3 Exciting Current/Magnetic Flux Weakening Current (-Id)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A111	240Bh	h	M3 Torque Current	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	N	Y	
A112	240Ch	h	M3 Slip Frequency (For driving)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A113	240Dh	h	(For braking)	1	0.001 to 10.000 Hz	Y	0.001	Y	N	4	Y	Y	N	N	
A114	240Eh	h	M3 Iron Loss Factor 1	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	N	
A115	240Fh	h	M3 Iron Loss Factor 2	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A116	2410h	h	M3 Iron Loss Factor 3	1	0.00 to 10.00%	Y	0.00	Y	N	3	Y	Y	N	Y	
A117	2411h	h	M3 Magnetic Saturation Factor 1	1	0.0 to 100.0%	Y	93.8	Y	N	2	Y	Y	N	N	
A118	2412h	h	M3 Magnetic Saturation Factor 2	1	0.0 to 100.0%	Y	87.5	Y	N	2	Y	Y	N	N	
A119	2413h	h	M3 Magnetic Saturation Factor 3	1	0.0 to 100.0%	Y	75.0	Y	N	2	Y	Y	N	N	
A120	2414h	h	M3 Magnetic Saturation Factor 4	1	0.0 to 100.0%	Y	62.5	Y	N	2	Y	Y	N	N	
A121	2415h	h	M3 Magnetic Saturation Factor 5	1	0.0 to 100.0%	Y	50.0	Y	N	2	Y	Y	N	N	
A122	2416h	h	M3 Secondary Time constant	1	0.001 to 9.999 s	Y	0.001	Y	N	4	Y	Y	N	N	
A123	2417h	h	M3 Induced Voltage Factor	1	0 to 999 V	Y	0	Y	N	0	Y	Y	N	Y	
A124	2418h	h	M3 R2 Correction Factor 1	1	0.500 to 5.000	Y	1.000	Y	N	4	Y	Y	N	Y	
A125	2419h	h	M3 R2 Correction Factor 2	1	0.500 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A126	241Ah	h	M3 R2 Correction Factor 3	1	0.010 to 5.000	Y	1.000	Y	N	4	Y	Y	N	N	
A127	241Bh	h	M3 Exciting Current Correction Factor	1	0.000 to 5.000	Y	0.000	Y	N	4	Y	Y	N	N	
A128	241Ch	h	M3 ACR P Gain	1	0.1 to 20.0	Y	1.0	Y	N	2	Y	Y	N	Y	
A129	241Dh	h	M3 ACR I time Constant	1	0.1 to 100.0 ms	Y	1.0	Y	N	2	Y	Y	N	Y	
A130	241Eh	h	M3 Pulse Resolution	0	100 to 60000	N	1024	Y	N	0	Y	N	N	Y	
A131	241Fh	F1h	M3 Thermistor Selection	0	0 to 3 0: No thermistor 1: NTC thermistor 2: PTC thermistor 3: Ai (***M-TMP***) The protection level of the motor protective functions should be specified by E30 to E32.	N	1	Y	N	84	Y	Y	Y	Y	
A132	2420h	F2h	M3 Electronic Thermal Overload Protection (Select motor characteristics)	3	0 to 2 0: Disable (For a VG-dedicated motor) 1: Enable (For a general-purpose motor with shaft-driven cooling fan) 2: Enable (For an inverter-driven motor with separately powered cooling fan) Using an NTC thermistor of a VG-dedicated motor activates the motor overheat protection. If it happens, disable the electronic thermal overload protection.	Y	0	Y	N	85	Y	Y	Y	Y	
A133	2421h	F3h	(Detection level)	1	0.01 to 99.99 A 100.0 to 999.9 A 1000 to 2000 A	Y	0.01	Y	N	13	Y	Y	Y	Y	
A134	2422h	F4h	(Thermal time constant)	1	0.5 to 75.0 min	Y	0.5	Y	N	2	Y	Y	Y	Y	
A151	2433h	h	M2 External PG Correction Coefficient	0	0000 to 4FFF	N	4000	Y	N	9	Y	N	N	N	
A152	2434h	h	M3 Online Auto-tuning	0	0 to 1 0: Disable 1: Enable	Y	0	Y	N	68	Y	Y	N	N	
A153	2435h	E8h	M3 Maximum Output Voltage (at V/f maximum speed)	0	80 to 999 V	Y	80	Y	N	0	N	N	Y	Y	
A154	2436h	EFh	M3 Slip Compensation	3	-20.000 to 5.000 Hz	Y	0.000	Y	N	8	N	N	Y	N	
A155	2437h	F0h	M3 Torque Boost	1	0.0 to 20.0 Exclusive to V/f control. 0.0: Auto torque boost (for constant torque load) 0.1 to 0.9: For variable torque load 1.0 to 1.9: For proportional torque load 2.0 to 20.0: For constant torque load	Y	0.0	Y	N	2	N	N	Y	N	
A156	2438h	h	M3 Output Current Fluctuation Damping Gain	1	0.00 to 1.00	Y	0.20	Y	N	3	N	N	Y	N	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
A159	243Bh	h	M3 ABS Signal Input Definition	13	0 to 16 Specifies the operation interface to detect the magnetic pole position, in accordance with the encoder specifications. 0: 1 bit (Terminal; F0) Z-phase interface 1: 3 bits (Terminal: F0/F1/F2) U-,V-,W-phase interface 2: 4 bits (Terminal; F0/F1/F2/F3) Gray code interface 3-5: Reserved. 6: SPGT 17-bit serial interface 7-16: Reserved.	N	0	Y	N	0	N	N	N	Y	
A160	243Ch	h	M3 Magnetic Pole Position Offset	1	0.0 to 359.9 (0° to 359.9° CCW) Specifies the offset value for the PG reference position and the actual motor magnetic pole position.	Y	0.0	Y	N	2	N	N	N	Y	
A161	243Dh	h	M3 Salient Pole Ratio (%Xq/%Xd)	1	1.000 to 5.000 Specifies the saliency ratio of PMSM. Setting = Lq/Ld To drive a SPM motor, set 1.000.	N	1.000	Y	N	4	N	N	N	Y	
A162	243Ch	h	M3 q-axis Inductance Magnetic Saturation Coefficient	1	0.0 to 100.0%	Y	1.000	Y	N	2	N	N	N	Y	
A163	243Dh	h	M3 Magnetic Flux Limiting Value	1	50.0 to 150.0%	Y	1.000	Y	N	2	N	N	N	Y	
A164	2440h	h	M3 Overcurrent Protection Level	1	0.00: Disable 0.01 to 99.99 A 100.0 to 999.9 A 1000 to 5000 A Specifies the allowable current value to prevent the permanent magnet of a PMSM from getting demagnetized. If the current exceeding this setting flows, an overcurrent alarm (OC) occurs.	N	0.00	Y	N	0	N	N	N	Y	
A165	2441h	h	M3 Torque Correction Gain 1	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A166	2442h	h	M3 Torque Correction Gain 2	1	0.00 to 10.00	Y	1.00	Y	N	3	N	N	N	Y	
A167	2443h	h	M3 Torque Correction Gain 3	1	-1.000 to 1.000	Y	0.000	Y	N	8	N	N	N	Y	
A168	2444h	h	M3 Torque Correction Gain 4	1	-1.000 to 1.000	Y	0.000	Y	N	8	N	N	N	Y	
A169	2445h	h	M3 Torque Correction Gain 5	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A170	2446h	h	M3 Torque Correction Gain 6	1	-50.0 to 50.0	Y	0.00	Y	N	7	N	N	N	Y	
A171	2447h	h	M3 Torque Correction Gain 7	1	-1.000 to 1.000	Y	0.000	Y	N	8	N	N	N	Y	

■ o codes (Option Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
o01	601h	F5h	DIA Function Selection	4	0 or 1 0 : Binary 1 : BCD	N	0	Y	Y	86	Y	Y	Y	Y	
o02	602h	F6h	DIB Function Selection	1	0 or 1 0 : Binary 1 : BCD	N	0	Y	Y	86	Y	Y	Y	Y	
o03	603h	h	DIA BCD Input Speed Setting	1	99 to 7999	N	1000	Y	Y	0	Y	Y	Y	Y	
o04	604h	h	DIB BCD Input Speed Setting	1	99 to 7999	N	1000	Y	Y	0	Y	Y	Y	Y	
o05	605h	h	PG (PD) Option Setting (Feedback pulse)	0	0 to 1 0: Build-in PG 1: PG(PD) option	N	0	Y	Y	96	Y	N	N	Y	
o06	606h	h	(Digital line speed detection definition, PG pulses)	3	100 to 60000 P/R	Y	1024	Y	Y	0	Y	Y	Y	Y	
o07	607h	h	(Digital line speed detection definition, Detection pulse correction 1)	1	1 to 9999	Y	1000	Y	Y	0	Y	Y	Y	Y	
o08	608h	h	(Digital line speed detection definition, Detection pulse correction 2)	1	1 to 9999	Y	1000	Y	Y	0	Y	Y	Y	Y	
o09	609h	h	M1 Absolute Signal Input Definition	3	0 to 16 Specifies the operation interface to detect the magnetic pole position, in accordance with the encoder specifications. 0: 1 bit (Terminal; F0) Z-phase interface 1: 3 bits (Terminal: F0/F1/F2) U-,V-,W-phase interface 2: 4 bits (Terminal; F0/F1/F2/F3) Gray code interface 3-5: Reserved. 6: SPGT 17-bit serial interface 7-16: Reserved.	N	0	Y	N	0	N	N	N	Y	
o10	60Ah	h	M1 Magnetic Pole Position Offset	1	0.0 to 359.9 (0° to 359.9° CCW) Specifies the offset value for the PG reference position and the actual motor magnetic pole position.	Y	0.0	Y	N	2	N	N	N	Y	
o11	60Bh	h	M1 Salient Pole Rate (%Xq/%Xd)	1	1.000 to 5.000 Specifies the saliency ratio of PMSM. Setting = Lq/Ld To drive an SPM motor, set 1.000.	N	1.000	Y	N	4	N	N	N	Y	
o12	60Ch	h	Command Pulse Selection	8	0 or 1 0: PG(PD) option 1: Internal speed command	N	0	Y	Y	97	Y	N	N	Y	
o13	60Dh	h	Pulse Train Input Form	1	0 to 2 0: Phase difference 90° between A-phase and B-phase 1: A-phase : Reference pulse, B-phase :Reference sign 2: A-phase : Forward pulse, B-phase : Reverse pulse	N	0	Y	Y	98	Y	N	N	Y	
o14	60Eh	F7h	Command Pulse Correction 1	1	1 to 9999	Y	1000	Y	Y	0	Y	N	N	Y	
o15	60Fh	F8h	Command Pulse Correction 2	1	1 to 9999	Y	1000	Y	Y	0	Y	N	N	Y	
o16	610h	F9h	APR Gain 1	1	0.1 to 999.9 times	Y	1.0	Y	Y	2	Y	N	N	Y	
o17	611h	FAh	Feedforward Gain 1	1	0.0 to 1.5 times	Y	0.0	Y	Y	2	Y	N	N	Y	
o18	612h	h	Overdeviation Width	1	0 to 65535 pulses	Y	65535	Y	Y	0	Y	N	N	Y	
o19	613h	h	Zero Deviation Width	1	0 to 1000 pulses	Y	20	Y	Y	0	Y	N	N	Y	
o20	614h	h	APR Gain 2 (Available soon)	1	0.1 to 999.9 times	Y	1.0	Y	Y	2	Y	N	N	Y	
o21	615h	h	F/F Gain 2 (Available soon)	1	0.0 to 1.5 times	Y	0.0	Y	Y	2	Y	N	N	Y	
o22	616h	h	Position Control Gain Switching (Available soon)	3	0 to 3 0: Disable 1: Positional deviation (x 10) 2: Detected speed (10000/Maximum speed) 3: Speed command (10000/Maximum speed) Select a trigger to switch between the 1st and 2nd gains of the position control system. Switching gains can reduce noise or vibration when the inverter is stopped.	Y	0	Y	Y	229	Y	N	N	Y	
o23	617h	h	Position Control Gain Switching Level (Available soon)	1	0 to 10000	Y	0	Y	Y	0	Y	N	N	Y	
o24	618h	h	Position Control Gain Switching Time (Available soon)	1	0 to 1000 ms	Y	0	Y	Y	0	Y	N	N	Y	
o30	61Eh	h	(Communications error processing)	3	0 to 3 0: Immediately trip with alarm Er-4 1: Trip with alarm Er-4 after running for the period specified by timer o31 2: Trip with alarm (Er-4) if the communication error remains exceeding the period specified by timer o31. 3: Continue to run Specifies the error processing to be performed if a communications link error occurs. For CC-Link, when o30 = 0 to 3, the inverter produces different operation.	N	0	Y	Y	73	Y	Y	Y	Y	

Function code	Communica-tions address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
o31	61Fh	h	(Timer)	1	0.01 to 20.00 s Specifies the duration from an occurrence of communications problem on the link until the inverter cause a communications error.	N	0.10	Y	Y	3	Y	Y	Y	Y	
o32	620h	h	(Link format selection)	1	0 to 4 0: Link format 1 1: Link format 2 2: Link format 3 3: Link format 4 4: Link format 5	N	0	Y	N	87	Y	Y	Y	Y	
o33 ***1**	621h	FDh	Multiplex System (Control mode)	2	0 to 2 0: Disable 1: Multiwinding motor control system 2: Multiplex system 1 (Direct parallel connection) Selects whether or not to use a high-speed serial communications terminal block as a component of the multiwinding system or multiplex system. Refer to ***MT-CCL*** (Cancel multiplex system) in the description of E01 to E13 (Terminal X Function).	N	0	Y	Y	232	Y	N	N	N	
o34	622h	h	(No. of slave stations)	1	1 to 5 Specifies the numbers of slave units except a master unit when the multiplex system is enabled.	N	1	Y	Y	0	Y	N	N	N	
o38 ***1**	626h	h	UPAC Start/Stop	3	0: Stop UPAC 1: Start UPAC 2: Start UPAC (Initial start-up) Starts or stops the UPAC option.	N	0	Y	Y	68	Y	Y	Y	Y	
o39 ***1**	627h	h	UPAC Memory Mode	1	00 to 1F Setting "0" or "1" to one of bits 1 to 5 holds or zero-clears the corresponding memory area when the UPAC option is stopped for change, respectively. Bit 1: IQ area Bit 2: M area Bit 3: RM area Bit 4: FM area Bit 5: SFM area o39 defines whether to hold or zero-clear the designated memory area when the UPAC option is switched from start to stop or it is stopped.	N	00	Y	Y	9	Y	Y	Y	Y	
o40 ***1**	628h	h	UPAC Address	1	100 to 255 Specifies the UPAC station address required for access from a computer to the UPAC option in RS-485 communication.	N	100	Y	N	0	Y	Y	Y	Y	
o50	632h	h	Station Address Assignment for Multiplex System	0	0 to 5 0: Master 1-5: Slave 1 to 5	N	0	N	Y	0	Y	N	N	N	
o101	2501h	h	Reflection of Arbitrary Assignment ***2**	0	0 or 1 After data writing, o101 data automatically reverts to "0."	N	0	N	N	11	Y	Y	Y	Y	
o122	2516h	h	Write Function Code Assignment 1	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o123	2517h	h	Write Function Code Assignment 2	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o124	2518h	h	Write Function Code Assignment 3	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	

*1 Available in the ROM version H1/2 0020 or later.

*2 Availble in the ROM version H1/2 02□□, which supports PROFINET-IRT.

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
o125	2519h	h	Write Function Code Assignment 4	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o126	251Ah	h	Write Function Code Assignment 5	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o127	251Bh	h	Write Function Code Assignment 6	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o128	251Ch	h	Write Function Code Assignment 7	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o129	251Dh	h	Write Function Code Assignment 8	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o130	251Eh	h	Write Function Code Assignment 9	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o131	251Fh	h	Write Function Code Assignment 10	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o132	2520h	h	Write Function Code Assignment 11	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o133	2521h	h	Write Function Code Assignment 12	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o160	253Ch	h	Read Function Code Assignment 1	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o161	253Dh	h	Read Function Code Assignment 2	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o162	253Eh	h	Read Function Code Assignment 3 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o163	253Fh	h	Read Function Code Assignment 4 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o164	2540h	h	Read Function Code Assignment 5 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o165	2541H	h	Read Function Code Assignment 6 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o166	2542h	h	Read Function Code Assignment 7 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o167	2543h	h	Read Function Code Assignment 8 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o168	2544h	h	Read Function Code Assignment 9 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o169	2545h	h	Read Function Code Assignment 10 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o170	2546h	h	Read Function Code Assignment 11 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	
o171	2547h	h	Read Function Code Assignment 12 (*1)	0	0000 to FFFF	Y	0000	Y	Y	9	Y	Y	Y	Y	

*1 Availble in the ROM version H1/2 02□□, which supports PROFINET-IRT.

■ L codes (Lift Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
L01	901h	h	Password Data 1	0	0 to 9999 A maximum of 8-digit password can be specified with L01 and L02 to restrict access to function code data or check it. Setting either one of L01 and L02 at any numeral except "0" enables password protection.	Y	0	N	N	0	Y	Y	N	Y	
L02	902h	h	Password Data 2	0	0 to 9999	Y	0	N	N	0	Y	Y	N	Y	
L03	903h	h	Lift Rated Speed	0	0.0 to 999.9 m/min	Y	100.0	Y	Y	2	Y	Y	N	Y	
L04	904h	h	Preset S-curve Pattern	11	0 to 2 0: Disable Normal accel/decel, S-curve (15 steps, S-curve 5) 1: Method 1 For VG3/VG5, accel/decel can be controlled via terminal [12] with ***SS1***, ***SS2***, and ***SS4*** all OFF. 2: Method 2 For VG7, zero speed is selected with ***SS1***, ***SS2***. Select S-curve pattern and application of multistep speed.	Y	0	Y	Y	80	Y	Y	N	Y	
L05	905h	h	S-curve Pattern 1	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L06	906h	h	S-curve Pattern 2	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L07	907h	h	S-curve Pattern 3	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L08	908h	h	S-curve Pattern 4	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L09	909h	h	S-curve Pattern 5	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L10	90Ah	h	S-curve Pattern 6	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L11	90Bh	h	S-curve Pattern 7	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L12	90Ch	h	S-curve Pattern 8	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L13	90Dh	h	S-curve Pattern 9	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	
L14	90Eh	h	S-curve Pattern 10	1	0 to 50%	Y	0	Y	Y	0	Y	Y	N	Y	

■ U codes (User Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
U01	B01h	DBh	USER P1	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U02	B02h	DCh	USER P2	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U03	B03h	DDh	USER P3	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U04	B04h	DEh	USER P4	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U05	B05h	DFh	USER P5	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U06	B06h	E0h	USER P6	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U07	B07h	E1h	USER P7	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U08	B08h	E2h	USER P8	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U09	B09h	E3h	USER P9	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U10	B0Ah	E4h	USER P10	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U11	B0Bh	h	USER P11 SX bus / E-SX Bus Communications Format	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U12	B0Ch	h	USER P12	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U13	B0Dh	h	USER P13 SX Bus Station Number Monitor	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U14	B0Eh	h	USER P14	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U15	B0Fh	h	USER P15	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U16	B10h	h	USER P16	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U17	B11h	h	USER P17	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U18	B12h	h	USER P18	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U19	B13h	h	USER P19	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U20	B14h	h	USER P20	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U21	B15h	h	USER P21	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U22	B16h	h	USER P22	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U23	B17h	h	USER P23	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U24	B18h	h	USER P24	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U25	B19h	h	USER P25	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U26	B1Ah	h	USER P26	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U27	B1Bh	h	USER P27	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U28	B1Ch	h	USER P28	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U29	B1Dh	h	USER P29	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U30	B1Eh	h	USER P30	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U31	B1Fh	h	USER P31	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U32	B20h	h	USER P32	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U33	B21h	h	USER P33	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U34	B22h	h	USER P34	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U35	B23h	h	USER P35	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U36	B24h	h	USER P36	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U37	B25h	h	USER P37	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U38	B26h	h	USER P38	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U39	B27h	h	USER P39	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U40	B28h	h	USER P40	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U41	B29h	h	USER P41	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U42	B2Ah	h	USER P42	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U43	B2Bh	h	USER P43	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U44	B2Ch	h	USER P44	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U45	B2Dh	h	USER P45	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U46	B2Eh	h	USER P46	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U47	B2Fh	h	USER P47	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U48	B30h	h	USER P48	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U49	B31h	h	USER P49	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U50	B32h	h	USER P50	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U51	B33h	h	USER P51	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U52	B34h	h	USER P52	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U53	B35h	h	USER P53	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U54	B36h	h	USER P54	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U55	B37h	h	USER P55	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U56	B38h	h	USER P56	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U57	B39h	h	USER P57	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U58	B3Ah	h	USER P58	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U59	B3Bh	h	USER P59	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U60	B3Ch	h	USER P60	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U61	B3Dh	4Bh	USER P61/U-Ai1	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U62	B3Eh	4Ch	USER P62/U-Ai2	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U63	B3Fh	4Dh	USER P63/U-Ai3	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U64	B40h	4Eh	USER P64/U-Ai4	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
U101	2701h	h	USER P101	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U102	2702h	h	USER P102	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U103	2703h	h	USER P103	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U104	2704h	h	USER P104	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U105	2705h	h	USER P105	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U106	2706h	h	USER P106	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U107	2707h	h	USER P107	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U108	2708h	h	USER P108	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U109	2709h	h	USER P109	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U110	270Ah	h	USER P110	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U111	270Bh	h	USER P111	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U112	270Ch	h	USER P112	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U113	270Dh	h	USER P113	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U114	270Eh	h	USER P114	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U115	270Fh	h	USER P115	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U116	2710h	h	USER P116	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U117	2711h	h	USER P117	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U118	2712h	h	USER P118	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U119	2713h	h	USER P119	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U120	2714h	h	USER P120	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U121	2715h	h	USER P121	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U122	2716h	h	USER P122	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U123	2717h	h	USER P123	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U124	2718h	h	USER P124	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U125	2719h	h	USER P125	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U126	271Ah	h	USER P126	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U127	271Bh	h	USER P127	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U128	271Ch	h	USER P128	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U129	271Dh	h	USER P129	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U130	271Eh	h	USER P130	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U131	271Fh	h	USER P131	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U132	2720h	h	USER P132	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U133	2721h	h	USER P133	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U134	2722h	h	USER P134	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U135	2723h	h	USER P135	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U136	2724h	h	USER P136	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U137	2725h	h	USER P137	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U138	2726h	h	USER P138	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U139	2727h	h	USER P139	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U140	2728h	h	USER P140	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U141	2729h	h	USER P141	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U142	272Ah	h	USER P142	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U143	272Bh	h	USER P143	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U144	272Ch	h	USER P144	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U145	272Dh	h	USER P145	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U146	272Eh	h	USER P146	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U147	272Fh	h	USER P147	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U148	2730h	h	USER P148	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U149	2731h	h	USER P149	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	
U150	2732h	h	USER P150	0	-32768 to 32767	Y	0	Y	Y	5	Y	Y	Y	Y	

■ SF codes (Safety Functions)

Function code	Communica-tions address 485 No.	Communica-tions address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
SF00	2800h	h	Password state monitor	0	0 or 1 0: Locked 1: Unlocked	N	0	N	N	0	Y	Y	Y	Y	
SF01	2801h	h	SS1 Level	0	30 to 30000 r/m	N	150	N	N	0	Y	Y	Y	Y	
SF02	2802h	h	SS1 Timer	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	N	10.00	N	N	13	Y	Y	Y	Y	
SF03	2803h	h	SS1/SLS Deceleration Time	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	N	5.00	N	N	13	Y	Y	Y	Y	
SF04	2804h	h	SLS Level	0	30 to 30000 r/m	N	300	N	N	0	Y	Y	Y	Y	
SF05	2805h	h	SLS Timer	0	0.01 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	N	10.00	N	N	13	Y	Y	Y	Y	
SF06	2806h	h	SS1/SLS Upper Limit	0	0 to 30000 r/m	N	300	N	N	0	Y	Y	Y	Y	
SF07	2807h	h	Motor Maximum Speed	0	50 to 30000 r/m	N	1500	N	N	0	Y	Y	Y	Y	
SF08	2808h	h	Upper Limit Monitor Wait Time	0	0.00 to 99.99 s 100.0 to 999.9 s 1000 to 3600 s	N	0.00	N	N	13	Y	Y	Y	Y	
SF09	2809h	h	PG Failure Detection Function	0	0 or 1 0: Disable 1: Enable	N	1	N	N	68	Y	Y	Y	Y	
SF10	280Ah	h	PG Pulse Resolution	0	300 to 60000	N	1024	N	N	0	Y	Y	Y	Y	
SF11	280Bh	h	Speed Detection Filter	0	0.000 to 0.100 s	N	0.010	N	N	4	Y	Y	Y	Y	
SF12	280Ch	h	STO Diagnostic Forecast Time	0	0.0 to 1.0 s	N	0.0	N	N	2	Y	Y	Y	Y	
SF20	2814h	h	Terminal [SL1]/[SL2] Function	0	0 to 2 0: No function 1: SS1 function 2: SLS function	N	0	N	N	219	Y	Y	Y	Y	
SF21	2815h	h	SS1 Stop Mode	0	0 or 1 0: Speed monitor 1: Time monitor	N	1	N	N	220	Y	Y	Y	Y	
SF22	2816h	h	Encoder Selection	0	0 to 2 0: Unrecommended PG or no PG 1: Recommended 15V encoder 2: Recommended 12V encoder	N	0	N	N	221	Y	Y	Y	Y	
SF23	2817h	h	Fault Reaction Selection	0	0 or 1 0: STO (SBC if enabled) 1: SS1	N	0	N	N	222	Y	Y	Y	Y	
SF24	2818h	h	SBC Function Selection	0	0 to 2 0: Disable 1: Enable, Via safety relay 2: Enable, Brake direct connection	N	0	N	N	224	Y	Y	Y	Y	
SF25	2819h	h	SS1 Error Processing	0	0 to 1 0: Select fault reaction 1: Select light alarm	N	0	N	N	227	Y	Y	Y	Y	
SF26	281Ah	h	SLS Deceleration Error Processing	0	0 to 1 0: Select fault reaction 1: Select light alarm	N	0	N	N	223	Y	Y	Y	Y	
SF27	281Bh	h	SLS Upper Limit Error Processing	0	0 to 1 0: Select fault reaction 1: Select light alarm	N	0	N	N	223	Y	Y	Y	Y	
SF28	281Ch	h	Save All of Safety-related Function Codes	0	0 or 1 0: No save 1: Save all (Automatically reverts to "0")	N	-	N	N	0	Y	Y	Y	Y	
SF30	281Eh	h	Safety-related Password Authentication 1	0	0000 to FFFF	N	0000	N	N	9	Y	Y	Y	Y	
SF31	281Fh	h	Safety-related Password Authentication 2	0	0000 to FFFF	N	0000	N	N	9	Y	Y	Y	Y	

*1 The SF00 through SF31 function codes are available in the ROM version H1/2 0020 or later.

■ S codes (Serial Communication Functions)

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
S01	701h	1h	Reference Frequency/Speed 1	7	-20000 to 20000 : (data)*Nmax/20000 r/min	Y	-	N	N	5	Y	Y	Y	Y	
S02	702h	2h	Torque Command	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S03	703h	3h	Torque Current Command	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S04	704h	4h	Magnetic-flux Command	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	N	N	N	
S05	705h	5h	Orientation Position Command	1	0000 to FFFF	Y	-	N	N	9	Y	N	N	Y	
S06	706h	6h	Run Command 1	1	0000 to FFFF	Y	-	N	N	32	Y	Y	Y	Y	
S07	707h	7h	Universal Do	1	0000 to FFFF	Y	-	N	N	33	Y	Y	Y	Y	
S08	708h	8h	Acceleration Time	2	0.0 to 3600.0 s	Y	-	N	N	2	Y	Y	Y	Y	
S09	709h	9h	Deceleration Time	1	0.0 to 3600.0 s	Y	-	N	N	2	Y	Y	Y	Y	
S10	70Ah	Ah	Torque Limiter Level 1	2	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S11	70Bh	Bh	Torque Limiter Level 2	1	-327.68 to 327.67% : 0.01%/1d	Y	-	N	N	7	Y	Y	N	Y	
S12	70Ch	Ch	Run Command 2	0	0000 to FFFF	Y	-	N	N	9	Y	Y	Y	Y	
S13	70Dh	h	Universal Ao	0	-16384 to 16384 (-10V to +10V)	Y	-	N	N	5	Y	Y	Y	Y	
S16	710h	h	General-purpose Setting 1 (Available soon)	2	-32768 to 32767 Assign functions using E90.	Y	-	N	N	5	Y	Y	Y	Y	
S17	711h	h	General-purpose Setting 2 (Available soon)	1	-32768 to 32767 Assign functions using E91.	Y	-	N	N	5	Y	Y	Y	Y	

■ M codes (Monitoring Functions)

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
M01	801h	Fh	Reference Speed 4 (ASR input)	15	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M02	802h	10h	Torque Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M03	803h	11h	Torque Current Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M04	804h	12h	Magnetic-flux Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	N	
M05	805h	13h	Output Frequency Command	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M06	806h	14h	Detected Speed	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M07	807h	15h	Calculated Torque	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M08	808h	16h	Calculated Torque Current	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M09	809h	17h	Output Frequency	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M10	80Ah	18h	Motor Output	1	0.1 kW/1d	N	-	N	N	2	Y	Y	Y	Y	
M11	80Bh	19h	Effective Output Current	1	0.1 A/1d	N	-	N	N	2	Y	Y	Y	Y	
M12	80Ch	1Ah	Effective Output Voltage	1	0.1 V/1d	N	-	N	N	2	Y	Y	Y	Y	
M13	80Dh	1Bh	Final Run Command	1	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M14	80Eh	1Ch	Running Status	1	0000 to FFFF	N	-	N	N	21	Y	Y	Y	Y	
M15	80Fh	1Dh	Output Terminals Y1-Y18	1	0000 to FFFF	N	-	N	N	33	Y	Y	Y	Y	
M16	810h	1Eh	Latest Alarm Data (Multiple alarm, Trip cause)	4	0000 to 5540	N	-	N	N	14	Y	Y	Y	Y	
M17	811h	1Fh	Latest Alarm History	1	0000 to FF40	N	-	N	N	15	Y	Y	Y	Y	
M18	812h	20h	1st Last Alarm History	1	0000 to FF40	N	-	N	N	15	Y	Y	Y	Y	
M19	813h	21h	2nd Last Alarm History	1	0000 to FF40	N	-	N	N	15	Y	Y	Y	Y	
M20	814h	22h	Cumulative Run Time	7	0 to 65535 h	N	-	N	N	0	Y	Y	Y	Y	
M21	815h	23h	DC Link Bus Voltage	1	1 V/1d	N	-	N	N	0	Y	Y	Y	Y	
M22	816h	24h	Motor Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M23	817h	25h	Model Code	1	0000 to FFFF 200V class series : 1313h 400V class series : 1314h	N	-	N	N	29	Y	Y	Y	Y	
M24	818h	26h	Capacity Code	1	0 to 34	N	-	N	N	28	Y	Y	Y	Y	
M25	819h	27h	Inverter ROM (Main Control) Version	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M26	81Ah	28h	Communications Error Code	1	0000 to FFFF	N	-	N	N	34	Y	Y	Y	Y	
M27	81Bh	29h	Alarm (Latest) Speed Command	19	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M28	81Ch	2Ah	Alarm (Latest) Torque Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M29	81Dh	2Bh	Alarm (Latest) Torque Current Command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	Y	
M30	81Eh	2Ch	Alarm (Latest) Magnetic-flux command	1	0.01%/1d	N	-	N	N	7	Y	Y	N	N	
M31	81Fh	2Dh	Alarm (Latest) Output Frequency Command	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M32	820h	2Eh	Alarm (Latest) Detected Speed	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M33	821h	2Fh	Alarm (Latest) Calculated Torque	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M34	822h	30h	Alarm (Latest) Calculated Torque Current	1	0.01%/1d	N	-	N	N	7	Y	Y	Y	Y	
M35	823h	31h	Alarm (Latest) Output Frequency	1	0.1 Hz/1d	N	-	N	N	2	Y	Y	Y	Y	
M36	824h	32h	Alarm (Latest) Motor Output	1	0.1 kW/1d	N	-	N	N	2	Y	Y	Y	Y	
M37	825h	33h	Alarm (Latest) Effective Output Current	1	0.1 A/1d	N	-	N	N	2	Y	Y	Y	Y	
M38	826h	34h	Alarm (Latest) Effective Output Voltage	1	0.1 V/1d	N	-	N	N	2	Y	Y	Y	Y	
M39	827h	35h	Alarm (Latest) Run Command	1	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M40	828h	36h	Alarm (Latest) Running Status	1	0000 to FFFF	N	-	N	N	21	Y	Y	Y	Y	
M41	829h	37h	Alarm (Latest) Output Signal	1	0000 to FFFF	N	-	N	N	33	Y	Y	Y	Y	
M42	82Ah	38h	Alarm (Latest) Cumulative Run Time	1	0 to 65535 h	N	-	N	N	0	Y	Y	Y	Y	
M43	82Bh	39h	Alarm (Latest) DC Link Bus Voltage	1	1 V/1d	N	-	N	N	0	Y	Y	Y	Y	
M44	82Ch	3Ah	Alarm (Latest) Inverter Internal Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M45	82Dh	3Bh	Alarm (Latest) Heat Sink Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M46	82Eh	3Ch	Capacity of Main Circuit Capacitor	3	0 to 100%	N	-	N	N	0	Y	Y	Y	Y	
M47	82Fh	3Dh	Service Life of Electrolytic Capacitor on PCB	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M48	830h	3Eh	Cooling Fan Service Life	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	

Function code	Communications address		Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control				Remarks
	485 No.	Link No.									VC w/ PG	VC w/o PG	V/f	VC for PMSM	
M49	831h	3Fh	Reference Speed 1 (before multistep speed command)	3	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M50	832h	40h	Reference Speed 2 (before calculation of acceleration/deceleration)	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M51	833h	41h	Reference Speed 3 (after speed limiting)	1	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M52	834h	42h	Control Output 1	3	0000 to FFFF	N	-	N	N	125	Y	Y	Y	Y	
M53	835h	43h	Control Output 2	1	0000 to FFFF	N	-	N	N	126	Y	Y	Y	Y	
M54	836h	44h	Control Output 3	1	0000 to FFFF	N	-	N	N	127	Y	Y	Y	Y	
M55	837h	45h	Option Monitor 1	6	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M56	838h	46h	Option Monitor 2	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M57	839h	47h	Option Monitor 3	1	0 to 65535	N	-	N	N	0	Y	Y	Y	Y	
M58	83Ah	48h	Option Monitor 4	1	0 to 65535	N	-	N	N	0	Y	Y	Y	Y	
M59	83Bh	49h	Option Monitor 5	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M60	83Ch	4Ah	Option Monitor 6	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M61	83Dh	h	Current Date, Year/Month	3	0000 to FFFF Upper 2 digits: Year, Lower 2 digits: Month	N	-	N	N	143	Y	Y	Y	Y	
M62	83Eh	h	Current Date, Day/Hour	1	0000 to FFFF Upper 2 digits: Day, Lower 2 digits: Hour	N	-	N	N	144	Y	Y	Y	Y	
M63	83Fh	h	Current Date, Minute/Second	1	0000 to FFFF Upper 2 digits: Minute, Lower 2 digits: Second	N	-	N	N	145	Y	Y	Y	Y	
M64	840h	h	Date of Occurrence of Latest Alarm, Year/Month	3	0000 to FFFF Upper 2 digits: Year, Lower 2 digits: Month	N	-	N	N	143	Y	Y	Y	Y	
M65	841h	h	Date of Occurrence of Latest Alarm, Day/Hour	1	0000 to FFFF Upper 2 digits: Day, Lower 2 digits: Hour	N	-	N	N	144	Y	Y	Y	Y	
M66	842h	h	Date of Occurrence of Latest Alarm, Minute/Second	1	0000 to FFFF Upper 2 digits: Minute, Lower 2 digits: Second	N	-	N	N	145	Y	Y	Y	Y	
M67	843h	h	Date of Removal of Latest Alarm, Year/Month	3	0000 to FFFF Upper 2 digits: Year, Lower 2 digits: Month	N	-	N	N	143	Y	Y	Y	Y	
M68	844h	h	Date of Removal of Latest Alarm, Day/Hour	1	0000 to FFFF Upper 2 digits: Day, Lower 2 digits: Hour	N	-	N	N	144	Y	Y	Y	Y	
M69	845h	h	Date of Removal of Latest Alarm, Minute/Second	1	0000 to FFFF Upper 2 digits: Minute, Lower 2 digits: Second	N	-	N	N	145	Y	Y	Y	Y	
M70	846h	h	Latest Alarm Extension ID	18	0 or 1 0: Alarm at the local station 1: Alarm at the remote station	N	-	N	N	212	Y	Y	Y	Y	
M71	847h	h	Latest Multiple Alarm, 2nd	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M72	848h	h	Latest Multiple Alarm, 3rd	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M73	849h	h	Latest Multiple Alarm, 4th	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M74	84Ah	h	Latest Multiple Alarm, 5th	1	0000 to FFFF	N	-	N	N	14	Y	Y	Y	Y	
M75	84Bh	h	Latest Alarm, Subcode	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M76	84Ch	h	Latest Alarm, Maximum Speed	1	0 to 65535 r/min	N	-	N	N	0	Y	Y	Y	Y	
M77	84Dh	h	Latest Alarm, Input Power	1	0.0 to 6553.5 kW	N	-	N	N	2	Y	Y	Y	Y	
M78	84Eh	h	Latest Alarm, Motor Temperature	1	1°C/1d	N	-	N	N	5	Y	Y	Y	Y	
M79	84Fh	h	Latest Alarm, Running Status 2 (a)	1	0000 to FFFF	N	-	N	N	141	Y	Y	Y	Y	
M80	850h	h	Latest Alarm, Running Status 2 (b)	1	0000 to FFFF	N	-	N	N	142	Y	Y	Y	Y	
M81	851h	h	Latest Alarm, Run Command (Communications Link)	1	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M82	852h	h	Latest Alarm, Run Command 2 (Communications Link)	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M83	853h	h	Latest Alarm, For Particular Manufacturers	1	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M84	854h	h	Latest Alarm, M1 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M85	855h	h	Latest Alarm, M2 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M86	856h	h	Latest Alarm, M3 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M87	857h	h	Latest Alarm, EN Terminal Input	1	0000 to FFFF	N	-	N	N	100	Y	Y	Y	Y	
M93	85Dh	h	Light Alarm (Latest)	4	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M94	85Eh	h	Light Alarm (2nd last)	1	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M95	85Fh	h	Light Alarm (3rd last)	1	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M96	860h	h	Light Alarm (4th last)	1	0 to 255	N	-	N	N	102	Y	Y	Y	Y	
M98	862h	h	EN Terminal Input	0	0000 to FFFF	N	-	N	N	100	Y	Y	Y	Y	
M100	2900h	h	Effective Parameter Set Condition	0	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	

Function code	Communications address: 485 No.	Communications address: Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control: VC w/ PG	Drive control: VC w/o PG	Drive control: V/f	Drive control: VC for PMSM	Remarks
M101	2901h	h	Run Command 2 (Communications Link)	0	0000 to FFFF Monitors X terminal functions to be used exclusively via the communications link.	N	-	N	N	32	Y	Y	Y	Y	
M102	2902h	h	Load Factor	0	-327.68 to 327.67% Motor load factor, Motor rated load/100%	N	-	N	N	7	Y	Y	Y	Y	
M103	2903h	h	Input Power	0	0.0 to 6553.5 kW Input power to inverter	N	-	N	N	2	Y	Y	Y	Y	
M104	2904h	h	Running Status 2(a)	0	0000 to FFFF	N	-	N	N	141	Y	Y	Y	Y	
M105	2905h	h	Running Status 2(b)	0	0000 to FFFF	N	-	N	N	142	Y	Y	Y	Y	
M106	2906h	h	Detected Load Shaft Speed	0	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M107	2907h	h	Detected Line Speed	0	-32000 to 32000 : (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	Y	Y	
M108	2908h	h	PID Command Value	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	Y	Y	
M109	2909h	h	PID Feedback Amount	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	Y	Y	
M110	290Ah	h	PID Output	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	Y	Y	
M112	290Ch	h	Remaining allowance for M1 motor overload	3	0 to 65535% When M112 = 0 (%), the inverter issues OL1 alarm.	N	-	N	N	0	Y	Y	Y	Y	
M113	290Dh	h	Remaining allowance for M2 motor overload	1	0 to 65535% When M113 = 0 (%), the inverter issues OL2 alarm.	N	-	N	N	0	Y	Y	Y	Y	
M114	290Eh	h	Remaining allowance for M3 motor overload	1	0 to 65535% When M114 = 0 (%), the inverter issues OL3 alarm.	N	-	N	N	0	Y	Y	Y	Y	
M115	290Fh	h	Input Watt-hour	4	0.000 to 9999 100 kWh/1.000d Limited at 999900 kWh.	N	-	N	N	101	Y	Y	Y	Y	
M116	2910h	h	Input Watt-hour Data	1	0000 to 9999 100 kWh/1.000d * Display coefficient M116 = M115 (Input watt-hour) x F84 (Display coefficient for input watt-hour data) Specifying the electric rate per 100 kWh with F84 shows the electricity price.	N	-	N	N	101	Y	Y	Y	Y	
M117	2911h	h	Input Watt-hour (Lower 16 bits)	1	(81920d/unit 100% rating)(kW) x Cumulative time (s) x 2^(-16)	N	-	N	N	9	Y	Y	Y	Y	
M118	2912h	h	Input Watt-hour (Upper 16 bits)	1	(81920d/unit 100% rating)(kW) x Cumulative time (s) x 2^(-32)	N	-	N	N	9	Y	Y	Y	Y	
M119	2913h	h	Inverter Internal Temperature (Real-time value)	2	-32768 to 32767℃	N	-	N	N	5	Y	Y	Y	Y	
M120	2914h	h	Heat Sink Temperature (Real-time value)	1	-32768 to 32767℃	N	-	N	N	5	Y	Y	Y	Y	
M121	2915h	h	Main Circuit Capacitor Service Life (Elapsed time)	0	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M123	2917h	h	M1 Number of Startups	3	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M124	2918h	h	M2 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M125	2919h	h	M3 Number of Startups	1	0 to 65535 times	N	-	N	N	0	Y	Y	Y	Y	
M126	291Ah	h	M1 Cumulative Motor Run Time	3	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M127	291Bh	h	M2 Cumulative Motor Run Time	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M128	291Ch	h	M3 Cumulative Motor Run Time	1	0 to 65535 (10h)	N	-	N	N	0	Y	Y	Y	Y	
M129	291Dh	h	Run Command (Via communications link)	0	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M130	291Eh	h	Torque Bias	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	Y	
M131	291Fh	h	Magnetic Pole Position Signal	0	-32768 to 32767	N	-	N	N	5	N	N	N	Y	
M132	2920h	h	Universal AO1	0	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M133	2921h	h	Option AO1	0	0000 to FFFF	N	-	N	N	9	Y	Y	Y	Y	
M134	2922h	h	Control Input 1	0	0000 to FFFF	N	-	N	N	133	Y	Y	Y	Y	
M135	2923h	h	Control Input 2	0	0000 to FFFF	N	-	N	N	134	Y	Y	Y	Y	
M136	2924h	h	Control Input 3	0	0000 to FFFF	N	-	N	N	135	Y	Y	Y	Y	
M137	2925h	h	Control Input 4	0	0000 to FFFF	N	-	N	N	136	Y	Y	Y	Y	
M138	2926h	h	Control Input 5	0	0000 to FFFF	N	-	N	N	137	Y	Y	Y	Y	
M139	2927h	h	Control Input 6	0	0000 to FFFF	N	-	N	N	138	Y	Y	Y	Y	
M140	2928h	h	Control Input 7	0	0000 to FFFF	N	-	N	N	139	Y	Y	Y	Y	
M141	2929h	h	Control Input 8	0	0000 to FFFF	N	-	N	N	140	Y	Y	Y	Y	
M142	292Ah	h	Control Output 4	0	0000 to FFFF (bit 0: E-SX bus tact synchronizing signal)	N	-	N	N	128	Y	Y	Y	Y	
M143	292Bh	h	Control Output 5	0	0000 to FFFF	N	-	N	N	129	Y	Y	Y	Y	
M144	292Ch	h	Control Output 6	0	0000 to FFFF	N	-	N	N	130	Y	Y	Y	Y	
M146	292Eh	h	Detected Speed 2	0	-32000 to 32000: (data) * Nmax / 20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M147	292Fh	h	Exciting Current Command	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	N	
M148	2930h	h	Detected Exciting Current	0	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	N	
M149	2931h	h	Magnetic-flux Calculation	0	0.00 to 655.35%	N	-	N	N	3	Y	Y	N	N	
M161	293Dh	h	Ai Adjustment Value (12)	5	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M162	293Eh	h	Ai Adjustment Value (Ai1)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M163	293Fh	h	Ai Adjustment Value (Ai2)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M164	2940h	h	Ai Adjustment Value (Ai3)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M165	2941h	h	Ai Adjustment Value (Ai4)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	

Function code	Communications address 485 No.	Communications address Link No.	Name	Dir.	Data setting range	Change when running	Default setting	Data copying	Initialization	Format type	Drive control VC w/ PG	Drive control VC w/o PG	Drive control V/f	Drive control VC for PMSM	Remarks
M166	2942h	h	Input Signal (Terminal)	0	0000 to FFFF	N	-	N	N	32	Y	Y	Y	Y	
M167	2943h	h	Analog Input Signal (12)	3	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M168	2944h	h	Analog Input Signal (Ai1)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M169	2945h	h	Analog Input Signal (Ai2)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M170	2946h	h	Analog Output Signal (Ao1)	3	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M171	2947h	h	Analog Output Signal (Ao2)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M172	2948h	h	Analog Output Signal (Ao3)	1	-32768 to 32767 (-16384 to 16384 : -10V to +10V)	N	-	N	N	5	Y	Y	Y	Y	
M173	2949h	h	AIO Input/Output Status 1(Ai3)	4	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M174	294Ah	h	AIO Input/Output Status 1(Ai4)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M175	294Bh	h	AIO Input/Output Status 2(Ao4)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M176	294Ch	h	AIO Input/Output Status 2(Ao5)	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M177	294Dh	h	PG(SD) Input Pulse	4	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M178	294Eh	h	PG(LD) Input Pulse	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M179	294Fh	h	PG(PR) Input Pulse	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M180	2950h	h	PG(PD) Input Pulse	1	-32768 to 32767	N	-	N	N	5	Y	Y	Y	Y	
M181	2951h	h	DIOA Input Status (Terminal)	0	0000 to FFFF	N	-	N	N	146	Y	Y	Y	Y	
M182	2952h	h	DIOA Input Status (Via communications link)	0	0000 to FFFF	N	-	N	N	146	Y	Y	Y	Y	
M183	2953h	h	DIOB Option Input Status	0	0000 to FFFF	N	-	N	N	26	Y	Y	Y	Y	
M184	2954h	h	DIOB Option Output Status	0	0000 to FFFF	N	-	N	N	27	Y	Y	Y	Y	
M193	295Dh	h	General-purpose Setting 1 Monitor (Available soon)	0	-32768 to 32767 Monitors the S16 setting.	N	-	N	N	5	Y	Y	Y	Y	
M194	295Eh	h	General-purpose Setting 2 Monitor (Available soon)	0	-32768 to 32767 Monitors the S17 setting.	N	-	N	N	5	Y	Y	Y	Y	
M200	2A00h	h	Pulse Train Position Command Monitor	5	0000 to FFFF	N	-	N	N	9	Y	N	N	Y	
M201	2A01h	h	Position Detection Monitor	1	0000 to FFFF	N	-	N	N	9	Y	N	N	Y	
M202	2A02h	h	Position Detection (Z-phase Input) Monitor	1	0000 to FFFF	N	-	N	N	9	Y	N	N	Y	
M220	2A14h	h	Load Compensating Speed Control Value	3	-32000 to 32000: (data)*Nmax/20000 r/min	N	-	N	N	5	Y	Y	N	Y	
M221	2A15h	h	Hoisting Load Calculation Result Monitor	1	0 to 65535 kg	N	-	N	N	0	Y	Y	N	Y	
M222	2A16h	h	Travel Torque Calculation Monitor	1	-327.68 to 327.67%	N	-	N	N	7	Y	Y	N	Y	

4.2.4 Data Format List

You can use the following formats to access function codes through the link and these formats are common to the FRENIC-VG.

4.2.4.1 Data Type 0 to 13

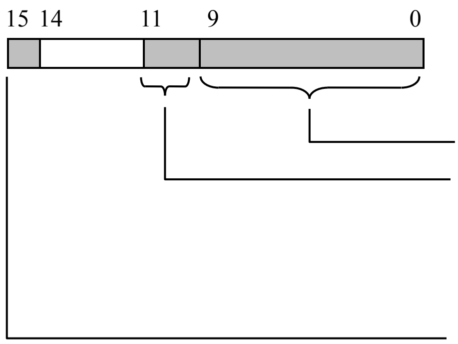
You can basically exchange data in the data types from 0 to 13.

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		0.0, 0.1, 0.2, ...	0.1	
3	Fixed point	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		-0.1, 0.0, 0.1, ...	0.1	
7	Fixed point (signed)	-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	
13	Exponent/mantissa 2		0.01	

4.2.4.2 Data Type 12 to 145

The following data have special formats.

Type [12]: Time, current, power, PID process values

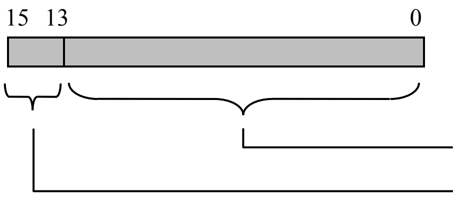


Mantissa Exponent = 0: 0 to 999, Exponent = 1 to 3: 100 to 999

Exponent 0: 0.01 times (0.00 to 9.99)
1: 0.1 times (10.0 to 99.9)
2: 1 times (100 to 999)
3: 10 times (1000 to 9990)

Polarity 0: Positive (+), 1: Negative (-)

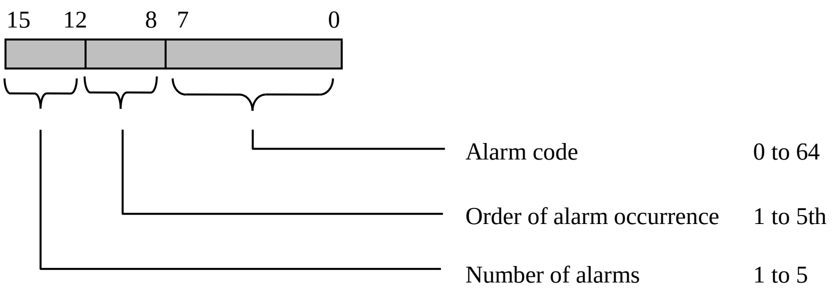
Type [13]: Current and others



Mantissa Exponent = 0: 0 to 9999, Exponent = 1, 2, 3: 1000 to 9999

Exponent 0: 0.01 times (0.00 to 99.99)
1: 0.1 times (100.0 to 999.9)
2: 1 times (1000 to 9999)
3: 10 times (10000 to 99990)

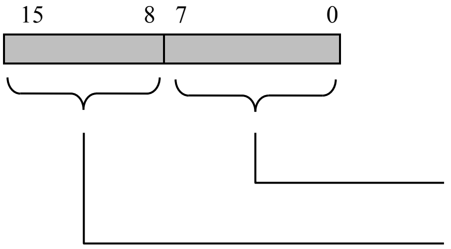
Type [14]: Cause of alarm



Alarm codes

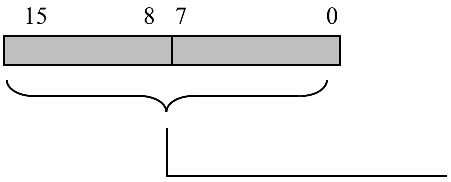
Code	Display	Description	Code	Display	Description	Code	Display	Description
0	- - -	No alarm	22	OH2	External alarm	44	Ar-C	Error code C for specific user application
1	- - -	IPM error	23	OH3	Inverter internal overheat	45	Ar-d	Error code D for specific user application
2	dbH	Braking resistor overheated	24	OH4	Motor overheat	46	Ar-E	Error code E for specific user application
3	dCF	DC fuse blown	25	OL1	Motor 1 overload	47	Ar-F	Error code F for specific user application
4	dO	Excessive positioning deviation	26	OL2	Motor 2 overload	48	dbA	Braking transistor broken
5	EF	Ground fault	27	OL3	Motor 3 overload	49	ECF	Functional safety circuit failure
6	Er1	Memory error	28	OLU	Inverter overload	50	Er-H	Hardware error
7	Er2	Keypad communications error	29	OS	Overspeed	51	Err	Mock alarm
8	Er3	CPU error	30	OU	Overvoltage	52	LoC	Start delay
9	Er4	Network error	31	PbF	Charger circuit fault	53	dFA	DC fan locked
10	Er5	RS-485 communications error	32	PG	PG wire break	54	Et1	PG failure
11	Er6	Operation error	33	Ar1	Error code 1 for specific user application	55	- - -	No alarm
12	Er7	Output wiring fault	34	Ar2	Error code 2 for specific user application	56	EC	PG communication error
13	Er8	A/D converter error	35	Ar3	Error code 3 for specific user application	57	- - -	No alarm
14	Er9	Speed not agreed	36	Ar4	Error code 4 for specific user application	58	- - -	No alarm
15	ErA	UPAC error	37	Ar5	Error code 5 for specific user application	59	- - -	No alarm
16	Erb	Inter-inverter communications link error	38	Ar6	Error code 6 for specific user application	60	- - -	No alarm
17	Lin	Power supply phase loss	39	Ar7	Error code 7 for specific user application	61	OPL	Output phase loss
18	LU	Undervoltage	40	Ar8	Error code 8 for specific user application	62	SiF	Functional safety card error
19	nrb	NTC thermistor wire break error	41	Ar9	Error code 9 for specific user application	63	SrF	Functional safety card error
20	OC	Overcurrent	42	ArA	Error code A for specific user application	64	- - -	No alarm
21	OH1	Heat sink overheat	43	Arb	Error code B for specific user application			

Type [15]: Alarm history



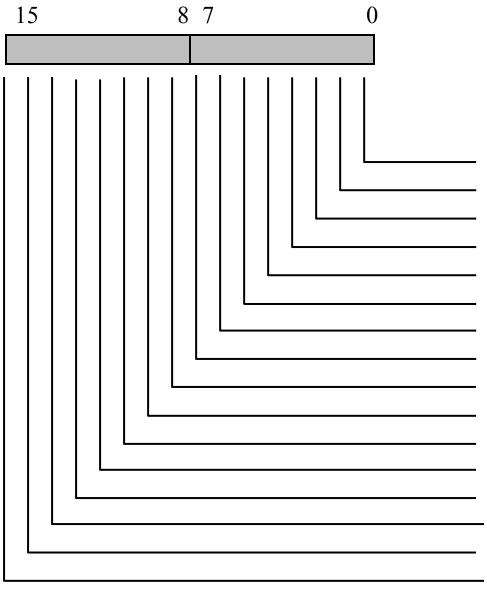
Alarm code	0 to 64 (See "Type [14]")
Number of the occurrence of the same alarm	0 to 255

Type [16]: Percentage



Percentage -300% to 300% (-30000 to 30000)
Decimal places are not displayed.

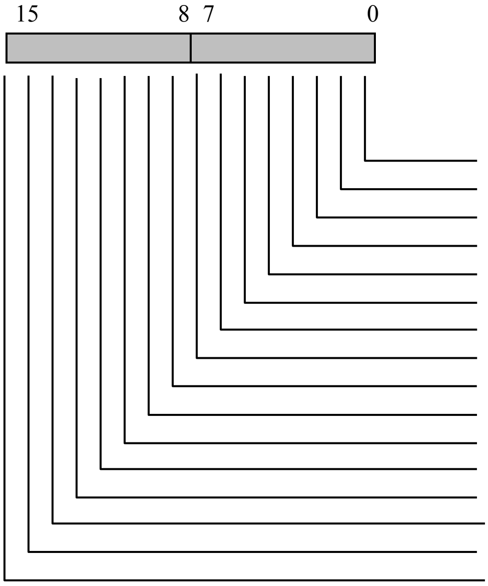
Type [21]: Operation status



0) FWD (forward operation)
1) REV (reverse operation)
2) EXT (DC braking, pre-exciting)
3) INT (Inverter shut off)
4) BRK (Braking)
5) NUV (DC link circuit voltage established)
6) TL (Torque limiting)
7) VL (Voltage limiting)
8) IL (Current limiting)
9) ACC (Accelerating)
10) DEC (Decelerating)
11) ALM (Alarm relay output)
(0 to 11: 0: OFF, 1: ON)
12) 0: REM/LOC, 1: COM
13)
14)
15)
(13 to 15: Not used.)

Type [26]: DIOB option input state

Type [27]: DIOB option output state



Bit	[26] Input state	[27] Output state
0)	X21,	Y21
1)	X22,	Y22
2)	X23,	Y23
3)	X24,	Y24
4)	X25,	Y25
5)	X26,	Y26
6)	X27,	Y27
7)	X28,	Y28
8)	X29,	Y29
9)	X30,	Y30
10)	X31	
11)	X32	
12)	X33	
13)	X34	
14)	X35	
15)	X36	

0: OFF, 1: ON

Type [28]: Inverter capacity

Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity	Code	Inverter capacity
0	0.05	8	5.5	16	45	24	220	32	630
1	0.1	9	7.5	17	55	25	250	33	710
2	0.2	10	11	18	75	26	280	34	800
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	30	OTHER		
7	3.7	15	37	23	200	31	500		

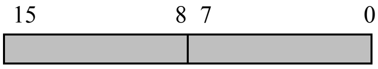
Type [29]: Inverter model (common to entire Fuji inverter system)

The number is fixed to 1313h or 1314h for the FRENIC-VG.

200 V system: fixed to 1313h

400 V system: fixed to 1314h

Type [31]: Speed



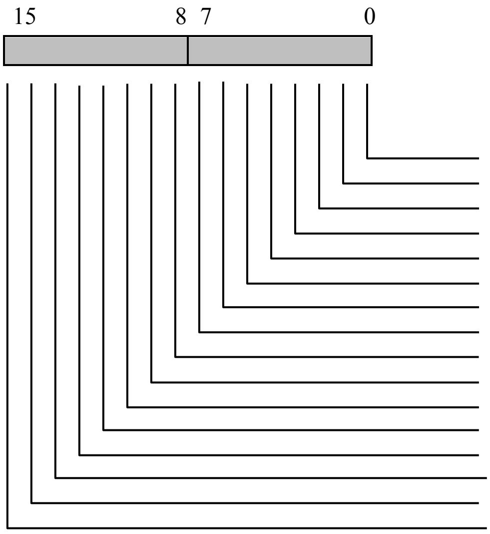
Data (0 to ±20,000) → (0 to ±24,000 × r/min): (Data) × Nmax/20,000 conversion

(Example) When the maximum speed is Nmax = 1,500 r/min,

- If you want to direct a speed command of 1,000 r/min,
  Specify a data of $\frac{1,000}{1,500} \times 20,000 \rightarrow \underline{13,333}$
- 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

Type [32]: Operation commands, [33]: Y1 to Y18

This type is the same as S06 and S07.



Bit	[32]	[33]	
0)	FWD (forward operation command)	Y1	0: OFF, 1: ON
1)	REV (reverse operation command)	Y2	
2)	X1	Y3	
3)	X2	Y4	
4)	X3	Y5A	
5)	X4	Not used.	
6)	X5	Not used.	
7)	X6	Not used.	
8)	X7	Y11	
9)	X8	Y12	
10)	X9	Y13	
11)	X11	Y14	
12)	X12	Y15	
13)	X13	Y16	
14)	X14	Y17	
15)	RST (RESET command)	Y18	

Type [34]: Communication error codes

15 8 7 0

Description of alarms in the communication through the link (RS-485, T-Link, SX-bus, E-SX 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 .

M26 (HEX.)	KEYPAD panel display	Communication error name	Description
0 (0H)	-	No communication error	Normal communication A data is written to an unused address of the function code (writing to address out of the specified range is defined separately). Data is read from missing function code address in the middle of continuous read. The data will be "0000". Writing to the S area while link operation is disabled. The data will not be reflected and cause no error. A data out of range is written to the S area. The data is written after adjusted to the upper or the lower limit. Access from another link or the KEYPAD panel occurs during data writing (EEPROM other than the S area is accessed). 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. Writing to/reading from option function codes that are not displayed on the KEYPAD panel.
1 to 32	-	-	-
33 to 70	-	Not used	
71 (47H)	04	Checksum error, CRC error	Software error: Checksum value or CRC value does not match.
72 (48H)	05	Parity error	Hardware error: Parity does not match.
73 (49H)	06	Others (such as overrun, framing)	Physical (reception) errors other than above.
74 (4AH)	01	Format error	Incorrect format. Characters requesting transmission are incorrect. Characters terminating transmission are not in the specified order.
75 (4BH)	01	Command error	Codes other than the specified commands are transmitted.
76 (4CH)	07	Link priority error	Writing to the S area through RS-485 while a link option is installed. Writing to the S area through a link with lower priority while multiple link options are installed.
77 (4DH)	07	No right to write function code data	Not used
78 (4EH)	02	Function code error	Access to a data out of the address range of the function codes (such as access to a data over F80). Writing data over 16 words.
79 (4FH)	07	Error on writing to write-disabled data	Write-disabled function codes (Read-only data or the M area). Function codes write-disabled during operation. 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. Function codes that cannot be written through the link (link function codes: H31 to 40). Writing to M1 function code (P) area when motor parameters are protected. Writing through the link in the copy mode operation of the KEYPAD panel.
80 (50H)	03	Data	Written data is out of the setting range in the area other than the S area.
81 (51H)	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 FRENIC-VG different from the assignment for the general-purpose inverters.

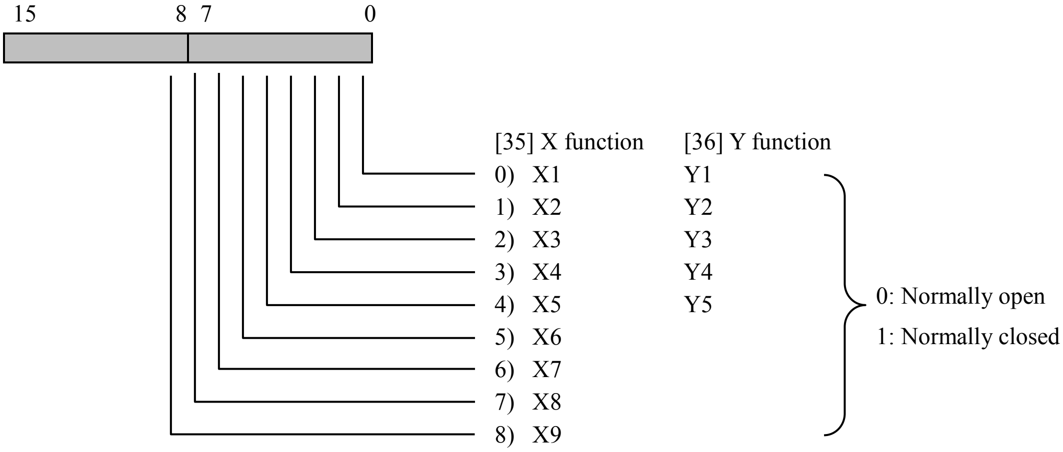
The communication error codes 71 to 81 are common to the different models. Note that some causes of alarm are specific to models.

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.

Type [35]: X function normally open/closed

Type [36]: Y function normally open/closed



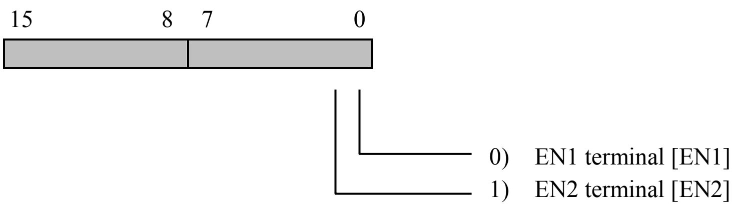
Type [40 to 99]

These types are reserved for the manufacturer. Users can considers these types as type [0] to use.

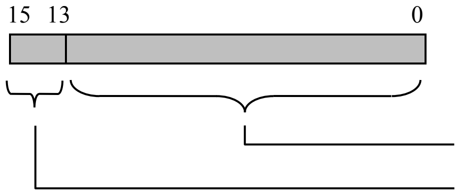
Type [82]: M1 Motor selection

Code	kW display	HP display	Code	kW display	HP display	Code	kW display	HP display
0	00: 0.75-2	00: 1-2	17	17: 3.7-4	17: 5-4	34	34: 200-4	34: 250-4
1	01: 1.5-2	01: 2-2	18	18: 5.5-4	18: 7.5-4	35	35: 220-4	35: 300-4
2	02: 2.2-2	02: 3-2	19	19: 7.5-4	19: 10-4	36	36: P-OTR	36: P-OTR
3	03: 3.7-2	03: 5-2	20	20: 11-4	20: 15-4	37	37: OTHER	37: OTHER
4	04: 5.5-2	04: 7.5-2	21	21: 15-4	21: 20-4	38	38: 30-2A	38: 40-2A
5	05: 7.5-2	05: 10-2	22	22: 18.5-4	22: 25-4	39	39: 55-2A	39: 75-2A
6	06: 11-2	06: 15-2	23	23: 22-4	23: 30-4	40	40: 75-2A	40: 100-2A
7	07: 15-2	07: 20-2	24	24: 30-4	24: 40-4	41	41: 90-2A	41: 125-2A
8	08: 18.5-2	08: 25-2	25	25: 37-4	25: 50-4	42	42: 30-4A	42: 40-4A
9	09: 22-2	09: 30-2	26	26: 45-4Y	26: 60-4Y	43	43: 55-4A	43: 75-4A
10	10: 30-2	10: 40-2	27	27: 45-4S	27: 60-4S	44	44: 75-4A	44: 100-4A
11	11: 37-2	11: 50-2	28	28: 55-4	28: 75-4	45	45: 90-4A	45: 125-4A
12	12: 45-2Y	12: 60-2Y	29	29: 75-4	29: 100-4	46	46: 110-4A	46: 150-4A
13	13: 45-2S	13: 60-2S	30	30: 90-4	30: 125-4	47	47: 132-4A	47: 175-4A
14	14: 55-2	14: 75-2	31	31: 110-4	31: 150-4	48	48: 160-4A	48: 200-4A
15	15: 75-2	15: 100-2	32	32: 132-4	32: 175-4	49	49: 200-4A	49: 250-4A
16	16: 90-2	16: 125-2	33	33: 160-4	33: 200-4	50	50: 220-4A	50: 300-4A

Type [100]: EN Input terminals



Type [101]: (Power)



Mantissa Exponent 0: 0 to 9999, Exponent 1, 2, 3: 1000 to 9999

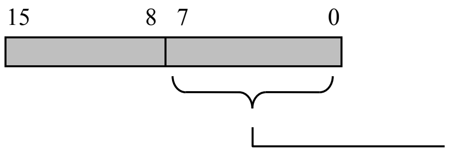
Exponent 0: 0.001 times (0.000 to 9.999)

1: 0.01 times (10.00 to 99.99)

2: 0.1 times (100.0 to 999.9)

3: 1 times (1000 to 9999)

Type [102]: (Cause of alarm)

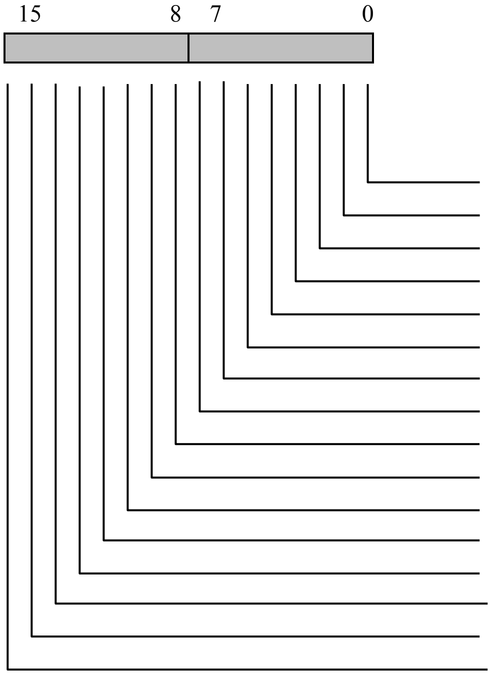


Light alarm code 0 to 64

Light alarm codes

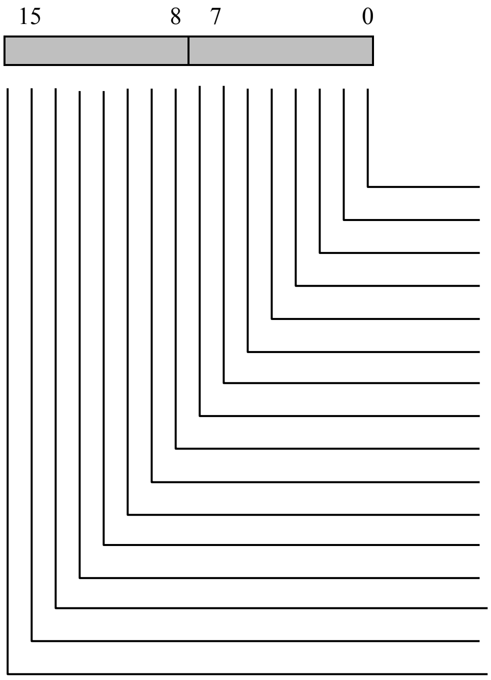
Code	Display	Description	Code	Display	Description	Code	Display	Description
0	- - -	No alarm	30	- - -	No alarm	60	- - -	No alarm
1	- - -	No alarm	31	- - -	No alarm	61	- - -	No alarm
2	- - -	No alarm	32	- - -	No alarm	62	- - -	No alarm
3	- - -	No alarm	33	- - -	No alarm	63	- - -	No alarm
4	- - -	No alarm	34	- - -	No alarm	64	- - -	No alarm
5	- - -	No alarm	35	- - -	No alarm	65	- - -	No alarm
6	- - -	No alarm	36	- - -	No alarm	66	- - -	No alarm
7	- - -	No alarm	37	- - -	No alarm	67	- - -	No alarm
8	- - -	No alarm	38	- - -	No alarm	68	- - -	No alarm
9	Er4	Network error	39	- - -	No alarm	69	- - -	No alarm
10	Er5	RS-485 communications error	40	- - -	No alarm	70	- - -	No alarm
11	- - -	No alarm	41	- - -	No alarm	71	- - -	No alarm
12	- - -	No alarm	42	- - -	No alarm	72	- - -	No alarm
13	- - -	No alarm	43	- - -	No alarm	73	- - -	No alarm
14	Er9	Speed mismatch	44	- - -	No alarm	74	- - -	No alarm
15	- - -	No alarm	45	- - -	No alarm	75	- - -	No alarm
16	- - -	No alarm	46	ArE	E-SX bus tact synchronization error	76	- - -	No alarm
17	- - -	No alarm	47	ArF	Error code F for particular users	77	- - -	No alarm
18	- - -	No alarm	48	- - -	No alarm	78	- - -	No alarm
19	nrb	NTC thermistor wire break error	49	- - -	No alarm	79	- - -	No alarm
20	- - -	No alarm	50	- - -	No alarm	80	- - -	No alarm
21	- - -	No alarm	51	Err	Mock alarm	81	LiF	Life time early warning
22	OH2	External alarm	52	LOC	Start delay	82	OH	Heat sink overheat early warning
23	- - -	No alarm	53	dFA	DC fan locked	83	OL	Overload early warning
24	OH4	Motor overheat	54	- - -	No alarm	84	MOH	No alarm
25	OL1	Motor 1 overload (M1)	55	- - -	No alarm	85	MOL	No alarm
26	OL2	Motor 2 overload (M2)	56	- - -	No alarm	86	- - -	No alarm
27	OL3	Motor 3 overload (M3)	57	- - -	No alarm	87	BaT	Battery life expired
28	- - -	No alarm	58	- - -	No alarm	88	SnF	Safety printed circuit board light alarm
29	- - -	No alarm	59	- - -	No alarm			

Type [125]: Control output 1



0)	Inverter running	***RUN***
1)	Speed valid	***N-EX***
2)	Speed agreement 1	***N-AG1***
3)	Speed arrival signal	***N-AR***
4)	Speed detected 1	***N-DT1***
5)	Speed detected 2	***N-DT2***
6)	Speed detected 3	***N-DT3***
7)	Undervoltage detected (Inverter stopped)	***LU***
8)	Torque polarity detected (braking/driving)	***B/D***
9)	Torque limiting	***TL***
10)	Torque detected 1	***T-DT1***
11)	Torque detected 2	***T-DT2***
12)	Keypad operation enabled	***KP***
13)	Inverter stopped	***STOP***
14)	Inverter ready to run	***RDY***
15)	Magnetic flux detected	***MF-DT***

Type [126]: Control output 2



0)	Motor M2 selected	***SW-M2***
1)	Motor M3 selected	***SW-M3***
2)	Brake release signal	***BRK***
3)	Alarm content 1	***AL1***
4)	Alarm content 2	***AL2***
5)	Alarm content 4	***AL4***
6)	Alarm content 8	***AL8***
7)	Cooling fan in operation	***FAN***
8)	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 acceleration	***U-ACC***
14)	Under deceleration	***U-DEC***
15)	Inverter overload early warning	***INV-OL***

Type [127]: Control output 3

15 8 7 0

Bit	Description	Symbol
0)	Motor overheat 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)	In limiting under load adaptive control	***ANL***
5)	In calculation under load adaptive control	***ANC***
6)	Analog torque bias being held	***TBH***
7)	Custom Do1	***C-Do1***
8)	Custom Do2	***C-Do2***
9)	Custom Do3	***C-Do3***
10)	Custom Do4	***C-Do4***
11)	Custom Do5	***C-Do5***
12)	Custom Do6	***C-Do6***
13)	Custom Do7	***C-Do7***
14)	Custom Do8	***C-Do8***
15)	Custom Do9	***C-Do9***

Type [128]: Control output 4

15 8 7 0

Bit	Description	Symbol
0)	Custom Do10	***C-Do10***
1)	Not used.	
2)	Not used.	
3)	Multiplex system communications link being established	***MTS***
4)	Answerback to cancellation of multiplex system	***MEC-AB***
5)	Multiplex system master selected	***MSS***
6)	Multiplex system local station failure	***AL-SF***
7)	Stopped due to communications link error*	***LES***
8)	Alarm output (for any alarm)	***ALM***
9)	Light alarm	***L-ALM***
10)	Maintenance timer	***MNT***
11)	Braking transistor broken	***DBAL***
12)	DC fan locked	***DCFL***
13)	Speed agreement 2	***N-AG2***
14)	Speed agreement 3	***N-AG3***
15)	Axial fan stopped	***MFAN***

Type [129]: Control output 5

Bits 15 … 8 | 7 … 0

Bit	Description	Signal
0)	Not used.	-
1)	Not used.	-
2)	Answerback to droop control enabled	***DSAB***
3)	Answerback to cancellation of torque command/torque current command	***TCL-C***
4)	Answerback to cancellation of torque limiter mode 1	***F40-AB***
5)	Not used.	-
6)	Not used.	-
7)	73 ON command	***PRT-73F***
8)	Turn ON Y-terminal test output	***Y-ON***
9)	Turn OFF Y-terminal test output	***Y-OFF***
10)	Not used.	-
11)	System clock battery lifetime expired	***BATT***
12)	Not used.	-
13)	SPGT battery warning*	***SPGT-B***
14)	Not used.	-
15)	Not used.	-

* Available soon

Type [130]: Control output 6

Bits 15 … 8 | 7 … 0

Bit	Description	Signal
0)	EN terminal detection circuit failure	***DECF***
1)	EN terminal OFF	***ENOFF***
2)	Safety function in progress	***SF-RUN***
3)	Not used.	-
4)	STO under testing	***SF-TST***
5)	Not used.	-
6)	Not used.	-
7)	Not used.	-
8)	Not used.	-
9)	Not used.	-
10)	Not used.	-
11)	Not used.	-
12)	Not used.	-
13)	Not used.	-
14)	Not used.	-
15)	Not used.	-

*Output from bits 0 to 3 is available in the ROM version H1/2 0020 or later.

Type [133]: Control input 1

15 8 7 0

Bit	Function	Symbol
0)	Select multistep speed 1	***SS1***
1)	Select multistep speed 2	***SS2***
2)	Select multistep speed 4	***SS4***
3)	Select multistep speed 8	***SS8***
4)	Select ASR and ACC/DEC time 1	***RT1***
5)	Select ASR and ACC/DEC time 2	***RT2***
6)	Enable 3-wire operation	***HLD***
7)	Coast to a stop	***BX***
8)	Reset alarm	***RST***
9)	Enable external alarm trip	***THR***
10)	Ready for jogging	***JOG***
11)	Select speed command N2/N1	***N2/N1***
12)	Select motor 2	***M-CH2***
13)	Select motor 3	***M-CH3***
14)	Enable DC braking	***DCBRK***
15)	Clear ACC/DEC to zero	***CLR***

Type [134]: Control input 2

15 8 7 0

Bit	Function	Symbol
0)	Switch creep speed under UP/DOWN control	***CRP-N2/N1***
1)	UP (Increase speed)	***UP***
2)	DOWN (Decrease speed)	***DOWN***
3)	Enable data change with keypad	***WE-KP***
4)	Cancel PID control	***KP/PID***
5)	Switch normal/inverse operation	***IVS***
6)	Interlock (52-2)	***IL***
7)	Enable data change via communications link	***WE-LK***
8)	Enable communications link	***LE***
9)	Universal DI	***U-DI***
10)	Enable auto search for idling motor speed at starting	***STM***
11)	Synchronous operation command (PG (PR) optional function)	***SYC***
12)	Lock at zero speed	***LOCK***
13)	Pre-excitation	***EXITE***
14)	Cancel speed limiter	***N-LIM***
15)	Cancel H41 (Torque command)	***H41-CCL***

Type [135]: Control input 3

Bits 15–8, 7–0

Bit	Description	Code
0)	Cancel H42 (Torque current command)	***H42-CCL***
1)	Cancel H43 (Magnetic flux command)	***H43-CCL***
2)	Cancel F40 (Torque limiter mode 1)	***F40-CCL***
3)	Select torque limiter level 2/1	***TL2/TL1***
4)	Bypass ACC/DEC processor	***BPS***
5)	Select torque bias command 1	***TB1***
6)	Select torque bias command 2	***TB2***
7)	Select droop control	***DROOP***
8)	Zero-hold Ai1	***ZH-AI1***
9)	Zero-hold Ai2	***ZH-AI2***
10)	Zero-hold Ai3 (AIO optional function)	***ZH-AI3***
11)	Zero-hold Ai4 (AIO optional function)	***ZH-AI4***
12)	Reverse Ai1 polarity	***REV-AI1***
13)	Reverse Ai2 polarity	***REV-AI2***
14)	Reverse Ai3 polarity (AIO optional function)	***REV-AI3***
15)	Reverse Ai4 polarity (AIO optional function)	***REV-AI4***

Type [136]: Control input 4

Bits 15–8, 7–0

Bit	Description	Code
0)	Inverse PID output	***PID-INV***
1)	Cancel PG alarm	***PG-CCL***
2)	Cancel undervoltage alarm	***LU-CCL***
3)	Hold Ai torque bias	***H-TB***
4)	STOP1	***STOP1***
5)	STOP2	***STOP2***
6)	STOP3	***STOP3***
7)	Latch DIA data (DIA optional function)	***DIA***
8)	Latch DIB data (DIB optional function)	***DIB***
9)	Cancel multiplex system	***MT-CCL***
10)	Custom Di1	***C-DI1***
11)	Custom Di2	***C-DI2***
12)	Custom Di3	***C-DI3***
13)	Custom Di4	***C-DI4***
14)	Custom Di5	***C-DI5***
15)	Custom Di6	***C-DI6***

Type [137]: Control input 5

15 8 7 0

Bit	Function	Symbol
0)	Custom Di7	***C-DI7***
1)	Custom Di8	***C-DI8***
2)	Custom Di9	***C-DI9***
3)	Custom Di10	***C-DI10***
4)	Select load adaptive parameters 2/1*	***AN-P2/1***
5)	Cancel PID components	***PID-CCL***
6)	Enable PID FF component	***PID-FF***
7)	Reset completion of speed limit calculation*	***NL-RST***
8)	Toggle signal 1	***TGL1***
9)	Toggle signal 2	***TGL2***
10)	Cause external mock alarm	***FTB***
11)	Cancel NTC thermistor alarm	***NTC-CCL***
12)	Cancel lifetime alarm signal	***LF-CCL***
13)	Not used.	-
14)	Switch PID feedback signals	***PID-FB2***
15)	Select PID torque bias	***TB-PID***

* Available soon

Type [138]: Control input 6

15 8 7 0

Bit	Function	Symbol
0)	Not used.	
1)	Not used.	-
2)	Not used.	-
3)	Not used.	-
4)	Not used.	-
5)	Not used.	-
6)	Not used.	-
7)	Not used.	-
8)	Not used.	-
9)	Not used.	-
10)	Not used.	-
11)	Not used.	-
12)	Not used.	-
13)	Not used.	-
14)	Not used.	-
15)	Not used.	-

Type [139]: Control input 7

Type [140]: Control input 8

In preparation

Type [141]: Operation status 2(a)

15 8 7 0

0)
1)

- 00: HD (High duty mode, overload capability) (F80 = 0, 2)
- 01: LD (Low duty mode, overload capability) (F80 = 1)
- 10: MD (Medium duty mode, overload capability) (F80 = 3)

2)
3)
4)
5)
6)

- 00000(0): Keypad [HAND]
- 00001(1): Analog input to terminal [12](0 to ±10 V)
- 00010(2): Analog input to terminal [12](0 to +10 V)
- 00011(3): ***UP/DOWN*** control (Initial speed = 0)
- 00100(4): ***UP/DOWN*** control (Initial speed = Last value)
- 00101(5): ***UP/DOWN*** control (Initial speed = Creep speed 1 or 2)
- 00110(6): DIA card input [DIA]
- 00111(7): DIB card input [DIB]
- 01000(8): Select multistep speed (***SS8***, ***SS4***, ***SS2***, ***SS1***)
- 01001(9): Enable communications link (***LE***), H30: Communications Link Function (Link operation)
- 01010(10): UPAC SW1 (Speed command 1) enabled [UPAC]
- 01011(11): Synchronization operation command (PG (PR) optional function) ***SYC***
- 01100(12): Orientation[ORT]
- 01101(13): Lock at zero speed ***LOCK***
- 01110(14): Not used.
- 01111(15): Not used.
- 10000(16): Ready for jogging (***JOG***)
- 10001(17): Not used.
- 10010(18): ***N-REFV*** input to terminal [Ai1]
- 10011(19): ***N-REFC*** input to terminal [Ai2]
- 10100(20): Local mode keypad [LOCAL]

7)
8)

- 00: Motor 1
- 01: Motor 2
- 10: Motor 3

9)
10)
11)
12)

- 0000(0): Vector control with speed sensor
- 0001(1): Vector control without speed sensor
- 0010(2): Simulation mode
- 0011(3): Vector control for PMSM with speed sensor
- 0100(4): V/f control for IM
- 0101(5): Vector control with speed sensor (Multiplex master)
- 0110(6): Vector control with speed sensor (Multiplex slave)
- 0111(7): Vector control without speed sensor (Multiplex master)
- 1000(8): Vector control without speed sensor (Multiplex slave)

13) FWD input (0: OFF, 1: ON)
14) REV input (0: OFF, 1: ON)
15) Not used.

Type [142]: Operation status 2(b)

15 8 7 0

Bit	Item	Value
0)	Current limit	(0: No limit, 1: Under limiting)(*1)
1)	Undervoltage	(0: Normal, 1: Undervoltage)
2)	Voltage limit	(0: No limit, 1: Under limiting)(*1)
3)	Torque limit	(0: No limit, 1: Under limiting)(*1)
4)	Not used.	
5)	Not used.	
6)	STOP1 input	(0: OFF, 1: ON)
7)	STOP2 input	(0: OFF, 1: ON)
8)	STOP3 input	(0: OFF, 1: ON)
9)	BX input	(0: OFF, 1: ON)

10) 11) 12) 13)
- 0000(0): Keypad (F02 = 0) [REM] [HAND]
- 0001(1): ***FWD*** or ***REV*** (F02 = 1) [REM]
- 0010(2): Run command via communications link [COMM]
- 0011(3): Local mode keypad [LOC] [HAND]

14) Not used.
15) Not used.

(*1) Current limit, voltage limit and torque limit are the same as information in Type [21].

Type [143]: Calendar clock [Year/month]

15 8 7 0

- Month (bits 7–0): 1 to 12 months: 0001(1) to 1100(12)
- Year (bits 15–8): 2000 to 2099 years: 0000 0000(00) to 0110 0011(99)

Type [144]: Calendar clock [Day/hour]

15 8 7 0

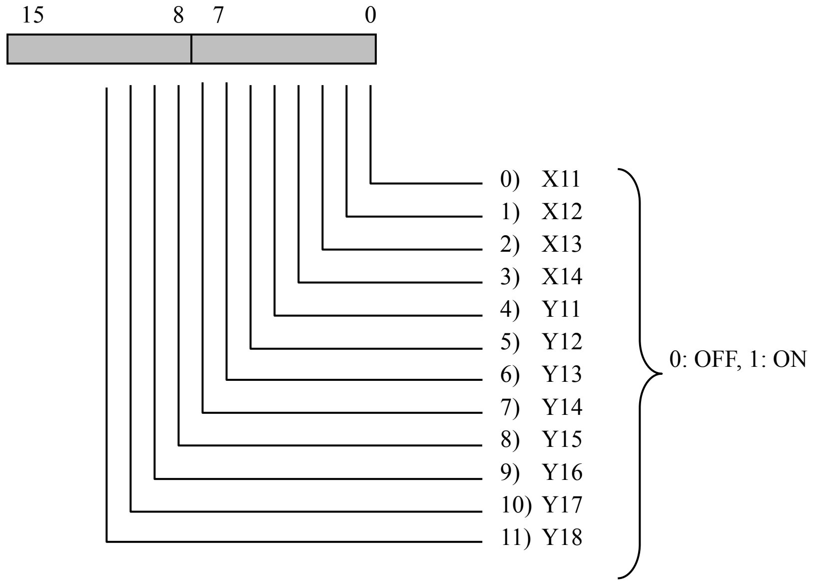
- Hour (bits 7–0): 0 to 23 hours: 0000 0000(0) to 0001 0111(23)
- Day (bits 15–8): 1 to 31 days: 0000 0001(1) to 0001 1111(31)

Type [145]: Calendar clock [Minute/second]

15 8 7 0

- Second (bits 7–0): 0 to 59 seconds: 0000 0000(0) to 0011 1011(59)
- Minute (bits 15–8): 0 to 59 minites: 0000 0000(0) to 0011 1011(59)

Type [146]: DIOA Input/output status



4.3 Details of Function Codes

4.3.1 F codes (Fundamental Functions)

F00	Data Protection

F00 specifies whether to protect setting data from accidentally getting changed from the keypad. When the data protection is enabled, the "DATA PRTC" displays on the LCD monitor.

This data protection applies to access to data from the keypad. The data protection for access via the communications link (RS-485, T-Link, SX-bus, fieldbus, etc.) can be defined with H29.

F	0	0	D	A	T	A		P	R	T	C	

Data = 0: Allow data change. 0: CHGOK
1: Protect data. 1: PROTECT

Setting procedure

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

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

F01	Speed Command N1

F01 sets a command source that specifies a reference speed.

Using the terminal command ***N2/N1*** assigned to any digital input terminal switches a command source between the Speed command N1 specified by F01 and Speed command N2 specified by C25. For details about switching, refer to the ***N2/N1*** in the descriptions of E01 through E13 (data = 11).

F	0	1	S	P	D		C	M	D		1	

Data =
0: Enable the [∧] and [∨] keys on the keypad. 0: KEYPAD
1: Enable the voltage input to terminal [12] (0 to ±10 VDC) 1: 12INPUT
2: Enable the voltage input to terminal [12] (0 to +10 VDC) 2: 12(ABS)
3: Enable ***UP*** and ***DOWN*** terminal commands*1 (Initial value: 0) 3: U/D(0)
4: Enable ***UP*** and ***DOWN*** terminal commands*1 (Initial value: Last value) 4: U/D(BEF)
5: Enable ***UP*** and ***DOWN*** terminal commands*1 (Initial value: CRP1, CRP2) 5: U/D(CRP)
6: Enable a DIA card 6: DIA CARD
7: Enable a DIB card 7: DIB CARD
8: Enable the reference speed setting to terminal [Ai1] to [Ai4]. (0 to ±10 VDC)*2 8: N-REFV
9: Enable the current input to terminal [Ai2] (4 to 20 mADC)*3 9: N-REFC

*1 The ***UP*** and ***DOWN*** should be assigned to digital input terminals (X terminals) with E01 to E13 (data = 17 and 18) beforehand. For the initial and last values of the UP/DOWN function, refer to ***UP*** and ***DOWN*** in function codes E01 to E13.

*2 The ***N-REFV*** (Main speed setting) should be assigned to one of analog input terminals ([Ai1] to [Ai4]) with E49 to E52 (data = 25) beforehand.

*3 Exclusive to terminal [Ai2]. The ***N-REFC*** (Current input speed setting) should be assigned to analog input terminal [Ai2] with E50 (data = 26) beforehand.

Check the specified speed command with Menu #3 "Operation status monitor" on the keypad.

Shown at the right is the OPR MTR screen that appears when the inverter is running at 1200 r/min.

```
          1200
N*=1200. 0r/m
N =1200. 0r/m
f*  =xxxx. xHz
TRQ=xxxx. x%
∧∨→PAGE SHIFT 1
```

F02 Operation Method

F02 selects a command source that specifies a run command.

F02 OPR METHOD

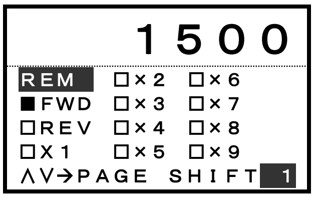
Data = 0: Enable the (FWD), (REV), and (STOP) keys on the keypad (Local mode). 0: KEYPAD
1: Enable input terminal commands ***FWD*** and ***REV*** (Remote mode). 1: FWD, REV

The remote and local modes can be switched also by pressing the (RESET) and (STOP) keys simultaneously. This key operation changes the setting of F02.

When H30 (Communications link operation) = "2" or "3," link operation has priority over the setting of F02.

When F02 = 0, entering a run command from the keypad turns the green LED lamp ON. When F02 = 1, to check the command status, use Menu #4 "I/O Checking" (REM screen) on the keypad and check that the box of the current input (***FWD*** or ***REV***) appears black (■).

Shown at the right is the I/O screen that appears when ***FWD*** is externally turned ON.



Note that the COMM screen in Menu #4 "I/O Checking" shows commands entered via the communications link. It has no relationship with terminal block commands.

F03 Maximum Speed M1

F03 specifies the maximum speed (r/min) for motor 1. Specifying the maximum speed exceeding the rating of the equipment driven by the inverter may damage the motor or the machinery. Make sure that the maximum speed setting matches the equipment rating.

The ratio between the inverter rated speed and the maximum speed should be 1 : 6 or below.

F03 M1—MAX

Data setting range: 50 to 30000 (r/min)

⚠CAUTION

Settings of some function codes (relating to the acceleration/deceleration time and the ASR P gain of analog speed setting) are based on the maximum speed (F03). Changing the maximum speed in the already adjusted system in order to decrease the top speed may cause the inverter to malfunction.

It is therefore necessary to change the ASR P gain (F61/C40/C50/C60) in proportion to the change of the F03 setting. When F03 = 1500 and F61 = 10.0, for example, changing the F03 setting from 1500 to 150 will cause hunting. This change means that the ASR P gain is multiplied by 10 (1500/150), so be sure to change the F61 setting from 10.0 to 1.0.

F04 Rated Speed M1

F04 specifies the rated speed in the constant torque range of motor 1. Set the rated speed printed on the nameplate labeled on the motor.

Selecting a VG-dedicated motor with P02 automatically configures the F04 data and does not allow it to be changed. Selecting the "P-OTR" with P02 does not allow the F04 data to be changed.

The ratio between the inverter rated speed and the maximum speed should be 1 : 6 or below.

F04 M1—Nr

Data setting range: 50 to 30000 (r/min)

F05 Rated Voltage M1

F05 specifies the rating of the output voltage to be supplied to motor 1. Set the rated voltage printed on the nameplate labeled on the motor.

Selecting a VG-dedicated motor with P02 automatically configures the F05 data and does not allow it to be changed. Selecting the "P-OTR" with P02 does not allow the F05 data to be changed.

F	0	5	M	1	–	V	r					

Data setting range: 80 to 999 (V)

F07 Acceleration Time 1

F08 Deceleration Time 1

F07 specifies the acceleration time, the length of time required for the speed to increase from "0" to the maximum speed. F08 specified the deceleration time, the length of time required for the speed to decrease from the maximum speed down to "0."

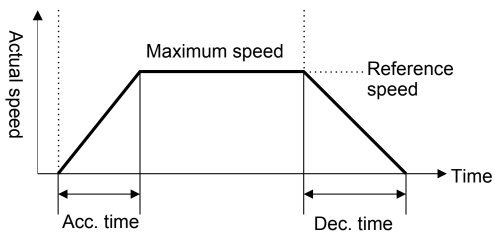
The actual acceleration/deceleration time is calculated based on the maximum speed (F03, A06, A106). See the expression given below.

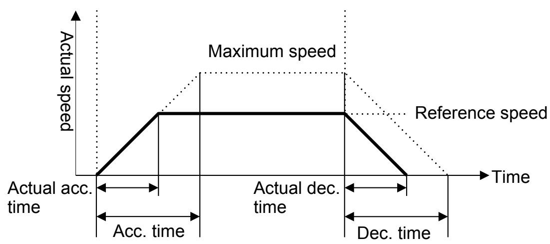
$$\text{Actual acceleration/deceleration time} = \text{F07/F08 setting} \times \frac{\text{Reference speed}}{\text{Maximum speed (F03, A06, A106)}}$$

If the S-curve acceleration/deceleration is selected, the actual acceleration/deceleration time becomes longer than the specified time. For details, refer to the description of F67.

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

Data setting range: 0.01 to 99.99 (s)
100.0 to 999.9 (s)
1000 to 3600 (s)





Writing data to S08 (Acceleration time) or S09 (Deceleration time) via the communications link (RS-485, T-Link, SX-bus, or fieldbus) automatically copies the data to F07 or F08 as is, respectively.

F10	M1 Electronic Thermal Overload Protection (Select motor characteristics)
F11	**M1 Electronic Thermal Overload Protection (Detection level)**
F12	**M1 Electronic Thermal Overload Protection (Thermal time constant)**

F10 through F12 specify the thermal characteristics of the motor (motor rotation, output current and running time) for its electronic thermal overload protection that is used to detect overload conditions of the motor inside the inverter. This function protects motor M1. When a dedicated motor for the FRENIC-VG is used, disable this function (no setting is required).

F10 M1-EOL-SEL

- Select motor characteristics

When a dedicated motor for the FRENIC-VG is used, connecting an NTC thermistor built in the motor with the FRENIC-VG activates the motor overheat protection so that no electronic thermal overload protection is required. Disable this function.

If the motor overheat protection by an NTC thermistor is not available, use F10 to select the motor cooling mechanisms (shaft-driven cooling fan or separately powered cooling fan) to specify its characteristics.

When 150% of the current specified by F11 flows for the time specified by F12, the inverter activates the motor overload protection and issues an alarm OL1.

Data = 0: Disable (For a dedicated motor for the FRENIC-VG. Protected by an NTC thermistor)
1: Enable (For a general-purpose motor with shaft-driven cooling fan)
2: Enable (For a Fuji inverter-driven motor with separately powered cooling fan)

F11 M1-EOL-LVL

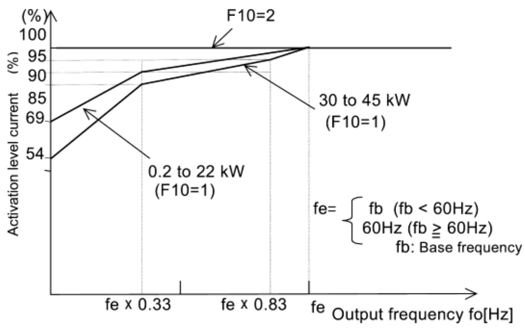
- Detection level

F11 specifies the level (current value) at which the electronic thermal overload protection becomes activated.

In general, set the F11 data to 1.0 to 1.1 times of the M1 rated current specified by P04.

By factory default, F11 data is set to the rated current of the Fuji general-purpose motor. To connect any other motor, change the setting.

Data 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

F12 specifies the thermal time constant of the motor. If the current of 150% of the overload detection level specified by F11 flows for the time specified by F12, the electronic thermal overload protection becomes activated to detect the motor overload.

The thermal time constant for general-purpose motors including Fuji motors is approx. 5 minutes for motors of 22 kW or below and 10 minutes for motors of 30 kW or above by factory default

Data setting range: 0.5 to 75.0 (min)

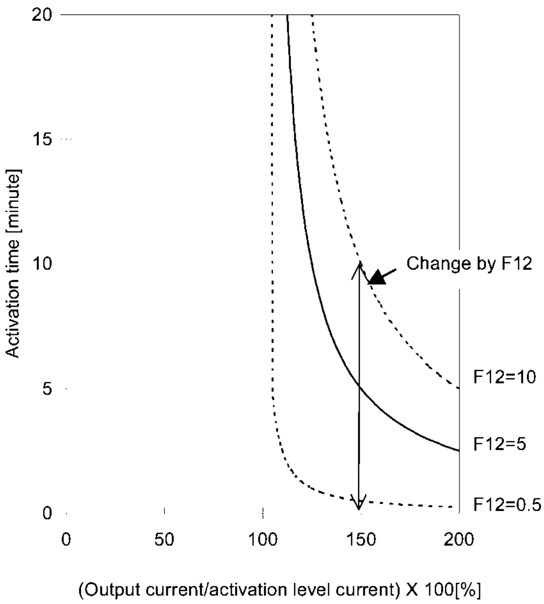
(Example) When the F12 data is set at 5 minutes

As shown at the right, the electronic thermal overload protection is activated to detect an alarm condition (alarm code OL1) when the output current of 150% of the overload detection level (specified by F11) flows for 5 minutes, and 120% for approx. 13 minutes.

Since the current flowing through a motor is not usually constant, the average current in a certain period is used to start the timer for the electronic thermal overload protection.

Note: In the case of the load which is repeatedly and very frequently driven by a motor, the motor current fluctuates largely so that it may enter the short-time rating (100% or more) range of the motor repeatedly. If it happens, refer to Chapter 9, Section 9.1.3.4 "Calculating the RMS rating of the motor" to calculate the equivalent effective current and limit this value under the rated current of a motor (in the case of a separately-powered cooling fan).

Example of current-activation time characteristics



F14 Restart Mode after Momentary Power Failure (Mode selection)

F14 specifies the action to be taken by the inverter such as trip and restart in the event of 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.

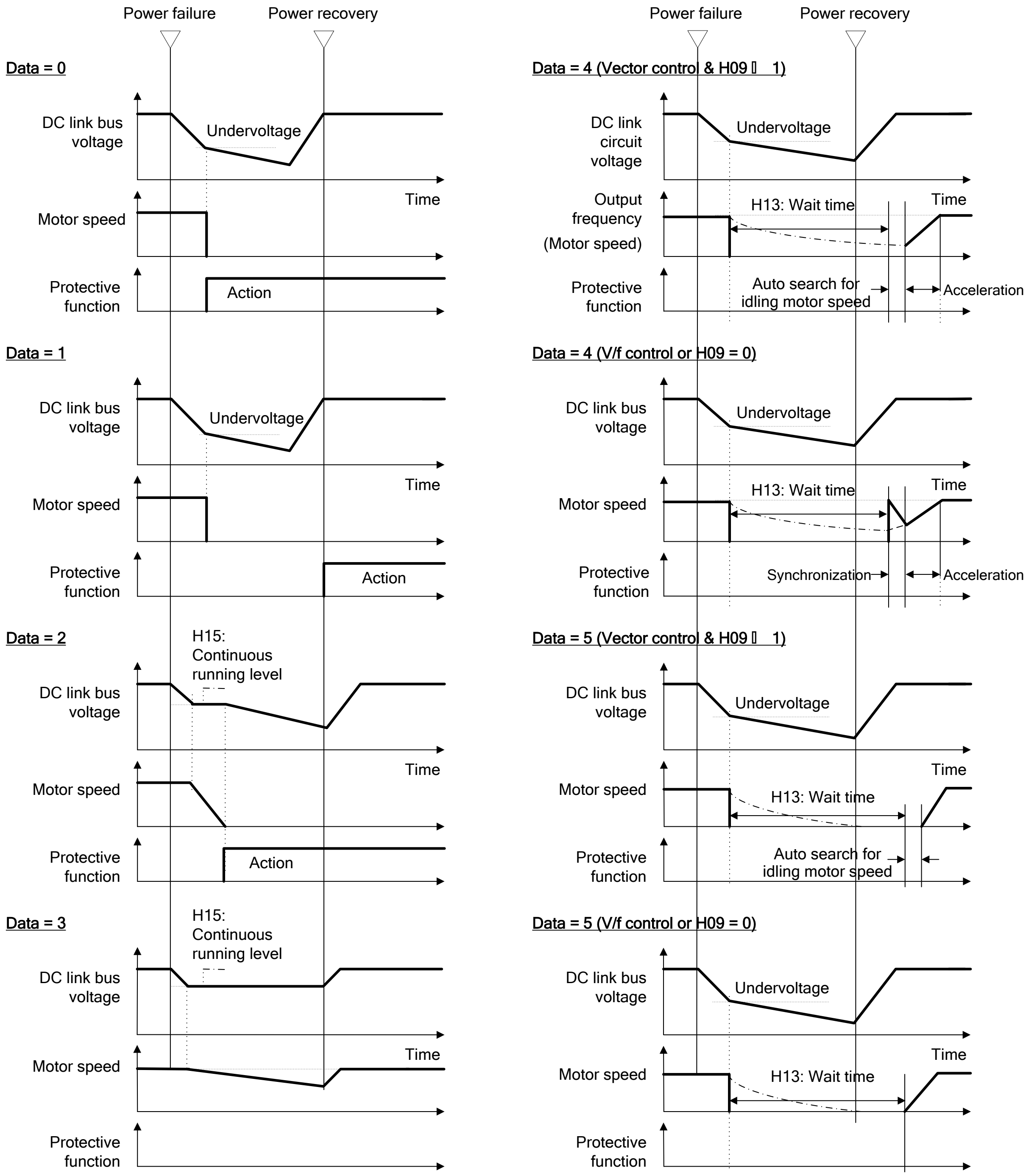
See the following table for more information on this function.

The restart mode related function codes include H13 to H17 (Restart Mode after Momentary Power Failure, Wait time, Decrease rate in speed, Continuous running level, Run command self-hold setting and Run command self-hold time), H09 (Starting Mode, Auto search), and E01 (Terminal [X1] Function ***STM***, data = 26 "Enable auto search for idling motor speed at starting"). Also be familiar with these functions.

To restart the inverter after momentary power failure under V/f control, enable the overcurrent suppression (H58 = 1).

F14 RESTART

<table>
<tr><th>Data for F14</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 LU 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 LU 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 LU is not activated. The inverter collects the inertia energy of the load and controls the motor until it stops, then the undervoltage protective function LU is activated. If the amount of inertia energy from the load is small, and the undervoltage level is achieved during deceleration, the undervoltage protective function LU 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. 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 rowspan="2">4</td><td rowspan="2">Active (restart at the speed on power failure)</td><td rowspan="2">If undervoltage is detected, the protective function is not activated and the output is turned off.</td><td colspan="2"><u>Vector control & H09 ≥ 1</u>
The inverter performs auto search for idling motor speed and restarts running the motor at the same speed as the motor.</td></tr>
<tr><td colspan="2"><u>V/f control or H09 = 0</u>
The inverter restarts running the motor at the speed at which the power failure occurred.</td></tr>
<tr><td rowspan="2">5</td><td rowspan="2">Active (restart at the starting speed)</td><td rowspan="2">If undervoltage is detected, the protective function is not activated and the output is turned off.</td><td colspan="2"><u>Vector control & H09 ≥ 1</u>
The inverter performs auto search for idling motor speed and restarts running the motor at the same speed as the motor.</td></tr>
<tr><td colspan="2"><u>V/f control or H09 = 0</u>
The automatically restarts running the motor at 0 r/min.</td></tr>
</table>


Power failure
Power recovery
Data = 0
DC link bus voltage
Undervoltage
Time
Motor speed
Protective function
Action
Data = 1
DC link bus voltage
Undervoltage
Time
Motor speed
Protective function
Action
Data = 2
H15: Continuous running level
DC link bus voltage
Time
Motor speed
Protective function
Action
Data = 3
H15: Continuous running level
DC link bus voltage
Time
Motor speed
Protective function
Power failure
Power recovery
Data = 4 (Vector control & H09 ▯ 1)
DC link circuit voltage
Undervoltage
Output frequency (Motor speed)
H13: Wait time
Time
Protective function
Auto search for idling motor speed
Acceleration
Data = 4 (V/f control or H09 = 0)
DC link bus voltage
Undervoltage
Motor speed
H13: Wait time
Time
Protective function
Synchronization
Acceleration
Data = 5 (Vector control & H09 ▯ 1)
DC link bus voltage
Undervoltage
Motor speed
H13: Wait time
Time
Protective function
Auto search for idling motor speed
Data = 5 (V/f control or H09 = 0)
DC link bus voltage
Undervoltage
Motor speed
H13: Wait time
Time
Protective function

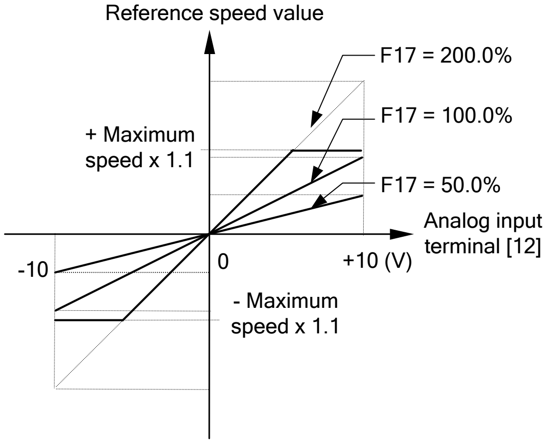
F17 Gain (for terminal [12] input)

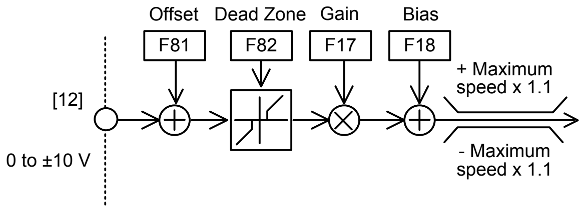
F17 specifies the proportion to the reference speed value (analog input) from control terminal [12]. The reference speed is limited to 110% (1.1 times) of ±maximum speed (F03).

Note: The reference speed value is finally limited by the speed limiter (F76, F77, F78).

F17 GAIN (12)

Data setting range: 0.0 to 200.0 (%)





F18 Bias (for terminal [12] input)

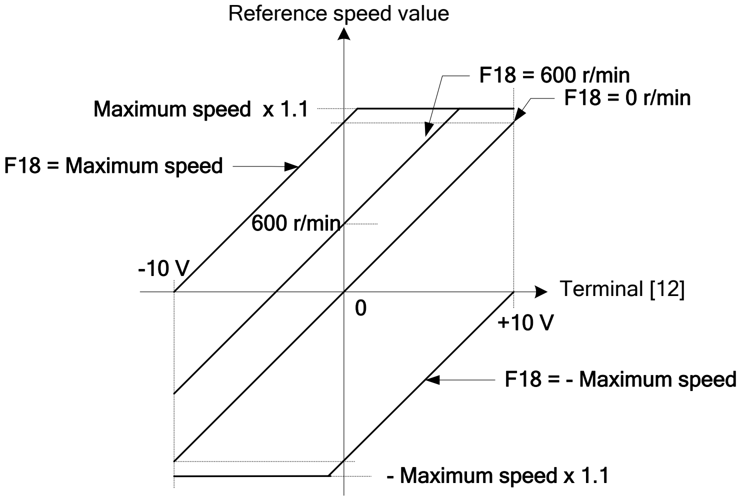
F18 specifies a bias speed to be added to the reference speed value (analog input) from control terminal [12].

The bias speed is limited to ±maximum speed (F03). The reference speed is limited to 110% (1.1 times) of ±maximum speed (F03).

Note: The reference speed value is finally limited by the speed limiter (F76, F77, F78).

F18 BIAS (12)

Data setting rage: 0 to 30,000 (r/min)



F20	DC Braking (Braking starting speed)
F21	DC Braking (Braking level)
F22	DC Braking (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

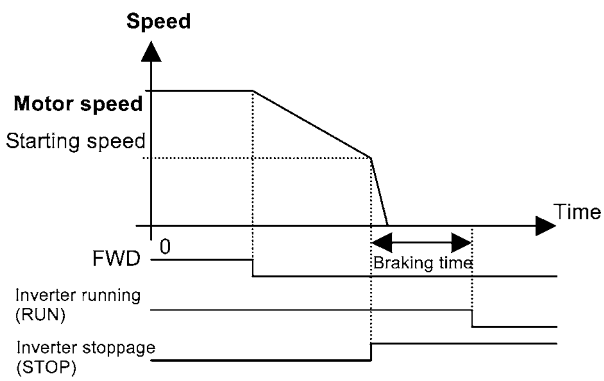
Sets the operation time for the DC braking

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.

Specify the slip frequency conversion speed level at F20. If a very large value is specified, the control becomes unstable, possibly causing overvoltage protection being activated.



⚠CAUTION

The brake function of the inverter does not provide a mechanical hold.

You may be injured.

F23	Starting Speed (Speed)
F24	Starting Speed (Holding time)

You can set a starting speed to assure a starting torque.

Under vector control

This function acts to release a mechanical brake. If you enter the operation command after setting the starting speed to 0 r/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.

Under V/f control

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

F23 START N

- Starting speed

Sets the rotation at start.

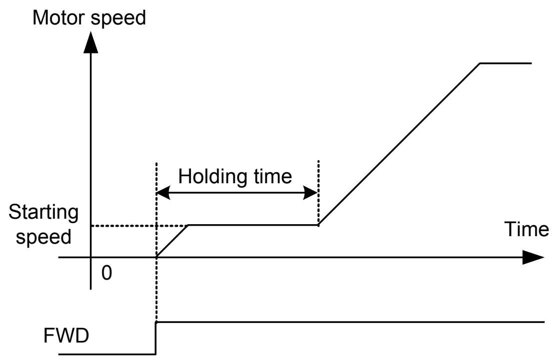
Setting range: 0.0 to 150.0 (r/min)

F24 HLD START t

- Holding time

Sets the period for maintaining the starting time.

Setting range: 0.00 to 10.00 (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 frequency)

F26 controls the carrier frequency to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, avoid resonance with the machinery, and reduce the leakage current from the output (secondary) circuit.

F 2 6 M T R S O U N D

Data setting range: 2 to 15 (kHz) (The upper limit differs depending upon the capacity and current rating (HD/LD/MD).)

Carrier frequency	2 to 15 kHz
Motor sound noise emission	High to low
Ripples in output current waveform	Large to small
Leakage current	Low to high
Electromagnetic noise emission	Low to high

Note 1: Specifying a too low carrier frequency causes the output current waveform to have a large amount of ripples (harmonics components). As a result, the motor loss increases, causing the motor temperature to rise. Specifying a high carrier frequency increases the motor loss, causing the inverter temperature to rise.

Note 2: When F26 = 9, 8 kHz of the carrier frequency applies, when F26=11, 10 kHz, when F26 = 13 or 14, 12 kHz.

Note 3: Running a permanent magnet synchronous motor (PMSM) at a low carrier frequency may heat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, be sure to check the allowable carrier frequency of the motor.

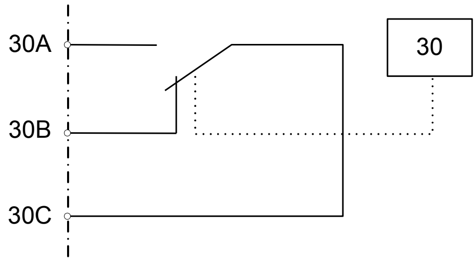
F36	30RY Drive Mode

F36 selects whether to activate (excite) the alarm output relay (30RY) in a normal state or in an abnormal state.

F36 RY MODE

Data setting range: 0, 1

Data for F36	Normal state	Abnormal state
0	30A-30C: OFF 30B-30C: ON	30A-30C: ON 30B-30C: OFF
1	30A-30C: ON 30B-30C: OFF	30A-30C: OFF 30B-30C: ON



Note: When F36 = 1, the contacts between 30A and 30C are connected after the inverter control voltage is established (about five seconds after turning on). Since the relay is excited in a normal state, the relay can detect a wire break in the alarm output line.

F37	Stop Speed (Speed)
F38	Stop Speed (Detection mode)
F39	Stop Speed (Zero speed holding time)

F37 STOP N

- Stop speed

F37 specifies the stop speed.

Data setting range: 0.0 to 150.0 (r/min)

F38 DET SIGNAL

- Detection mode

F38 specifies whether to detect the stop speed with the reference speed (Reference speed 4 (ASR input)) or detected speed (Detected speed 1).

Data setting range: 0: Detected speed
1: Reference speed

However, under V/f control or vector control without speed sensor, the reference speed only takes effect irrespective of the F38 setting.

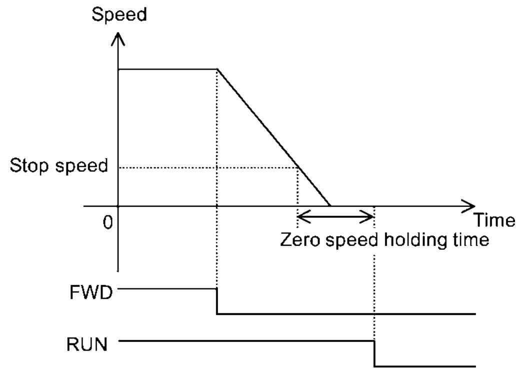
Under V/f control, the inverter stops its output when it detects the output frequency (M05), irrespective of the F38 setting.

F39 HLD STOP t

- Zero speed holding time

Data setting range: 0.00 to 10.00 (s)

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



This function is used to adjust the timing to apply a mechanical brake.

Under V/f control or vector control without speed sensor, however, this function is invalid. Even under vector control, when H41 (Torque command source) ≠ 0 or H42 (Torque current command source) ≠ 0, this function is invalid.

F40	Torque Limiter Mode 1
F41	Torque Limiter Mode 2

F40 specifies torque limiter mode 1 in which the torque limiter, power limiter or torque current limiter can be selected. In the mode, it is also possible to disable those limiters. Turning ON the terminal command ***F40-CCL*** ("Cancel F40"), which is functionally equivalent to F40 set at "0," also disables those limiters.

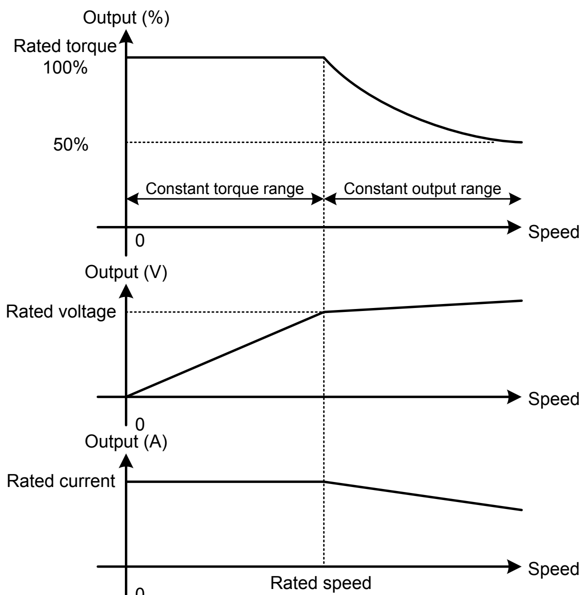
F40 TLIM MODE1

Data setting range: 0: Disable limiters
1: Enable torque limiter
2: Enable power limiter
3: Enable torque current limiter

Under V/f control, the torque current limiter is enabled irrespective of whether F40 is set at 1, 2 or 3.

<u>Background information</u>

The right graph shows a continuous permissible torque (not short-time rating) for forward rotation driving in the speed control range (0 to Rated speed to 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.



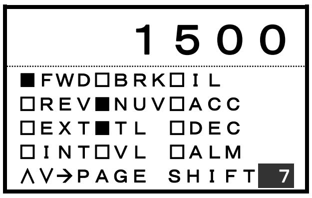
Output characteristic
(first quadrant, forward rotation driving)

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

Over the rated speed, since the inverter capacity (output: power) restricts the torque, the output torque decreases in inverse proportion to the speed. The torque limiter condition switches depending upon whether the speed is less than or exceeds the rated speed.

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.



F41 specifies torque limiter mode 2 in which the configuration of target quadrants can be selected.

F41 TLIM MODE2

Data setting range: 0: Level 1 to all four quadrants
1: Level 1 to driving, Level 2 to braking
2: Level 1 to upper limit, Level 2 to lower limit
3: Level 1/Level 2 (switchable) to 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 descriptions of F42 and F43.

Under V/f control, setting F41 at "3" produces the same result as "0."

Description and application of the limiter mode 1

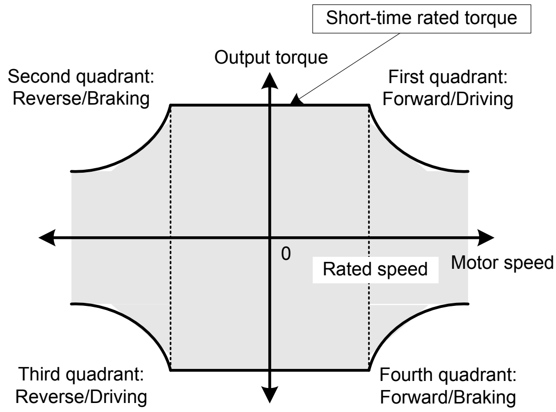
Limiter type	Limiter description	Application
Disable limiters F40 = 0 or ***F40-CCL*** = ON	Limits the torque by the maximum output current (One-minute, ten-second ratings) in the entire speed limiting range. $\tau\,(\text{Torque}\,\%) = \dfrac{\sqrt{\text{Imax}^2 - \text{Im}^2 - (I_T \times \frac{\text{Iron loss coefficient}}{100})^2}}{I_T} \times 100(\%)$ (Ex.) In the case of HD-mode inverters of 30 kW, 200 V, with FRENIC-VG dedicated motor, the maximum driving torque is 214%. Imax (Short-time rated current) = 238 (A) Im (Exciting current: P08) = 53.42 (A) It (Torque current: P09) = 108.18 (A) Iron loss coefficient: P12 = 2.50% $\tau\,(\text{Torque}\,\%) = \dfrac{\sqrt{238^2 - 53.42^2 - (\frac{108.18 \times 2.50}{100})^2}}{108.18} \times 100(\%)$ $\fallingdotseq 214(\%)$	Use for the shortest acceleration/deceleration with the inverter. Note: Check the operation sequence to avoid activating the protective function due to the inverter over load 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.
Enable torque limiter F41 = 1	Limits the output of the speed control unit (ASR). Restrain the torque (N· m) in terms of the percentage of the rated torque of a motor assumed as 100%. The maximum output current of the inverter 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.
Enable power limiter F41 = 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%. The maximum output current of the inverter 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). Use for braking that uses the capacity of a braking resistor. Also use for stopping that uses only the inverter loss (kW) when you do not use an external braking resistor (DB).
Enable torque current limiter F41 = 3	Limits the torque in the constant torque range and limits the power in the constant output range. Restricts the torque current command 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. Use when you limit the output torque for the motor temporarily.

See the following pages for detailed application examples.

(1) Disable limiters

Code	Set value	Description
F40	0	Disable limiters
F41	0, 1, 2, 3	Not effective

- Limits the torque by the maximum output current (one-minute, three-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 (RHC series) or connect braking resistors.

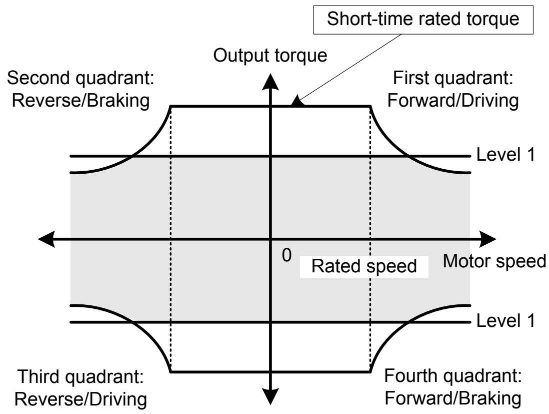


(2) Enable torque limiter

(2)-1 Level 1 to all four quadrants

Code	Set value	Description
F40	1	Enable torque limiter
F41	0	Level 1 to all four quadrants

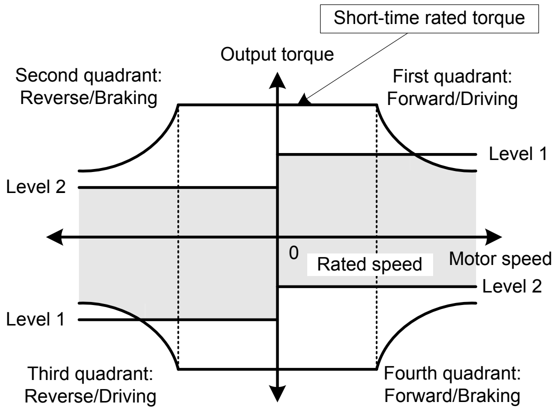
- The short-time rated torque limits the torque where the Level 1 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.



(2)-2 Level 1 to driving, Level 2 to braking

Code	Set value	Description
F40	1	Enable torque limiter
F41	1	Level 1 to driving, Level 2 to braking

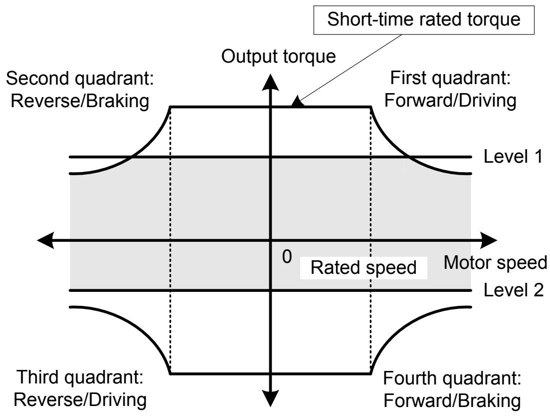
- The short-time rated torque limits the torque where the Level 1 or the Level 2 exceeds the short-time rated torque as in the right figure.
- Though you can specify the Level 1 and the Level 2 both in plus and minus values, you do not have to use a minus value, since it is interpreted as a plus value.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

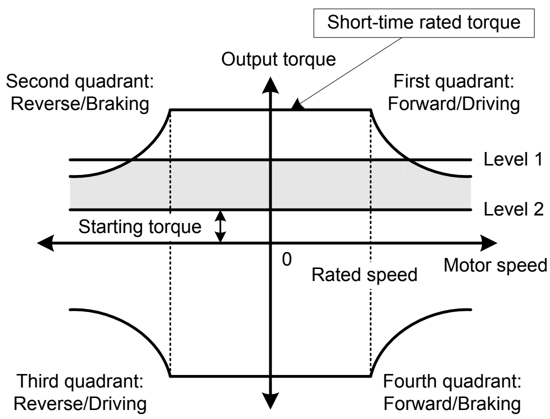


(2)-3 Level 1 to upper limit, Level 2 to lower limit

Code	Set value	Description
F40	1	Enable torque limiter
F41	2	Level 1 to upper limit, Level 2 to lower limit

- Plus and minus values specify Level 1 and Level 2. Make sure the setting polarity is correct. Usually **Level 1 is set to plus and 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).





⚠CAUTION

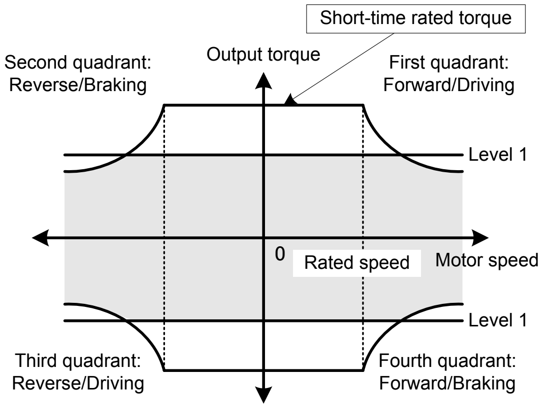
If you set the Level 2 larger than Level 1, the output torque will be fixed to the Level 1. Unless you want this operation, never use this setting. A motor may become out of control and dangerous.

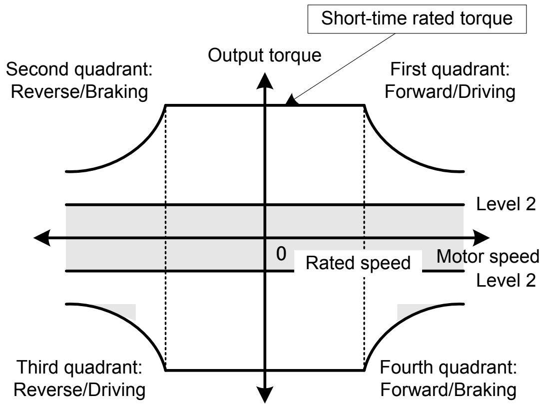
Accidents or physical injuries may occur.

(2)-4 Level 1/Level 2 (switchable) to all four quadrants

Code	Set value	Description
F40	1	Enable torque limiter
F41	3	Level 1/Level 2 (switchable) to all four quadrants

- 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.





- 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) Enable power limiter

(3)-1 Level 1 to all four quadrants

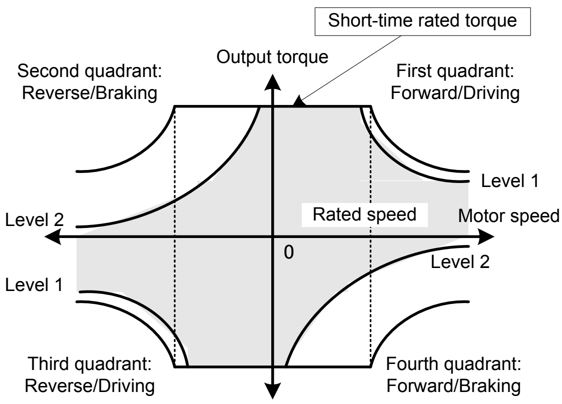
Code	Set value	Description
F40	2	Enable power limiter
F41	0	Level 1 to all four quadrants

Since there is not such an application, this setting is not recommended although setting is possible.

(3)-2 Level 1 to driving, Level 2 to braking

Code	Set value	Description
F40	2	Enable power limiter
F41	1	Level 1 to driving, Level 2 to braking

- 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 Level 1 to upper limit, Level 2 to lower limit

Code	Set value	Description
F40	2	Enable power limiter
F41	2	Level 1 to upper limit, Level 2 to lower limit

Since there is not such an application, this setting is not recommended although setting is possible.

(3)-4 Level 1/Level 2 (switchable) to all four quadrants

Code	Set value	Description
F40	2	Torque limiter enabled
F41	3	Level 1/Level 2 (switchable) to all four quadrants

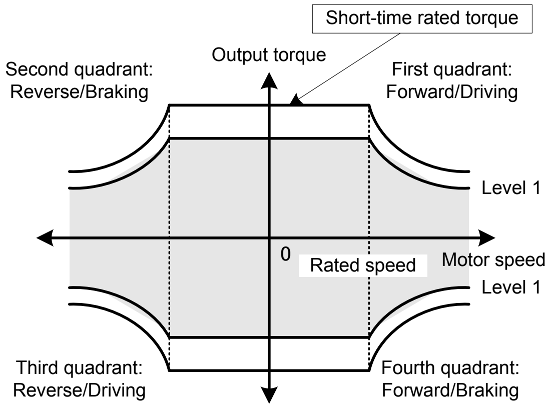
Since there is not such an application, this setting is not recommended although setting is possible.

(4) Enable torque current limiter

(4)-1 Level 1 to all four quadrants

Code	Set value	Description
F40	3	Enable torque current limiter
F41	0	Level 1 to all four quadrants

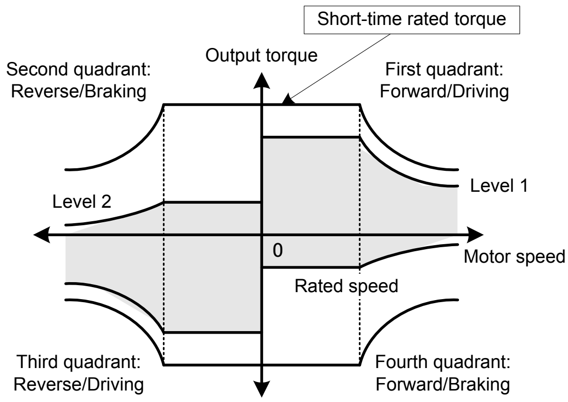
- Unless you set the Level 1 over the short-time rated torque, the short-time rated torque does not limit the torque.
- When protective actions (inverter overload OLU or motor overload OL1, OL2, OL3) occur frequently, you can lower the setting level to avoid this phenomenon.
- Though you can specify 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 Level 1 to driving, Level 2 to braking

Code	Set value	Description
F40	3	Enable torque current limiter
F41	1	Level 1 to driving, Level 2 to braking

- 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 Level 1 to upper limit, Level 2 to lower limit

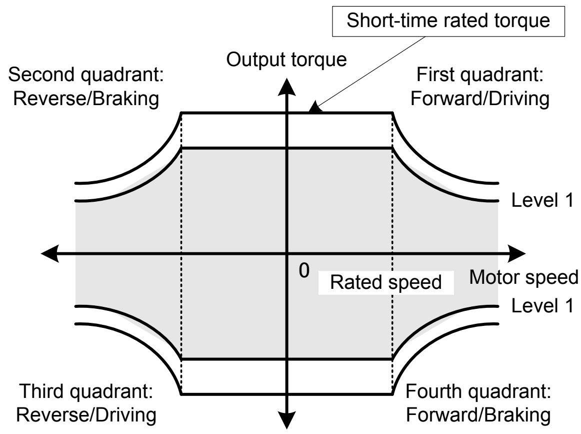
Code	Set value	Description
F40	3	Enable torque current limiter
F41	2	Level 1 to upper limit, Level 2 to lower limit

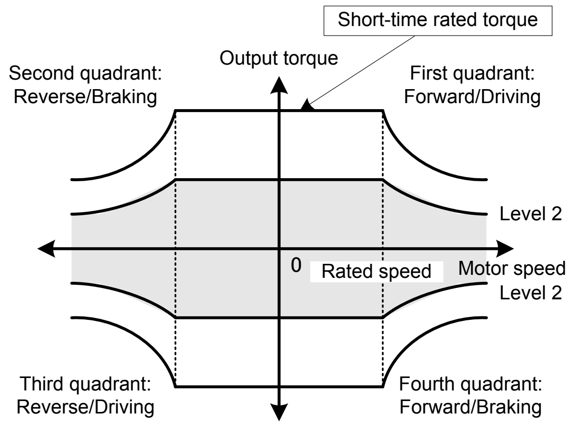
Since there is not such an application, this setting is not recommended although setting is possible.

(4)-4 Level 1/Level 2 (switchable) to all four quadrants

Code	Set value	Description
F40	3	Enable torque current limiter
F41	3	Level 1/Level 2 (switchable) to all four quadrants

- When you turn on with assigning the torque limiter ***TL2/TL1*** (Level 1, Level 2 selection) to a digital input signal, you can switch between the Level 1 and the 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.
- When protective actions (inverter overload OLU or motor overload OL1, OL2, OL3) 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 Level 1 Source
F43	Torque Limiter Level 2 Source

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 (RS-485, 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

Data setting range: 0 (Function code F44)
1 (Ai ***TL-REF1***)
2 (DIA card)
3 (DIB card)
4 (Communications link)
5 (PID output)

- Level 2

Selects a mean that sets the Level 2

Data setting range: 0 (Function code F45)
1 (Ai ***TL-REF2***)
2 (DIA card)
3 (DIB card)
4 (Communications link)
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 using 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 using 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 (offset, dead zone, gain, bias, filter, and increment/decrement limiter).

(4) When using 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 using the communications 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 (RS-485, T-Link, SX, field bus).
- Set 1 or 3 to the function code H30 to enable the command 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 (command 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 using 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 (Section 4.1.9) 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 Level 1
F45	Torque Limiter 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

Data setting range: -300 to 300 (%)

F46	Mechanical Loss Compensation

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

F	4	6	T	–	M	E	C	–	L	O	S	

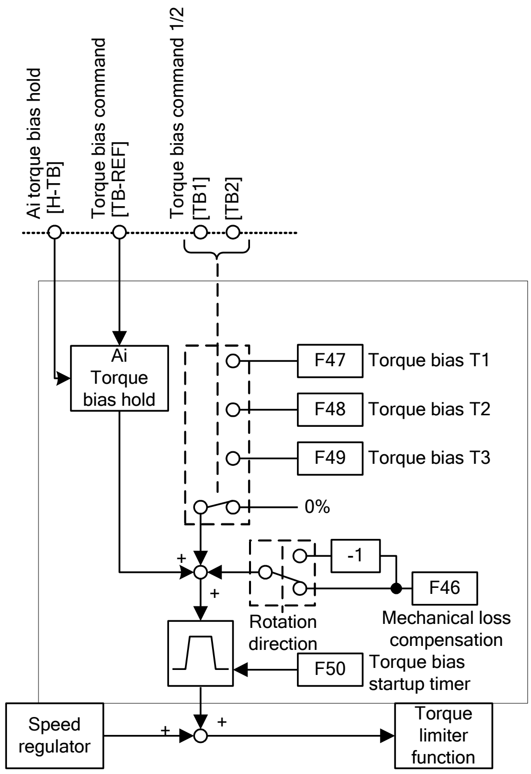
Data setting range: -300.00 to 300.00 (%)

F47	Torque Bias T1
F48	Torque Bias T2
F49	Torque Bias T3

You can add these setting values to the torque command values. The addition is conducted on a stage before the torque limiter. You can use the function selection Di, the torque bias command 1 [TB1] and the torque bias command 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			

Data setting range: -300.00 to 300.00 (%)



F50	Torque Bias Startup Timer

Sets the time to increase the torque by 300%.

If there is a shock at the start of operation with a torque bias added, adjust this timer.

F	5	0	T	–	B	I	A	S	–	T	I	M

Data setting range: 0.00 to 1.00 (s)

F51 Torque Command Monitor (Polarity)

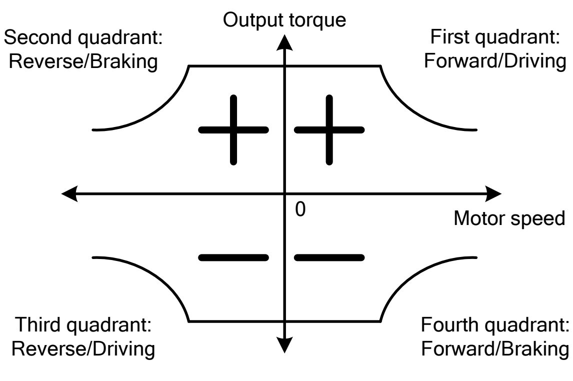
Sets the polarity for data display related to torque. (AO monitor, KEYPAD panel LED monitor, KEYPAD panel LCD monitor)

F51 T-REF-MNTR

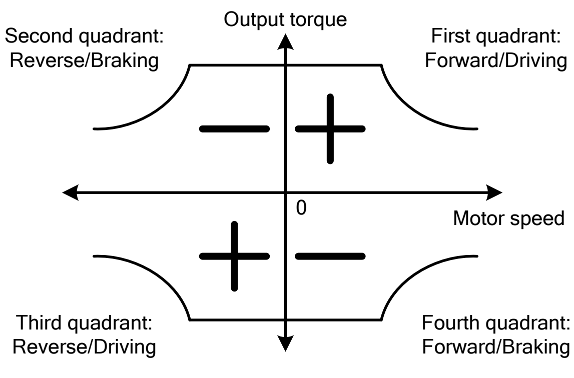
Data setting range: 0 (Torque polarity)
1 (+ for driving, − for braking)

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 command value
	4	Torque command value
	5	Calculated torque value
KEYPAD panel LCD monitor	Operation status monitor	Torque command value
	Alarm information	Torque command value on alarm
Analog output (AO1, 2, 3)	6	Torque current command value (torque ammeter, two-way deflection)
	8	Torque command value (torque meter, two-way deflection)
Function codes M (monitor codes)	M02	Torque command value
	M03	Torque current command value
	M07	Calculated torque value
	M08	Calculated torque current value
	M28	Torque command value on alarm
	M29	Torque current command 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	LED Monitor (Display coefficient A)
F53	**LED Monitor (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 value of the PID regulator on the KEYPAD panel LED.

Data 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)

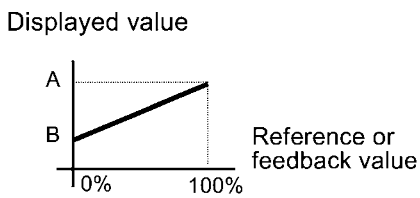
The effective display range is 0.01 to 200.00 while the setting range is ±999.00. The minimum value 0.01 or the maximum value 200.00 replaces a value out of the display range. Foe example, you should specify as F52=0.02 when the motor speed is 1500 (r/min) and the line speed is 30 (m/min).

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				



F54	LED Monitor (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.

Specify the time constant of the primary filter.

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

Data setting range: 0.0 to 5.0 (s)

F55 LED Monitor (Item selection)

F55 specifies the running status item (listed below) to be monitored and displayed on the LED monitor.

F55 LED MNTR

Data for F55	Function	Unit	Description
00	Detected speed 1	(r/min)	F56 switches the display to be applied when the motor is stopped.
01	Reference speed 4	(r/min)	ASR input data
02	Output frequency	(Hz)	Slip included
03	Torque current command value	(%)	
04	Reference torque	(%)	
05	Calculated torque	(%)	
06	Input power	(kW, HP)	Switchable between kW and HP with F60.
07	Output current	(A)	
08	Output voltage	(V)	
09	DC link bus voltage	(V)	
10	Magnetic-flux command value	(%)	
11	Calculated magnetic-flux value	(%)	
12	Motor temperature	(°C)	Displays --- when NTC thermistor is not installed
13	Load shaft speed	(r/min)	Use F56 to change display when motor is stopping
14	Line speed	(m/min)	
15	Ai adjustment value (12)	(%)	
16	Ai adjustment value (Ai1)	(%)	
17	Ai adjustment value (Ai2)	(%)	
18	Ai adjustment value (Ai3)	(%)	Displayed when an option is used
19	Ai adjustment value (Ai4)	(%)	Displayed when an option is used
20	PID command value	(%)	Displayed in the PID mode
21	PID feedback value	(%)	
22	PID output value	(%)	
23	Option monitor 1	(HEX)	Displayed when an option is used (HEX: Hexadecimal data)
24	Option monitor 2	(HEX)	
25	Option monitor 3	(DEC)	Displayed when an option is used (DEC: Decimal data) Positive data.
26	Option monitor 4	(DEC)	
27	Option monitor 5	(DEC)	Displayed when an option is used (DEC: Decimal data) Positive and negative data.
28	Option monitor 6	(DEC)	
30	Load factor	(%)	
31	Input power	F60 = 0 (kW) F60 = 1 (HP)	
32	Input watt-hour	(kWh)	Input watt-hour = Display value x 100 (kWh)

- Values 20 to 22 display when H20 (PID Control, Mode selection) is set at "1" (Active), "2" (Inverse action 1) or "3" (Inverse action 2), respectively.
- Values 18, 19, 23 to 28 display when specific control options are mounted. See the corresponding option section in Chapter 6 for more details.

F56 | LED Monitor (Display when stopped)

F56 switches the F55 data display between the detected data and reference data when the motor is stopped (No inverter output, STOP state).

F56 LED MNTR2

Data setting range: 0 (Display reference data)
1 (Display detected data (actual data))

F56 takes effect when F55 = 0 (Detected speed 1), = 13 (Load shaft speed), or = 14 (Line speed).

F57 | LCD Monitor (Item selection)

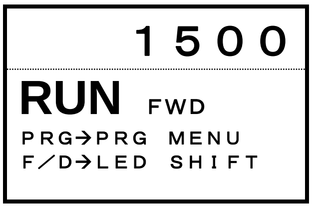
F57 selects the display contents of the LCD monitor in the Running mode.

F57 LCD MNTR

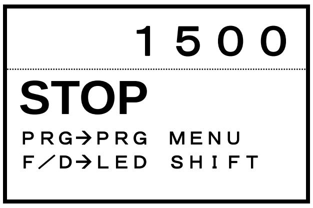
Data setting range: 0 (Running status, rotation direction, and date & time or operation guide)
1 (Bar graphs for motor speed, output current, and torque command value)

When F57 = 0

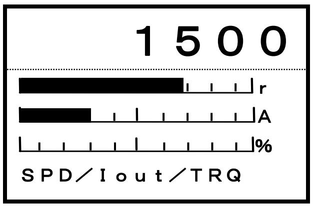
In running



At a stop



When F57 = 1



Full scale values for bar graphs

Display item	Full scale value
Motor speed	Maximum speed (F03, A06, and A106)
Output current	Motor rated current × 200%
Torque command value	Rated torque × 200%

Note: The scale is not adjustable.

F58 LCD Monitor (Language selection)

F58 selects a language to be displayed on the LCD monitor.

F	5	8	L	A	N	G	U	A	G	E		

Data for F58	Displayed language	Data for F58	Displayed language
0	Japanese	6	Chinese
1	English	7	Korean

Note 1: The language in the LCD screens shown in this manual is English.

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

Note 3: Even if Korean is selected, the function code names are shown in English.

Note 4: When F58 = 2 to 5, the LCD screens are shown in English.

F59 LCD Monitor (Contrast control)

F59 controls the contrast of the LCD monitor. Increasing the data value increases the contrast and decreasing it decreases the contrast.

F	5	9	C	O	N	T	R	A	S	T		

Data for F59	0, 1, 2 ………… 8, 9, 10	
Screen	Light	Dark

F60 Output Unit (HP/kW)

F60 switches the display unit of the inverter output (input power) shown on the LED monitor and LCD monitor and the display unit of M1 motor selection (P02) between kW and HP.

F	6	0	k	W	/	H	P					

Data setting range: 0 (kW)
1 (HP)

F61	ASR1 (P-gain)
F62	ASR1 (Integral constant)

F61 and F62 specifies the P-gain and integral constant of the ASR1.

F	6	1	A	S	R	1	−	P				
F	6	2	A	S	R	1	−	I				

Data setting range: F61 = 0.1 to 500.0 (times)
F62 = 0.000 to 10.000 (s) (Setting 0.000 disables the integral constant.)

■ P gain

Adjust according to the mechanical inertia (inertia and mechanical constant) connected to the motor shaft. The factory default value 10.0 corresponds to the inertia of a single FRENIC-VG motor. The following table provides a guideline for setting. If you drive a machine whose inertia is larger than that of the FRENIC-VG 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.

Inertia	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 command is 100% (corresponding to the maximum speed setting) when the speed deviation (speed command − 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 0.000 to 10.000 s to set the speed deviation (speed command-observed speed) at steady state to zero. Setting 0.000 s 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

Integration action is a delay element. The constant of integration corresponds to the gain of a delay element. Increasing the response of the integration action makes the delay element larger, destabilizing 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 (Feedforward gain)

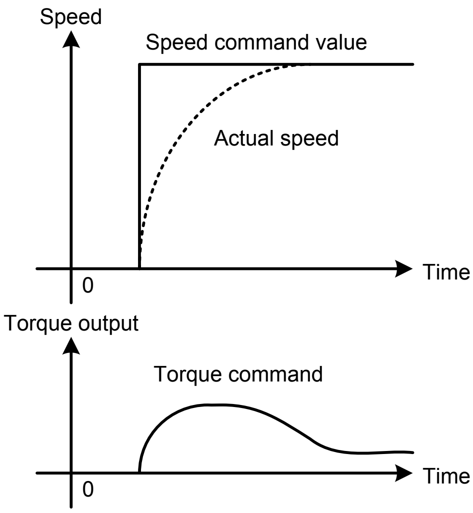
F63 specifies the feedforward gain for a feedforward control that adds torque determined by the change of the speed command to the torque command directly.

The PI control by the ASR is a feedback control adjusting the speed against the command 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 command value are followed after they appear in the deviation (Speed command - Actual speed). Since you can obtain a control value (torque command) for a known factor, you can expect a faster control by adding it to the torque command directly. This function is provided for this purpose.

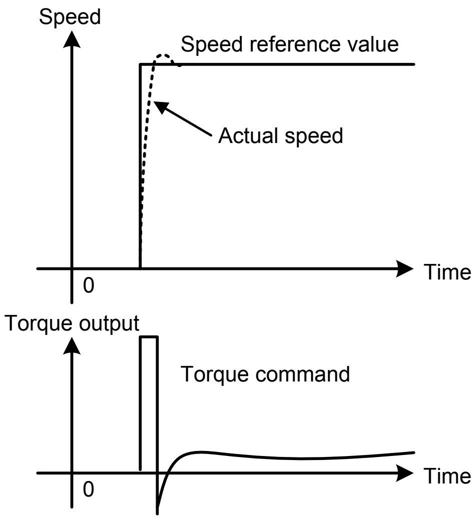
F63 ASR1–FF

Data setting range: 0.000 to 9.999 (s)

It is effective when the inertia is known. The differences in follow-up speed against the command 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 also 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)

F64 specifies the time constant for the first-order lag filter applied to a reference speed. Usually do not change the factory default.

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			

Data setting range: 0.000 to 5.000 (s)

F65 ASR1 (Detection filter)

F65 specifies the time constant for the first-order lag filter applied to the detected speed. Usually do not change the factory default. In particular, it is not necessary to change the factory default when a pulse generator (PG) is used for speed detection. Use an oscilloscope to check the waveform if the output of the PG is unstable.

Use this filter when you use the line speed detection signal ***LINE-N*** 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		

Data setting range: 0.000 to 0.100 (s)

F66	ASR1 (Output filter)

F66 specifies the time constant for the first-order lag filter applied to the torque command. 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		

Data 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.

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

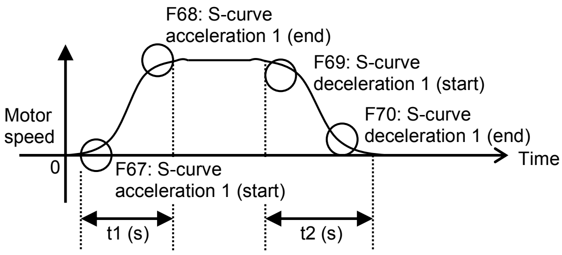
- Though you can reduce the resonance amplitude, excessive filter elements may cause instability.

3) Use oscillation suppressing observer

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

F67	S-curve Acceleration 1 (Start)
F68	S-curve Acceleration 1 (End)
F69	S-curve Deceleration 1 (Start)
F70	S-curve Deceleration 1 (End)

These function codes arrange 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	

Data setting range: 0 to 50 (%)

Setting the S-curve extends acceleration time 1 (F07) and deceleration time 1 (F08) according to the following expressions.

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

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

F72 Pre-excitation Mode

F72 specifies when pre-excitation should start. Pre-excitation flows exciting current through a motor beforehand in order to make the response quicker at the start of motor driving.

F	7	2	P	R	E		E	X		S	E	L

Data setting range: 0

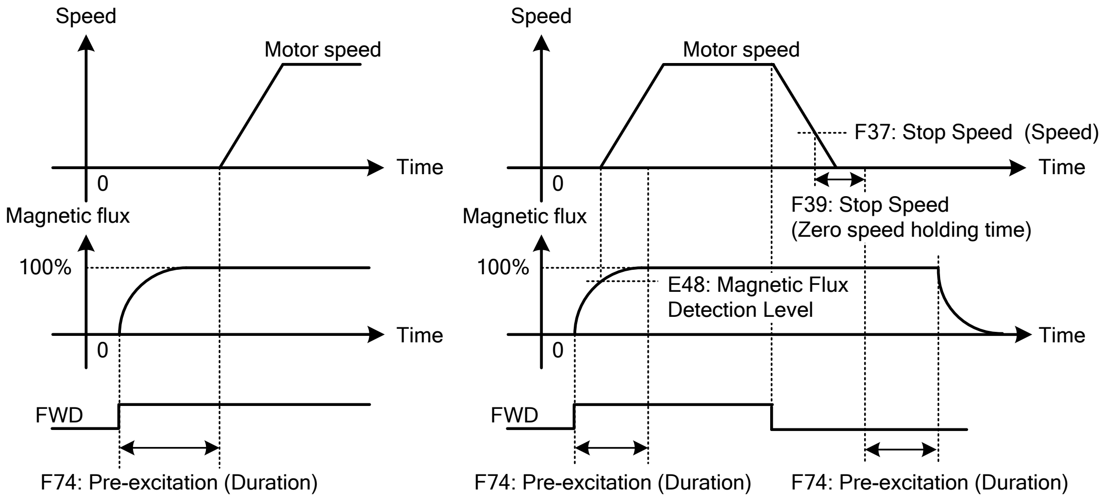
Cause pre-excitation at the time of a startup. Pre-excitation continues for the duration specified by F74

1

Cause pre-excitation at the time of a startup and stop.

At the time of a startup, pre-excitation continues for the duration specified by F74 or until the magnetic flux command reaches the detection level specified by E48, whichever is earlier.

After a stop, pre-excitation continues until the duration specified by F74 elapses. It is effective for starting the motor immediately following a stop (when pre-excitation is in progress), e.g., for inching (intermittent running).



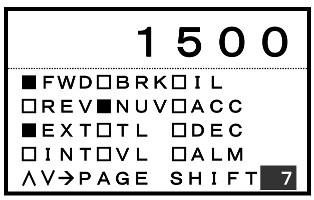
When F72 = 0 | When F72 = 1

When F72 = 0, set the pre-excitation duration (F74) so that the motor starts rotating after the magnetic flux has been saturated (100%), as shown in the above graph.

Note: The motor may rotate during pre-excitation, so be sure to use a mechanical brake to avoid unexpected rotation.

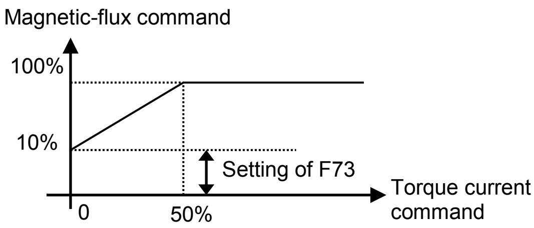
Even if F72 = 1, under vector control without speed sensor or under torque control, pre-excitation after a motor stop does not occur. When H09 ≠ 0 (Auto search is enabled) under vector control without speed sensor, pre-excitation at a startup caused when H72 = 0 applies.

Whether a motor is during pre-excitation or in normal operation can be checked with the running status page in Menu #4 "I/O CHECK." ■EXT indicates "during pre-excitation" and □EXT, "in normal operation."



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 command decreases according to the torque current command to reduce the electromagnetic noise.



F	7	3	M	I	N		F	L	U	X		

Data setting range: 10 to 100 (%)

Note: F73 is valid only under vector control with speed sensor.

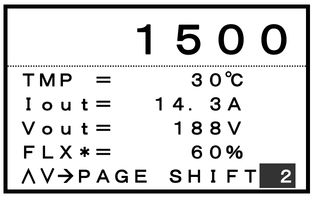
You can view the level (%) of the magnetic-flux command on the "Operation monitor" of the KEYPAD panel.

See "FLX*" (magnetic-flux command) 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%

Under vector control without speed sensor, the magnetic flux level is fixed at 100%.



F74 Pre-excitation (Duration)

F74 specifies the pre-excitation duration.

F	7	4	P	R	E		E	X		t		

Data setting range: 0.0 to 10.0 (s)

F75 Pre-excitation (Initial level)

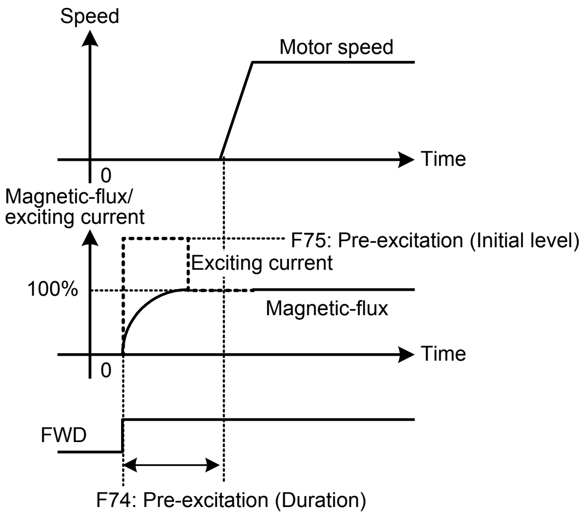
Sets the initial level of the pre-excitation.

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

Data setting range: 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 command 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%.



Under vector control without speed sensor and when H09 = 1 or 2 (Auto search is enabled), the data setting range is limited to 200 to 400%. Even if F75 is set at 100%, 200% applies.

If a trip occurs in auto search with 60 Hz or higher (1800 r/min in terms of 4-pole motor), increasing the F75 setting may improve the problem.

F76	Speed Limiter (Mode)
F77	Speed Limiter (Level 1)
F78	Speed Limiter (Level 2)

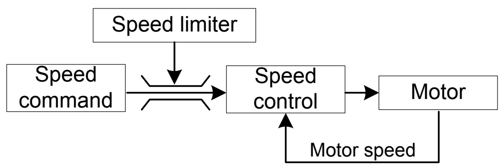
The speed control and the torque control (torque control, torque current control) differs in the usage of these function codes.

Usage for speed control

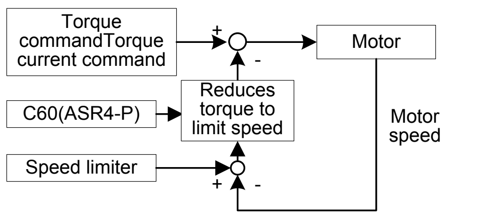
Since the inverter usually (factory setting) controls speed (internal ASR enabled, motor controlled by speed command), and the speed limiter is applied to the speed command (See "(1) Speed control") You can use the function code H41 "Torque command selection" and H42 "Torque current command selection" 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 command 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 command (see "(2) Torque control").

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

(1) For speed control



(2) For torque control



(1) Speed control

You can set the speed limit to the speed command value.

F	7	6	N	–	L	I	M	–	M	O	D	E

- Method selection

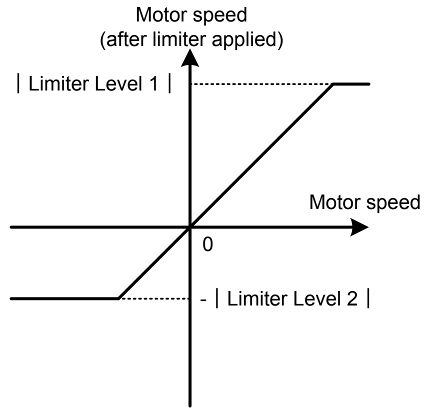
Data setting range: 0 (Limit forward (Level 1) and reverse (Level 2) individually.)
1 (Limit forward and reverse in Level 1.)
2 (Limit upper limit by Level 1 and the lower limit by Level 2.)
3 (Reserved. (Equivalent to "0").

F	7	7	N	–	L	I	M	–	L	V	L	1
F	7	8	N	–	L	I	M	–	L	V	L	2

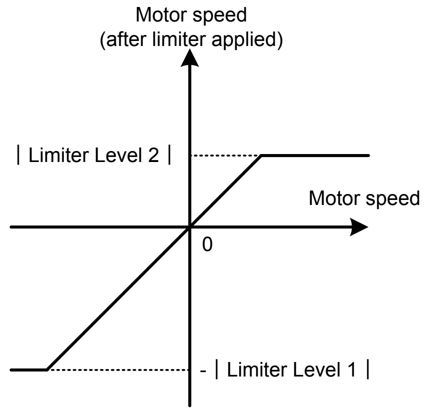
- Level 1, 2

Data setting range: -110.0 to 110.0 (%)

When F76 = 0, the upper and lower limit levels during FWD and REV operations switch between Levels 1 and 2.

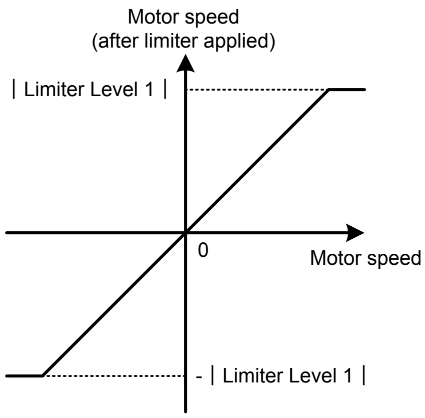


When F76 = 0, FWD = ON

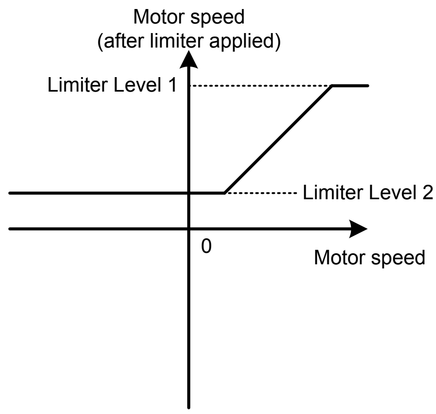


When F76= 0, REV = ON

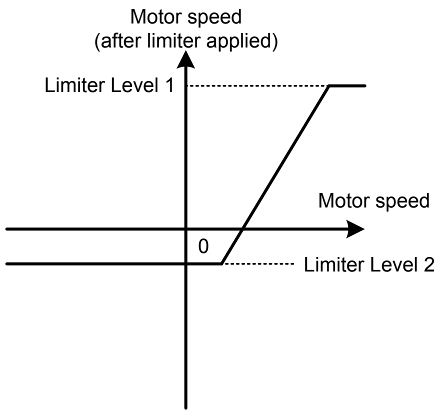
When F76 = 1 or 2, the speed limiter acts as shown below.



When F76 = 1



When F76 = 2



When F76 = 2

⚠CAUTION

Specify such that the limiter 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.

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 = 0, the limiter level 1 = 100.0% and the limiter level 2 = 0.0%.

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

F76 N-LIM-MODE

- Method selection

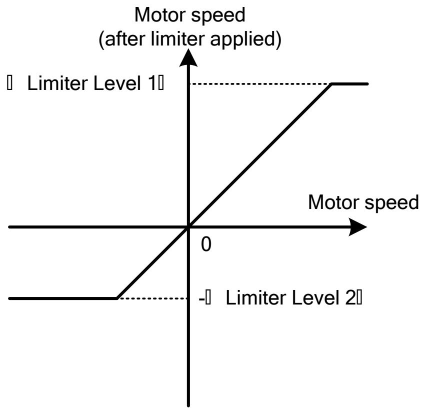
Data setting range: 0 (Limit forward and reverse individually. FWD and REV switch the levels.
1 (Level 1 limits forward and reverse.)
2 (Invalid (Even if specified, the setting is assumed to be "0."))
3 (Individual limiters for forward and reverse rotation. [12] input is added as a variable part of limiters.)

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

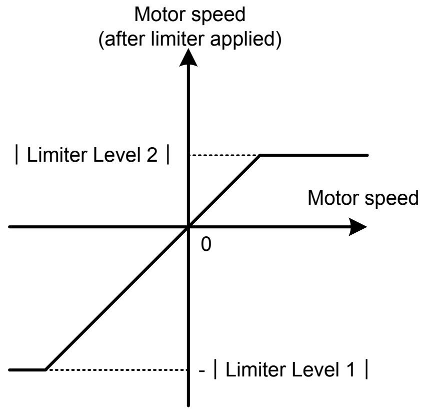
- Level 1, 2

Data setting range: -110.0 to 110.0 (%)

When F76 = 0, the upper and lower limit levels during FWD and REV operations switch between Levels 1 and 2.

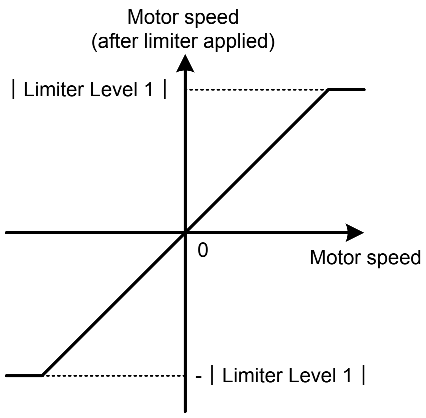


When F76 = 0, FWD = ON



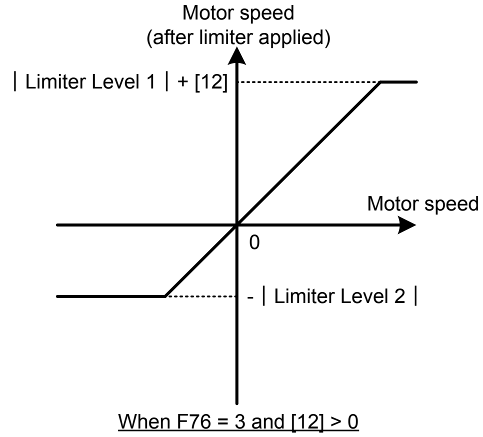
When F76= 0, REV = ON

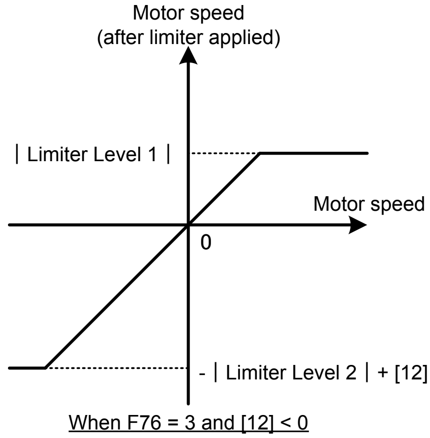
When F76 = 1, the speed limiter acts as shown below.



When F76 = 1

When F76 = 3, input to [12] acts as a bias as shown below.





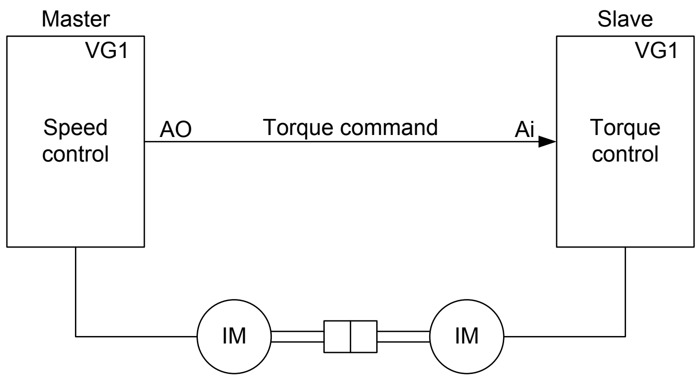
Input voltage for [12] is ± 10V at the maximum motor speed (± 100%).

Use C60 (ASR4-P) to adjust the speed stability under speed limit.

⚠CAUTION
When the magnetic flux decreasing function (F73) is used, the factory default of the ASR4 P-gain (C60 = 10) causes the response of the speed limiter to slower so that the speed may not be controlled. In particular, setting F73 data to an extremely small value (10% or 20%) may cause large speed hunting. If it happens, increase the C60 setting (ASR4 P-gain) or increase the F73 setting to stabilize the speed.

The torque limit in accordance with the line speed (input at [12]) can be added if F76 is "3."

To perform mechanically coupled operation with torque command handover (see the figure below), enter a slightly larger value (+5%) than that specified on the master as a speed limit level for the inverter (slave) driven under torque control.



Note: Since the slave inverter runs under torque control, configure it to be controlled by the speed limiter if it malfunctions.

F79	Motor Selection (M1, M2, M3)

The FRENIC-VG can hold three sets of motor parameters (M1, M2 and M3) which can be selected by F79 or X terminal functions (***M-CH2*** and ***M-CH3***)

F79 M1-3SELECT

Data setting range: 0 (Select M1. Note that the X terminal functions (***M-CH2***, ***M-CH3***) have higher priority as shown below.)

When (***M-CH2*** and ***M-CH3***) = (OFF, OFF) or (ON, ON), or no ***M-CH2*** or ***M-CH3*** has been assigned, M1 is selected.
When (***M-CH2*** and ***M-CH3***) = (ON, OFF), M2 is selected.
When (***M-CH2*** and ***M-CH3***) = (OFF, ON), M3 is selected.

1 (Select M2.)

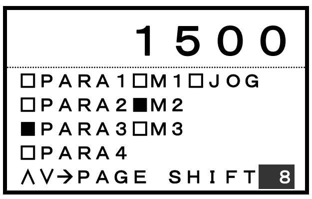
2 (Select M3.)

Merits and restrictions for selecting M1, M2, or M3

	When M1 (1st motor) is selected	When M2 (2nd motor) is selected	When M3 (3rd motor) is selected
Control type	<u>Set by P01</u> Vector control for IM with speed sensor Vector control for IM without speed sensor Vector control for PMSM with speed sensor V/f control Simulation mode	<u>Set by A01</u> Vector control for IM with speed sensor Vector control for IM without speed sensor Vector control for PMSM with speed sensor V/f control	<u>Set by A101</u> Vector control for IM with speed sensor Vector control for IM without speed sensor Vector control for PMSM with speed sensor V/f control
Motor parameters	Function codes F03 to F05, F10 to F12, P03 to P51, H47, H49, H51, H112 to H118, H160 to H162, o09 to o11 When a FRENIC-VG motor is selected, the inverter automatically set data to the above function codes.	Function codes A02 to A71, H48, H50, H52, H170 to H172 To be set manually.	Function codes A102 to A171, H125 to H127, H180 to H182 To be set manually.
Protective functions specific to motor parameters	Provided. When a FRENIC-VG motor is selected with P02 (P02 = 0 to 35, 38 to 50) or P-OTHER is selected (P02 = 36), the write-protect function becomes activated.	Not provided.	Not provided.

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.



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 ***M-CH2*** and ***M-CH3*** to switch motors.

It is recommended to activate overcurrent suppression function (H58 = 1) when M3 is selected (V/f control).

F80 Switching between HD, MD and LD Drive Modes

F80 specifies whether to drive the inverter in the high duty (HD), medium duty (MD) or low duty (LD) mode.

F80 Ir SELECT

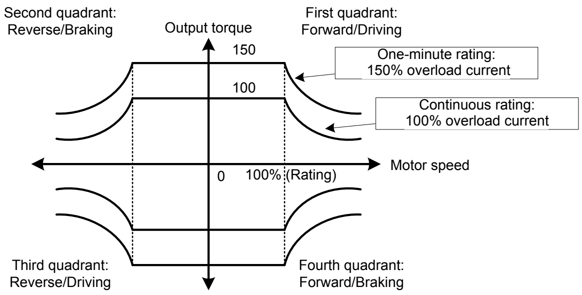
Data setting range: 0, 2 (High Duty, overload current 150%-1 min, 200%-3 sec.)
1 (Low Duty, overload current 120%-1 min)
2 (Middle Duty, overload torque 150%-1 min)

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%).

Note: Select peripheral equipment in accordance with the current rating. (Refer to the Chapter 8, "SELECTING PERIPHERAL EQUIPMENT.")

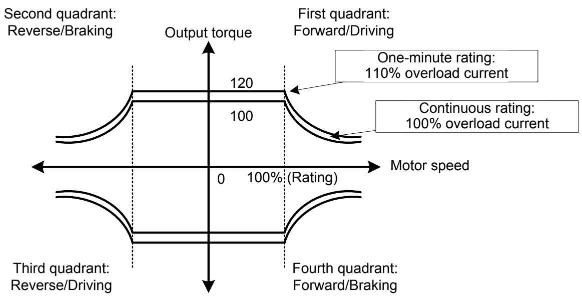
- Torque characteristics for HD mode

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 command.



- Torque characteristics for LD/MD mode

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 or two ranks lower than the HD-mode inverter. Note that the maximum carrier frequency is smaller than that in the HD mode. See Chapter 2, Section 2.1 "Standard Specifications" for more details

(Note) Replacing the HT-rating VG7 with the FRENIC-VG

The FRENIC-VG does not support the HT rating equivalent of the VG7. When replacing the HT-rating VG7, use the FRENIC-VG with one capacity rank higher.

Note that the 200 V class series inverters of 7.5 to 22 kW and 400 V class series ones of 18.5 to 22 kW can be replaced with the FRENIC-VG with the same capacity as long as the carrier frequency is 10 kHz or below.

Drive mode	Inverter capacity (kW)	Carrier frequency (kHz)	Applied motor (relative to the inverter capacity)	Overload rating
HD "Heavy duty load" (F80 = 0)	0.75 to 45 (200V) 3.7 to 55 (400V)	2 to 15	Same capacity	Current 150% 1 min 200% 3 s
	55 to 90 (200V) 75 to 400 (400V)	2 to 10		
	500 to 630 (400V)	2 to 5	Same capacity	
MD "Medium duty load" (F80 = 3)	90 to 400 (400V)	2 to 4	One rank higher capacity	Current 150% 1 min
LD "Low duty load" (F80 = 1)	30 to 90 (200V) 30 to 630 (400V)	2 to 10/6/4	One rank higher capacity	Current 120% 1 min

If the LD or MD mode is selected for the inverter capacity not available to the mode, the inverter runs in the HD mode.

F81 Offset for Speed Setting on Terminal [12]

F81 specifies an offset for analog speed input on terminal [12]. Use this setting for adjustment of out-of-offset signals sent from external equipment.

F81 12 OFFSET

Data setting range: -30000 to 30000 (r/min)

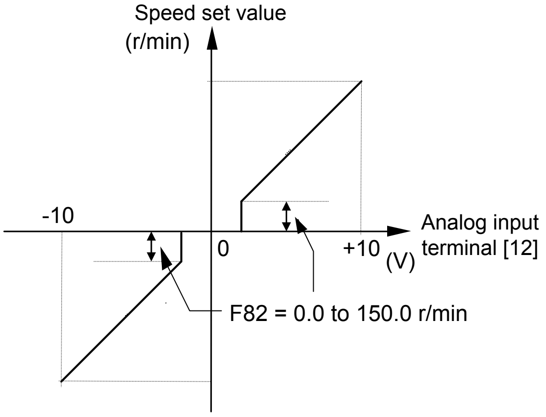
F82 Dead Zone for Speed Setting on Terminal [12]

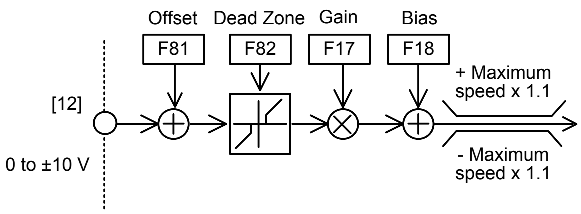
F82 specifies the dead zone speed for analog speed input on terminal [12] to limit the ±speed setting value within the range of ±F82 data to 0 r/min.

(This function is available in the ROM version H1/2 0019 or later.)

F82 12 BLIND

Data setting range: 0.0 to 150.0 (r/min)





F83 Filter for Speed Setting on Terminal [12]

F83 specifies a time constant determining the first order delay of the analog speed input on terminal [12].

F	8	3	1	2		F	I	L	T	E	R	

Data setting range: 0.000 to 5.000 (s)

F84 Display Coefficient for Input Watt-hour Data

F84 specifies a display coefficient for displaying the input watt-hour data (M116).

Input watt-hour data (M116) = F84 x M115 (Input watt-hour) (Unit: 100 kWh)

F	8	4	P	W	R		C	O	E	F		

Data setting range: 0.000 to 9999
(Specification of "0.000" clears the input watt-hour data and stops counting.)

Setting the F84 data to 1/1000 of the electric rate per 100 kWh enables the total electricity price (in units of ¥1,000) to be displayed. If the electric rate is ¥18 per kWh, for example, setting the F84 data to "1.8" displays 18.00 (thousand yen) if the input watt-hour data is 10.00 (100 kWh).

F85 Display Filter for Calculated Torque

F85 specifies a display filter for outputting the calculated torque (Monitoring function code M07) on the LED and LCD monitors.

F	8	5	T	R	Q		F	I	L	T	E	R

Data setting range: 0.000 to 1.000 (s)

4.3.2 E codes (Extension Terminal Functions)

E01 to E13	X Terminal Function

E01 to E13 assign commands (listed below) to general-purpose, programming digital input terminals, [X1] to [X9] and [X11] to [X14].

([X11] to [X14] are available when the optional OPC-VG1-DIOA is mounted or a communications option (e.g., RS-485, T-Link, SX-bus, and fieldbus) is mounted.)

Before using these terminal commands, see Chapter 4, Section 4.1 "Control Block Diagrams" and check the switching positions of the control contacts.

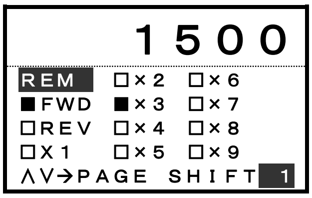
The FRENIC-VG runs under four drive controls: "Vector control for IM with speed sensor," "Vector control for IM without speed sensor," "V/f control for IM," and "Vector control for PMSM with speed sensor." Some terminal commands apply exclusively to the specific drive control, which is indicated in the "Drive control" column in the function code tables given in Section 4.2.

Using digital input terminals

A total of 13 digital inputs are available--nine on terminals [X1] to [X9] as standard and four on terminal [X11] to [X14] as option (when a DIOA option is mounted). Using the communications link (RS-485, T-Link, SX-bus and fieldbus) enables access to those 13 digital inputs.

Configuration procedure

- Select a desired function (***BX*** ("Coast to a stop") in this example).
- Assign ***BX*** to any one of terminal [X1] to [X9] and [X11] to [X14]. To assign it to terminal [X3], for example, set "7" to Function code E03.
- Turn [X3] ON from external equipment to activate ***BX*** ("Coast to a stop"). Turn it OFF to deactivate ***BX***.
- To check the ON/OFF status of [X3], use Menu #4 "I/O Checking" (REM screen) on the keypad and check that the box of the X3 appears black (■) as shown at the right.
- When accessing to the digital inputs via the communications link, see the COMM screen in Menu #4 "I/O Checking."



Configuring contacts ("normal open" or "normal close")

Terminals [X1] to [X9] can be configured individually as a "normal open" or "normal close" contact with Function code E14. For details refer to the description of E14.

E	0	1	X	1		F	U	N	C			
						|						
E	1	3	X	1	4		F	U	N	C		

Data setting range: 00 to 83

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
00 01 02 03	Select multistep speed (1 to 15 steps)	***SS1*** ***SS2*** ***SS4*** ***SS8***	27	Synchronization operation command (PG (PR) optional function)	***SYC***
04 05	Select ASR and ACC/DEC time (4 steps)	***RT1*** ***RT2***	28	Lock at zero speed	***LOCK***
06	Enable 3-wire operation	***HLD***	29	Pre-excitation	***EXITE***
07	Coast to a stop	***BX***	30	Cancel speed limiter	***N-LIM***
08	Reset alarm	***RST***	31	Cancel H41 (Torque command)	***H41-CCL***
09	Enable external alarm trip	***THR***	32	Cancel H42 (Torque current command)	***H42-CCL***
10	Ready for jogging	***JOG***	33	Cancel H43 (Magnetic flux command)	***H43-CCL***
11	Select speed command N2/N1	***N2/N1***	34	Cancel F40 (Torque limiter mode 1)	***F40-CCL***
12	Select motor 2	***M-CH2***	35	Select torque limiter level 2/1	***TL2/TL1***
13	Select motor 3	***M-CH3***	36	Bypass ACC/DEC processor	***BPS***
14	Enable DC braking	***DCBRK***	37, 38	Select torque bias command	***TB1,TB2***
15	Clear ACC/DEC to zero	***CLR***	39	Select droop control	***DROOP***
16	Switch creep speed under UP/DOWN control	***CRP-N2/N1***	40	Zero-hold Ai1	***ZH-AI1***
17	UP (Increase speed)	***UP***	41	Zero-hold Ai2	***ZH-AI2***
18	DOWN (Decrease speed)	***DOWN***	42	Zero-hold Ai3 (AIO optional function)	***ZH-AI3***
19	Enable data change with keypad	***WE-KP***	43	Zero-hold Ai4 (AIO optional function)	***ZH-AI4***
20	Cancel PID control	***KP/PID***	44	Reverse Ai1 polarity	***REV-AI1***
21	Switch normal/inverse operation	***IVS***	45	Reverse Ai2 polarity	***REV-AI2***
22	Interlock (52-2)	***IL***	46	Reverse Ai3 polarity (AIO optional function)	***REV-AI3***
23	Enable data change via communications link	***WE-LK***	47	Reverse Ai4 polarity (AIO optional function)	***REV-AI4***
24	Enable communications link	***LE***	48	Inverse PID output	***PID-INV***
25	Universal DI	***U-DI***	49	Cancel PG alarm	***PG-CCL***
26	Enable auto search for idling motor speed at starting	***STM***	50	Cancel undervoltage alarm	***LU-CCL***

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
51	Hold Ai torque bias	***H-TB***	72	Toggle signal 1	***TGL1***
52	STOP1 (Decelerate to stop with normal deceleration time)	***STOP1***	73	Toggle signal 2	***TGL2***
53	STOP2 (Decelerate to stop with deceleration time 4)	***STOP2***	74	Cause external mock alarm	***FTB***
54	STOP3 (Decelerate to stop with maximum braking torque, ignoring the deceleration time setting)	***STOP3***	75	Cancel NTC thermistor alarm	***NTC-CCL***
55	Latch DIA data (DIA optional function)	***DIA***	76	Cancel lifetime alarm signal	***LF-CCL***
56	Latch DIB data (DIB optional function)	***DIB***	78	Switch PID feedback signals	***PID-1/2***
57	Cancel multiplex system	***MT-CCL***	79	Select PID torque bias	***TB-PID***
58-67	Custom Di1-Di10	***C-DI1*** to ***C-DI10***			
68	Select load adaptive parameters 2/1 (Available soon)	***AN-P2/1***			
69	Cancel PID components	***PID-CCL***			
70	Enable PID FF component	***PID-FF***			
71	Reset completion of speed limit calculation (Available soon)	***NL-RST***			

Function code data = 00, 01, 02, 03 **Select multistep speed (1 to 15 steps) -- *SS1*, *SS2*, *SS4*, *SS8***

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.

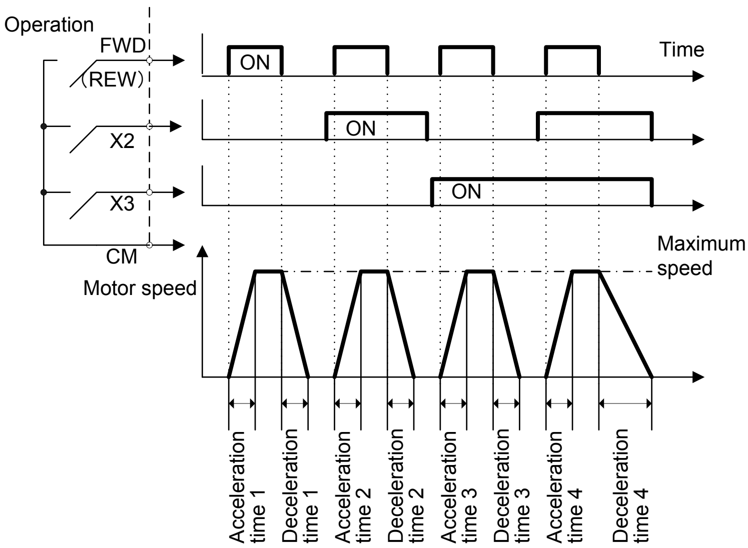
Input signal combination to select specified data				Speed to be selected	
03 ***SS8***	02 ***SS4***	01 ***SS2***	00 ***SS1***		
OFF	OFF	OFF	ON	C05 Multistep speed 1, N-1	Related function codes C05 to C19 Setting range 0 to 30000 r/min or 0.00 to 100.00% or 0.0 to 999.9 m/min
OFF	OFF	ON	OFF	C06 Multistep speed 2, N-2	
OFF	OFF	ON	ON	C07 Multistep speed 3, N-3	
OFF	ON	OFF	OFF	C08 Multistep speed 4, N-4	
OFF	ON	OFF	ON	C09 Multistep speed 5, N-5	
OFF	ON	ON	OFF	C10 Multistep speed 6, N-6	
OFF	ON	ON	ON	C11 Multistep speed 7, N-7	
ON	OFF	OFF	OFF	C12 Multistep speed 8, N-8	
ON	OFF	OFF	ON	C13 Multistep speed 9, N-9	
ON	OFF	ON	OFF	C14 Multistep speed 10, N-10	
ON	OFF	ON	ON	C15 Multistep speed 11, N-11	
ON	ON	OFF	OFF	C16 Multistep speed 12, N-12	
ON	ON	OFF	ON	C17 Multistep speed 13, N-13	
ON	ON	ON	OFF	C18 Multistep speed 14, N-14/ Creep speed 1, CREP1	
ON	ON	ON	ON	C19 Multistep speed 15, N-15/ Creep speed 2, CREP2	

<u>Function code data = 04, 05</u> Select ASR and ACC/DEC time (4 steps) -- *RT1*, *RT2*

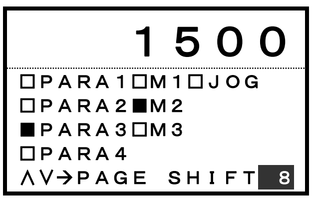
You can switch predetermined acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations specified by function codes through external digital input signals. Assign data 04 to 05 to digital terminals to select acceleration/deceleration times, ASR constants and S-curve accelerations/decelerations.

Input signal combination to select specified data		Acceleration/deceleration times to be selected	
05 ***RT2***	04 ***RT1***		
OFF	OFF	F07 Acceleration Time 1 F08 Deceleration Time 1 F61 to F66 ASR1 constants F67 S-curve Acceleration 1 (Start) F68 S-curve Acceleration 1 (End) F69 S-curve Deceleration 1 (Start) F70 S-curve Deceleration 1 (End)	Related function codes F07, 08, F61 to F70 C40 to C69
OFF	ON	C40 to C45 ASR 2 constants C46 Acceleration Time 2 C47 Deceleration Time 2 C48 S-curve 2 (Start side) C49 S-curve 2 (End side)	
ON	OFF	C50 to C55 ASR 3 constants C56 Acceleration Time 3 C57 Deceleration Time 3 C58 S-curve 3 (Start side) C59 S-curve 3 (End side)	
ON	ON	C60 to C65 ASR 4 constants C66 Acceleration Time 4 C67 Deceleration Time 4 C68 S-curve 4 (Start side) C69 S-curve 4 (End side)	

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



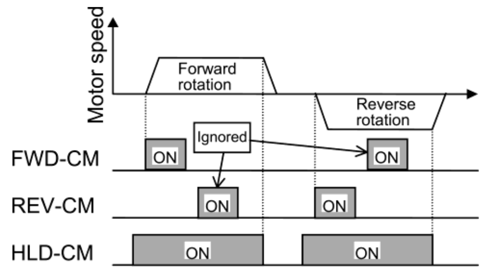
* If you switch the acceleration/deceleration times, the ASR constants and S-curve actions are switched simultaneously. You can see which set is currently selected from (1, 2, 3, 4) on the "I/O check" screen of the KEYPAD panel. When the data set 3 is selected, "■PARA3" is indicated on the display.



Function code data = 06
Enable 3-wire operation -- *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.

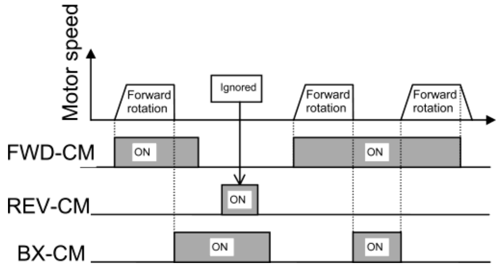


Function code data = 07 Coast to a stop-- *BX*

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.



Function code data = 08 Reset alarm -- *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.

Function code data = 09 Enable external alarm trip -- *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 X9 ***THR*** and [CM] to the overheat detection contact of the braking resistor or the like.
- 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.

Function code data = 10 Ready for jogging -- *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.

Function code data = 11 Select speed command -- *N2/N1*

Use an external digital input signal to switch the speed setting method predetermined with function 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 Command N1
ON	C25 Speed Command N2

Function code data = 12, 13 Select motor 2, 3 -- *M-CH2*, *M-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 ***M-CH3***	12 ***M-CH2***		
OFF	OFF	First motor	F03 to F05, F10 to F12, P01 to P51, H47, H49, H51, H112 to H118, H160 to H162, o09 to o11
OFF	ON	Second motor	A01 to A71, H48, H50, H52, H170 to H172
ON	OFF	Third motor	A101 to A171, H125 to H127, H180 to H182
ON	ON	First motor	F03 to F05, F10 to F12, P01 to P51, H47, H49, H51, H112 to H118, H160 to H162, o09 to o11

Note: Both ***M-CH2*** and ***M-CH3*** are ON, the first motor is selected. See also the description of the function code F79.

Note: When inverter is stopped, if motor switch 1/2 is changed during rotation of the connected motor (during naturally coasting or coasting with a load), the analog speed detection output, digital speed detection signal or the like may cause unpredictable operation.

Function code data = 14 **Enable DC braking --** ***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

Function code data = 15 **Clear ACC/DEC to zero --** ***CLR***

During the UP/DOWN operation, this digital input signal clears the acceleration/deceleration speed and operates the inverter at 0 r/min or the creep speed specified by the C18 and 19 "Multistep speed".

Function code data = 16 **Switch creep speed under UP/DOWN control --** ***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 Multistep Speed 15, N-15/Creep Speed 1, CREP1
ON	C19 Multistep Speed 16, N-16/Creep Speed 2, CREP2

Function code data = 17 **UP (Increase speed) --** ***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.

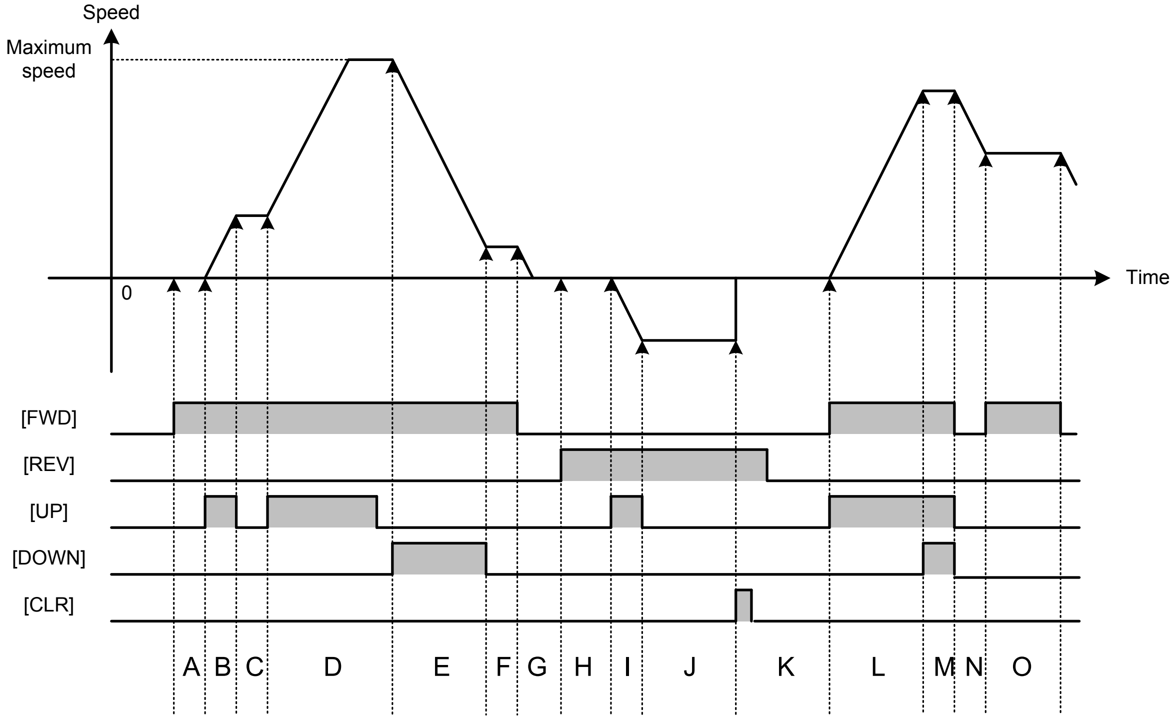
Function code data = 18 **DOWN (Decrease speed) --** ***DOWN***

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.

<u>(1) UP/DOWN, Initial value = 0 r/min</u>, N1 (F01)/N2 (C25) = 3

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

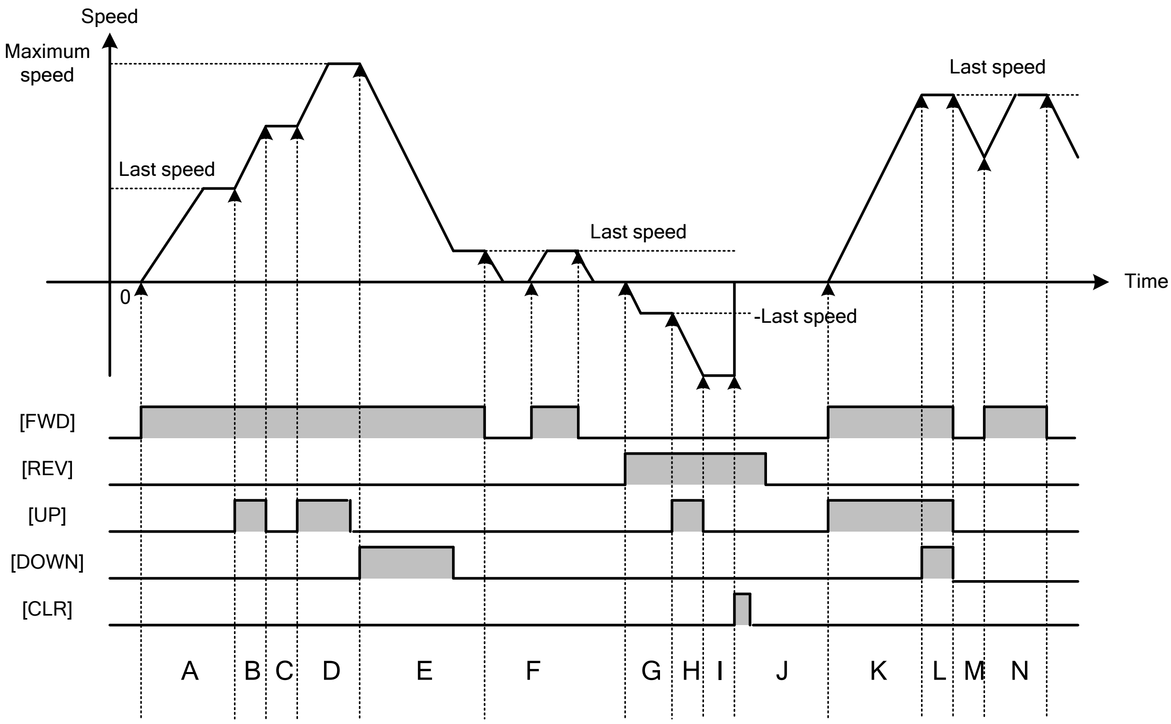


A: Operates at 0 r/min speed command
B: Accelerates in forward direction
C: Fixed to the speed command value when [UP] is set to OFF
D: Restricted by the maximum speed after acceleration in forward direction
E: Decelerates in forward direction
F: Fixed to the speed command value when [DOWN] is set to OFF
G: Decelerates to stop
H: Operates at 0r/min speed command value
I: Accelerates in reverse direction
J: Fixed to the speed command value 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 command value 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 = Last value), N1 (F01)/N2 (C25) = 4

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

The last value is defined as the speed command value adopted when the last operation command (FWD, REV) is turned OFF. The last 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 "+Last speed command value (speed command value just before the operation command is set to OFF)"

B: Accelerates in forward direction

C: Fixed to the speed command value 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 command value when [DOWN] is set to OFF

F: Stores the speed as a last value when the [FWD] is set to OFF. Accelerates in forward direction to the last 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 "−Last speed command value"

H: Accelerates in reverse direction

I: Fixed to the speed command value when [UP] is turned OFF

J: Resets to 0 r/min when [CLR] is turned ON

K: Accelerates in forward direction

L: Simultaneous [UP] and [DOWN] are treated as OFF. Fixed to the speed command value when both [UP] and [DOWN] are turned ON

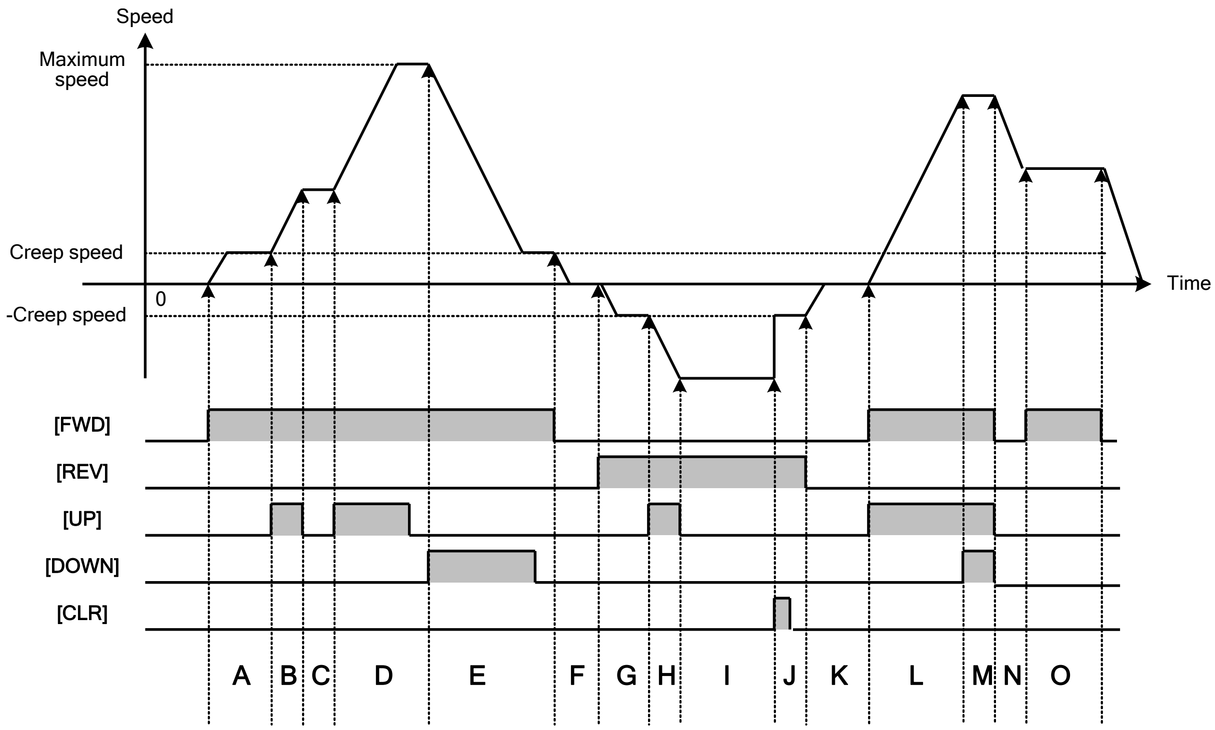
M: Decelerates to stop. Stores the speed as a last value when the [FWD] is set to OFF.

N: Accelerates in forward direction up to "+Last speed command value".

(3) UP/DOWN, Initial value = Creep speed 1 or 2, N1 (F01)/N2 (C25) = 5

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.
- Because priority is given on the clearing process even if [FWD] or [REV] is turned off while [CLR] is turned on, the motor speed remains the creeping speed.
- The creeping speed continues even if the creeping speed is decreased after it is reached.
- A: Converted into an absolute value and processed into the input creep speed.



A: Accelerates in forward direction up to "+creep speed"

B: Acceleration in forward direction

C: Fixed to the speed command value 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 command value 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 command value when both [UP] and [DOWN] are turned ON

N: Deceleration to stop

O: If [FWD] is turned off temporarily and restored again during deceleration, the speed at the timing of activation of FWD is held if the speed is equal to or larger than the creeping speed. If the speed has dropped below the creeping speed, the speed increases to the creeping speed upon activation of FWD.

<u>Function code data = 19</u> **Enable data change with 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.

<u>Function code data = 20</u> **Cancel PID control -- *KP/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

<u>Function code data = 21</u> **Switch normal/inverse operation -- *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

<u>Function code data = 22</u> **Interlock (52-2) -- *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. Valid if the setting of F14 (restart after momentary power failure (action selection)) is "3," "4" or "5."

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

<u>Function code data = 23</u> Enable data change via communications link -- *WE-LK*

This function enables changes to the function codes through RS-485, 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	Function to be selected	Applicable communication system
23		
OFF	Changes to data disabled	Integrated RS-485 T-Link, SX-bus, Fieldbus
ON	Changes to data enabled	

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

<u>Function code data = 24</u> Enable communications link -- *LE*

The external digital input enables/disables the speed command 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.

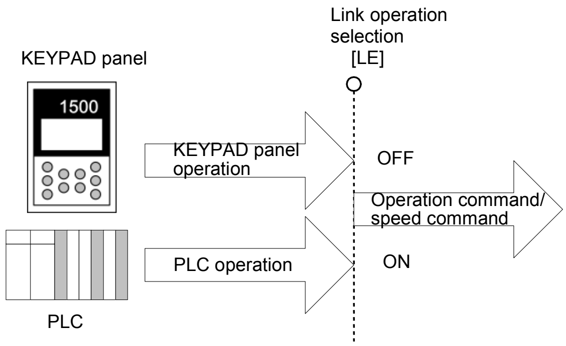
Input signal to select specified data	Function to be selected
24	
OFF	Link commands disabled (link disabled regardless of setting by H30)
ON	Link commands enabled (setting by H30 enabled)

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

Priority	Operation command (FWD, REV), speed command	Description of source of commands
1	Field options	One option selected from T-Link, SX-bus, and fieldbus can be installed at a time.
2	Integrated RS-485	Disabled when the option above is installed.

<Application example 1>

When you specify the operation command and the speed command from the KEYPAD panel and use the terminal function [LE] to switch to the operation command and the speed command 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.



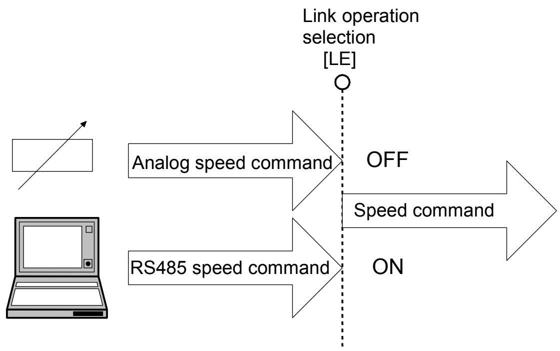
The description "Not assigned (*)" in the following table on the next page indicates that a function 24 [LE] is not assigned to an X function terminal. If this is a case, the setting by the function code H30 becomes effective. The PLC operation requires option cards (If you use RS-485, an integrated function is available). See the descriptions of the option or RS-485 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 command from KEYPAD panel			
	H30 = 3	Initial setting enabling both speed command 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 command from the analog terminal [12] input (0±10V) or the RS-485 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 RS-485 will be enabled if the terminal [LE] is ON.

If you use RS-485, an integrated function is available. See the descriptions of RS-485 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 command from analog input at terminal [12]	Enabled	Disabled	
	H30 = 1	Initial setting enabling only speed command from link (RS-485)	Disabled	Enabled	

<u>Function code data = 25</u>   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 RS-485, T-Link, SX-bus, or fieldbus.

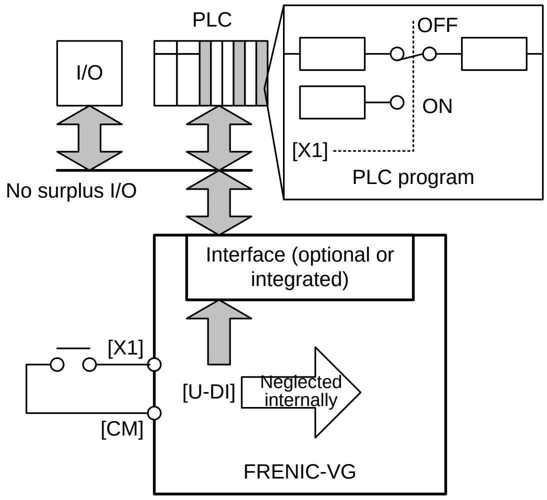
2) Use for an input to software created with the UPAC option without affecting the inverter operation.

<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***.



<u>**Function code data = 26**</u> **Enable auto search for idling motor speed at starting -- *STM***

The external digital input signal enables/disables the function H09 "Start mode (Auto search)".

When inverter is in “vector control of induction motor with PG” mode (P01 = 0) or “vector control of synchronous motor with PG” mode (P01 = 3), the starting mode (auto search) is always enabled.

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	Function to be selected
26	
OFF	Follow the setting of H09 (startup characteristics (rotating motor pickup mode)).
ON	The startup characteristics function is valid irrespective of the setting of H09 (rotating motor startup characteristics (pickup mode)).

<u>Function code data = 27</u> Synchronization operation command (PG (PR) optional function) -- *SYC*

This function switches between the speed command converted from a pulse train received as a position command via the position control and other speed command. 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.

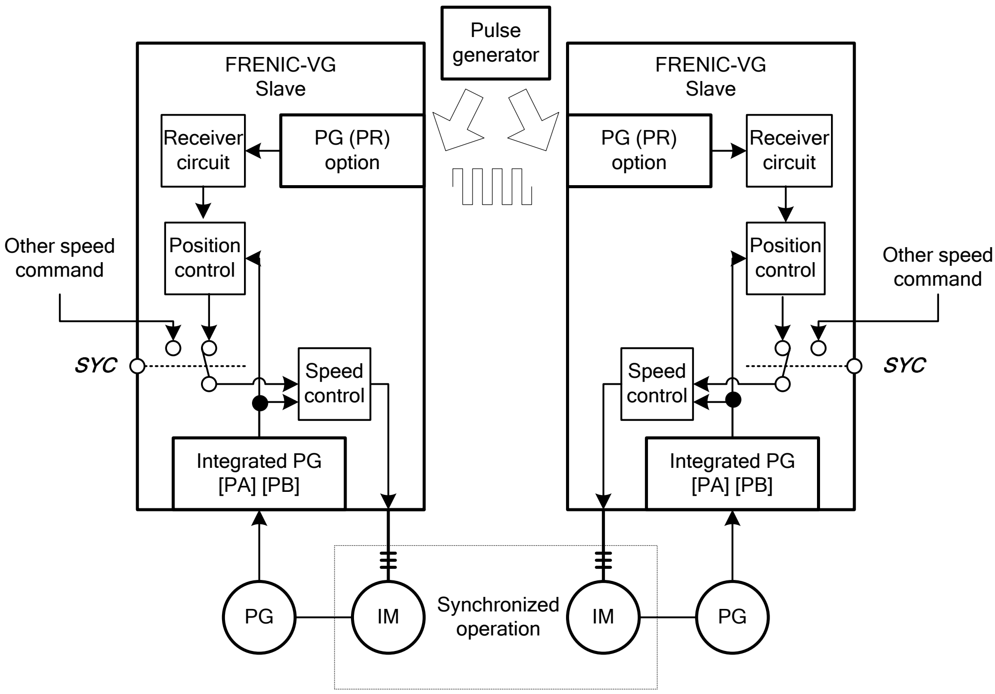
Input signal to select specified data 27	Function to be selected
OFF	Synchronized speed disabled (Other speed command enabled)
ON	Synchronized speed enabled

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

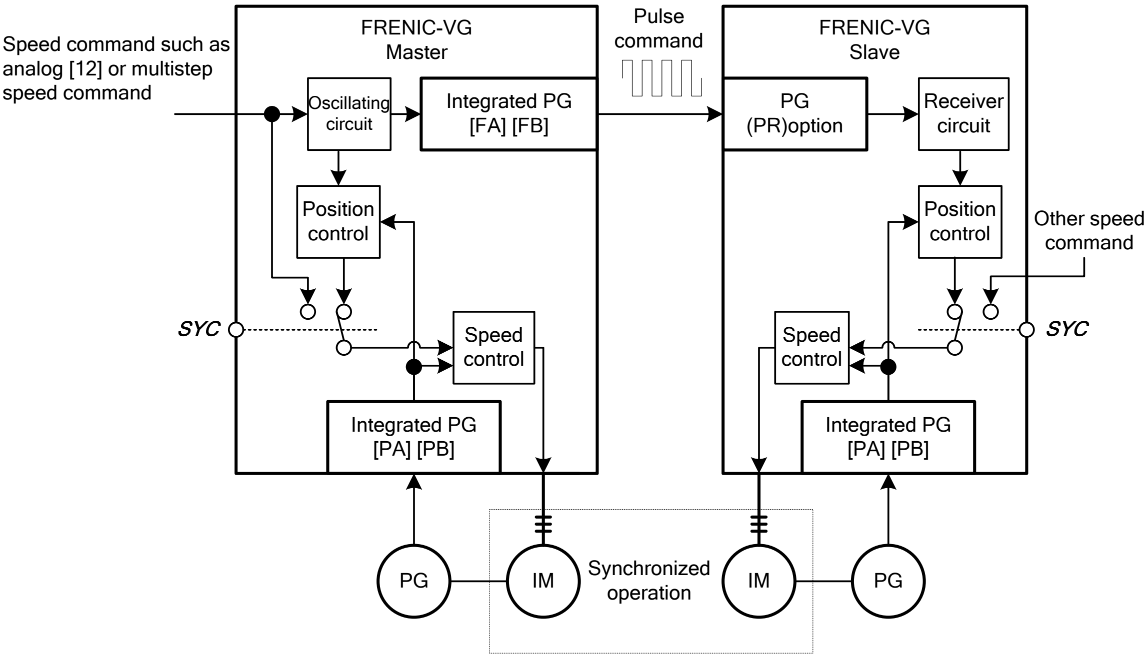
Apply a pulse train signal from the external pulse generator to the PG (PR) options of multiple inverters to be synchronized. The position command received by the option is converted into a synchronized speed command and the ***SYC*** enables the speed command.



<Application example 2> Synchronized operation by pulse generation

Pulse signal converted (oscillated) from an internal speed command (such as [12] input or multistep speed command) is also converted into a speed command through the position control and the ***SYC*** enables the resulting speed command. 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 1024 P/R at 1500 r/min, the frequency is 1500×1024/60=25.6 kHz. The pulse compensation is available on the slave side. See the function codes o14 and o15 or the PG (PR) option for more details.



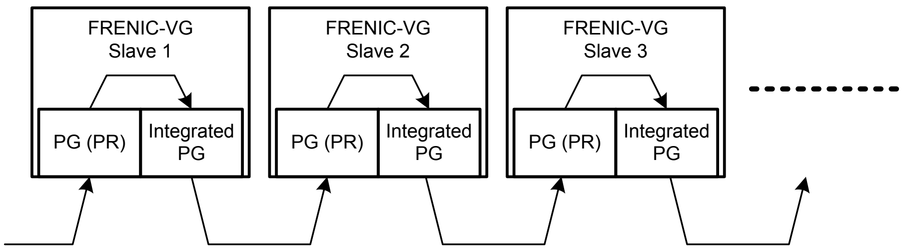
The complete synchronization (± 2 pulses or less) is possible both in the application example 1 and 2 during both transient and steady states.

About differences in methods

Method	Merits	Demerits
<Application example 1> Synchronized operation by receiving pulse	No position deviation	One PG (PR) option necessary Pulse generator necessary
<Application example 2> Synchronized operation by pulse generation	No position deviation One PG (PR) option can be omitted. 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 command applied to the PG (PR) option to the [FA] and the [FB] of the integrated PG.

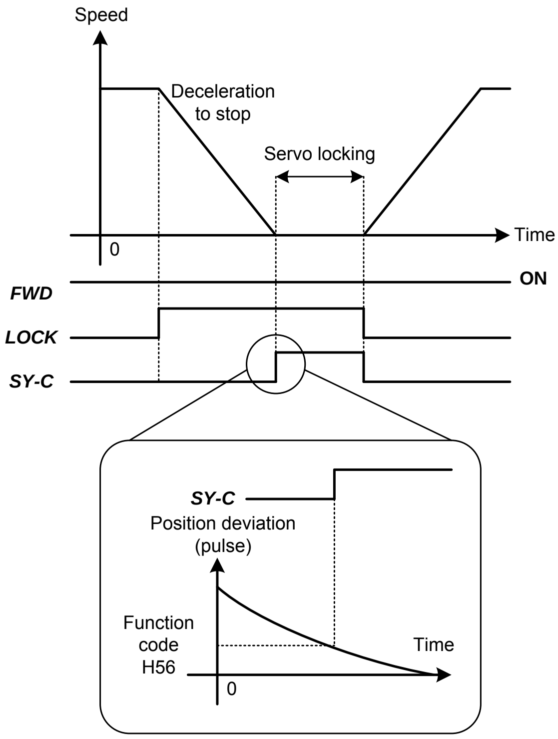


<u>Function code data = 28</u>   Lock at zero speed -- *LOCK*

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	Function to be selected
28	
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 command of the acceleration/deceleration calculation unit reaches to zero. The acceleration/ deceleration calculation unit declines a step speed command 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.
6) Because only one rotation is detected if the motor turns due to an external force after it is locked at zero speed, the DO output (synchronous control complete ***SYC***) may be turned on each time the predetermined position passes.

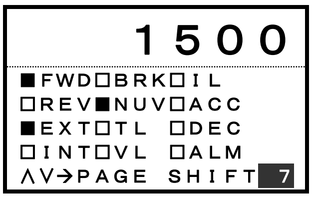
<u>Function code data = 29</u> Pre-excitation -- *EXITE*

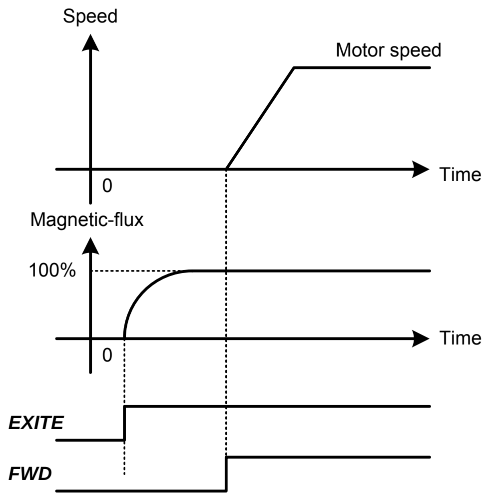
The external digital input signal switches the inverter in pre-exciting state. Assign a data 29 to a desired digital input terminal and the state of the input signal applied to it selects the function. When the operation command (FWD, REV) is set to ON, the state changes from pre-exciting to normal.

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

You can also use the function codes F72, 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.





<u>Function code data = 30</u> Cancel speed limiter -- *N-LIM*

The external digital input signal disables the speed command 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 command limiter function.

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

<u>Function code data = 31</u> Cancel H41 (Torque command) -- *H41-CCL*

The external digital input signal cancels the setting specified by the H41 "Torque command 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	Function to be selected
31	
OFF	H41 setting enabled
ON	H41 setting disabled (internal ASR enabled)

<u>Application</u>

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

Function code data = 32 **Cancel H42 (Torque current command) -- *H42-CCL***

The external digital input signal cancels the setting specified by the H42 "Torque current command" (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	Function to be selected
32	
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 command control.

Function code data = 33 **Cancel H43 (Magnetic flux command) -- *H43-CCL***

The external digital input signal cancels the setting specified by the H43 "Magnetic-flux command 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	Function to be selected
33	
OFF	H43 setting enabled
ON	H43 setting disabled (internal calculation enabled)

Function code data = 34 **Cancel F40 (Torque limiter mode 1) -- *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	Function to be selected
34	
OFF	F40 setting enabled
ON	F40 setting disabled (limiter disabled)

Function code data = 35 **Select torque limiter level 2/1 -- *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	Function to be selected
35	
OFF	F42: Torque limiter value (level 1) selection
ON	F43: Torque limiter value (level 2) selection

<u>Function code data = 36</u>   Bypass ACC/DEC processor -- *BPS*

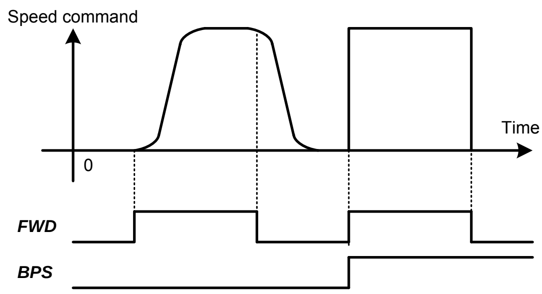
The external digital input signal bypasses the acceleration/deceleration calculation unit to disable the acceleration/deceleration time and the S-curve specifications. Assign a data 36 to a desired digital input terminal and the state of the input signal applied to it switches between the enabled state 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	Function to be selected
36	
OFF	Acceleration/deceleration calculation unit enabled
ON	Acceleration/deceleration calculation unit enabled

The speed command 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 command.

Use the dedicated jogging operation function codes (C30 to C38), not the ***BPS***, for jogging operation.



<u>Restrictions</u>

- When you use the ***BPS***, control functions such as the UP/DOWN control and the active drive (when V/f control is selected) are also disabled.
- The ***BPS*** does not affect the auxiliary speed setting 2 and the PID calculation output (speed command). 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.

<u>Function code data = 37, 38</u>   Select torque bias command -- *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

Function code data = 39 **Select droop control --** ***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	Function to be selected
39	
OFF	Droop control disabled
ON	Droop control enabled

Function code data = 40 **Zero-hold Ai1 --** ***ZH-AI1***
Function code data = 41 **Zero-hold Ai2 --** ***ZH-AI2***
Function code data = 42 **Zero-hold Ai3 (AIO optional function) --** ***ZH-AI3***
Function code data = 43 **Zero-hold Ai4 (AIO optional function) --** ***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.

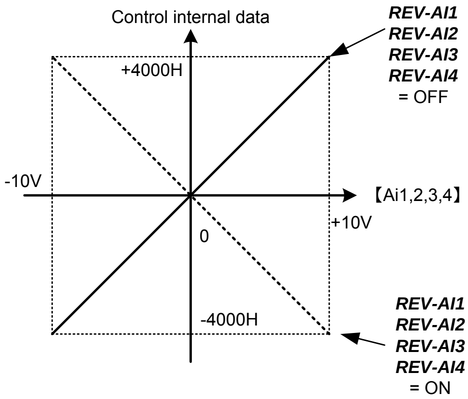
You need optional OPC-VG1-AIO for Ai3 and Ai4.

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

Function code data = 44 **Reverse Ai1 polarity --** ***REV-AI1***
Function code data = 45 **Reverse Ai2 polarity --** ***REV-AI2***
Function code data = 46
Reverse Ai3 polarity (AIO optional function) -- ***REV-AI3***
Function code data = 47
Reverse Ai4 polarity (AIO optional function) -- ***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.

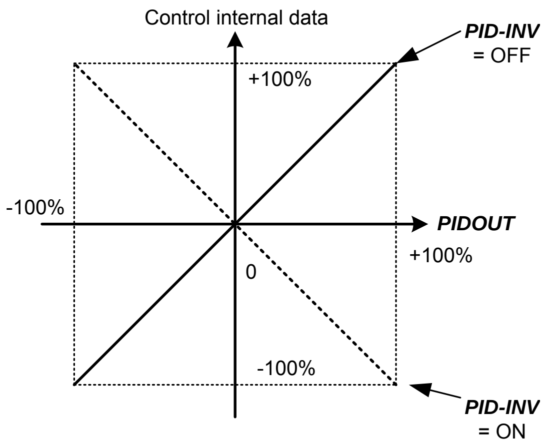
You need optional OPC-VG1-AIO for Ai3 and Ai4.



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

<u>Function code data = 48</u> Inverse PID output -- *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

<u>Function code data = 49</u> Cancel PG alarm -- *PG-CCL*

The external digital input signal cancels the PG alarm (PG). This function is available when you select "vector control" for the function code P01, A01, or A101.

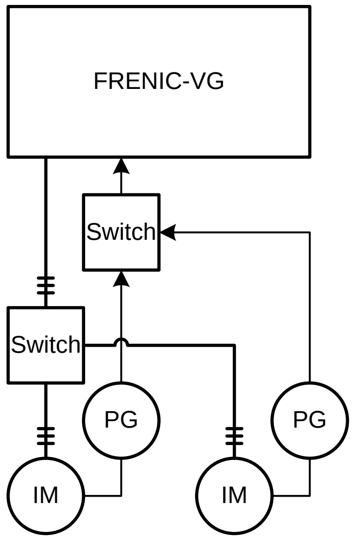
The inverter does not issue the alarm even when the PG wiring is disconnected during the input signal is ON. Assign a data 49 to a desired digital input terminal and the existence of the input signal cancels the PG alarm.

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

Actions on detecting PG disconnection

Alarm operation	***PG-CCL*** = OFF	***PG-CCL*** = ON
	Normal operation	PG alarm (PG) 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 (PG) is issued if the PGs are switched externally. Chancel the PG alarm (PG) at the sequence timing when the PGs are switched.

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 **0.6 mA 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 command 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 command and the torque current command to the maximum, either the inverter overload (OLU) or the motor overloads (OL1, OL2, OL3) 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 FRENIC-VG is a slip frequency type vector control. The inverter obtains the motor speed (ωr) from the PG signal and the slip frequency (ωs) from the current detection to determine the output frequency to the motor (ω1 = ωr + ωs). In case of a PG disconnection, the motor speed is 0 (ωr = 0) and the output frequency to the motor becomes the **slip frequency ωs**.

In the speed control system (ASR), since the motor speed (ωr) does not follow the speed command (ωr*), the speed control system (ASR) conducts an integral operation (I constant of ASR) to increase the speed deviation (ωr*−ωr) and the saturation is reached in a short period. The output of the ASR is the torque command and this torque command is fixed to the maximum value resulting in an overload alarm (OLU).

Function code data = 50   **Cancel undervoltage alarm -- *LU-CCL***

The external digital input signal cancels the undervoltage alarm (LU). 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 (LU).

Input signal to select specified data	Function to be selected
50	
OFF	Normal operation
ON	Undervoltage alarm (LU) canceled

Actions on detecting undervoltage inside the inverter

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

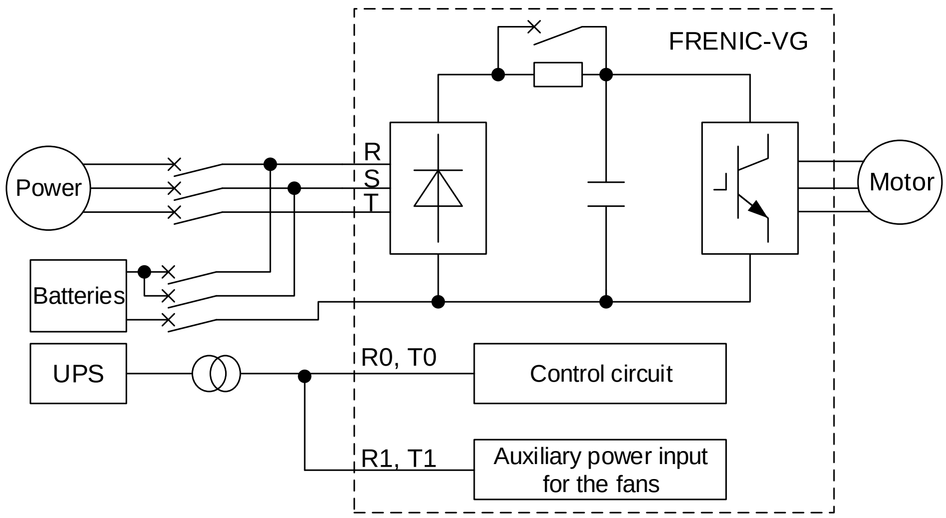
Application

Since this is a special function, limit your application to the following cases.

1) When the control power is supplied via [R0] and [T0] separately, shutting down the main circuit power causes the inverter to detect an undervoltage alarm (LU) and enter the Alarm mode. To avoid the alarm, use ***LU-CCL***.

2) To drive a lifting unit or the like at the time of a power failure, use ***LU-CCL***. Inverters of 30 kW or below (200 V class series) or those of 55 kW or below (400 V class series) can run even on the voltage lower than the undervoltage level (180 V for 200 V class series and 360 V for 400 V class series) as long as the inverter runs at the low speed, so use ***LU-CCL*** when configuring a system using an uninterruptible power supply (UPS), battery, stand-by generator and so on.

   Note: To run inverters of 37 kW or above (200 V class series) or those of 75 kW or above (400 V class series) on the voltage lower than the undervoltage level, it is necessary to connect terminals R1, T1 to power source and to switch the connector of fan power.



3) During cancellation of an undervoltage alarm, no parameter change or operation is allowed from the keypad as well as from Loader.

<u>Function code data = 51</u>   Hold Ai torque bias -- *H-TB*

The external digital input signal directs to preserve the torque bias data supplied via an analog input. Assign 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	Function to be selected
51	
OFF	Torque bias hold disabled
ON	Torque bias hold enabled

<u>Function code data = 52</u>   STOP1 (Decelerate to stop with normal deceleration time) -- *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 data 52 to a desired digital input terminal and the existence of the input signal activates the operation.

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

<u>Function code data = 53</u>   STOP2 (Decelerate to stop with deceleration time 4) -- *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 data 53 to a desired digital input terminal and the existence of the input signal activates the operation.

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

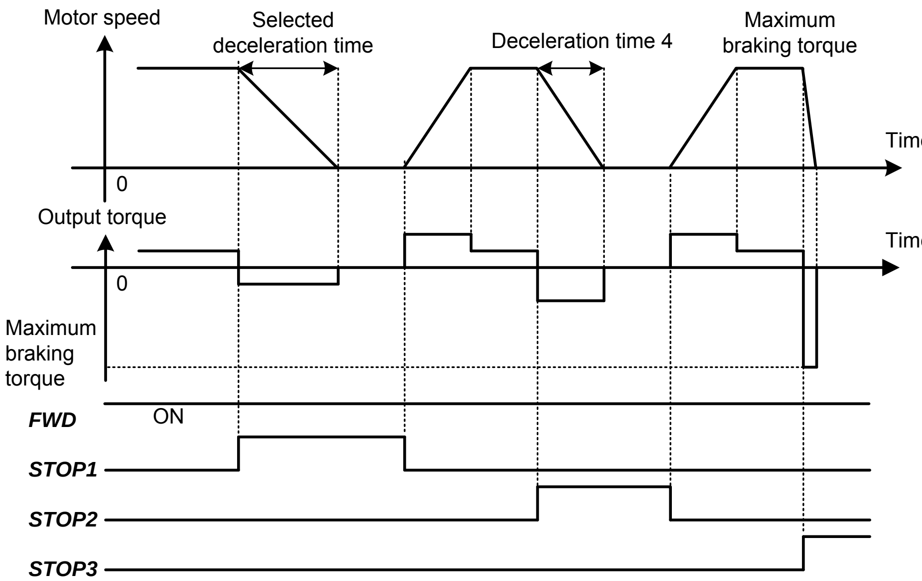
Function code data = 54 STOP3 (Decelerate to stop with maximum braking torque) -- *STOP3*

Turning this external digital input signal ON causes the motor to decelerate to a stop with the maximum braking torque (or the torque limiter value in terms of the inverter maximum current when the torque limiter is disabled), ignoring the specified deceleration time. Note that, after the actual speed exceeds the rated speed the braking torque will be reduced.

When a braking unit (150% maximum torque) of the same capacity as the inverter is used, an overvoltage alarm (OU) may occur during deceleration to a stop. To avoid the alarm, use a braking unit with one rank higher or set the torque limiter value (braking) to 150%.

Assign data 54 to a desired digital input terminal and the existence of the input signal activates the operation.

Input signal to select specified data	Function to be selected
54	
OFF	Normal operation
ON	Deceleration to stop (with maximum braking torque)



Function code data = 55 Latch DIA data -- *DIA*
Function code data = 56 Latch DIB data -- *DIB*

The external digital input signal enables to read in a data through the DI option (OPC-VG1-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	Function to be selected
55	
OFF	Hold ***DIA*** data
ON	Read ***DIA*** data

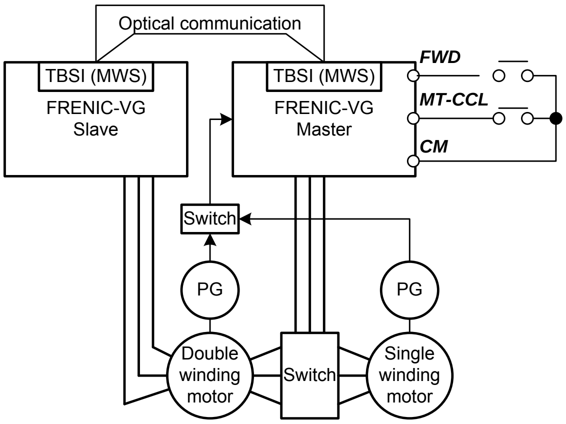
Input signal to select specified data	Function to be selected
56	
OFF	Hold ***DIB*** data
ON	Read ***DIB*** data

<u>Function code data = 57</u> Cancel multiplex system -- *MT-CCL*

The external digital input signal cancels the multiwinding drive with SI (MWS) option (OPC-VG1-TBSI) 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-VG1-CPG).

For details of the multiplex system, refer to the description of Options.



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

<u>Function code data = 58 to 67</u> Custom Di1-Di10 -- *C-DI1* to *C-DI10*

Di terminal for manufacturer. Do not assign.

<u>Function code data = 68</u> Select load adaptive parameters 2/1 -- *AN-P2/1* (Available soon)

Turning this signal ON or OFF selects the load adaptive parameter 2 or 1, respectively.

Input signal to select specified data	Function to be selected
68	
OFF	Load adaptive parameter 1
ON	Load adaptive parameter 2

<u>Function code data = 69</u> Cancel PID components -- *PID-CCL*

When an integrated PID function is used, turning this signal ON zero-holds the PID output and clears the PID integral component memory.

Input signal to select specified data	Function to be selected
69	
OFF	Do not zero-hold the PID output.
ON	Zero-hold the PID output. Clear the PID integral component memory.

<u>Function code data = 70</u>   Enable PID FF component -- *PID-FF*

When an integrated PID function is used, turning this signal ON enables the feedforward component.

Input signal to select specified data	Function to be selected
70	
OFF	Disable PID feedforward component
ON	Enable PID feedforward component

<u>Function code data = 71</u>   Reset completion of speed limit calculation -- *NL-RST* (Available soon)

Turning this signal ON clears the load adaptive calculation result and calculates the limit speed again at the next acceleration time in the same direction.

Input signal to select specified data	Function to be selected
71	
OFF	Do not reset completion of speed limit calculation
ON	Reset completion of speed limit calculation

For details, refer to H214 to H227 (Load adaptive control parameter setting 2).

<u>Function code data = 72</u>   Toggle signal 1 -- *TGL1*
<u>Function code data = 73</u>   Toggle signal 2 -- *TGL2*

Assigning toggle signals 1 and 2 to two X terminals enables the toggle monitor control. If either one of those signals is not assigned, the toggle monitor control becomes disabled.

■ **What is toggle monitor control**

The toggle monitor control monitors whether the inverter and the host equipment mutually *function normally*. The "*function normally*" means not "no alarm has occurred" but "CPUs and I/O devices of both the inverter and the host equipment have not stopped."

(1) Toggle monitor method

<u>- This monitor is available to operations via the T-link, SX bus(*1), E-SX bus(*2) communications link.</u>
<u>- Operations via digital input terminals are not assumed.</u>

When H30 = 2 or 3, the target bit is operated via the communications link.

The toggle control uses digital inputs on X11 to X14 and does not use those on X1 to X9.

Toggle data (PLC ⇒ VG1) uses 2 bits out of bits 11 to 14 of function code S06 [Type 32].

The host equipment uses the above 2-bit data to transfer toggle data to the inverter in the sequence of 00→01→10→11→00 at the constant cycle.

The inverter checks that the transferred toggle data is incremented.

If the inverter detects a toggle data error during running and the error is not recovered within the detection time specified by H144, then the inverter trips with an alarm (Ar-F).

*1 For SX bus communication, the bus tact cycle of applications that send a transmission toggle at the MICREX-SX side should be 1 ms or more.

*2 As well, for E-SX but communication, the bus tact cycle should be 0.5 ms or more

(2) Toggle error detection alarm (Ar-F)

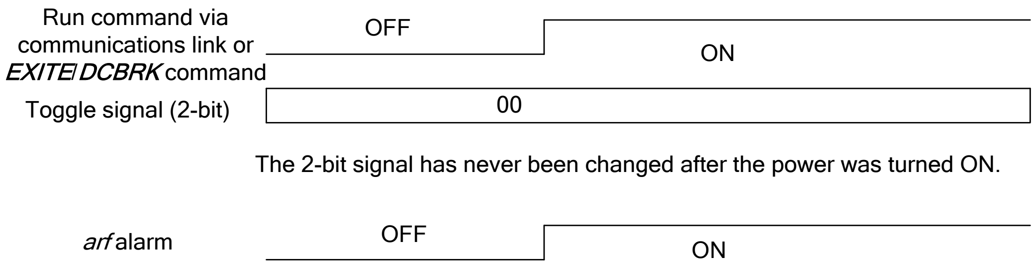
The toggle error detection alarm (Ar-F) is treated as a heavy alarm.

H144 specifies the toggle signal error detection time.

No.	Parameter name	Data setting range	Initial value	Remarks
H144	Toggle data error timer	0.01 to 20.00 s	0.10 s	Acts as a toggle signal error monitor timer.

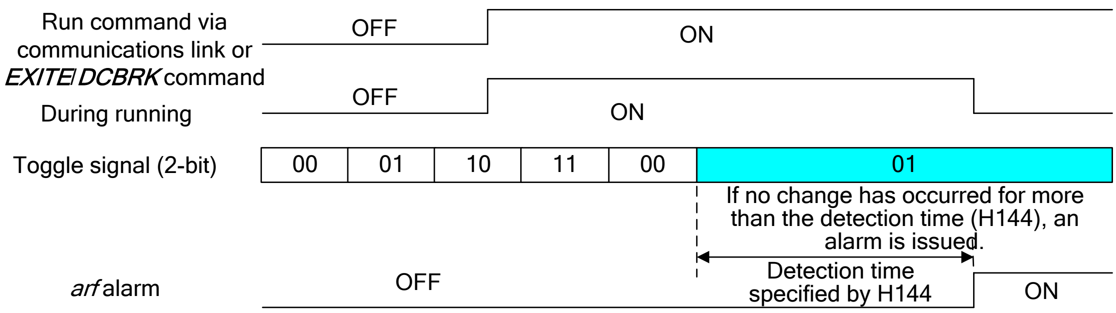
A toggle error detection alarm (Ar-F) occurs upon detection of any of the following conditions when a run command is given via the communications link or during running initiated by an auxiliary excitation command or DC braking command.

- When a toggle signal has never been changed, a run command or ***EXITE*** ("Pre-excitation")/***DCBRK*** ("Enable DC braking") is entered.



Note: When the power is turned ON, a run command is entered with the start of toggle signal monitor, an alarm Ar-F is issued. Therefore, enter a run command after at least one cycle of toggle signal like 00→01→10→11.

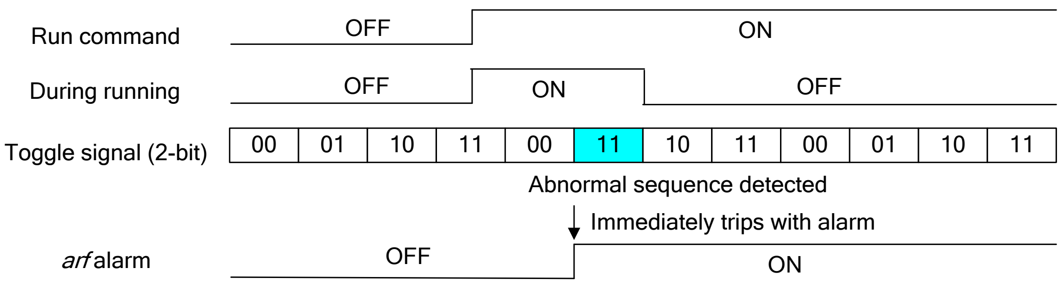
- During running, no change has occurred in a toggle signal for more than the detection time specified by H144.



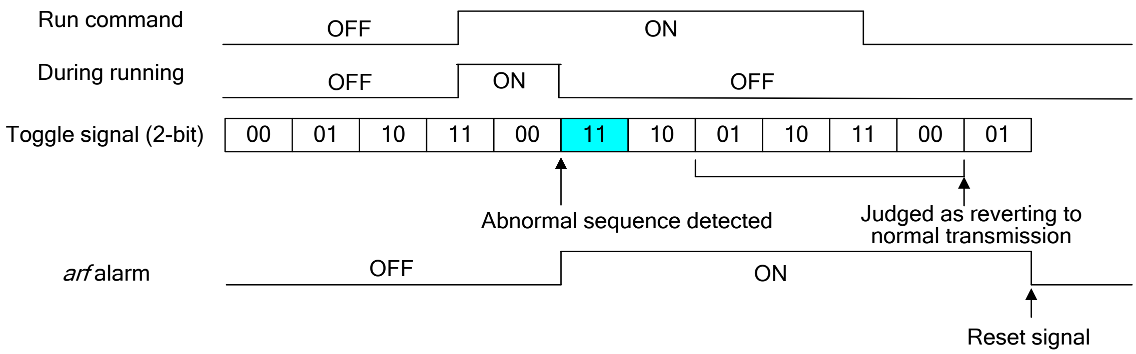
- During running, a toggle signal does not respond in the sequence of 00→01→10→11.

  If a change in a toggle signal is abnormal, the inverter immediately trips as a PLC program error. After detection of the error, normal sequence (00→01→10→11) of 2-bit signals is judged as a normal recovery.

  Alarm occurrence example 1



Alarm occurrence example 2 (Normal recovery after detection of an alarm)



Note: If a toggle error detection alarm (ArF) occurs during pre-excitation or DC braking, disable (turn OFF) the ***EXCITE*** or ***DCBRK*** command, respectively. If the command remains enabled (ON), turning the alarm reset signal ON causes repeating of instantaneous cancellation and recurrence of ArF alarm (chattering).

Function code data = 74 Cause external mock alarm -- *FTB*

This external digital input signal causes a mock alarm (Err) in the inverter.

The factory default of this signal is Normal open contact.

When terminals [FTB] and [CM] are opened, it is treated as normal. Closing those terminals shuts down the inverter output so that the motor coasts to a stop.

For setting to use as Normal close contact, refer to the description of external alarm (OH2).

Function code data = 75 Cancel NTC thermistor alarm -- *NTC-CCL*

This external digital input signal cancels an NTC thermistor wire break alarm (nrb).

Function code data = 76 Cancel lifetime alarm signal -- *LF-CCL*

This external digital input signal cancels a lifetime alarm signal ***LIFE***.

Function code data = 78 Switch PID feedback signals -- *PID-1/2*

This external digital input signal switches between the PID feedback 1 ***PID-FB1*** and PID feedback 2 ***PID-FB2***, which are assigned to analog input terminals.

Input signal to select specified data	PID feedback to be selected (Analog input terminal)
78	
OFF	15: PID feedback 1 ***PID-FB1***
ON	27: PID feedback 2 ***PID-FB2***

Function code data = 79 Select PID torque bias -- *TB-PID*

This external digital input signal enables PID output to be used as a torque bias.

Input signal to select specified data	Function to be selected
79	
OFF	Disable PID output as a torque bias
ON	Enable PID output as a torque bias

E14 X Terminal Function (Normal open/close)

E14 configures terminals [X1] to [X9] individually as a "normal open" or "normal close" contact by software when they have no connections.

OP: Normal open
CL: Normal close

Use this function for configuring a "normal close" contact for terminal command ***THR*** ("Enable external alarm trip"), for example.

```
              1500
CLOSE/OPEN (X)
■■■■■■■■□OP
□□□□□□□□■CL
123456789
∧∨→DATA  ADJUST
```

<u>Configuration change example via the RS-485 communications link</u>

To configure terminal [X9] (***THR***) as a "normal close" contact and other X terminals, as a "normal open" contact, use the following.

(1) Assign bits in accordance with format [35]. Refer to Chapter 4, Section 4.2.4.2 "Data type 12-145."

To configure terminal [X9] as a "normal close" contact, the bit assignment is 0000 0001 0000 0000 (in binary).

(2) Convert the bit assignment from binary to hexadecimal format.

0000 0001 0000 0000 (binary) = 0100 (hexadecimal)

Set the hexadecimal data to E14 for configuring terminal [X9].

E	1	4	X		N	O	R	M	A	L		

E15 to E27 Y Terminal Function

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-VG1-DIOA.

The valid and invalid functions vary according to the drive control (vector control for IM with/without speed sensor, vector control without speed sensor, V/f control and vector control for PMSM with speed sensor). For details, refer to the function code tables in Section 4.2.

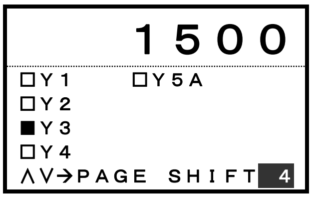
<Using digital output>

You can use a total of 13 terminals, which are five terminals from Y1 to Y4 and Y5A as standard and eight terminals from Y11 to Y18 (when a DIOA option is used). Similarly to the link function (RS-485, T-Link, SX, Field Bus), you can refer to the output of 13 points through the communications link.

You can use the function codes M52, M53, M54, M142, M143 and M144 (control output 1 to 6) to read all information (85 bits in total) that are available for the DO outputs through the communications link (RS-485, T-Link, SX bus, and fieldbus) and UPAC. For details, refer to M52 to M54 (data types 125 to 127) and M142 to M144 (data types 128 to 130) in the function code tables.

<u>Setting procedure</u>

- 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.

E	1	5	Y	1		F	U	N	C			
E	1	6	Y	2		F	U	N	C			
E	1	7	Y	3		F	U	N	C			
E	1	8	Y	4		F	U	N	C			
E	1	9	Y	5		F	U	N	C			
E	2	0	Y	1	1		F	U	N	C		
E	2	1	Y	1	2		F	U	N	C		
E	2	2	Y	1	3		F	U	N	C		
E	2	3	Y	1	4		F	U	N	C		
E	2	4	Y	1	5		F	U	N	C		
E	2	5	Y	1	6		F	U	N	C		
E	2	6	Y	1	7		F	U	N	C		
E	2	7	Y	1	8		F	U	N	C		

Data setting range: 00 to 84

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
00	Inverter running	***RUN***	24	Resetting	***TRY***
01	Speed valid	***N-EX***	25	Universal DO	***U-DO***
02	Speed agreement 1	***N-AG1***	26	Heat sink overheat early warning	***INV-OH***
03	Speed arrival signal	***N-AR***	27	Synchronization completion signal	***SY-C***
04	Speed detected 1	***N-DT1***	28	Lifetime alarm	***LIFE***
05	Speed detected 2	***N-DT2***	29	Under acceleration	***U-ACC***
06	Speed detected 3	***N-DT3***	30	Under deceleration	***U-DEC***
07	Undervoltage detected (Inverter stopped)	***LU***	31	Inverter overload early warning	***INV-OL***
08	Torque polarity detected (braking/driving)	***B/D***	32	Motor overheat early warning	***M-OH***
09	Torque limiting	***TL***	33	Motor overload early warning	***M-OL***
10	Torque detected 1	***T-DT1***	34	DB overload early warning	***DB-OL***
11	Torque detected 2	***T-DT2***	35	Link transmission error	***LK-ERR***
12	Keypad operation enabled	***KP***	36	In limiting under load adaptive control	***ANL***
13	Inverter stopped	***STOP***	37	In calculation under load adaptive control	***ANC***
14	Inverter ready to run	***RDY***	38	Analog torque bias being held	***TBH***
15	Magnetic flux detected	***MF-DT***	39-48	Custom Do1 to Do10	***C-DO1*** to ***C-DO10***
16	Motor M2 selected	***SW-M2***			
17	Motor M3 selected	***SW-M3***	49	-	-
18	Brake release signal	***BRK***	50	-	-
19	Alarm content 1	***AL1***	51	Multiplex system communications link being established	***MTS***
20	Alarm content 2	***AL2***	52	Answerback to cancellation of multiplex system	***MEC-AB***
21	Alarm content 4	***AL4***	53	Multiplex system master selected	***MSS***
22	Alarm content 8	***AL8***	54	Multiplex system local station failure	***AL-SF***
23	Cooling fan in operation	***FAN***	55	Stopped due to communications link error	***LES***

Function code data	Terminal commands assigned	Symbol	Function code data	Terminal commands assigned	Symbol
56	Alarm output (for any alarm)	***ALM***	72	Turn ON Y-terminal test output	***Y-ON***
57	Light alarm	***L-ALM***	73	Turn OFF Y-terminal test output	***Y-OFF***
58	Maintenance timer	***MNT***	74	-	-
59	Braking transistor broken	***DBAL***	75	System clock battery lifetime expired	***BATT***
60	DC fan locked	***DCFL***	76	-	-
61	Speed agreement 2	***N-AG2***	77	SPGT battery warning (Available soon)	***SPGT-B***
62	Speed agreement 3	***N-AG3***	78	-	-
63	Axial fan stopped	***MFAN***	79	-	-
64	-	-	80 *1	EN terminal detection circuit failure	***DECF***
65	-	-	81 *1	EN terminal OFF	***ENOFF***
66	Answerback to droop control enabled	***DSAB***	82 *1	Safety function in progress	***SF-RUN***
67	Answerback to cancellation of torque command/torque current command	***TCL-C***	83	-	-
68	Answerback to cancellation of torque limiter mode 1	***F40-AB***	84 *1	STO under testing	***SF-TST***
71	73 ON command	***PRT-73***			

*1 Function code data 80 to 82 and 84 are available in the ROM version H1/2 0020 or later.

Function code data = 00 Inverter running -- *RUN*

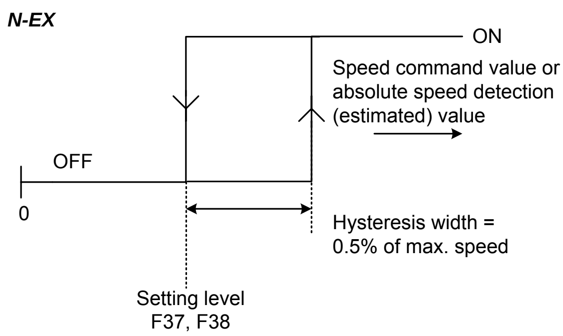
"Running" is defined as a state when the inverter supplies output. This signal is ON when the inverter is running and OFF when the inverter is stopping.

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).

Function code data = 01 Speed valid -- *N-EX*

Turns ON when the absolute value of the speed command 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 command or the actual speed.



Function code data = 02 Speed agreement 1 -- *N-AG1*

Turns ON when motor M1 is selected and the actual speed value falls in the detection range specified by the speed command value (Reference speed 4: ASR input).

See the function description of E44 "Speed agreement (Detection range) (Off delay timer)"and E45 "Enable/disable alarm for speed disagreement".

When motor M1 is not selected, this signal is always OFF.

Function code data = 03 Speed arrival signal -- *N-AR*

Turns ON when the actual speed value reaches the speed command value (Speed command 1: acceleration/deceleration calculation unit input). See the function description of E42.

Function code data = 04, 05, 06 Speed detected 1, 2, 3 -- *N-DT1*, *N-DT2*, *N-DT3*

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.

Function code data = 07 Undervoltage detected (Inverter stopped) -- *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: 180 V for 200 V class series and 360 V for 400 V class series

Function code data = 08 Torque polarity detected (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.

Function code data = 09 Torque limiting -- *TL*

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

Function code data = 10, 11 Torque detected 1, 2 -- *T-DT1*, *T-DT2*

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

Function code data = 12 Keypad operation enabled -- *KP*

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

Function code data = 13 Inverter stopped -- *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).

Function code data = 14 Inverter ready to run -- *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. During operation with the UPAC option (o38 ≠ 0), [RDY] is turned on upon UPAC operation in addition to the above-mentioned condition. (It takes about 2 or 3s.)

This signal is turned off if the coast-to-stop command is turned on.

When the SX bus interface card (OPC-VG1-SX) or E-SX bus interface card (OPC-VG1-ESX) is mounted, the ON-conditions of ***RDY*** are as follows.

When commands via the SX bus or E-SX bus are enabled (H30 = 2 or 3 and ***LE*** = ON), ***RDY*** comes ON the moment the SX bus or E-SX bus becomes ready to communicate.

When commands via the SX bus or E-SX bus are disabled (H30 = 0 or 1 or ***LE*** = OFF), ***RDY*** comes ON as usual.

Function code data = 15 Magnetic flux detected -- *MF-DT*

Turns ON when the calculated magnetic-flux value exceeds the magnetic-flux detection level (E48-5%).

<u>Function code data = 16, 17</u> Motor M2, M3 selected -- *SW-M2*, *SW-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-M2	***SW-M3***	
OFF	OFF	Motor 1
OFF	ON	Motor 2
ON	OFF	Motor 3

<u>Function code data = 18</u> Brake release signal -- *BRK* (Not available under V/f control)

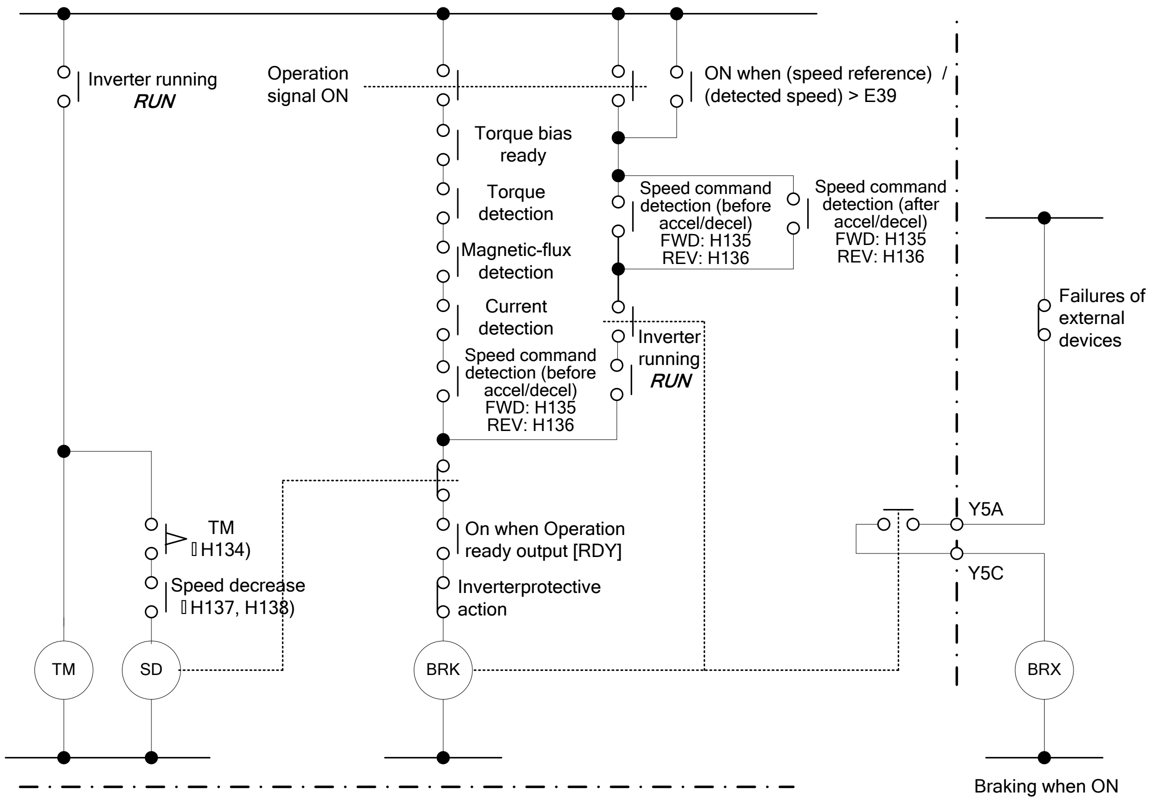
Provides the mechanical brake apply/release signal.

There are the torque bias (F47 to F50), torque detection levels 1 and 2 (E46, E47), magnetic-flux detection level (E48) and speed command detection level (H135, H136) as parameters (user-defined) for releasing (opening) brake.

There are the speed detection level 1 (E38, E39), speed decrease detection delay timer (H134, H137, H138) and speed command detection level (H135, H136) as parameter for applying brake.

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

Y5A-Y5C: Closing this releases brake and opening this applies brake.



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. We recommend to use the servo lock function not independently but together with a mechanical brake.

< Setting >

Brake release sequence

When all of the following conditions 1) to 6) are met, ***BRK*** ("Brake release signal") is turned ON to release the mechanical brake.

1) ***RDY*** ("Inverter ready to run") ON
   After main power ON → DC link bus voltage established → initialization completed, ***RDY*** comes ON.

2) Current detection
   If the inverter detects current of 30% or more of the P08 (M1 exciting current), A10 (M2 exciting current) or A110 (M3 exciting current) when M1, M2 or M3 is selected, respectively, it judges the state as "current detected."

3) Completion of torque bias startup
   Torque bias can be added with F46 (Mechanical loss compensation), F47 to F49 (Torque bias T1 to T3) and F50 (Torque bias startup timer). The inverter defines the elapse of the time specified by F50 as completion of torque bias startup.

   When no torque bias is added, the inverter judges ***RUN*** ("Inverter running") ON as completion of torque bias startup.

4) Both ***FWD*** ("Run forward") and ***T-DT1*** ("Torque detected 1") ON, or both ***REV*** ("Run reverse") ON and ***T-DT2*** ("Torque detected 2") ON
   For ***FWD***, specify the torque detection level 1 with E46; for ***REV***, specify the torque detection level 2 with E47. When the torque command comes to be the torque detection level 1/2 or above, ***T-DT1*** or ***T-DT2*** is turned ON, respectively.

5) ***MF-DT*** ("Magnetic-flux detected") ON
   This signal is turned ON when the calculated magnetic-flux value comes to be "Magnetic-flux detection level (E48) - 5%" or above.

6) ***N-DT1*** ("Speed detected 1"), ***N-DT2*** ("Speed detected 2") or ***N-DT3*** ("Speed detected 3") ON
   For ***FWD*** or ***REV***, the speed detection signal is turned ON when the reference speed (before acceleration/deceleration) comes to be the speed command detection level (H135 or H136) or above.

Brake applying sequence

When any one of the following conditions 1) to 6) is met, ***BRK*** ("Brake release signal") is turned OFF to apply the mechanical brake.

1) Both run command (***FWD*** or ***REV***) and ***N-DT1*** ("Speed detected 1") OFF
   Specify the speed detection mode with E38 and the speed detection level 1 with E39. When "***N-FB1±*** ("Detected speed 1") / ***N-REF4*** ("Reference speed 4") ≤ (Speed detection level (E39) - 1% of maximum speed)," ***N-DT1*** goes OFF.

   If the speed detection level 1 (E39) is 1% or below of the maximum speed, ***N-DT1*** goes OFF when "***N-FB1±*** ("Detected speed 1") / ***N-REF4*** ("Reference speed 4") = 0 (r/min).

   Note: Under vector control without speed sensor, select ***N-REF4*** ("Reference speed 4"). (E38 = 1**).

2) ***RDY*** ("Inverter ready to run") OFF

3) ***RUN*** ("Inverter running") OFF

4) Inverter protective function (alarm) activated

5) ***N-DT1*** ("Speed detected 1"), ***N-DT2*** ("Speed detected 2") or ***N-DT3*** ("Speed detected 3") ON

   For ***FWD*** or ***REV***, the speed detection signal is turned ON when both the reference speed (before acceleration/deceleration) and the reference speed (after acceleration/deceleration) drops to "Speed command detection level (H135 or H136) - 0.5%" or below.

   (When H135 or H136 = 0.0 r/min, this condition is invalid.)

6) When the detected speed is kept at the speed decrease detection level (H137) or below during the time specified by the speed command detection delay timer (H138), the brake is applied irrespective of the presence of a run command.

   (When H137 = 0.0 r/min, this condition is invalid.)

Starting speed/Stop speed

Brake application and release timings can be adjusted with the starting speed (F23, F24) and stop speed (F37 to F39).

(1) At the time of start

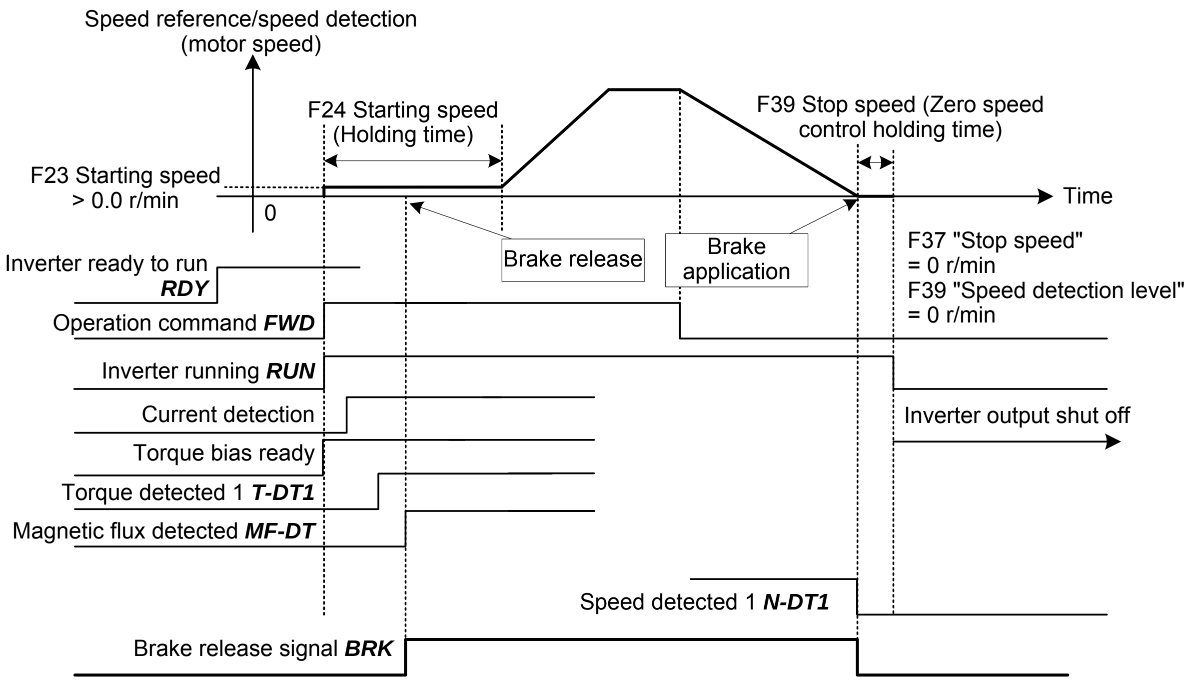
Starting speed without torque bias:
In order not to release brake during acceleration, set the starting speed (F23) to 0.1 r/min or above and set the torque detection level 1, 2 (E46, E47) so that ***T-DT1*** or ***T-DT2*** ("Torque detected 1 or 2") comes ON within the holding time (F24).

Starting speed with torque bias:
Set the starting speed (F23) to 0.0 r/min and set the torque detection level 1, 2 (E46, E47) so that ***BRD*** ("Brake release signal") comes ON within the holding time (F24).

(2) At the time of stop

Adjust the braking conditions to apply brake within the zero speed control holding time (F39).

Specifying the zero speed control (F37 = 0.0 r/min) and the speed detection level 1 (E39 = 0 r/min) enables ***BRD*** ("Brake release signal") to go off after the motor (machine) stops completely.



<u>Function code data = 19, 20, 21, 22</u>   **Alarm content --** ***AL1*****,** ***AL2*****,** ***AL4*****,** ***AL8***

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, dbA, ECF)	OFF	OFF	ON	OFF
CPU system error (Er1, Er3, Er8, ErA*1) Functional safety card error (SiF*1, SrF*1)	ON	OFF	ON	OFF
Overheat (dbH, OH1, OH3, OH4, dFA)	OFF	ON	ON	OFF
Overload (OL1, OL2, OL3, OLU)	ON	ON	ON	OFF
Speed error (dO, Er9, OS, LOC)	OFF	OFF	OFF	ON
Input phase loss (Lin, OPL)	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, Err)	OFF	ON	ON	ON
Others (ErH, Ar1 to ArF)	ON	ON	ON	ON

*1 Available in the ROM version H1/2 0020 or later.

<u>Function code data = 23</u>   **Cooling fan in operation --** ***FAN***

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

<u>Function code data = 24</u>   **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)".

Function code data = 25   **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 RS-485, 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:

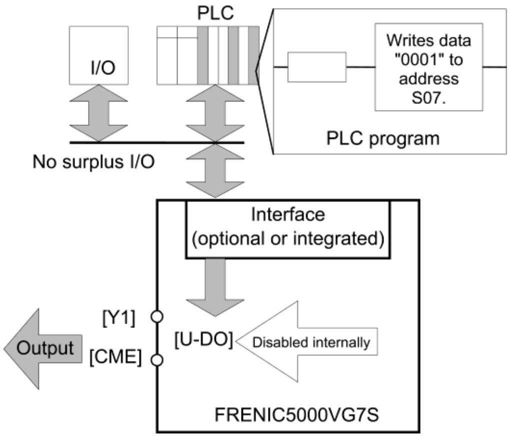
1) To set ON/OFF to the control terminal directly through RS-485 or field bus.
2) To put the output which are assigned by the software created by the UPAC option on a DO of the control terminals.

<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]:

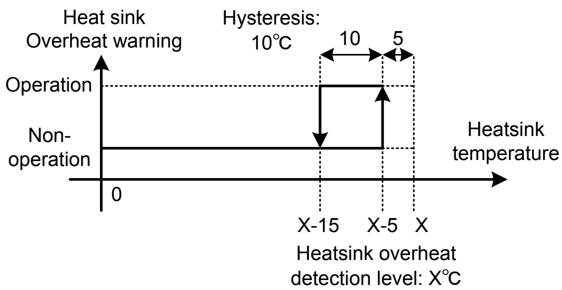
1) Set 25 ***U-DO*** to the function code E15 "Y1 function selection". Now the inverter does not use the Y1 terminal internally and you can use the terminal for the output of the communication.
2) Use the PLC to write "1" to the corresponding bit (data type: 33) of the function code S07 "Universal DO".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



Function code data = 26   **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 heat sink 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 (HD, LD, and MD), and user cannot change it.



Function code data = 27   **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-VG1-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).

<u>Function code data = 28</u>   Lifetime alarm -- *LIFE*

Turns ON when any one of the DC link bus capacitor (capacitance), the electrolytic capacitors on the control print circuit boards (cumulative running time), and the cooling fans (cumulative running time) approaches the end of the lifetime. This signal turns ON also when the DC fan stops.

The lifetime is judged by the following criteria and this signal comes ON if any one of the above components reaches the end-of-life criteria. The lifetime information can be monitored in Menu #5 Maintenance or with monitoring function codes (M codes) on the LCD monitor in real-time.

<table>
<tr><th>Object of life prediction</th><th>Prediction function</th><th>End-of-life criteria</th><th>On the LCD monitor (Monitoring function codes)</th></tr>
<tr><td rowspan="3">DC link bus capacitor</td><td rowspan="2"><u>Measurement of discharging time</u>
Measures the discharging time of the DC link bus capacitor when the main power is shut down and calculates the capacitance.
For details, refer to Function code H80 "Capacitance Measurement of DC Link Bus Capacitor."</td><td>85.0% or lower of the initial capacitance at shipment (Units digit of H104 = 0)</td><td rowspan="2">CAP:
Capacitance (%)
(M46)</td></tr>
<tr><td>85% or lower of the reference capacitance* under ordinary operating conditions at the user site (Units digit of H104 = 1)
*To be measured when the inverter is set up.</td></tr>
<tr><td><u>ON-time counting</u>
Counts the time elapsed when the voltage is applied to the DC link bus capacitor, while correcting it according to the capacitance measured above.</td><td>Exceeding 87,600 hours (10 years)</td><td>CAPEH:
Elapsed time (h)
(M121)
CAPRH:
Remaining time (h)</td></tr>
<tr><td>Electrolytic capacitors on printed circuit boards</td><td>Counts the time elapsed when the voltage is applied to the capacitors.</td><td>Exceeding 87,600 hours (10 years)</td><td>TCAP:
Elapsed time (h)
(M47)</td></tr>
<tr><td>Cooling fans</td><td>Counts the run time of the cooling fans.</td><td>Exceeding 87,600 hours (10 years)
Note that this is an estimated life expectancy at the inverter ambient temperature of 40°C.</td><td>TFAN:
Elapsed time (h)
(M48)</td></tr>
</table>

This function indicates merely an approximate life span. Daily inspection and periodic inspection are necessary to avoid failures and keep operating at high reliability over a long period of time. (Refer to the Instruction Manual.)

<u>Function code data = 29</u>   Under acceleration -- *U-ACC*
<u>Function code data = 30</u>   Under deceleration -- *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)".

<u>Function code data =31</u>   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.

<u>Function code data =32</u>   Motor overheat 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.

<u>Function code data =33</u>   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.

Function code data = 34 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.

Function code data = 35 Link transmission error -- *LK-ERR*

Turns ON when a communication error occurs in the transmission through the link (RS-485, T-Link, SX, field bus). Turns OFF when the communication returns to normal.

Function code data = 36 In limiting under load adaptive control -- *ANL*

This signal comes ON when the reference speed is limited with the speed limiter value calculated under load adaptive control. It goes OFF when any one of the following OR conditions is met.

OR conditions

- Inverter stop (Drive OFF)
- Terminal command ***N-LIM*** ("Cancel speed limiter") = ON
- During pre-excitation
- Polarity change of speed command (Speed reference 4: ASR input)
- ***N-FB1±*** ("Detected speed 1") < 50% of rated speed and ***NL-RST*** ("Reset completion of speed limit calculation") = ON

Function code data = 37 In calculation under load adaptive control -- *ANC*

This signal comes ON during calculation of a movable load and speed limiter value under load adaptive control. It goes OFF when any one of the following OR conditions is met.

OR conditions

- Inverter stop (Drive OFF)
- During pre-excitation
- Polarity change of speed command (Speed reference 4: ASR input)
- ***N-FB1±*** ("Detected speed 1") < 50% of rated speed and ***NL-RST*** ("Reset completion of speed limit calculation") = ON
- ***N-FB1±*** ("Detected speed 1") ≥ H226 ("Limit speed discrimination zone, Completion speed")
- ***N-FB1±*** ("Detected speed 1") < H226 ("Limit speed discrimination zone, Start speed") and Limit speed calculation incomplete

For ***ANL*** and ***ANC***, refer to the description given for function codes H60 to H66 and H201 to H228 (Load adaptive control).

Function code data = 38 Analog torque bias being held -- *TBH*

This signal is turned ON when an analog torque bias hold command is entered.

Function code data = 39-47 Custom Do1 to Do9 -- *C-DO1 to C-DO9*

Do terminals for manufacturer.

Function code data = 48 Custom Do10 -- *C-DO10*

This signal comes ON in tact synchronization so that it is possible to check whether the tact cycle of the E-SX bus is synchronized with the inverter control cycle.

Function code data = 51 Multiplex system communications link being established -- *MTS*

This signal comes ON when the communications link of the multiplex system has been established.

Function code data = 52 Answerback to cancellation of multiplex system -- *MEC-AB*

This is an answerback signal for switching the digital input ***MT-CCL*** ("Cancel multiplex system").

<u>Function code data = 53</u> Multiplex system master selected -- *MSS*

This signal comes ON when the master unit is configured with the multiplex system selected.

<u>Function code data = 54</u> Multiplex system local station failure -- *AL-SF*

If an alarm occurs in a multiplex system, only the inverter (local station) that detects failure outputs this signal.

In the single-machine mode, this signal is functionally equivalent to "Alarm output (for any alarm)."

<u>Function code data = 55</u> Stopped due to communications link error -- *LES*

This signal applies when the CC-Link interface card is mounted. It comes ON when the inverter switches to a stop operation due to an occurrence of an alarm Er-4 or Er-5. Removing the alarm and restarting the inverter turns this signal OFF.

<u>Function code data = 56</u> Alarm output (for any alarm) -- *ALM*

The ALM can be output also via the Y terminal.

<u>Function code data = 57</u> Light alarm -- *L-ALM*

This signal comes ON when a light alarm has occurred. Removing the alarm factor automatically turns this signal OFF.

<u>Function code data = 58</u> Maintenance timer -- *MNT*

This signal comes ON when the total of the M1, M2 and M3 startups (M123 to M125) exceeds the H82 setting or the total of the M1, M2 and M3 cumulative motor run time (M126 to M128) exceeds the H83 setting.

Modifying either of the H82 or H83 setting that constitutes a forecasting factor turns this signal OFF.

<u>Function code data = 59</u> Braking transistor broken -- *DBAL*

This signal comes ON when the error factor of a braking transistor alarm (dbA) arises. Even if the alarm is defined as a light alarm, this signal comes ON.

<u>Function code data = 60</u> DC fan locked -- *DCFL*

This signal comes ON when the DC fan for circulating air inside the inverter is stopped for two seconds.

The above inverter state also constitutes a heavy or light alarm factor. Alarms can be defined by H108 as a heavy or light alarm.

<u>Function code data = 61</u> Speed agreement 2 -- *N-AG2*

This signal applies when motor M2 is selected. It comes ON when the deviation of the detected speed from the speed command value (Reference speed 4: ASR input) is within the allowable range.

For details, refer to the descriptions of E114 and E115 (Speed Agreement 2, Detection width and Off-delay timer) and E45 (Speed Disagreement Alarm/Phase Loss Detection Level).

When motor M2 is not selected, this signal is always OFF.

<u>**Function code data = 62**</u> **Speed agreement 3 -- *N-AG3***

This signal applies when motor M3 is selected. It comes ON when the deviation of the detected speed from the speed command value (Reference speed 4: ASR input) is within the allowable range.

For details, refer to the descriptions of E116 and E117 (Speed Agreement 3, Detection width and Off-delay timer) and E45 (Speed Disagreement Alarm/Phase Loss Detection Level).

When motor M3 is not selected, this signal is always OFF.

<u>**Function code data = 63**</u> **Axial fan stopped -- *MFAN***

This signal comes ON when the NTC detection temperature of the motor having an NTC thermistor drops below the setting specified by E118 and the inverter is stopped.

<u>**Function code data = 64**</u> **Arbitrarily assigned RDY -- *AS-RDY*** (Available soon)

<u>**Function code data = 66**</u> **Answerback to droop control enabled -- *DSAB***

This signal is turned ON when the droop control is activated by turning ON the ***DROOP*** signal on an X terminal.

When the inverter is stopped or under torque control, even turning ON the ***DROOP*** signal does not turn this signal ON.

<u>**Function code data = 67**</u> **Answerback to cancellation of torque command/torque current command -- *TCL-C***

This is an answerback signal for switching between ***H41-CCL*** (Cancel H41 (Torque command)) and ***H42-CCL*** (Cancel H42 (Torque current command)).

<u>**Function code data = 68**</u> **Answerback to cancellation of torque limiter mode 1 -- *F40-AB***

This is an answerback signal for switching ***F40-CCL*** (Cancel F40 (Torque limiter mode 1)).

<u>**Function code data = 71**</u> **73 ON command -- *PRT-73***

When a charger circuit is configured outside the inverter, use this signal as a 73 ON command for switching the charger resistor bypass circuit. Turning this signal ON bypasses the charger resistor.

<u>**Function code data = 72**</u> **Turn ON Y-terminal test output -- *Y-ON***

This signal comes ON when it is assigned to the Y terminal function. Use this signal to check the connection of Y terminals.

<u>**Function code data = 73**</u> **Turn OFF Y-terminal test output -- *Y-OFF***

This signal comes OFF when it is assigned to the Y terminal function. Use this signal to check the connection of Y terminals.

<u>**Function code data = 75**</u> **System clock battery lifetime expired -- *BATT***

This signal comes ON when the battery voltage level of the integrated battery (option for inverters of 22 kW or below, included as standard for those of 30 kW or above) drops. If this signal comes ON, replace the integrated battery as soon as possible.

<u>Function code data = 77</u> **SPGT battery warning --** ***SPGT-B*** (Available soon)

<u>Function code data = 80</u> **EN terminal detection circuit failure --** ***DECF*** (Available soon)

This signal comes ON when a functional safety circuit failure is detected.

<u>Function code data = 81</u> **EN terminal OFF --** ***ENOFF*** (Available soon)

This signal comes ON when Enable input on the EN1 and EN2 terminals is OFF.

<u>Function code data = 82</u> **Safety function in progress --** ***SF-RUN***
<u>Function code data = 84</u> **STO under testing --** ***SF-TST***

These signals are available when the functional safety card is mounted.

📖 For details, refer to the Functional Safety Card Instruction Manual (INR-SI47-1541).

Note: Function code data 80, 81, 82 and 84 are available in the ROM version H1/2 0020.

E28 Y Terminal Function (Normal open/close)

E28 specifies whether to open or close output terminals [Y1] to [Y5] by software.

OP: Open
CL: Close (short-circuit)

E	2	8	Y		N	O	R	M	A	L		

Example of configuration change through RS-485 or other communications links

To configure Y2 and Y5 as normally closed contacts and configure other Y functions as normally open contacts

1) Perform bit assignment in binary according to type [36] (refer to Section 4.2.3.2 Data Type).
2) Next, convert the bit-assigned binary data into a hexadecimal.
   0000 0000 0001 0010 (binary) = 0012 (hexadecimal) Enter this hexadecimal data.

E29 PG Pulse Output Selection

Use this function to provide different applications with the PG pulse signal.

E	2	9	P	G	–	P	L	S	–	O	U	T

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 command (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.

   When E29 = 7: Pulse generation mode (A, B: Signals with 90° phase difference)
3) Converting the input via the PG interface card into arbitrary pulses to output

   When E29 = 8: OPC-VG1-PG (PD), pulse train detection input is directly supplied to the pulse output.

   When E29 = 9: OPC-VG1-PG (PR), pulse train command 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.
4) Converting the speed detection pulse input into arbitrary pulses to output

   When E29 = 10: Integrated PG, PG (SD), Detected speed pulse input oscillation mode

   When E29 = 7 to 10, arbitrary pulses can be output. For details, refer to the description of E109 and E110.

E30 Motor Overheat Protection (Temperature)

Sets the temperature at which the motor overheat alarm (0h4) is issued. Specify the protection level according to the isolation class of the motor.

E	3	0	M	–	P	R	T	–	C			

Data setting range: 50 to 200 (°C)

Note: The E30 setting takes effect when the selected motor (M1, M2 or M3) uses an NTC thermistor or the analog input signal ***M-TMP*** ("Motor temperature") is selected.

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.

E31 M-WARN-T

Data setting range: 50 to 200 (°C)

Note: This function is invalid if the PTC thermistor is used.

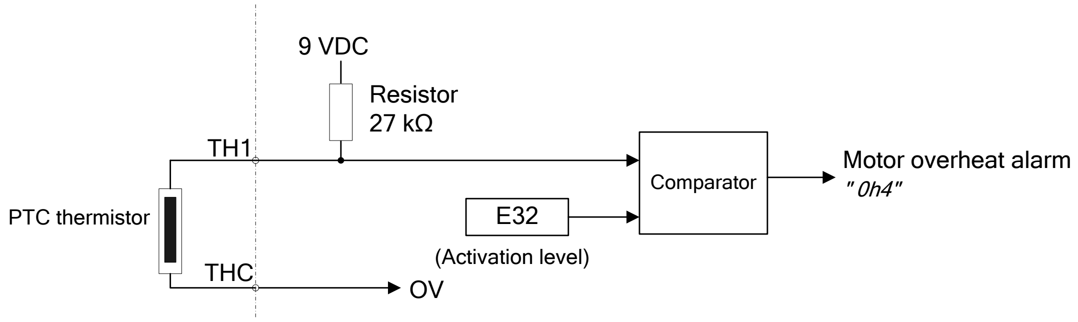
E32	M1-M3 PTC Activation Level

Activated when the input voltage from a PTC becomes higher than the specified voltage (activation level) if you select to use a thermistor.

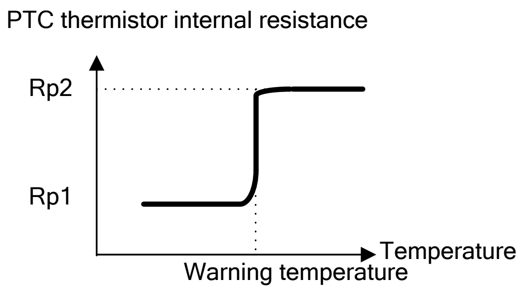
E32 M-PTC-LVL

Data setting range: 0.00 to 5.00 (V)

Connect a PTC thermistor as shown below.



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.



The voltage level (activation level) can be calculated with the following expression.

Voltage level (V) = 5 V/(Rp + 270000) x Rp

Set the Rp within the following range.
Rp1 < Rp < Rp2

To determine Rp easily, use the following expression.
Rp (Ω) = (Rp1 + Rp2)/2

Note: The above expression for determining the voltage level differs from that to be used for the VG7.

When a PTC thermistor wire breaks, the inverter recognizes Rp = (Ω) and issues a motor overheat alarm 0h4.

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 (OLU). 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

Data 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 (OL 1). 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	

Data 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

Data 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 (dbH). 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

Data 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		

Data setting range: 0 to 1,000 (s)

E38 Speed Detection Mode

E39 Speed Detection Level 1

E40 Speed Detection Level 2

E41 Speed Detection Level 3

If the detected speed or reference speed, which is selectable with E38, exceeds the speed detection level specified by E39, E40 or E41, the inverter outputs Speed detected 1 (***N-DT1***), Speed detected 2 (***N-DT2***), or Speed detected 3 (***N-DT3***), respectively.

E38 specifies which output (detected speed or reference speed) should be the base for speed detection in each of E39, E40 and E41.

- Detected speed: ***N-FB2±*** (Detected speed 2) (ASR input)
- Reference speed: ***N-REF4*** (Reference speed 4) (ASR input)

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		

■ Speed detection level (E39 to E41)

The hysteresis width to switch the Speed detection signal from ON to OFF is 1% of the maximum speed (100%/maximum speed).

If the specified speed detection level exceeds the maximum speed, the inverter interprets the detection level as the maximum speed.

If the specified speed detection level is 1% or less of the maximum speed, the inverter operation differs for Speed detection 1 and Speed detection 2 or 3, as described below.

E39 (Speed detection level 1): Detection using absolute speed value

Data setting range: 0 to 30000 (r/min)

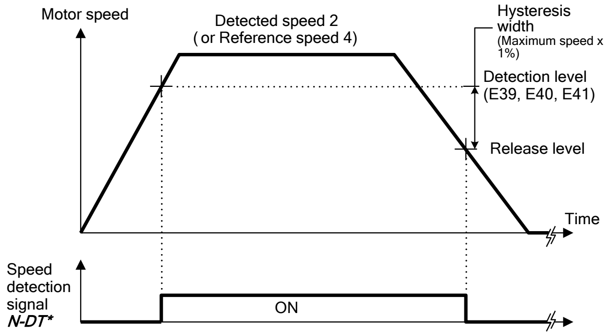
If the detection level is set at "0" (r/min), the Speed detection signal comes ON when the detected speed or reference speed is "0" (r/min) or more.

E40, E41 (Detection level 2, 3): Detection using speed with polarity, Positive operation in the forward rotation direction

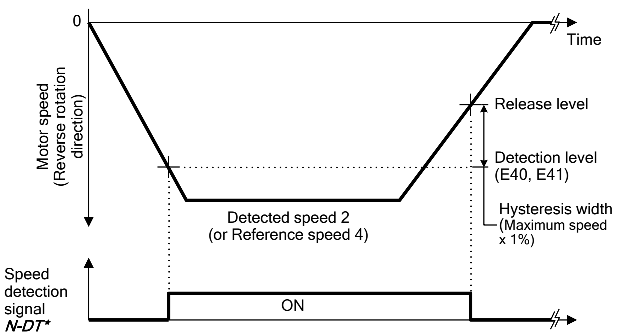
Data setting range: 0 to ±30000 (r/min)

If the detection level is set at "0" (r/min), the Speed detection signal comes ON when the inverter starts running.

Speed detection 1,
Speed detection 2, 3 in forward rotation direction



Speed detection 2, 3 in reverse rotation direction



N-DT*: Denotes any of ***N-DT1***, ***N-DT2***, and ***N-DT3***

■ **Speed detection mode (E38)**

E38 specifies which output (Detected speed 2 or Reference speed 4) should be the base for speed detection. As shown below, it can make the definition of the speed detection levels for E39, E40, and E41 individually.

Data setting range: 000 to 111

E38 = □□□

- Definition for E39 (***N-DT1***)
- Definition for E40 (***N-DT2***)
- Definition for E41 (***N-DT3***)

0: Detected speed 2 (***N-FB2±***)
(Under vector control without speed sensor, the estimated speed value is applied as Detected speed 2.)

1: Reference speed 4 (***N-REF4***) (ASR input)

E42	Speed Arrival (Detection width)

If the detected speed comes within the reference speed detection width specified by E42, the inverter outputs the Speed arrival signal ***N-AR***.

- Detected speed: ***N-FB2±*** (Detected speed 2) (ASR input)
- Reference speed: ***N-REF2*** (Reference speed 2) (Before ACC/DEC processing)

E	4	2	N	A	R	–	H	Y	S	T	R	

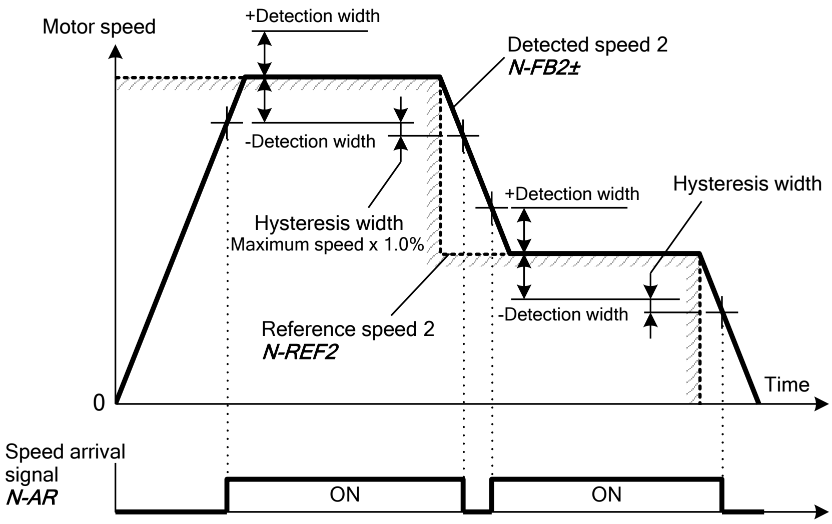
Data setting range: 1.0 to 20.0 (%)

The hysteresis width to switch the Speed arrival signal from ON to OFF is 1% of the maximum speed (100%/maximum speed).

The detection width specified by E42 (equally applied to positive and negative directions) is used for speed arrival processing.

$$\boldsymbol{N\text{-}AG}\ \text{ON condition} = -\text{E42} \le \frac{\boldsymbol{N\text{-}REF2} - |\boldsymbol{N\text{-}FB2}\pm|}{\text{Maximum speed}} \times 100.0\% \le \text{E42}$$

$$\boldsymbol{N\text{-}AG}\ \text{OFF condition} = -(\text{E42} + 1.0\%) \le \frac{\boldsymbol{N\text{-}REF2} - |\boldsymbol{N\text{-}FB2}\pm|}{\text{Maximum speed}} \times 100.0\% \le (\text{E42} + 1.0\%)$$



E43	Speed Agreement (Detection width)
E44	Speed Agreement (Off-delay timer)

If the detected speed agrees with the reference speed (ASR input) (or comes within the detection width specified by E43), the inverter outputs the Speed agreement signal ***N-AG1***.

- Detected speed: ***N-FB2±*** (Detected speed 2) (ASR input)
- Reference speed: ***N-REF4*** (Reference speed 4)

E	4	3	N	A	G		H	Y	D	T	R	
E	4	4	N	A	G		D	E	L	A	Y	

Data setting range: E43 = 1.0 to 20.0 (%)
E44 = 0.000 to 5.000 (s)

An off-delay timer can be set for output of the Speed agreement signal.

E43, E44 and Speed agreement signal ***N-AG1*** are valid when motor M1 is selected.

For Speed agreement signal ***N-AG2*** or ***N-AG3*** to be applied when motor M2 or M3 is selected, respectively, refer to the descriptions of E114 to E117.

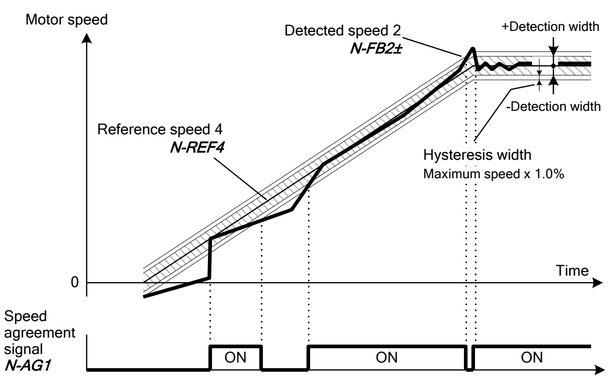
The hysteresis width to switch the Speed agreement signal from ON to OFF is 1% of the maximum speed (100%/maximum speed).

The detection width specified by E43 (equally applied to positive and negative directions) is used for speed agreement processing.

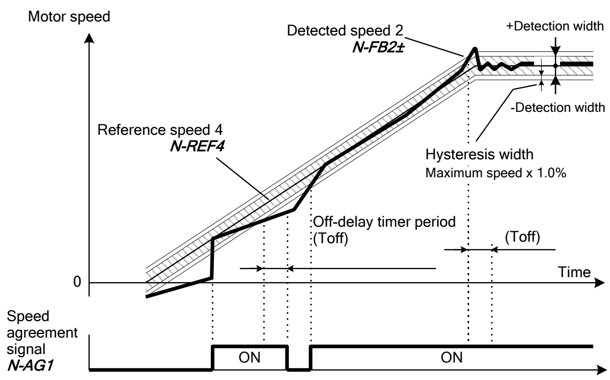
$$\boldsymbol{N\text{-}AG1}\ \text{ON condition} = -\text{E43} \le \frac{\boldsymbol{N\text{-}REF4} - |\boldsymbol{N\text{-}FB2}\pm|}{\text{Maximum speed}} \times 100.0\% \le \text{E43}$$

$$\boldsymbol{N\text{-}AG1}\ \text{OFF condition} = -(\text{E43} + 1.0\%) \le \frac{\boldsymbol{N\text{-}REF4} - |\boldsymbol{N\text{-}FB2}\pm|}{\text{Maximum speed}} \times 100.0\% \le (\text{E43} + 1.0\%)$$

Off-delay timer is set:



Off-delay timer is not set:



E45 Speed Disagreement Alarm/ Phase Loss Detection Level

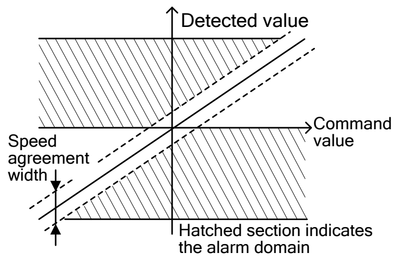
E45 specifies whether the Speed disagreement alarm (Er-9) is issued or not when the deviation between the Speed reference 4 (ASR input) and the Detected speed 2 remains for a certain period.

E	4	5	N	–	U	E	–	A	L	M		

Setting: □ □

Speed disagreement alarm (right digit)	0: Disable 1: Enable	
Phase loss detection level (left digit)	0: Standard level	
	1: Level for manufacturer	
	2: Cancel	

When ***BRK*** (Brake release signal) is assigned to a Y terminal and H149 ≠ 0.0, the speed disagreement alarm (Er-9) takes effect and the speed agreement specified by E43 and E44 takes no effect.



Note To use a PG amplifier (isolated signal conditioner), enable the above function.

Using a PG amplifier may prevent the inverter from detecting a wire break between the motor and PG amplifier. (The recommended PG amplifier has no wire break detection function.)

E46	Torque Detection Level 1
E47	Torque Detection Level 2

Provides a detection signal when the torque command exceeds a specified value. You can specify two levels of detection level, level 1 and level 2. 100% means a torque command 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		

Data 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		

Data setting range: 10 to 100 (%)

E49 to E52	Ai Terminal Function

E49 to E52 select functions to be assigned to analog input terminals [Ai1] to [Ai4], respectively.

Some functions are not available depending upon the drive control (vector control with/without speed sensor, V/f control and synchronous motor drive). For details, refer to Section 4.2 "Function Code Tables."

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		

Data setting range: 00 to 27

Function code data	Terminal commands assigned	Symbol	Scale	Remarks
00	Shut down input signal	***OFF***	—	—
01	Auxiliary speed setting 1	***AUX-N1***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
02	Auxiliary speed setting 2	***AUX-N2***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
03	Torque limiter level 1	***TL-REF1***	±10V/±150%	100%: Motor rated torque
04	Torque limiter level 2	***TL-REF2***	±10V/±150%	100%: Motor rated torque
05	Torque bias	***TB-REF***	±10V/±150%	100%: Motor rated torque
06	Torque command	***T-REF***	±10V/±150%	100%: Motor rated torque
07	Torque current command	***IT-REF***	±10V/±150%	100%: Torque Current (P09, A11, A111)
08	Creep speed 1 for UP/DOWN control	***CRP-N1***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
09	Creep speed 2 for UP/DOWN control	***CRP-N2***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
10	Magnetic flux reference	***MF-REF***	+10V/+100%	-
11	Detect line speed	***LINE-N***	±10V/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
12	Motor temperature	***M-TMP***	+10V/200°C	-
13	Speed override	***N-OR***	±10V/±50%	-
14	Universal Ai	***U-AI***	±10V/±4000 (h)	-
15	PID feedback 1	***PID-FB1***	±10V/±20000 (d)	-
16	PID reference value	***PID-REF***	±10V/±20000 (d)	-
17	PID correction gain	***PID-G***	±10V/±4000 (h)	-
18-24	Custom Ai1 to Ai7	***C-AI1-7***	±10V/±7FFF (h)	-
25	Main speed setting	***N-REFV***	±10V /±Nmax	Nmax: Maximum Speed (F03, A06, A106)
26	Current input speed setting	***N-REFC***	4-20 mADC/±Nmax	Nmax: Maximum Speed (F03, A06, A106)
27	PID feedback amount 2	***PID-FB2***	±10V/±20000 (d)	

<Using analog input>

There are 28 types of analog input functions from 00 to 27 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.

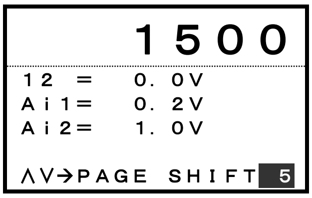
When you assign the same function to [Ai1] and [Ai2], the input to [Ai2] will become effective. When you install the AIO option and assign the same function to [Ai1], [Ai2], [Ai3], and [Ai4], the input to [Ai4] will become effective. (Priority order 1: [Ai1], 2: [Ai2], 3: [Ai3], 4: [Ai4])

Note that you should assign [U-AI] to all the analog input terminals at the same time.

Note: The current input function on terminal [Ai2] applies only to the ***N-REFC*** (Current input speed setting). The function cannot be used on terminal [Ai1].

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.
- You can specify the bias, the gain, the filter and the increment/ decrement limiter applied to the analog input.



Function	Application
Bias	Sets the bias.
Gain	Use to enlarge a small voltage range or to reduce a large voltage range. Use a minus value to invert the polarity.
Filter	Use to eliminate high frequency ripple and noise on the input voltage. 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.

Function code data = 00 Shut down input signal -- *OFF*

Select this signal to assign no function to an analog input terminal.

Make this setting when an analog input terminal is not to be used.

Function code data = 01, 02 Auxiliary speed setting 1, 2 -- *AUX-N1*, *AUX-N2*

Assign data "01" (***AUX-N1***) and "02" (***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 command values ([12] input and the multistep speed command). Two points are available to add a speed.

Auxiliary speed setting	Point of application	Restrictions
01 ***AUX-N1***	After multistep speed command	Disabled when you use "0: KEYPAD panel" and "03, 04, 05: UP/DOWN functions" of the function codes F01 and C25.
02 ***AUX-N2***	After acceleration/deceleration calculation (acceleration/deceleration calculation applied to input is disabled)	

If auxiliary speed setting 2 is larger than the stop speed level (F37), the motor keeps rotating at auxiliary speed setting 2 even after the operation command (FWD, REV) is turned off. In this case, use the Ai zero hold function with X function selection to zero-hold the Ai input simultaneously when the operation command is turned off.

<u>Function code data = 03, 04</u> Torque limiter level 1, 2 -- *TL-REF1*, *TL-REF2*

Assign data "03" (***TL-REF1***) and "04" (***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.

<u>Function code data = 05</u> Torque bias -- *TB-REF*

Assign data "05" (***TB-REF***) to a desired analog input terminal to designate it as Torque bias command terminal. See the function code F47 to 49 for more details.

<u>Function code data = 06</u> Torque command -- *T-REF*

Assign data "06" (***T-REF***) to a desired analog input terminal to designate it as Torque command terminal. See the control block diagram and the function code H41 "Torque command selection" for more details.

<u>Function code data = 07</u> Torque current command -- *IT-REF*

Assign data "07" (***IT-REF***) to a desired analog input terminal to designate it as Torque current command terminal. See the control block diagram and the function code H42 "Torque current command selection" for more details.

<u>Function code data = 08, 09</u> Creep speed 1, 2 for UP/DOWN control -- *CRP-N1*, *CRP-N2*

Assign data "08" (***CRP-N1***) and "09" (***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.

The Ai input is processed as an absolute value.

<u>Function code data = 10</u> Magnetic flux reference -- *MF-REF*

Assign data "10" (***MF-REF***) to a desired analog input terminal to designate it as Magnetic-flux command terminal. See the control block diagram and the function code H43 "Magnetic-flux command value" for more details.

<u>Function code data = 11</u> Detect line speed -- *LINE-N*

Assign 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.

<u>Function code data = 12</u>   Motor temperature -- *M-TMP*

Assign data "12" (***M-TMP***) to a desired analog input terminal to designate it as Motor temperature terminal. When you use a FRENIC-VG dedicated motor, you can use the NTC thermistor supplied with a motor to detect the motor temperature and to protect the motor from overheat (OH4). 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 (OL1, OL2, OL3).

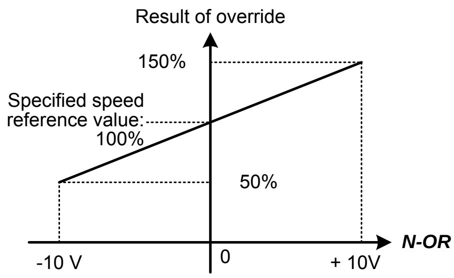
You can use this function to build your own motor overheat protection system detecting the motor temperature directly without using method mentioned above.

You can use the function code E30 "Motor overheat protection" and E31 "Motor overheat early warning" to specify the detection levels.

<u>Function code data = 13</u>   Speed override -- *N-OR*

Assign 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 with 150% of the speed reference and supply −10V to override with 50% of the speed 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. Used for acceleration/deceleration calculation. Restricted by the maximum speed.

<Application example>

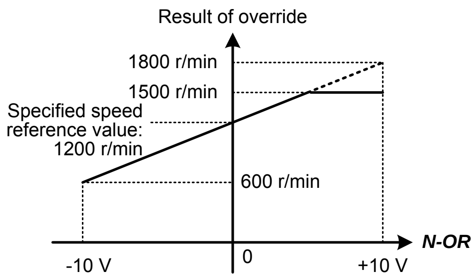
You can specify the coarse/fine adjustment of the speed.

Specified maximum speed value: 1,500 r/min
Specified speed reference value: 1,200 r/min (100%)
Input voltage applied to the terminal [N-OR]: ±10V

<u>Coarse adjustment</u>

As shown in the right graph, the overridden value is 600r/min for -10 V input and is restricted by the maximum speed for +10 V input.

Applying voltage enables coarse speed adjustment around the speed reference (1,200 r/min).

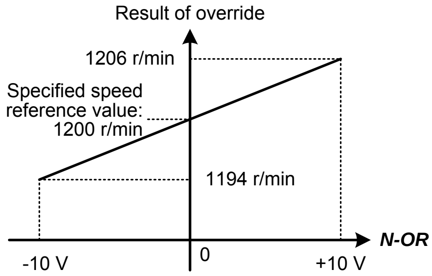


Fine adjustment

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 1206 r/min for +10V input. Applying voltage enables fine speed adjustment around the speed reference (1,200 r/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: 0.08 r/min.



The larger value between the following values determines the resolution.

Reference value of the maximum speed: 1,500 r/min ÷ internal data 20,000 = 0.075 r/min ≈ 0.08 r/min

Precision of the analog input: Unipolar scale (6 r/min) is divided into 15 bit. Thus, 6 r/min ÷ 32767 (15 bits) × 100 (scaling) = 0.018 r/min

Function code data = 14 Universal Ai -- *U-AI*

Assign 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 RS-485 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.

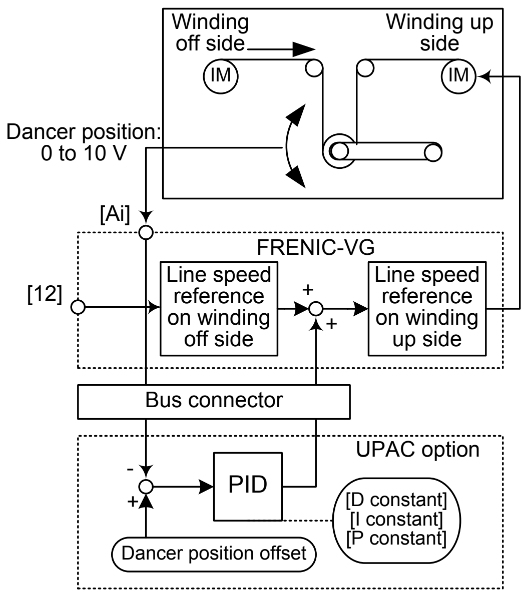
<Application example>

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 command generated by adding the PID output to the line speed command 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.



<u>Function code data = 15</u> PID feedback 1 -- *PID-FB1*
<u>Function code data = 16</u> PID reference value -- *PID-REF*
<u>Function code data = 17</u> PID correction gain -- *PID-G*

Assign data "15" (***PID-FB***), "16" (***PID-REF***) and "17" (***PID-G***) to desired analog input terminals to designate them as PID feedback value, PID command value, and PID correction value terminals, respectively.

These terminals can be used as input terminals for feedback signals, command signals and correction signals in the process under PID control. See the function codes H19 to H26 for more details on the PID functions.

<u>Function code data = 18-24</u> Custom Ai1 to Ai7 -- *C-AI1* to ***C-AI7***

Reserved for options and special applications.

<u>Function code data = 25</u> Main speed setting -- *N-REFV* ±10 V/±Nmax (Nmax: Maximum speed F03, A06, A40)

The voltage (±10 VDC, Maximum speed/±10 V) applied to an analog input terminal makes analog speed setting.

When using ***N-REFV*** on terminal [Ai2], set F01 data at "08" (***N-REFV***).

<u>Function code data = 26</u> Current input speed setting (4-20 mADC) -- *N-REFC* 4-20 mADC/Nmax

This analog input is available only on terminal [Ai2].

The current (4 to 20 mADC, Maximum speed/20 mADC) applied to terminal [Ai2] makes analog speed setting.

When using ***N-REFC*** on terminal [Ai2], set F01 data at "09" (***N-REFC***) and turn SW3 to the I position. (For configuration of SW3, refer to Section 3.3.3.9.)

<u>Function code data = 27</u> PID feedback amount 2 -- *PID-FB2*

This analog input is used to input feedback signals under PID process control.

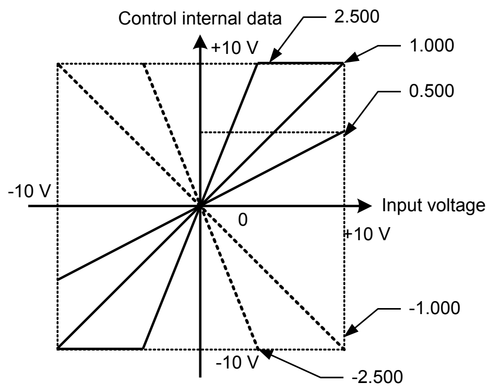
Analog inputs ***PID-FB1*** (PID feedback amount 1) and ***PID-FB2*** (PID feedback amount 2) can be switched by the digital input signal ***PID-1/2*** (Switch PID feedback signals, data = 78).

For details about the PID control, refer to the descriptions of H20 to H26.

E53 to E56 Ai Gain

These function codes specify gains to be applied to analog input terminals [Ai1] to [Ai4].

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		



Data setting range: -10.000 to 10.000 (times)

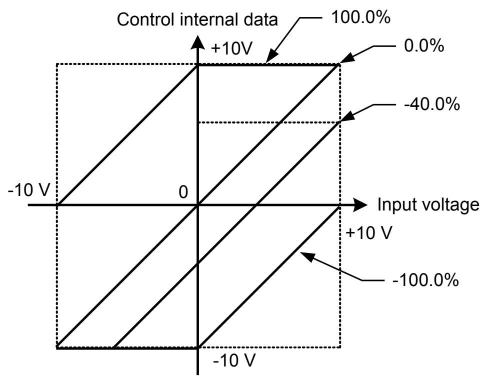
Note: Terminals [Ai3] and [Ai4] are available only when you install OPC-VG1-AIO.

The data changed with the ∧ or ∨ key at the keypad panel is valid. To save to the backup memory, press the FUNC/DATA key.

E57 to E60 Ai Bias

These function codes specify biases to be applied to analog input terminals [Ai1] to [Ai4]. 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		



Data setting range: -100.0 to 100.0 (%)

Note: Terminals [Ai3] and [Ai4] are available only when you install OPC-VG1-AIO.

The data changed with the ∧ or ∨ key at the keypad panel is valid. To save to the backup memory, press the FUNC/DATA key.

E61 to E64	Ai Filter

These function codes specify whether to apply a filter to analog input terminals [Ai1] to [Ai4], as well as specifying 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 command value gradually.

E61	FILTER Ai1
E62	FILTER Ai2
E63	FILTER Ai3
E64	FILTER Ai4

Data setting range: 0.000 to 0.500 (s)

Note: Terminals [Ai3] and [Ai4] are available only when you install OPC-VG1-AIO.

E65 to E68	Up/Down Limiter (Ai)

These function codes specify a time to increase a data inside the inverter from 0V to 10V when you change the input from 0 to 10V applied to analog input terminals [Ai1] to [Ai4].

<Application example>

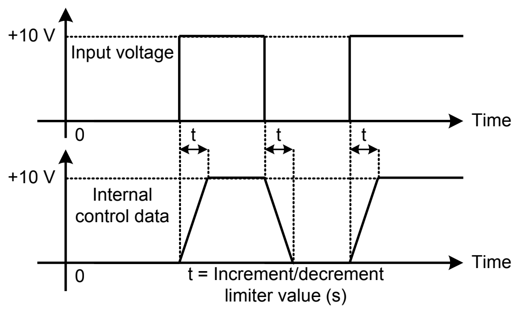
When you use the analog torque command or the analog torque bias, you may not use a command that changes stepwise. A step-wise torque command may tear a paper in a paper rolling machine or present an elastic vibration (damping) when a subject matter has a large elastic modulus.

To avoid this phenomenon, though you should change the command with an external volume, you can use this Increment/decrement limiter to specify the automatic increase and decrease of an analog command value.

E65	A/D L-Ai1
E66	A/D L-Ai2
E67	A/D L-Ai3
E68	A/D L-Ai4

Data setting range: 0.00 to 60.00 (s)

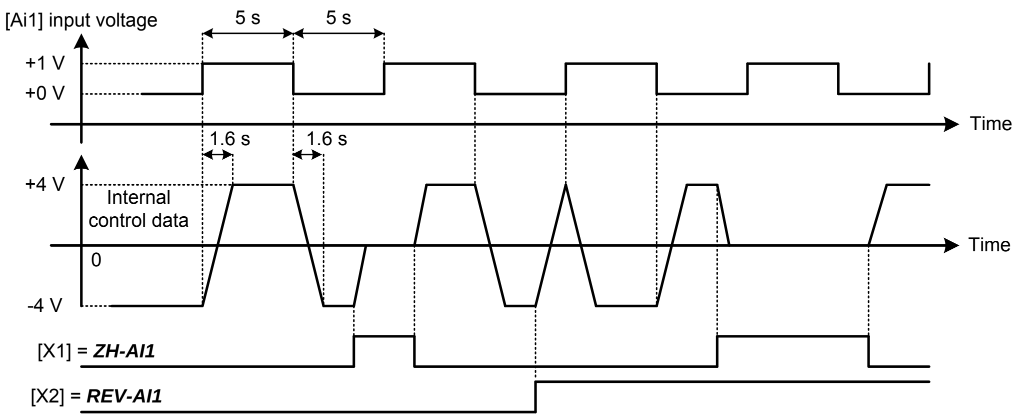
Note: Terminals [Ai3] and [Ai4] are available only when the OPC-VG1-AIO is mounted.



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: Terminal [X1] Function	40: Zero-hold Ai1 ***ZH-AI1***
E02: Terminal [X2] Function	44: Reverse Ai1 polarity ***REV-AI1***
E53: Ai1 Gain	8.000 (magnification)
E57: Ai1 Bias	-50.0 (%)
E65: Up/Down Limiter (Ai1)	2.00 s



- The increment/decrement limiter set the time for the change of an internal control data by 8 V (-4 V ↔ 4 V) to 2.0 s × 8/10 = 1.6 s. Note that the increment/decrement limiter is applied not to the change of the input voltage from 0 to 1 V, but to the change of the internal data scaled by the gain.
- The change of the internal control data to 0 V 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 to E73	Ao Terminal Function

E69 to E73 select functions to be assigned to analog output terminals [Ao1] to [Ao5], respectively.

Some functions are not available depending upon the drive control (vector control with/without speed sensor, V/f control and synchronous motor drive). For details, refer to Section 4.2 "Function Code Tables."

E69	AO1 FUNC
E70	AO2 FUNC
E71	AO3 FUNC
E72	AO4 FUNC
E73	AO5 FUNC

Data setting range: 00 to 40

17 to 29 are reserved. Do not use them.

Function code data	Terminal commands assigned	Symbol	Scale	Remarks
00	Detected speed 1 (Speed indicator, one-way deflection)	***N-FB1+***	+Nmax/10V	Nmax: Maximum Speed (F03, A06, A106)
01	Detected speed 1 (Speed indicator, two-way deflection)	***N-FB1±***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
02	Reference speed 2 (before ACC/DEC processing)	***N-REF2***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
03	Reference speed 4 (ASR input)	***N-REF4***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
04	Detected speed 2 (ASR input)	***N-FB2±***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
05	Detected line speed	***LINE-N±***	±Nmax/±10V	Nmax: Maximum Speed (F03, A06, A106)
06	Torque current command (Torque ammeter, one-way deflection)	***IT-REF±***	±150%/±10V	100%: Torque Current (P09, A11, A111)
07	Torque current command (Torque ammeter, two-way deflection)	***IT-REF+***	+150%/10V	100%: Torque Current (P09, A11, A111)
08	Torque command (Torque meter, two-way deflection)	***T-REF±***	±150%/±10V	100%: Motor rated torque
09	Torque command (Torque meter, one-way deflection)	***T-REF+***	+150%/10V	100%: Motor rated torque
10	Motor current	***I-AC***	200%/10V	100%: Rated Current (P04, A03, A103)
11	Motor voltage	***V-AC***	200%/10V	100%: Rated Voltage (F05, A04, A104)
12	Input power (Motor output)	***PWR***	200%/10V	100%: Motor rated torque
13	DC link bus voltage	***V-DC***	800V/10V	Maximum value 820V/10.25V
14	+10V test voltage output	***P10***	+10 VDC equivalent	-
15	-10V test voltage output	***N10***	-10 VDC equivalent	-
16	Motor temperature	***TMP-M***	±200°V/±10V	-
30	Universal AO	***U-AO***	±4000H/±10V	-
31-37	Custom Ao1-Ao7	***C-AO1-7***	±4000H/±10V	-
38	Input power	***PWR-IN***	200%/10V	100%: Inverter rated output
39	Magnetic pole position signal	***SMP***	TOP/5V	
40	PID output value	***PID-OUT***	±200%/±10V	

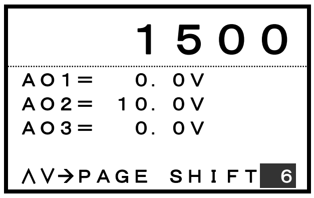
Note: Terminals [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.

<Using analog output>

There are 5 types of analog output functions--three terminals [AO1], [AO2] and [AO3] as standard and additional two terminals [AO4] and [AO5] when an AIO option is mounted.

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]). To assign it to [AO2], write ***N-FB1±*** (data = 01) 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 bias.
Gain	Use to enlarge a small voltage range or to reduce a large voltage range. Use a minus value to invert the polarity.
Filter	You do not need to change the factory set data 0.010 s (10 ms). This filter does work for the noise affecting a device (such as a meter) and wires between the device and [AO] terminal. 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 12-bit digital data into analog data for output. 11 bits are assigned to +12 V, thus binary data corresponding to 10V is 1705 (2047 × 10/12).

When using +10 V to supply a speed reference corresponding to the maximum speed of 1500 r/min, for example, the resolution is 1500/1700 = Approx. 0.88 r/min.

Output cycle

Output is supplied with a sampling cycle of approx. 1 ms.

Function code data = 00 **Detected speed 1 (Speed indicator, one-way deflection) -- *N-FB1+***
Function code data = 01 **Detected speed 1 (Speed indicator, two-way deflection) -- *N-FB1±***

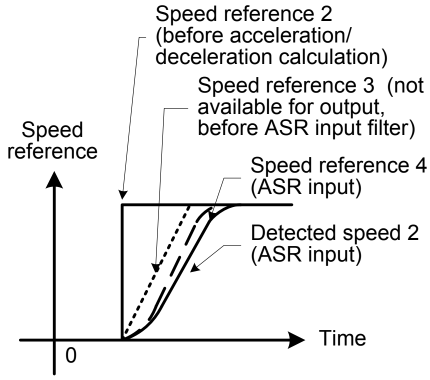
Assign data "00" (***N-FB1+***) and "01" (***N-FB1±***) to desired analog output terminals to designate them as speedometer functions.

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.

Function code data = 02 **Reference speed 2 (before ACC/DEC processing) -- *N-REF2***
Function code data = 03 **Reference speed 4 (ASR input) -- *N-REF4***
Function code data = 04 **Detected speed 2 (ASR input) -- *N-FB2±***

Assign data "02" (***N-REF2***), "03" (***N-REF4***) and "04" (***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.



Function code data = 05 **Detected line speed -- *LINE-N±***

Assign data "05" (***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.

Function code data = 06 **Torque current command (Torque ammeter, two-way deflection) -- *IT-REF±***
Function code data = 07 **Torque current command (Torque ammeter, one-way deflection) -- *IT-REF+***

Assign data "06" (***IT-REF±***) and "07" (***IT-REF+***) to desired analog output terminals to designate them as torque ammeters (see "Note: Torque Ammeters and Torque Meters" given below).

To use an analog output terminal as a unipolar meter, merely assign ***IT-REF+***. To use it as a bipolar meter, assign ***IT-REF±*** and set the data of F51* (Torque command monitor, Polarity).

*F51 (Torque command monitor, Polarity)
F51 specifies the polarity of the monitor output for the four quadrants defining torque current characteristics. The F51 data applies to all torque-related monitor outputs.

Function code data = 08 **Torque command (Torque meter, two-way deflection) -- *T-REF±***
Function code data = 09 **Torque command (Torque meter, one-way deflection) -- *T-REF+***

Assign data "08" (***T-REF±***) and "09" (***T-REF+***) to desired analog output terminals to designate them as torque meters (see "Note: Torque Ammeters and Torque Meters" given below).

To use an analog output terminal as a unipolar meter, merely assign ***T-REF+***. To use it as a bipolar meter, assign ***T-REF±*** and set the data of F51* (Torque command monitor, Polarity).

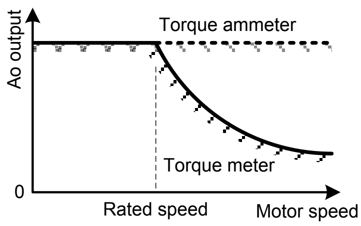
Note: Torque Ammeters and Torque Meters

A torque ammeter and a torque meter behave differently in the constant output range exceeding the rated speed (100%).

Torque ammeter: This is used as a load meter (equivalent to load-current detection type).
It outputs the actual torque current (%), based on the definition of the motor torque curve calculated internally as 100%.

Torque meter: This is used as an output equivalent to the actual torque reflecting torque decrement.
It outputs the actual torque (%), based on the definition of the motor rated torque as 100%.

Both the above meters output command values which can be used as real torque current and torque without problems since the FRENIC-VG controls the current.



Function code data = 10 Motor current -- *I-AC*
Function code data = 11 Motor voltage -- *V-AC*

Provide effective values of the output current and voltage supplied to the motor.

"100%" indicates the rated current and voltage of the motor.

Function code data = 12 Input power (Motor output) -- *PWR*

This analog signal outputs the motor output power. The "motor rated power (kW) x 2" is output as 10 V.

Function code data = 13 DC link bus voltage -- *V-DC*

See the control block diagram given in Section 4.1.8.

Function code data = 14 +10V test voltage output -- *P10*

This analog signal outputs +10 V for adjustment of an analog meter. (Use this signal for an analog meter externally connected.)

Function code data = 15 -10V test voltage output -- *N10*

This analog signal outputs -10 V for adjustment of an analog meter. (Use this signal for an analog meter externally connected.)

Function code data = 16 Motor temperature -- *TMP-M*

This analog signal outputs the motor temperature converted from input values selected by P30, A31 or A131 (M1, M2 or M3 thermistor selection).

<u>Function code data = 30</u> Universal AO -- *U-AO*

This analog signal is used to monitor the processing result of software made by the UPAC option or PLC connected via the communications link (e.g., SX bus and RS-485).

The U-AO enables monitor output independent of the inverter operation.

<u>Function code data = 31-37</u> Custom-Ao1 to Ao7 -- *C-Ao1 to C-Ao7*

Ao terminals for manufacturers. Do not assign these signals.

<u>Function code data = 38</u> Input power -- *PWR-IN*

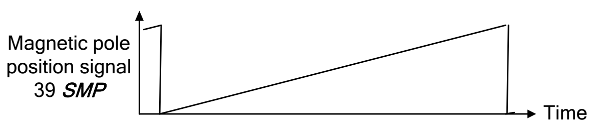
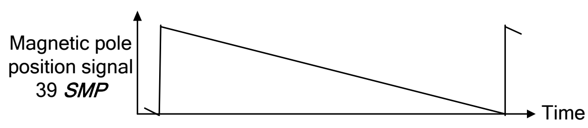
This analog signal outputs how much power is applied to the inverter. It outputs +10 V for the "inverter rated power (kW) x 2."

The purpose of this signal is to display the input power, so it does not display the regenerative power. For the combination with the power regenerative converter, use the converter's function code M10 "Input power."

<u>Function code data = 39</u> Magnetic pole position signal -- *SMP*

This analog signal outputs the "pulse integrated value of the encoder attached to a PMSM" plus the magnetic pole position offset (o10 when motor M1 is selected), as a magnetic pole position signal. This signal operates only when PMSM control is selected.

Depending upon the whether the motor rotation is forward or reverse, the inverter operates as shown below. A single motor rotation outputs 1/2 cycle signal of the number of motor poles.

In the case of forward rotation	In the case of reverse rotation
	

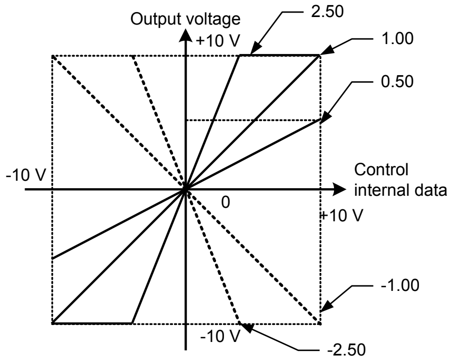
The ***SMP*** is used for adjustment of the magnetic pole position in Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor."

<u>Function code data = 40</u> PID output value -- *PID-OUT*

Set this analog signal in order to monitor PID output values issued from the PID control processing block.

E74 to E78 Ao Gain

These function codes specify gains to be applied to analog output terminals [Ao1] to [Ao5].



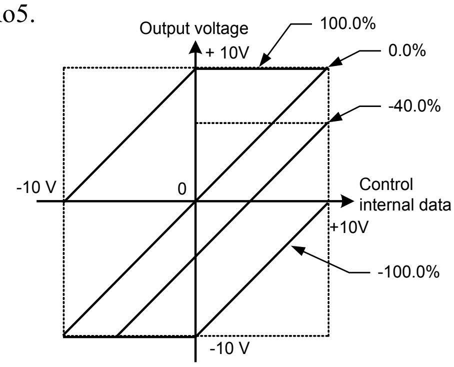
E	7	4	G	A	I	N		A	O	1		
E	7	5	G	A	I	N		A	O	2		
E	7	6	G	A	I	N		A	O	3		
E	7	7	G	A	I	N		A	O	4		
E	7	8	G	A	I	N		A	O	5		

Data setting range: -100.00 to 100.00 (times)

Note: [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.

E79 to E83 Ao Bias

These function codes specify the bias of analog output Ao1 to Ao5.



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		

Data setting range: -100.00 to 100.00 (%)

Note: [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.

E84 Ao1-Ao5 Filter

E84 specifies 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

Data setting range: 0.000 to 0.500 (s)

Note: [Ao4] and [Ao5] are available only when the OPC-VG1-AIO is mounted.

E90	Link Command Function Selection 1 (Available soon)
E91	**Link Command Function Selection 2 (Available soon)**

When E90 ≠ 0 (***OFF***) or E91 ≠ 0 (***OFF***), it is possible to select analog input data (Ai1 or Ai2) entered from the UPAC option or PLC via the communications link (link option that can use the link number of a communications address).

- To use the link command as the Ai1 function, function code S16 applies.
- To use the link command as the Ai2 function, function code S17 applies.

The setting made by E90 or E91 has priority over that made by E49 or E50 (Terminal Ai Function).

E	9	0	L	N	K		F	U	C	1		
E	9	1	L	N	K		F	U	C	2		

Data setting range: 00 to 12

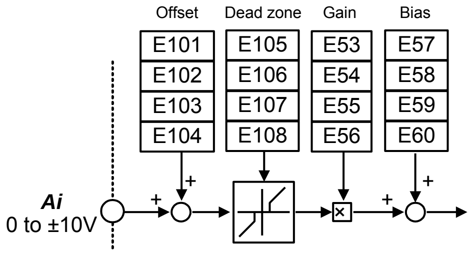
Data for E90 or E91	Terminal commands assigned	Symbol	Scale: S code setting	Scale: Internal definition	Scale: Internal range
00	Shut down input signal	***OFF***	—		
01	Auxiliary speed setting 1	***AUX-N1***	-20000d to 20000d	(data)*Nmax/20000d	-Nmax to Nmax
02	Auxiliary speed setting 2	***AUX-N2***	-20000d to 20000d	(data)*Nmax/20000d	-Nmax to Nmax
03	Torque bias level	***TB-REF***	-32768d to 32767d	0.01%/1d	-327.68 to 327.67%
04	Creep speed 1 for UP/DOWN control	***CRP-N1***	-20000d to 20000d	(data)*Nmax/20000d	-Nmax to Nmax
05	Creep speed 2 for UP/DOWN control	***CRP-N2***	-20000d to 20000d	(data)*Nmax/20000d	-Nmax to Nmax
06	Detect line speed	***LINE-N***	-20000d to 20000d	(data)*Nmax/20000d	-Nmax to Nmax
07	Motor temperature	***M-TMP***	0d to 200d	1ºC/1d	0 to 200ºC
08	Speed override	***N-OR***	-5000d to 5000d	0.01%/1d	-50.00 to +50.00%
09	PID feedback amount 1	***PID-FB1***	-22000d to 22000d	0.005%/1d	-110.000 to 110.000%
10	PID command amount	***PID-REF***	-22000d to 22000d	0.005%/1d	-110.000 to 110.000%
11	PID correction gain	***PID-G***	-16384d to 16384d	1 time/±16384d	-1.0000 to 1.0000 times
12	PID feedback amount 2	***PID-FB2***	-22000d to 22000d	0.005%/1d	-110.000 to 110.000%
13	Observer torque FB (Available soon)	***OBS-TFB***	—		

E101 to E104	Ai Offset

These function codes specify Ai offsets. Only changing the function code data with the ⋀ / ⋁ keys makes the new data effective. To save it into the backup memory, it is necessary to press the FUNC/DATA key.

These function codes are functionally equivalent to E57 to E60.

Use these function codes for adjustment of out-of-offset signals sent from external equipment.



E	1	0	1	A	i	1		O	F	S	E	T
E	1	0	2	A	i	2		O	F	S	E	T
E	1	0	3	A	i	3		O	F	S	E	T
E	1	0	4	A	i	4		O	F	S	E	T

Data setting range: -100.00 to 100.00 (%)

Note: [Ai3] and [Ai4] are available only when the OPC-VG1-AIO is mounted.

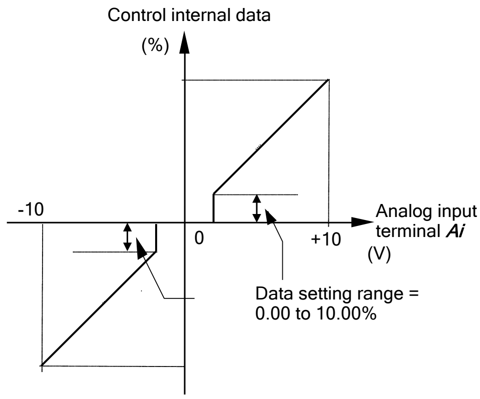
E105 to E108	Ai Dead Zone

These function codes specify Ai dead zones for analog input entered via analog input terminals [Ai1] to [Ai4]. Command values below this input will be limited to 0 V.

E	1	0	5	A	i	1		B	L	I	N	D
E	1	0	6	A	i	2		B	L	I	N	D
E	1	0	7	A	i	3		B	L	I	N	D
E	1	0	8	A	i	4		B	L	I	N	D

Data setting range: 0.00 to 10.00 (%)

Note: [Ai3] and [Ai4] are available only when the OPC-VG1-AIO is mounted.



E109	Dividing Ratio for FA, FB Pulse Output (Numerator)
E110	**Dividing Ratio for FA, FB Pulse Output (Denominator)**

E109 and E110 specify the numerator and denominator of the dividing ratio for FA and FB pulse output.

These settings are available when E29 = 7 to 10 or the SPGT option is mounted.

E	1	0	9	P	L	S		N	U	M	E		
E	1	1	0	P	L	S		D	E	N	O		

Data setting range: 1 to 65535

Note: Specify E109 and E110 data so that E109 ≤ E110. Even when E109 > E110, the dividing ratio comes to be "1."

E114	Speed Agreement 2 (Detection width)
E115	**Speed Agreement 2 (Off-delay timer)**

These function codes apply when motor M2 is selected.

If the detected speed agrees with the reference speed (ASR input) (or comes within the detection width specified by E114), the inverter outputs the Speed agreement signal ***N-AG2***.

- Detected speed: ***N-FB2±*** (Detected speed 2) (ASR input)
- Reference speed: ***N-REF4*** (Reference speed 4)

E	1	1	4	N	—	A	G	2		R	N	G	
E	1	1	5	N	—	A	G	2		T	I	M	

Data setting range: E114 = 1.0 to 20.0 (%)
E115 = 0.000 to 5.000 (s)

An off-delay timer can be set for output of the Speed agreement signal.

These function codes produce the same inverter operation as E43 and E44. For details, refer to the descriptions of those codes.

E116	Speed Agreement 3 (Detection width)
E117	**Speed Agreement 3 (Off-delay timer)**

These function codes apply when motor M3 is selected.

If the detected speed agrees with the reference speed (ASR input) (or comes within the detection width specified by E116), the inverter outputs the Speed agreement signal ***N-AG3***.

These function codes produce the same inverter operation as E43 and E44. For details, refer to the descriptions of those codes.

E	1	1	6	N	—	A	G	3		R	N	G	
E	1	1	7	N	—	A	G	3		T	I	M	

Data setting range: E116 = 1.0 to 20.0 (%)
E117 = 0.000 to 5.000 (s)

E118 Temperature for Axial Fan Stop Signal

When the NTC thermistor detection temperature of the motor equipped with an NTC thermistor drops below the setting made by E118, the inverter turns ***MFAN*** (Axial fan stop signal) ON.

The ***MFAN*** is used to stop the axial fan (cooling fan) of the motor when the motor is stopped.

Note that when the inverter is running, the ***MFAN*** signal is always OFF irrespective of the E118 setting.

E	1	1	8	F	–	S	T	P		T	M	P	

Data setting range: 0 to 200 (ºC)

Note 1: This function is available when the NTC thermistor is selected for the selected motor (M1, M2 or M3). When any other thermistor is selected, the ***MFAN*** is always OFF.

Note 2: For the VG5, VG7, and FRENIC-VG standard motors, set the temperature (E118) at 100°C or below. To avoid the temperature rise of the motor winding, when the NTC thermistor detection temperature exceeds 100°C, it is recommended that the inverter always be ventilated with a cooling fan(s).

4.3.3 C codes (Control Functions)

C01	Jump Speed 1
C02	Jump Speed 2
C03	Jump Speed 3
C04	Hysteresis Width for Jump Speed

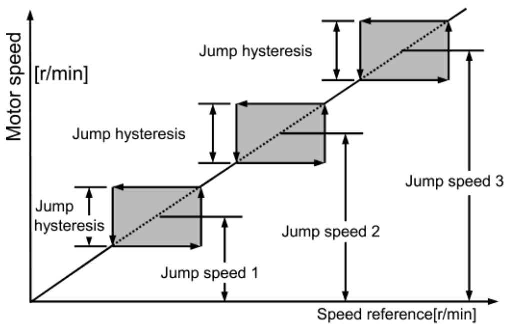
Jumps the speed reference to avoid mechanical resonance points of a load.

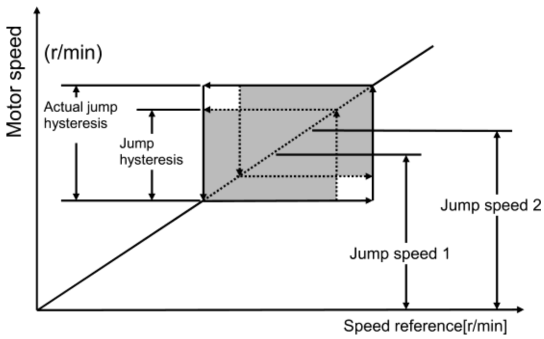
You can set three jump points. When you set the Jump speed 1 to 3 to 0 r/min, this function is disabled. The speed reference does not jump during acceleration/deceleration.

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

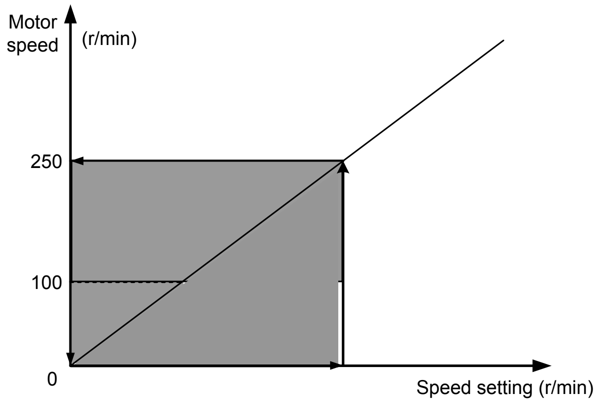
Data setting range: C01 to C03 = 0 to 30,000 (r/min)
C04 = 0 to 1,000 (r/min)





If the jump width is larger than twice the jump speed setting, the downward jump is limited at 0 r/min.

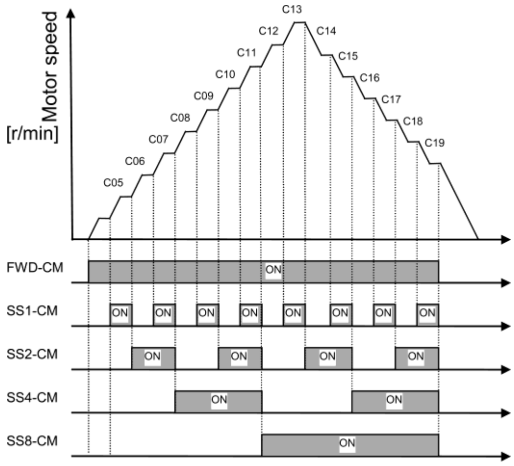
(Example) Jump speed = 100 (r/min)
Jump width = 300 (r/min)



C05 to C17 Multistep Speed 1 to 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 A106).



C	0	5	M	U	L	T	I		N	–	1	

I

C	1	7	M	U	L	T	I		N	–	1	3

Data setting range: 0 to 30,000 (r/min), 0.00 to 100.00 (%) or 0.0 to 999.9 (m/min)

C18 Multistep Speed 14/Creeping Speed 1

C19 Multistep Speed 15/Creeping 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

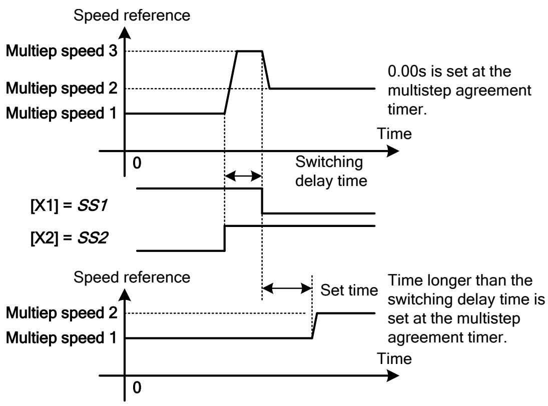
Data setting range: 0 to 30,000 (r/min), 0.00 to 100.00 (%) or 0.0 to 999.9 (m/min)

C20 — Multistep Speed 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 500 μs (0.5 ms) in the FRENIC-VG. You do not have to set this function if your switching period is shorter than the sampling cycle.

C20 MLT N TIME

Data setting range: 0.000 to 0.100 (s)

C21 — Multistep Speed Configuration Definition

Sets the unit to specify the multistep speed.

C21 MLT UNIT

Data setting range: 0 (Specify the multi-step speed in r/min.)
1 (Specify in increments of 0.01%.)
2 (Specify in m/min. (L03 lifter rated speed must be specified.))

If the C21 setting is changed, enter C05 through C19 again.

C25 — Speed Command N2

Sets a method to specify the speed command. 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.

C25 SPD CMD 2

C29 Jogging Speed

C29 JOG N

Data setting range: 0 to 30,000 (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 to C69 ASR S-curve Acceleration/Deceleration 2, 3 and 4, and JOG Function Code Group

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 C40 to C69 to either enabled or disabled. The speed limit function response gain in the torque control mode is adjusted with C60 (ASR4-P).

See E01 to E13 "X function selection" and the control block diagram for the details of switching.

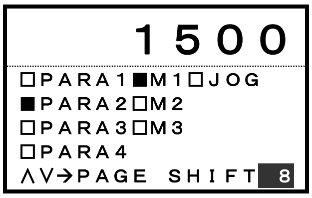
Acceleration/deceleration time: See the description of the function code F07 and F08.

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.

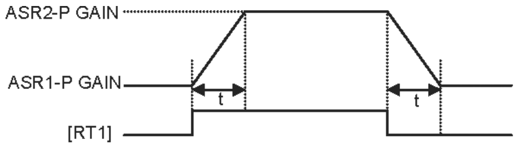


C70	ASR Switching Time

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. Specify the time necessary to change the ASR gain 100 times.

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.



$$t = \frac{|\,(\text{ASR2 P GAIN}) - (\text{ASR1 P GAIN})\,|}{100} \times \text{C70 (s)}$$

C	7	0	A	S	R		C	H		t		

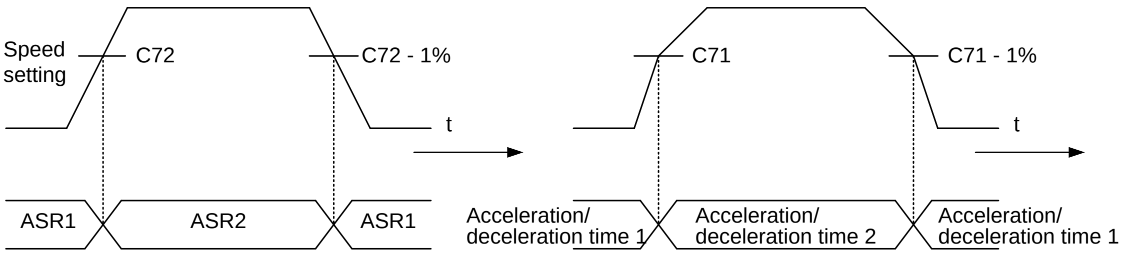
Data setting range: 0.00 to 2.55 (s)

C71	ACC/DEC Switching Speed
C72	ASR Switching Time

C	7	1	A	C	C	／	D	E	C		C	H
C	7	2	A	S	R		C	H		S	P	D

Data setting range: 0.00 to 100.00 (%)

If both X control terminals [RT1] and [RT2] are off, use the speed setting of this parameter to automatically switch the setting of acceleration/deceleration time ASR. (Deactivation of both [RT1] and [RT2] includes the case where [RT1] and [RT2] are not assigned to X control terminals.) When the speed setting (ASR input) exceeds the level specified at C71 and C72, changeover to acceleration/deceleration time 2 (ASR2) occurs. The hysteresis width is 1% of the maximum speed.



ASR1: F61-F66 settings are valid.
ASR2: C40-C45 settings are valid.

Acceleration/deceleration time 1:
F07, F08 and F67-F70 settings are valid.
Acceleration/deceleration time 2:
C46-C49 settings are valid.

If the setting is "0.00%," changeover does not occur.

"100.00%" indicates the maximum speed set at function codes F03, A06 and A106.

C73 Creep Speed Switching (under 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

Data setting range: 00 to 11

Description: □ □

- First digit: Creep speed 2 (0: function code C19, 1: analog input ***CRP-N2***)
- Second digit: Creep speed 1 (0: function code C18, 1: analog input ***CRP-N1***)

See the description of the UP/DOWN in the E01 to E13 "X function selection".

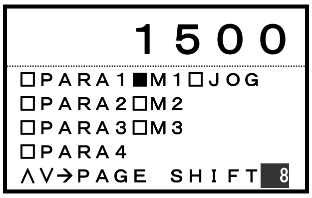
4.3.4 P codes (Motor Parameter Functions)

P codes specify motor parameters available when motor 1 (M1) is selected. To use motor 2 (M2) or motor 3 (M3), specify motor parameters with A codes.

M1, M2 and M3 can be switched with Function code F79 and terminal commands ***M-CH2*** and ***M-CH3*** (which are assigned to digital input terminals with E01 to E13). Refer to the related function code and terminal commands.

To check that M1 is selected, use Menu #4 "I/O Checking" on the keypad and check that the box of the M1 appears black (■) as shown at the right.

In addition to P codes, F03 to F05 and F10 to F12 are available when M1 is selected.



P01	M1 Drive Control

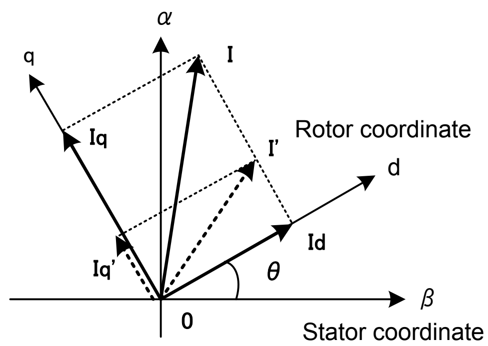
P01 specifies the drive control for motor 1, which can be selected from the following motor drive controls. Refer to the description of P02 in conjunction with that of P01.

P01 M1-CTL-MTD

Data = 0: Vector control for IM with speed sensor
1: Vector control for IM without speed sensor
2: Simulation mode
3: Vector control for PMSM with speed sensor
5: V/f control for IM

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 command 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 vector control without speed sensor

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>

Vector control without speed sensor 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 simulation mode

Selecting the simulation mode (P01 = 2) enables the inverter to internally run in a state similar to the actual run without connecting a motor. Use the simulation mode for checking the system including I/Os or for testing at the time of system startup.

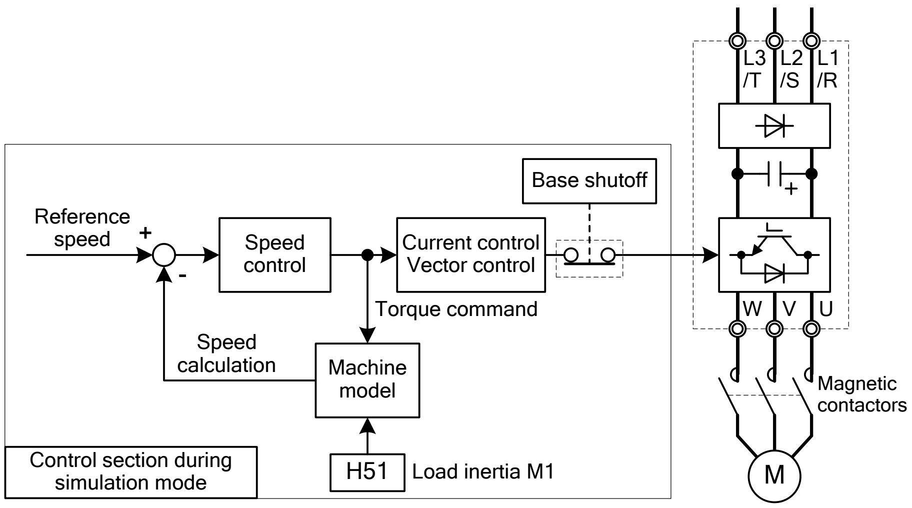
When P01 = 2, the inverter shifts to the simulation mode irrespective of the current motor state.

As shown below, giving a torque command to a machine model (Load inertia: H51) accelerates the model to a certain speed according to the load inertia. Since speed control is a type of feedback control, the machine model rotates to follow the reference speed in the end.

The running state can be checked on the LED monitor and LCD monitor or with monitor codes (M field). Note that neither current detection nor voltage detection is performed so that both the "output current" and "output voltage" on the LCD monitor show "0."

Individual function codes and protective functions are available as long as they are not restricted.

During simulation mode, the inverter shuts off the base (its output) so that no voltage is developed in the secondary side (U, V, W). For safety, however, cut off the secondary side or shut it off with magnetic contactors or the like.



P02	M1 Motor Selection

P02 specifies the motor type to be used.

The configuration procedure of the related function codes differs between the use of the VG-dedicated motors except Fuji VG1 5-series motors (Setting: "0.75-2" to "220-4" and "30-2A" to "220-4A") and that of other motors (Setting: OTHER).

When the VG-dedicated motor is used, selecting the combination of "Capacity (kW)-Voltage (2, 4)" from a choice of "0.75-2" to "220-4" and "30-2A" to "220-4A" automatically sets the optimum values of the standard motors (see the table given on the next page) to F04, F05 and P03 to P27 and then write-protects those function codes.

When any other motor (Fuji VG1 5-series motors, Fuji motors, VG3, etc.) is used, select "OTHER."

P	0	2	M	1	–	S	E	L	E	C	T	

List of Applicable Motors

P02 data		Applicable Motor Models	P02 data		Applicable Motor Models
kW	HP		kW	HP	
00: 0.75-2	00: 1-2	MVK6096, MVK6095A	26: 45-4Y	26: 60-4Y	MVK6208, MVK8208A
01: 1.5-2	01: 2-2	MVK6097, MVK8097A	27: 45-4S	27: 60-4S	MVK6208, MVK8208A
02: 2.2-2	02: 3-2	MVK6107, MVK8107A	28: 55-4	28: 75-4	MVK9250
03: 3.7-2	03: 5-2	MVK6115, MVK8115A	29: 75-4	29: 100-4	MVK9252
04: 5.5-2	04: 7.5-2	MVK6133, MVK8133A	30: 90-4	30: 125-4	MVK9280
05: 7.5-2	05: 10-2	MVK6135, MVK8135A	31: 110-4	31: 150-4	MVK9282
06: 11-2	06: 15-2	MVK6165, MVK8165A	32: 132-4	32: 175-4	MVK9310
07: 15-2	07: 20-2	MVK6167, MVK8167A	33: 160-4	33: 200-4	MVK9312
08: 18.5-2	08: 25-2	MVK6184, MVK8184A	34: 200-4	34: 250-4	MVK9316
09: 22-2	09: 30-2	MVK6185, MVK8185A	35: 220-4	35: 300-4	MVK9318
10: 30-2	10: 40-2	MVK6206	36: P-OTR	36: P-OTR	--
11: 37-2	11: 50-2	MVK6207,MVK8207A	37: OTHER	37: OTHER	Fuji VG1 5-series motors Fuji motors, VG3, etc
12: 45-2Y	12: 60-2Y	MVK6208,MVK8208A	38: 30-2A	38: 40-2A	MVK8187A
13: 45-2S	13: 60-2S	MVK6208,MVK8208A	39: 55-2A	39: 75-2A	MVK9250
14: 55-2	14: 75-2	MVK9224A	40: 75-2A	40: 100-2A	MVK9254A
15: 75-2	15: 100-2	MVK9252	41: 90-2A	41: 125-2A	MVK9256A
16: 90-2	16: 125-2	MVK9280	42: 30-4A	42: 40-4A	MVK8187A
17: 3.7-4	17: 5-4	MVK6115, MVK8115A	43: 55-4A	43: 75-4A	MVK9224A
18: 5.5-4	18: 7.5-4	MVK6133, MVK8133A	44: 75-4A	44: 100-4A	MVK9254A
19: 7.5-4	19: 10-4	MVK6135, MVK8135A	45: 90-4A	45: 125-4A	MVK9256A
20: 11-4	20: 15-4	MVK6165, MVK8165A	46: 110-4A	46: 150-4A	MVK9284A
21: 15-4	21: 20-4	MVK6167, MVK8167A	47: 132-4A	47: 175-4A	MVK9286A
22: 18.5-4	22: 25-4	MVK6184, MVK8184A	48: 160-4A	48: 200-4A	MVK931LA
23: 22-4	23: 30-4	MVK6185, MVK8185A	49: 200-4A	49: 250-4A	MVK931MA
24: 30-4	24: 40-4	MVK6206	50: 220-4A	50: 300-4A	MVK931NA
25: 37-4	25: 50-4	MVK6207, MVK6207A			

Note: When using Fuji VG1 5-series motors, select "OTHER" for P02 and specify the motor parameters given in the User's Manual, Chapter 12.

The table below lists the function codes to be configured for IM when vector control is selected. Configure them sequentially from the top of the table.

Function codes to be configured for IM under vector control

Function codes		FRENIC-VG, VG7S, and VG5-dedicated motors	VG3-dedicated motors and VG1 5-series motors	Fuji special motors	Other motors (incl. other manufacturers' motors)
For M1	Name				
P01	Drive control	0: Vector control for IM with speed sensor		Select either one of the following items depending upon whether a sensor is mounted. 0: Vector control for IM with speed sensor 1: Vector control for IM without speed sensor	
P02	Motor selection	Select from a choice of "0.75-2" to "220-4" and "30-2A" to "220-4A." For the relationship between the setting data and the motor type, refer to Format [82] in the FRENIC-VG User's Manual, Chapter 4, Section 4.2.4.2, "Data type 12-145."	Select "37: OTHER." Selecting "36: P-OTR" automatically write-protects Function codes F04, F05, and P03 to P27. Make this choice if needed after completion of configuration of other function codes.		
F04	Rated speed	Configuring P02 automatically sets the following function code data and write-protects it. - Motor nameplate values - Optimum motor parameter values Turning the power OFF does not lose these values. Do not perform auto-tuning of motor parameters with H01.	Manually enter data given in the FRENIC-VG User's Manual, Chapter 12, "Replacement Information." Do not perform auto-tuning of motor parameters with H01.	For values to be set, consult your Fuji sales representative.	Enter the motor nameplate values manually.
F05	Rated voltage				
P03	Rated capacity				
P04	Rated current				
P05	No. of poles				
P06	%R1				Perform auto-tuning of motor parameters, referring to the auto-tuning procedure given in the description of H01.
P07	%X				
P08	Exciting current				
P09	Torque current				
P10, P11	Slip frequency of motor for driving and braking				
P12-P14	Iron loss factors 1-3				
P15-P19	Magnetic saturation factors 1-5				
P20	Secondary time constant				
P21	Induced voltage factor				
P22-P24	R2 correction factors 1-3				
P25	Exciting current correction factor				
P26, P27	ACR P-gain, Integral constant			No change from the initial value is required.	
P28	Pulse resolution	Specify the pulse resolution of the motor PG. Not valid under vector control without speed sensor.			
P29	External PG correction factor	If the motor PG is incorporated in the machinery, specify the correction factor to convert the number of pulses into the motor speed. Not valid under vector control without speed sensor.			
P30	Thermistor selection	1: NTC thermistor		For details about motor protection, refer to the description of F10 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.1.	
F10	Electronic thermal overload protection (Select motor characteristics)	0: Disable (For VG-dedicated motors)			
P32	Online auto-tuning	Select whether to enable the compensation function for the resistance change due to the temperature rise of the motor running. (No tuning starts when the NTC thermistor is enabled.)			

Function codes		FRENIC-VG, VG7S, and VG5-dedicated motors	VG3-dedicated motors and VG1 5-series motors	Fuji special motors	Other motors (incl. other manufacturers' motors)
For M1	Name				
H01	Auto-tuning	Not required since configuring P02 as described above automatically sets the optimum values to the related function codes. Note that, perform auto-tuning (H01 = 2) when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.		Required. Be sure to perform auto-tuning with actual wiring. Refer to the auto-tuning procedure given in the description of H01.	
H02	Save all function	After performing auto-tuning with H01, be sure to execute the Save all function (H02 = 1) to write the tuning result into the non-volatile memory. Not required if no auto-tuning is performed.			

Note: The VG-dedicated motors are the same as the VG7- and VG5-dedicated motors in shape and motor parameters.

The table below lists the function codes to be configured for PMSM when vector control is selected. Configure them sequentially from the top of the table.

When Fuji standard motors (GNF2 type) are used, the following function codes take effect. For other motors, consult your Fuji sales representative.

Function codes to be configured for PMSM under vector control

<table>
<tr><th colspan="2">Function codes</th><th rowspan="2">FRENIC-VG dedicated motor</th><th rowspan="2">Other motors
(incl. other manufacturers' motors)</th></tr>
<tr><th>For M1</th><th>Name</th></tr>
<tr><td>P01</td><td>Drive control</td><td colspan="2">3: Vector control for PMSM with speed sensor</td></tr>
<tr><td>P02</td><td>Motor selection</td><td colspan="2">Select "37: OTHER."
Selecting "36: P-OTR" automatically write-protects Function codes F04, F05, and P03 to P27. Make this choice if needed after completion of configuration of other function codes.</td></tr>
<tr><td>P03</td><td>Rated capacity</td><td rowspan="14">Manually enter the data given in Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor."</td><td rowspan="12">For values to be set, consult your Fuji sales representative.</td></tr>
<tr><td>P04</td><td>Rated current</td></tr>
<tr><td>F05</td><td>Rated voltage</td></tr>
<tr><td>F04</td><td>Rated speed</td></tr>
<tr><td>F03</td><td>Maximum speed</td></tr>
<tr><td>P05</td><td>No. of poles</td></tr>
<tr><td>P06</td><td>%R1</td></tr>
<tr><td>P07</td><td>%X</td></tr>
<tr><td>P08</td><td>Magnetic flux weakening current</td></tr>
<tr><td>P09</td><td>Torque current</td></tr>
<tr><td>P21</td><td>Induced voltage factor</td></tr>
<tr><td>P26,
P27</td><td>ACR P-gain,
Integral constant</td></tr>
<tr><td>P28</td><td>Pulse resolution</td><td>Specify the pulse resolution of the motor PG.</td></tr>
<tr><td>P30</td><td>Thermistor selection</td><td rowspan="2">For details about motor protection, refer to the description of F10.</td></tr>
<tr><td>F10</td><td>Electronic thermal overload protection
(Select motor characteristics)</td><td>0: Disable (For VG standard motors)</td></tr>
<tr><td>P33</td><td>Maximum voltage Limit</td><td rowspan="9">Manually enter the data given in Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor."</td><td>Specify the maximum voltage applicable to the motor.</td></tr>
<tr><td>o09</td><td>Absolute signal input definition</td><td>Specify the data in accordance with the encoder specifications.</td></tr>
<tr><td>o10</td><td>Magnetic pole position offset</td><td rowspan="7">For values to be set, consult your Fuji sales representative.</td></tr>
<tr><td>o11</td><td>Salient pole rate (%Xq/%Xd)</td></tr>
<tr><td>P12-P14</td><td>Iron loss factors 1-3</td></tr>
<tr><td>P42</td><td>q-axis induction magnetic saturation coefficient</td></tr>
<tr><td>P43</td><td>Magnetic flux limiting value</td></tr>
<tr><td>P44</td><td>Overcurrent protection level</td></tr>
<tr><td>P45-P51</td><td>Torque correction gain 1-7</td></tr>
</table>

The table below lists the function codes to be configured for IM when V/f control is selected. Configure them sequentially from the top of the table.

Function codes to be configured for IM under V/f control

Function codes		FRENIC-VG, VG3-dedicated motors, and VG1 5-series motors	Other motors (incl. other manufacturers' motors)
For M1	Name		
P01	Drive control	5: V/f control for IM	
P02	Motor selection	Select "37: OTHER." Selecting "36: P-OTR" automatically write-protects Function codes F04, F05, and P03 to P27. Make this choice if needed after completion of configuration of other function codes.	
P03	Rated capacity	Manually enter data given in the FRENIC-VG User's Manual, Chapter 12, "Replacement Information." Do not perform auto-tuning of motor parameters with H01.	Enter the motor nameplate values manually.
P04	Rated current		
F03	Maximum speed		
F04	Rated speed		
F05	Rated voltage		
P05	No. of poles		
P06	%R1		Refer to the calculation procedures given in the description of P06 and P07 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.4.
P07	%X		
P08	Exciting current		Set the no-load current of the motor written on the motor test report.
P33	Maximum output voltage	Set the maximum voltage of the motor.	
P34	Slip compensation	Refer to the calculation procedure given in the description of P34 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.4.	
P35	Torque boost	0.0: Auto torque boost (factory default) If a starting torque is required, adjust the torque boost within the range of 0.1 to 20.0.	If the motor constant is unknown, set P35 to "2.0" (Manual boost). If a starting torque is required, adjust the torque boost within the range of 0.1 to 20.0.
P30	Thermistor selection	1: NTC thermistor	For details about motor protection, refer to the description of F10 in the FRENIC-VG User's Manual, Chapter 4, Section 4.3.1.
F10	Electronic thermal overload protection (Select motor characteristics)	0: Disable (For VG-dedicated motors)	
H01	Tuning	Not required since configuring P02 as described above automatically sets the optimum values to the related function codes. Note that, perform auto-tuning (H01 = 2) when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.	Required. Be sure to perform auto-tuning with actual wiring. Refer to the auto-tuning procedure given in the description of H01.
H02	Save all function	After performing auto-tuning with H01, be sure to execute the Save all function to write the tuning data into the non-volatile memory. Not required if no auto-tuning is performed.	

Note: The VG-dedicated motors are the same as the VG7- and VG5-dedicated motors in shape and motor parameters.

P03	M1 Rated Capacity

P03 specifies the rated capacity of motor 1. Set the motor nameplate value.

For a multiwinding motor, set the motor capacity per winding.

P	0	3	M	1	–	C	A	P				

Data setting range: For inverters of 400 kW or below
0.00 to 500.00 (kW) when F60 = 0
0.00 to 600.00 (HP) when F60 = 1

For inverters of 500 kW or above
0.00 to 1200.00 (kW) when F60 = 0
0.00 to 1600.00 (HP) when F60 = 1

P04	M1 Rated Current

P04 specifies the rated current of motor 1. Set the motor nameplate value.

P	0	4	M	1	–	I	r					

Data setting range: 0.01 to 99.99 (A)
100.0 to 999.9 (A)
1000 to 2000 (A)

P05	M1 Number of Poles

P05 specifies the number of poles of motor 1. Set the motor nameplate value.

P	0	5	M	1	–	P	O	L	E	S		

Data setting range: 2 to 100

P06	M1 %R1

P	0	6	M	1	−	%	R	1				

Data 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					

Data setting range: 0.00 to 200.00 (%)

$$\%X = \left(\frac{(L\sigma\,(H) + \text{Cable L (H)} \times \text{P04: Motor rated current (A)}}{\text{F05: Motor rated voltage (V)}/\sqrt{3}} \times 2\pi \left(\frac{\text{P05: Pole numbers} \times \text{F04: Rated speed (r/min)}}{120} \right) \times 100\,(\%) \right)$$

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/Magnetic Flux Weakening Current (-Id)

Sets the effective current value of the motor 1 during no-load operation.

P	0	8	M	1	−	I	M					

Data 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					

Data setting range: 0.01 to 99.99 (A)
100.0 to 999.9 (A)
1,000 to 2,000 (A)

$$\text{P09: Torque current} = \sqrt{(\text{P04: Rated current})^2 - (\text{P08: Exciting current})^2}\ \text{(A)}$$

P10	M1 Slip Frequency (For driving)
P11	**M1 Slip Frequency (For 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		

Data setting range: 0.001 to 10.000 (Hz)

$$\text{Slip frequency (Hz)} = \frac{\text{P05: Pole numbers} \times (\text{Synchronized speed})(\text{r/min}) - \text{F04: Rated speed (r/min)}}{120}$$

P12	M1 Iron Loss Factor 1
P13	**M1 Iron Loss Factor 2**
P14	**M1 Iron Loss Factor 3**

P12 to P14 specify iron loss factors to compensate the iron loss (hysteresis loss, eddy current loss) caused inside the motor.

When using motors other than Fuji standard motors, set the iron loss compensation at 0.00%..

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		

Data setting range: 0.00 to 10.00 (%)

P15	M1 Magnetic Saturation Factor 1
P16	**M1 Magnetic Saturation Factor 2**
P17	**M1 Magnetic Saturation Factor 3**
P18	**M1 Magnetic Saturation Factor 4**
P19	**M1 Magnetic Saturation Factor 5**

P15 to P19 specify the magnetic saturation factors for the exciting current to apply when the magnetic-flux command is 93.75%, 87.5%, 75%, 62.5% and 50%, respectively.

Since the relationship between the exciting current (that generates magnetic-flux in an IM) and the magnetic flux is non-linear. To compensate it, specify the factors with these function codes.

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			

Data 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		

Data 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 Factor

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

Data 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 Factor 1
P23	M1 R2 Correction Factor 2
P24	M1 R2 Correction Factor 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

P25	M1 Exciting Current Correction Factor

Corrects the exciting inductance. Do not change these settings.

P	2	5	M	1	–	I	M		C	O	R	R

P26	M1 ACR (P-gain)
P27	**M1 ACR (I-time)**

Vector control feeds back the motor output current to control a motor to follow the current command. 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 command 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: 0.1 to 100.0 (ms)

P28	M1 Pulse Resolution

P28 specifies the pulse resolution (P/R) of the speed detector PG of motor 1. Specification of a wrong value unstabilizes the detection of the speed and magnetic pole position, disabling accurate speed control or vector control.

P	2	8	M	1	–	P	G	–	P	L	U	S

Data setting range: 100 to 60,000

P29	M1 External PG Correction Factor

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			

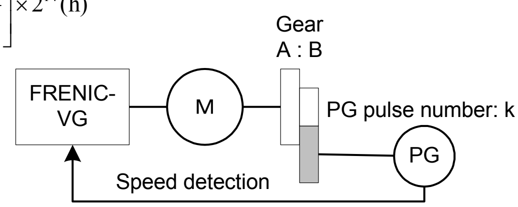
Data setting range: 0000 to 4FFF (h)

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.

$$\text{Function code P28 (M1-PG pulse number)} = \text{Integer part of} \left| k \text{ (PG pulse number)} \times \frac{B}{A} \right|$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[\frac{P28}{k \times B/A} \right] \times 2^{14} \text{(h)}$$



Setting example

If PG pulse number = 1,024 and the gear ratio A:B = 7:1, then:

$$\text{Function code P28 (M1-PG pulse number)} = \text{Integer part of} \left| 1024\,(\text{PG pulse number}) \times \frac{1}{7} \right| = 146$$

$$\text{Function code P29 (M1 external PG correction coefficient)} = \left[\frac{\text{P28}}{k \times B/A} \right] \times 2^{14}\,(\text{d}) = \left[\frac{146}{1024 \times 1/7} \right] \times 2^{14}\,(\text{d}) = 16352(\text{d}) = 3\text{FE0}(\text{h})$$

P30	M1 Thermistor Selection

P30 selects a thermistor type or an analog input (0 to 10 V) sent from the temperature sensor for motor protection.

For FRENIC-VG motors (VG7S, VG5 and VG3), select an NTC thermistor. If the motor has a PTC thermistor of overheat protection, select a PTC thermistor.

P	3	0	M	1	–	T	H	R				

Data setting range: 0 (No thermistor)
1 (NTC thermistor (for VG standard motors))
2 (PTC thermistor)
3 (Ai ***M-TMP***)

The protection level of the motor can be specified by E30 (Motor Overheat Protection, Temperature).

P32	M1 Online Auto-tuning
A52	M2 Online Auto-tuning
A152	M3 Online Auto-tuning

P32, A52 and A152 select whether or not to perform auto-tuning for compensating constants change due to temperature rise.

- Perform auto-tuning of motor constants.
- Be sure to test-run the combination of the inverter and motor beforehand.
- Auto-tuning is not available when an NTC thermistor is used.

P	3	2		M	1	–	O	N		T	U	N	E
A	5	2		M	2	–	O	N		T	U	N	E
A	1	5	2	M	3	–	O	N		T	U	N	E

Data setting range: 0 (Disable)
1 (Enable)

P33	M1 Maximum Output Voltage/Maximum Voltage Limit

P33 is provided for V/f control and vector control for PMSM. Under V/f control, the P33 setting applies to the maximum output voltage, so specify the output voltage of the inverter running at high speed. The voltage higher than the source voltage cannot be output.

Under vector control for PMSM, the P33 setting applies to the maximum voltage limit value, so specify the maximum voltage that the inverter can output. Do not specify the voltage less than the rated voltage.

P	3	3	M	1	–	V	m	a	x			

Data setting range: 80 to 999 (V)

P34 M1 Slip Compensation

P34 is exclusive to V/f control. 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.

P34 M1-SLIPd

Data setting range: -20.000 to 5.000 (Hz)

The slip compensation value can be calculated with the following expression.

$$\text{Slip compensation value} = \text{Base frequency x } \frac{\text{Slip (r/min)}}{\text{Synchronous speed (r/min)}} \text{ (Hz)}$$

Where, Slip = Synchronous speed - Rated speed

When P34 = 0.000 (Hz), the slip compensation control is disabled.

P35 M1 Torque Boost

P35 is exclusive to V/f control. The following choices are available.

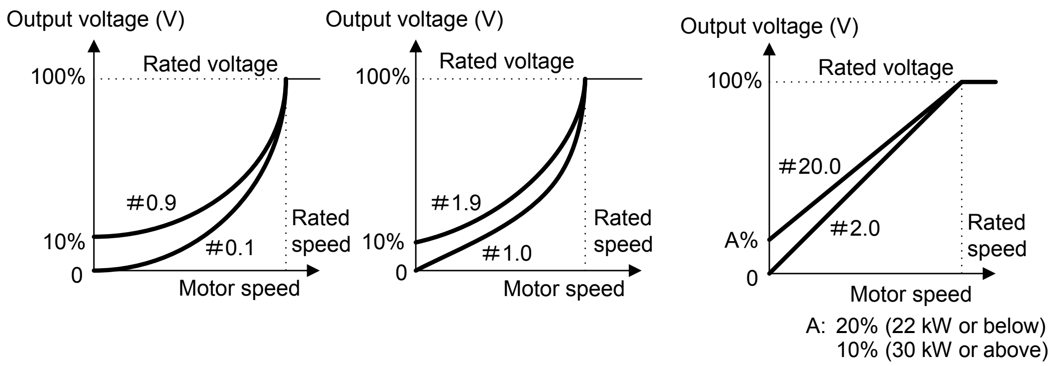
P35 M1-BOOST

- Load characteristics including automatic torque boost, variable torque load, proportional torque load, and constant torque load.
- Compensating insufficient magnetic-flux of a motor due to the voltage drop in the low frequency range and boosting torque at low speed operation (boosting V/f characteristic)

Data setting range	Description
0.0	Automatic torque boost characteristics to adjust torque boost value automatically for constant torque load changing linearly
0.1 to 0.9	Variable torque characteristics for fan/pump load
1.0 to 1.9	Linear torque characteristics for a load that has a middle characteristic between variable torque and constant torque characteristics
2.0 to 20.0	Constant torque characteristics changing linearly

Torque characteristic

<Variable torque characteristics> <Proportional torque characteristics> <Constant torque characteristics>



Note: When replacing the VG7 (22 kW or below) with the VG1, specify the torque boost according to the torque boost conversion table in Chapter 12, Section 12.5.

■ **Guide for setting the torque boost**

When adjusting the starting torque with manual boost (Setting data: 2.0 to 20.0) since the motor characteristics are unknown, use the following as a guide.

Motor capacity (kW)	Torque boost 1 to 3 P35, A55, A155
0.4	5.2 to 8.4 to 11.6
0.75 to 2.2	5.1 to 8.1 to 11.2
3.7	4.5 to 7.0 to 9.4
5.5	4.2 to 6.4 to 8.6
7.5	4.0 to 6.0 to 7.9
11	3.6 to 5.2 to 6.7
15	3.3 to 4.5 to 5.8
18.5 to 22	3.0 to 4.0 to 5.0
30 to 630	2.0 to 5.0

Note: Increasing the torque boost value results in overexcitation in the low-speed domain. Keeping the inverter running with the overexcited state may cause the motor to overheat. Check the characteristics of the motor to be driven.

P36 | M1 Output Current Fluctuation Damping Gain

P36 is exclusive to V/f control. When the inverter output current fluctuates due to the motor characteristics or backlash at the load side, adjust the damping gain. Do not change the factory default unless otherwise needed.

P	3	6	M	1	–	D	U	M	P		G	

Data setting range: 0.00 to 1.00

4.3.5 H codes (High Performance Functions)

H01	Auto-tuning

For inverters connected with a standard motor, no motor parameter tuning is required.

Perform auto-tuning correctly, referring to the tables and the flowcharts given on the following pages.

Tuning procedure

Change the H01 data to the desired value by pressing the (STOP) + (∧) keys or (STOP) + (∨) keys (simultaneous keying), and then press the (FUNC/DATA) key to start auto-tuning. Upon completion of auto-tuning, the H01 data automatically reverts to "0."

The tuning result is written to the volatile memory (RAM) that loses the data when the power is turned OFF. After completion of tuning, therefore, be sure to use the Save all function (H02) to write the data to the non-volatile memory.

The ASR auto-tuning (H01 = 1) should be performed, if needed, after motor parameters have been established (automatically, manually, or by tuning). (Available soon)

Tuning notes

Under any of the following conditions, no tuning is normally performed. Review the current settings.

(1) "NOT EXECUTE" appears on the LCD monitor.

In the case of M1, when H01 = any of 2 to 4, P02 ≠ 37 (OTHER).
⇒ Function codes to be tuned are write-protected. Set P02 to "37" (OTHER).

The JOG mode is selected. (The JOG indicator on the LCD monitor is lit.)
⇒ Cancel the JOG mode by pressing the (STOP) + (∧) keys (simultaneous keying).
⇒ If digital input signal ***JOG*** is ON, turn it OFF.

Tuning is in progress from FRENIC-VG Loader.
⇒ When tuning is in progress from FRENIC-VG Loader, do not change function code data from the keypad.

(2) Alarm Er-6 (Operation error) occurs.

The simulation mode is selected (P01 = 2).
⇒ No tuning is possible in the simulation mode.

The "V/f control for IM" is selected (P01/A01/A101 = 5).
⇒ Under V/f control, tuning by H01 = 1, 3 or 4 cannot be performed.

The "Vector control for PMSM with speed sensor" is selected (P01/A01/A101 = 3).
⇒ Under Vector control for PMSM, tuning by H01 = 3 cannot be performed.

Any of digital input signals ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** is ON.
Either one of safety function input terminals [EN1] and [EN2] is OFF.
⇒ When any of ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** is ON and either of [EN1] and [EN2] is OFF, no tuning starts.

The multiwinding motor drive system is selected.
⇒ No tuning is possible in the multiwinding motor drive system.

Undervoltage is detected (Power OFF).
⇒ When undervoltage is detected, the inverter does not accept a run command, causing an Er-6 error after 20 seconds from writing to H01.

(3) Alarm Er-7 (Output wiring fault) occurs.

A phase is missing in the connection between the inverter and the motor.
⇒ Connect the motor to the inverter correctly.

The brake is applied to the motor.
⇒ For auto-tuning with the motor running (H01 = 4), be sure to release the brake so that the motor can rotate.

H01 TUN MODE

The tuning type, data to be tuned, and tuning content differ depending upon the motor drive control. Select the tuning suitable for the drive control (P01).

When P01 = 0 or 1 (Vector control for IM with/without speed sensor) → go to [1] below.
When P01 = 5 (V/f control for IM) → go to [2] below.

[1] Under vector control for IM with/without speed sensor

Data for H01	Tuning type		Data to be tuned	Tuning content	Usage
1	ASR (Auto speed regulator) auto-tuning (To be performed after establishment of motor parameters) (Available soon)		ASR-P (gain) ASR-I (integral constant) Compensation gain Integral time Load inertia	The inverter measures the motor-shaft converted load inertia (mechanical time constant) of the connected machinery, calculates the optimum gain and integral constant, and sets them to the corresponding function codes.	Perform this tuning for a motor integrated in the machinery to tune the ASR. Particularly, perform this tuning for using the observer (H46) if the motor-shaft converted load inertia is unknown.
2	Motor parameter tuning	R1, Lσ	P06, P07 when M1 is selected A08, A09 when M2 is selected A108, A109 when M3 is selected	The inverter measures the motor primary resistance (%R1) and leakage reactance (Lσ) at the rated speed and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning for VG standard motors (VG3, VG5 and VG7) when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.
3		Tuning with the motor stopped	P06 to P25 when M1 is selected A08 to A27 when M2 is selected A108 to A123 when M3 is selected	The inverter measures the %R1 and %X <u>with the motor stopped</u>, just as when H01 = 2. After that, the inverter measures the exciting current, rated load slip, magnetic saturation factors, induced voltage, secondary time constant, R2 compensation factors, exciting current compensation factors <u>with the motor stopped</u>, tunes them, and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning beforehand when driving a non-standard motor or a special-purpose motor whose motor parameters are unknown. Perform this tuning when using the FRENIC-VG to drive a motor integrated in the existing machinery and not separated from it. Note that the tuning accuracy is slightly lower than that obtained by tuning with the motor running (H01 = 4).
4		Tuning with the motor running		The inverter measures the %R1 and %X <u>with the motor stopped</u>, just as when H01 = 2. After that, the inverter measures the exciting current, rated load slip, magnetic saturation factors, induced voltage, secondary time constant, R2 compensation factors, exciting current compensation factors <u>with the motor running</u>, tunes them, and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning beforehand when driving a non-standard motor or a special-purpose motor whose motor parameters are unknown. Since this tuning involves motor rotation, separate the motor from the machinery and make sure that there is no danger in rotating the motor before performing this tuning. The motor runs in accordance with the specified acceleration/ deceleration time.

[2] Under V/f control for IM

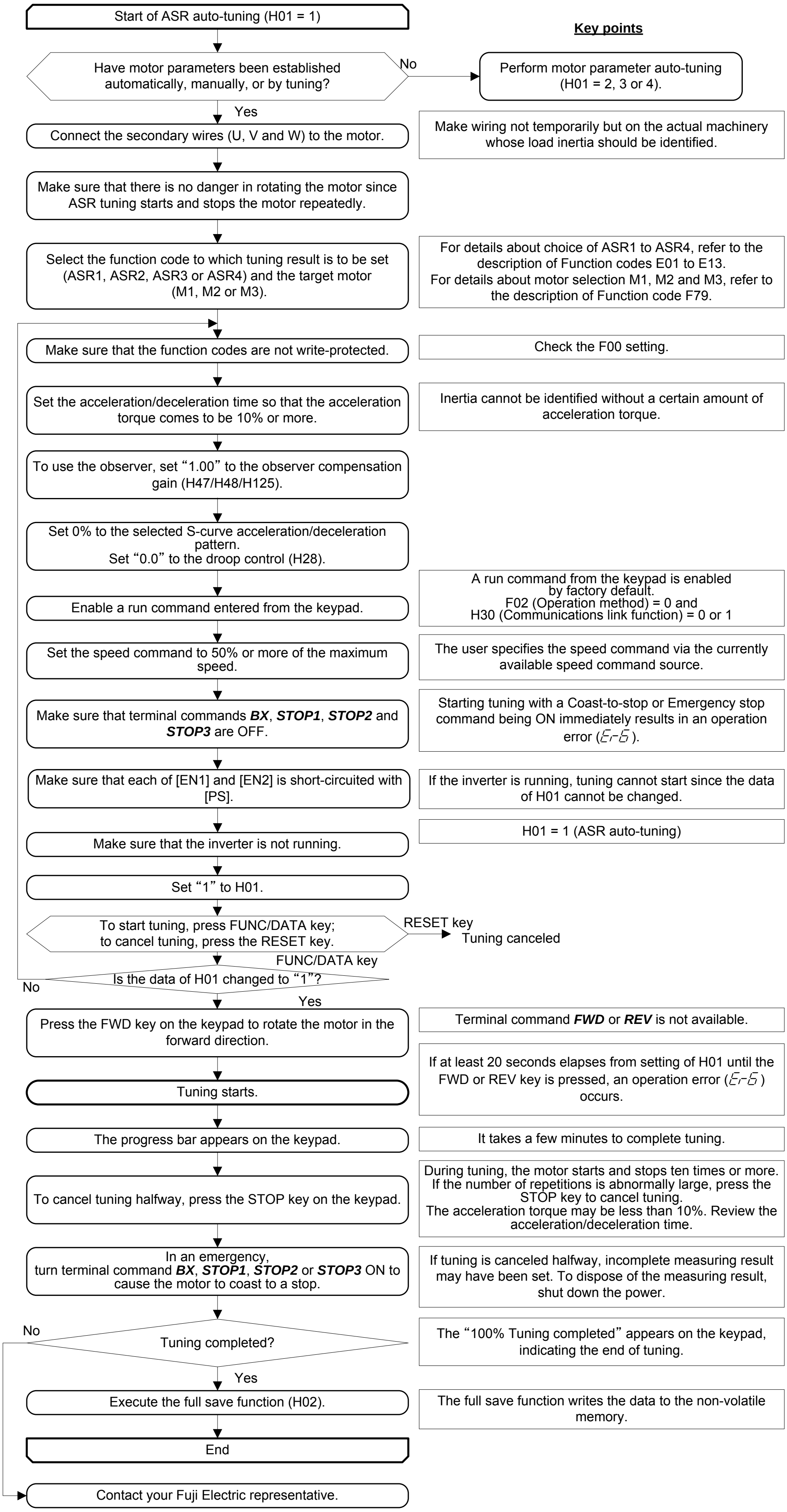
Data for H01	Tuning type		Data to be tuned	Tuning content	Usage
1	ASR (Auto speed regulator) auto-tuning Not available under V/f control.		--	--	--
2	Motor parameter tuning	R1, Lσ	P06, P07 when M1 is selected A08, A09 when M2 is selected A108, A109 when M3 is selected	The inverter measures the motor primary resistance (%R1) and leakage reactance (Lσ) at the rated speed and sets them to the corresponding motor parameters (M1, M2, or M3).	Perform this tuning when the impedance at the output side is not negligible because the wiring distance between the inverter and motor is long (100 m or more) or an output circuit filter (OFL) is connected.
3		Tuning with the motor stopped Not available under V/f control.	--	--	--
4		Tuning with the motor running Not available under V/f control.	--	--	--

⚠CAUTION

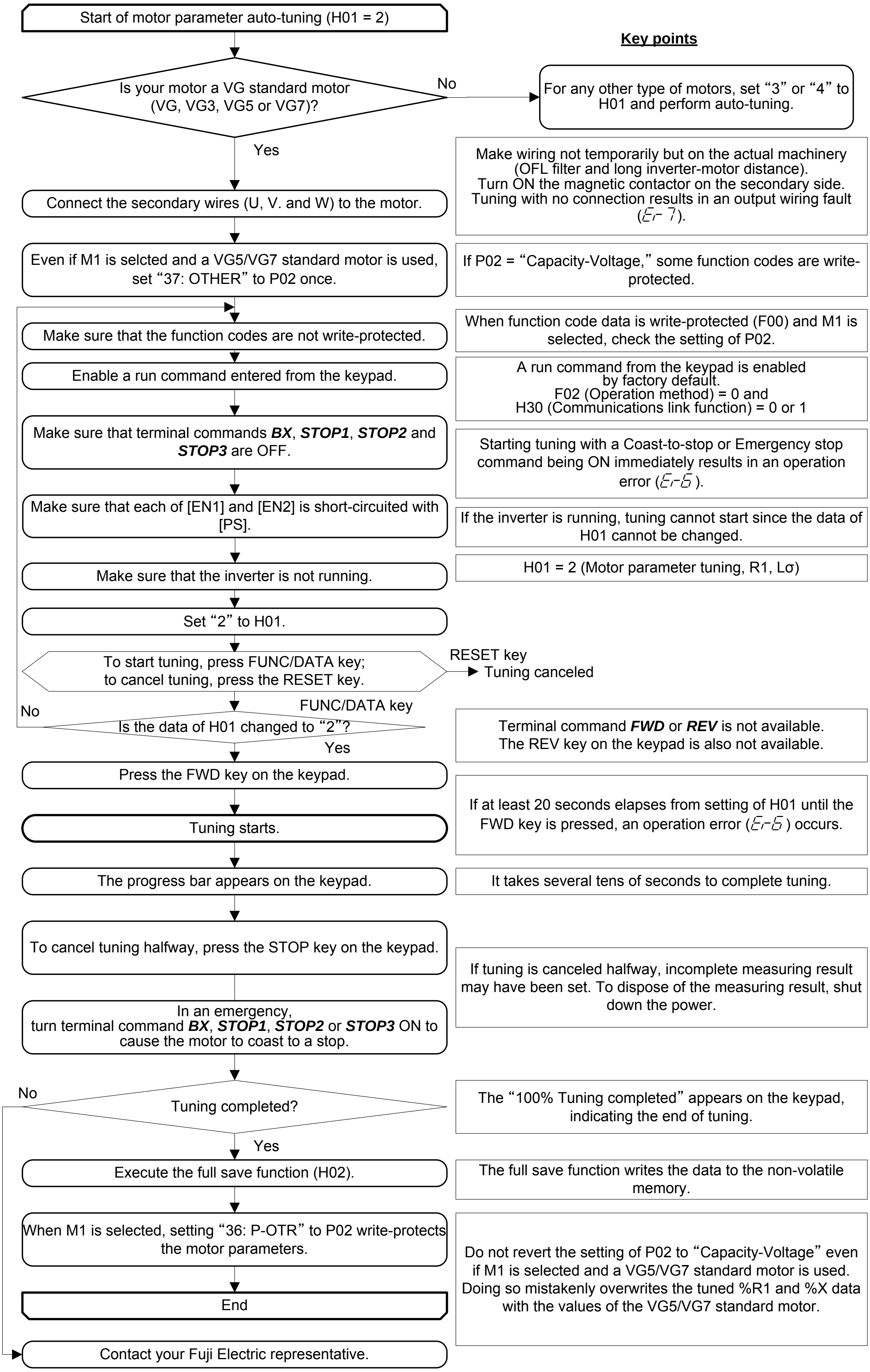
At the time of shipment, the torque boost function is set to "Auto torque boost." To use the inverter in applications requiring a starting torque, be sure to perform motor parameter auto-tuning.

An accident or injuries could occur.

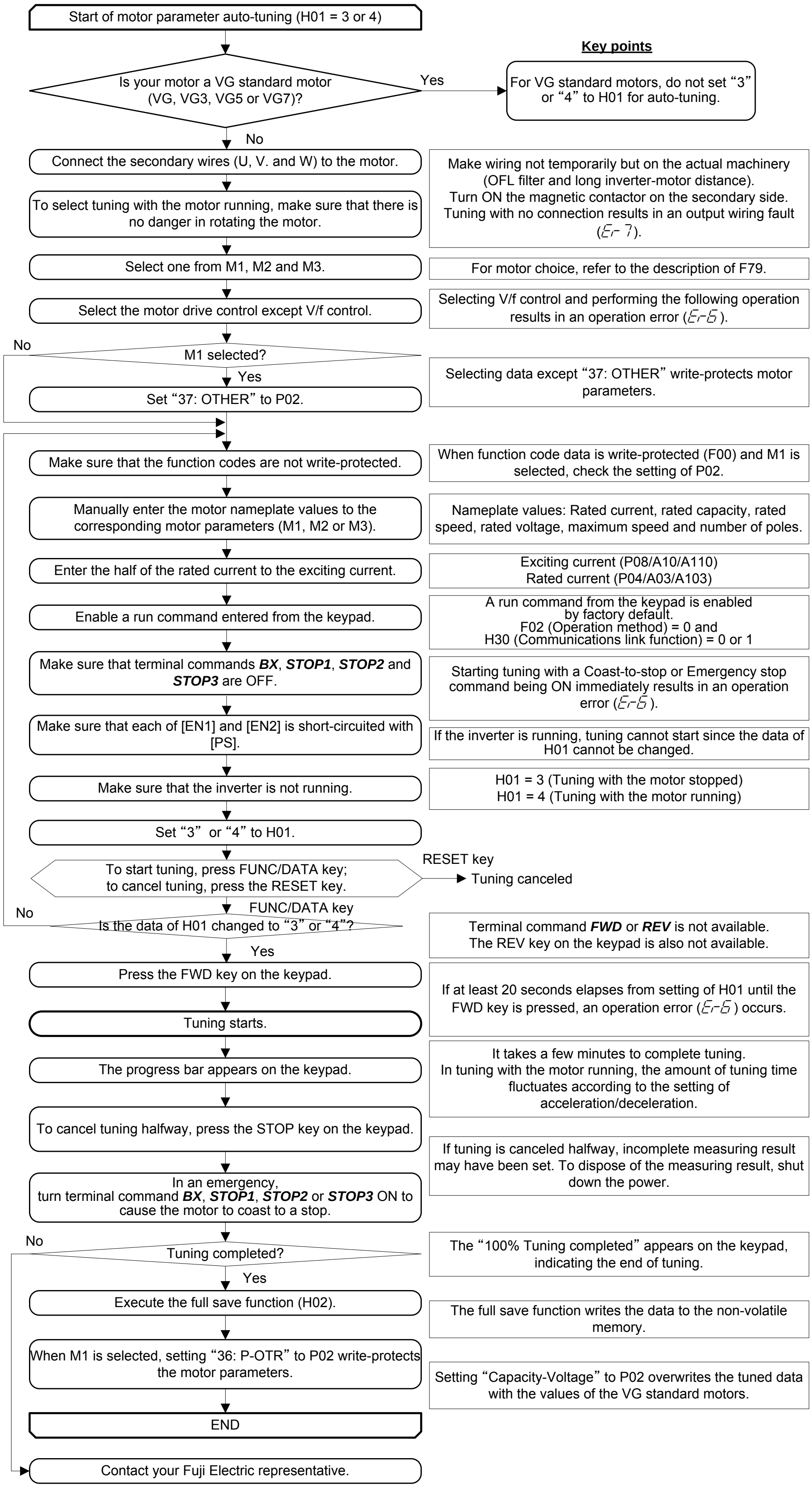
ASR (Auto speed regulator) auto-tuning procedure (H01 = 1) (Available soon)



Motor parameter auto-tuning procedure (H01 = 2)



Auto-tuning (with the motor stopped/running) procedure (H01 = 3 or 4)



⚠WARNING

When H01 = 1 or 4, the motor rotates during tuning. Make sure that there is no danger in rotating the motor.

Injuries could occur.

H02	Save All Function

When you execute H01 "Tuning operation" to rewrite the internal data or you rewrite data through the link (RS-485 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).

H	0	2	A	L	L		S	A	V	E		

Set the value
1 and press STOP and ⌃ keys at the same time to execute.

When you use the All save, you may delete previous data.

H03	Data Initialization

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	

Set the value
1 and press STOP and ⌃ keys at the same time to execute.

When you use the Data initializing, you may delete previous data.

H04	Auto-reset (Times)
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

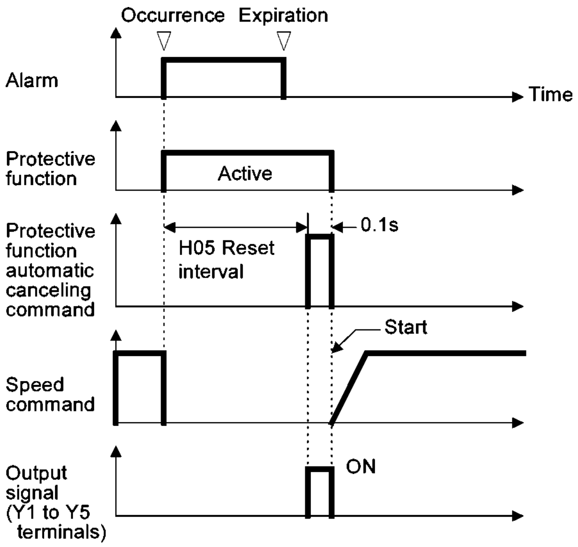
OC: Overcurrent	dbH: Braking resistor overheat
OU: Overvoltage	OL1, OL2, OL3: Motor 1,2, and 3 overload
OH1: Overheating at heat sink	OLU: Inverter overload
OH3: Inverter internal overheat	

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.

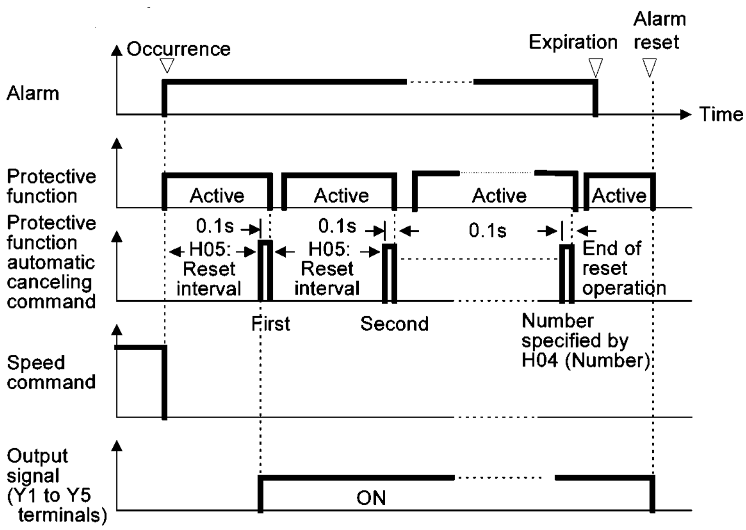
You can use the terminal [Y1] to [Y5] and [Y11] to [Y18] to monitor the retry operation. Note that if you want to use [Y11] to [Y18], you need the option OPC-VG1-DIOA. You can also use the link to poll M15 to read out the terminal information.

⚠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.**

Retry successful case



Retry failed case



H06	Cooling Fan ON/OFF Control

H06 specifies whether to enable automatic cooling fan ON/OFF control that detects the temperature of the heat sink inside the inverter unit when the main power is supplied to the inverter and turns the cooling fan ON or OFF.

The control turns the cooling fan OFF when the inverter is stopped and the temperature of the heat sink is kept under a certain level during the period (default: 10 minutes) specified by H77 (Cooling fan ON/OFF control continuation timer).

When the inverter is running, the cooling fan operates irrespective of the H06 setting.

The running status of the cooling fan can be monitored through terminals [Y1] to [Y5] and [Y11] to [Y18]. Note that [Y11] to [Y18] are available when the OPC-VG1-DIOA is mounted.

H	0	6	F	A	N		S	T	O	P		

Set value: 0: Disable
1: Enable

Cooling fan and ROM version

When the cooling fan ON/OFF control is enabled, the cooling fan operation immediately after the main power is turned ON differs depending on the ROM version.

ROM version H1/2 0019 or earlier: Even if the inverter is not running, the cooling fan rotates during the period specified by H77.

ROM version H1/2 0020 or later: Until the start of inverter running, the cooling fan is not turned ON.

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: Disable
1: Enable

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	Starting Mode (Auto search)

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.

Under UP/DOWN control, auto search mode is disabled.

When inverter is in “vector control of induction motor with PG” mode (P01 = 0) or “vector control of synchronous motor with PG” mode (P01 = 3), the starting mode (auto search) is always enabled.

When using the inverter under vector control without speed sensor, use auto search in 60 Hz (1800 r/min in terms of 4-pole motors) or below.

If a trip occurs in auto search in 60 Hz (1800 r/min in terms of 4-pole motors) or higher, the following may improve the problem.

(1) Change the carrier frequency (F26),

(2) Increase the initial level of pre-excitation (F75), and

(3) Perform motor tuning.

Under vector control without speed sensor, the property cannot be satisfied due to external factors such as load conditions, motor parameters and wiring length, so make a sufficient operation check before actual operation.

H	0	9	S	T	A	R	T		C	H	A	R

Set value: 0: Disable
1: Enable

Setting range: 0, 1, and 2

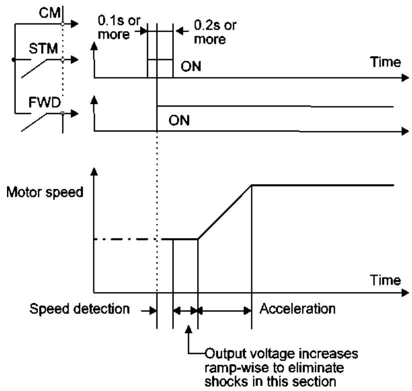
Set value	Normal start	Start after momentary power failure
0	Disabled	Disabled
1	Disabled	Enabled
2	Enabled	Enabled

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: Disable
1: Enable

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.
3: The motor decelerates to stop with ASR when the FWD-CM and the REV-CM are OFF (under torque control).
4: The motor coasts to stop when the FWD-CM and the REV-CM are OFF (under torque control).

When H11 = 3 or 4 and under ASR control, the motor decelerates to stop (H11 = 0). When H11 = 0 to 2, the operation is common to the ASR control and torque control.

When H11 = 0 or 3, turn OFF in accordance with F37 (Stop speed).

When H11 = 1 under vector control without speed sensor or V/f control, auto search is automatically disabled.

When H11 = 2 or 3, the inverter will perform free ran when digital input signal STOP 1~3 is turned ON.

H13 Restart Mode after Momentary Power Failure (Wait time)

Waits for a time specified this function after power recovery and restarts.

H	1	3	R	E	S	T	A	R	T		t	

Setting range: 0.1 to 5.0 (s)

H14 Restart Mode after Momentary Power Failure (Decrease rate in speed)

In restart mode after momentary power failure under V/f control, if the inverter output frequency and motor rotation speed are not synchronized with each other, an overcurrent flows, activating the current limiter.

Upon detection of the current limiter operation, the inverter automatically increase the output frequency (r/min) to synchronize with the motor rotation speed. H14 specifies the decrease rate in speed (r/min/s).

H	1	4	F	A	L	L		R	A	T	E	

Setting range: 1 to 3,600 (r/min/s)

Note

Increasing the decrease rate may perform regenerative control the moment the inverter output frequency (r/min) and the motor rotation speed are synchronized with each other, causing an overvoltage trip.

Decreasing it may lengthen the current limit operation duration until the synchronization, activating the inverter overload protection.

H15 Restart Mode after Momentary Power Failure (Continuous running level)

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 Restart Mode after Momentary Power Failure (Run 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 selfhold time)" when you specifies 0.

H	1	6	S	L	F	H	L	D		S	E	L

Setting range: 0 or 1

0: Hold a run command for the time specified by H17

1: Hold a run command until the main circuit power comes to be almost zero

H17 Restart Mode after Momentary Power Failure (Run 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	t	

Setting range: 0.0 to 30.0 (s)

H19 Active Drive

H19 specifies whether to enable active drive in which the inverter automatically limits the output torque to avoid an overload trip, etc. under vector control.

If 60s or a longer acceleration time is selected under V/f control, the acceleration time is automatically lengthened three-folded to avoid alarms.

H	1	9	A	C	T	–	D	R	I	V	E	

Setting range: 0: Disable
1: Enable

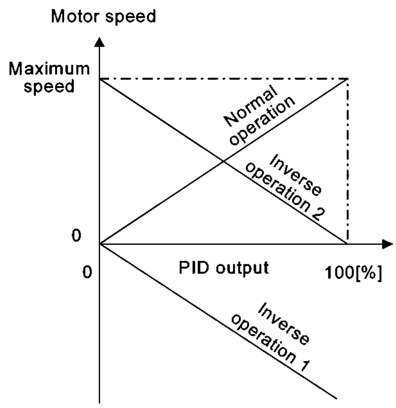
Before a trip is caused due to an inverter overload (OLU), heat sink overheat (OH1) or inverter inside overheat (OH3), the torque command value is limited or the acceleration time is extended to avoid alarms.

H20	PID Control (Mode selection)

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.



H20 PID COMND

Setting range: 0: Disabled
1: Enabled (normal operation)
2: Enabled (inverse operation 1)
3: Enabled (inverse operation 2)

H21	PID Control (Command selection)

Select the source of the reference value 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.

H21 PID REFER

H22	PID Control (P-action)
H23	PID Control (I-action)
H24	PID Control (D-action)

H	2	2	P	–	G	A	I	N				
H	2	3	I	–	G	A	I	N				
H	2	4	D	–	G	A	I	N				

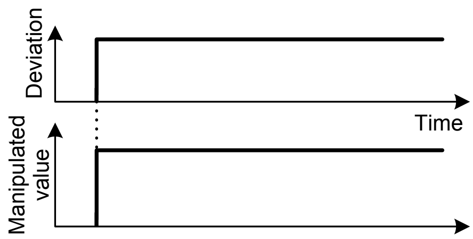
H22 setting range: 0.000 to 10.000 (times)
H23 setting range: 0.00 to 100.00 (s)
H24 setting range: 0.000 to 10.000 (s)

In general, P: Gain, I: Integral time, or D: Differential time is not used individually, but use them by combining them as P control, PI control, PD control, and PID control.

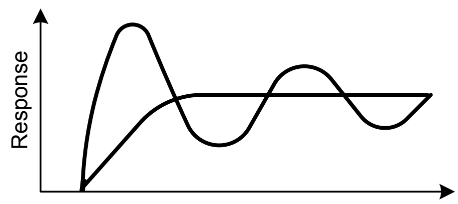
P control action

This action is referred to as P control action when a manipulated value (Speed command, Auxiliary speed command, 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.

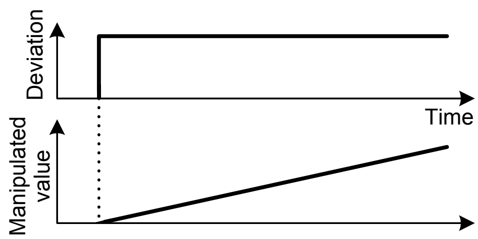


P: gain is a parameter to define a degree of the response to a deviation. When you set a large gain, you will have a quick response. Too large gain presents an oscillation. Too small gain slows down the response.



I control action

This action is referred to as I control action when a manipulated value (Speed command, Auxiliary speed command, 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 command). However I control cannot responds to a deviation changing quickly.

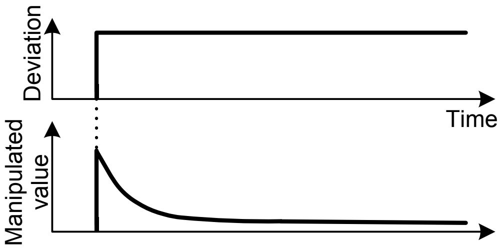


You can use I: integral time as a parameter to determine the effect of I control action. If you set a large integral time, you will have a slow response. A large integral time also decreases the repulsive force.

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 command, Auxiliary speed command, 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 value 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 selfdamping action.

PID control action

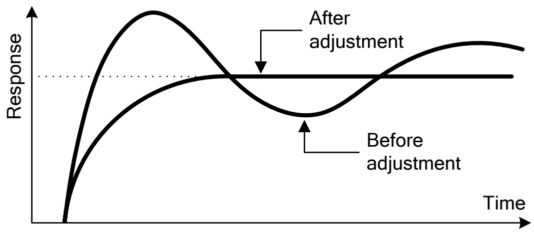
PID control action combines I control action, which acts to reduce deviation and D control action, which acts to restrain oscillation with P control action. You can obtain a stable response with no deviation.

This control is effective when applied to a load which respond slowly.

Adjusting PID setting

It is recommended that you use an oscilloscope to view a response waveform and adjust PID setting. Adjust the PID setting, using the procedure given below.

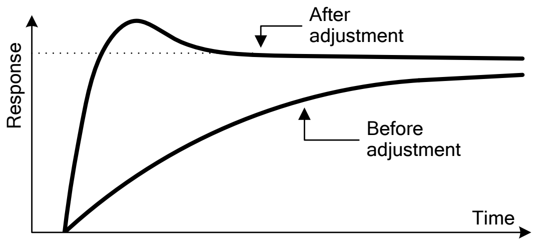
- Increase H22 "PID control setting (P control action)" (P gain) as long as it does not present an oscillation.
- Decrease H23 "PID control setting (I control action)" (I integral time) as long as it does not present an oscillation.
- Increase H24 "PID control setting (D control action)" (D differential time) as long as it does not present an oscillation.



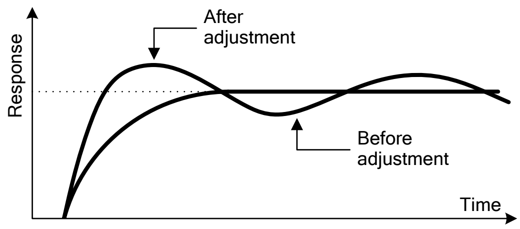
Follow the procedure below to adjust the response waveform.

- 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).

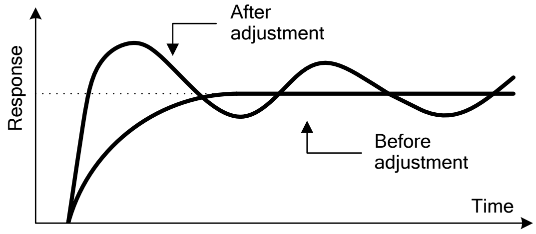
- To stabilize fast (accepting some overshoots.)
  Decrease H23 "PID control setting (I control action)" (I integral time). Increase H24 "PID control setting (D control action)" (D differential time).



- 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 (Upper limit)

H26 PID Control (Lower limit)

Set the upper and lower limiters applied to PID control.

H25	PID UPPER
H26	PID LOWER

Setting range: -300 to 300 (%)

H27 PID Control (Speed command selection)

Selects a destination of PID output to be used as a speed command.

H27	PID SP REF

Setting 0: Disabled
1: PID
2: Auxiliary speed setting range: -300 to 300 (%)

Usage	Destination of connection	Parameter setting
Parameter setting	Speed command	H27=1
Dancer control	Auxiliary speed command	H27=2
Torque control (tension control)	Torque command	H27=0 & H41=5
	Torque control value	H27=0 & (F42 or F43=5)

H28 Droop Control

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

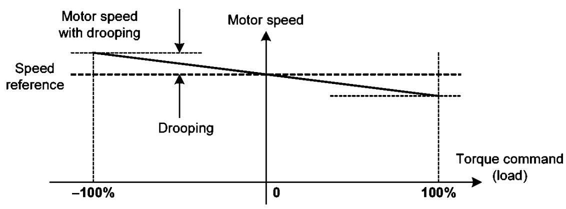
Setting range: 0.0 to 25.0 (%)

Set a drooping amount at 100% of torque command.

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 -150.0 r/min at 100% of torque command (load).

The droop function becomes valid after the [DROOP] contact input and ON "DROOP ON" are turned on.

If the droop gain is too large, the motor speed may increase too much under a control load, causing an excessive speed alarm (OS). If this happens, decrease the gain.



Chap. 4 CONTROL AND OPERATION

H29	Communications Link Function (Data protection via link)

Protects code data from false writing through different types of communication systems (such as integrated RS-485 and field bus).

H29 LINK PROCT

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 commands) separately.

When you assign ***WE-LINK*** to a digital input, you can protect from writing by short-circuiting between [WE-LINK] and [COM].

H30	Communications Link Function (Link operation)

Uses different types of communication systems (such as integrated RS-485 and field bus) to enable/disable command data (such as speed command, position command, torque command) and operation commands (FWD and REV), control inputs (X1-X9, X11-X14). Monitoring (access to M area) is always available. The command data correspond to S01 to S05 and S08 to S12. The operation commands correspond to the lowest two bits of S06.

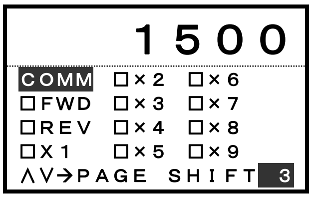
When you assign ***LE*** to a digital input, you can connect between [LE] and [CM] to enable the setting by H30 and open to disable operations specified through the link (set to H30=0 regardless of the setting by H30).

H30 LINK FUNC

Set value:

	Monitor	Command data (Speed commands, torque commands, etc.)	S06		Terminal block	
			Run commands (FWD, REV) Control inputs (X1 to X9, X11 to X14)	Reset command (RST)	FWD, REV (F02 = 1)	X1 to X9 (X11 to X14)
0	○	×	×	○	○	○
1	○	○	×	○	○	○
2	○	×	○	○	×	○
3	○	○	○	○	×	○

Note: If run commands and control inputs are enabled on both S06 and terminal block, they are ORed.



You can use the KEYPAD panel to check the operation commands from the link, and I/O check of control input.

H31 to H40 RS-485 Communication

Protects code data from false writing through different types of communication systems (such as integrated RS-485 and field bus).

Sets different types of specifications for RS-485 communication. Specify according to your host device.

See "Standard RS-485 interface" for the communication protocol.

H31 Station address

Sets the station address of RS-485

Setting range: 0 to 255 (Broad cast: (0: RTU), (99: FUJI)/address: 1 to 255)

H32 Action on error occurrence

Setting range: 0 to 3

Setting: 0: Immediate trip upon communication error
1: Trip upon communication error after continuation of operation for the time set at H33 "timer interval"
2: Trip upon communication error if the error persists after the time set at H33 "timer action time" has elapsed
3: Operation continues even if a communication error occurs. (The transmitted operation command is automatically restored after the cause of the failure is removed.)

H33 Timer operation time

Specify a procedure when an error occurs and an error handling time.

Timer operation time: 0.01 to 20.00 (s)

H34 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)

H35 Data length

Specifies data length.

Set value: 0: 8 (bit)
1: 7 (bit)
(The SX protocol and Modbus RTU protocol are fixed at 8 bits irrespective of the H35 setting.)

H36 Parity bit

Specifies parity bit.

Set value: 0: None
1: Even parity
2: Odd parity
(The SX protocol is fixed at the even parity irrespective of the H36 setting.)

H37 Stop bit

Specifies stop bit.

Set value: 0: 2 (bit)
1: 1 (bit)
(With the Modbus RTU protocol, the stop bit is automatically selected according to the parity bit selected at H36 irrespective of the H37 setting.)

H38 Continued communication disconnected time

Specifies a time to wait to provide a trip signal (Er-5) after detecting discontinued access due to disconnection during operation through RS-485 in a system where the station is always accessed in a certain period.

Setting range: 0: Detection disabled
0.1 to 60.0 (s)

H39 Interval time

Specifies a time between the completion of receiving a request from a host device (computer or PLC) and the start of responding to the request.

Setting range: 0.00 to 1.00 (s)

H40 Protocol selection

Specifies a communication protocol.

Set value: 0: FUJI general-purpose inverter protocol
1: SX bus protocol (loader protocol)
2: Modbus RTU protocol

To connect the inverter to FRENIC-VG Loader via the DX+/DX- control terminal (RS-485 communications link), set the H40 data to "1." When the inverter is connected via the USB terminal, it communicates regardless of the H40 setting.

To drive both FRENIC-VG inverters and Fuji general-purpose inverters via the common RS-485 communications link, set the H40 data to "0."

Note: Modbus RTU is a communication protocol defined by Modicon company.

H41 Torque Command Source

Selects an element with which you provide the torque command. 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 command

⚠WARNING

Make sure to use the speed limiter in cooperation with the torque command or the torque current command. You can avoid the motor overrun.

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, if the motor is rotated by the load with torque exceeding a torque command, even turning the run command OFF may not stop the motor but keep it running.

  To shut down the inverter output, take measures such as "Switch to speed control and decelerate to stop," "Shut down with a coast-to-stop command (***BX***)," or "Use automatic operation OFF function (H11 = 2 to 4)."

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, the inverter may not detect a power failure depending upon the load state. If it happens, input a power failure signal to the BX terminal to stop the inverter.

Accidents or physical injuries may occur.

H42 Torque Current Command Source

Selects an element with which you provide the torque command. 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 command

⚠WARNING

Make sure to use the speed limiter in cooperation with the torque command or the torque current command. You can avoid the motor overrun.

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, if the motor is rotated by the load with torque exceeding a torque command, even turning the run command OFF may not stop the motor but keep it running.

  To shut down the inverter output, take measures such as "Switch to speed control and decelerate to stop," "Shut down with a coast-to-stop command (***BX***)," or "Use automatic operation OFF function (H11 = 2 to 4)."

Accidents or physical injuries may occur.

⚠WARNING

- Under torque control, the inverter may not detect a power failure depending upon the load state. If it happens, input a power failure signal to the BX terminal to stop the inverter.

Accidents or physical injuries may occur.

H43 Magnetic Flux Command Source

Selects an element with which you provide the magnetic-flux command.

If the Ai input and link are selected, magnetic flux command inputs within 10% are fixed at 10%.

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 Command Value

Specifies magnetic-flux command value. This function becomes available when you set 2 to H43.

H	4	4	M		R	E	F					

Setting value: 10 to 100 (%)

H46	Observer (Mode 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 command 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.

H	4	6	O	B	S		M	O	D	E		

Setting value: 0: Disabled
1: Load disturbance observer
2: Oscillation suppressing observer

Note: When a load inertia specified by H51 or H52 and H127 has a large error, you cannot obtain an expected performance. Specify an accurate value.

H47, H48, H125	Observer (M1, M2, M3 compensation gain)
H49, H50, H126	Observer (M1, M2, M3 I-time)
H51, H52, H127	Observer (M1, M2, M3 load inertia)

Specifies the compensation gain, the integral time, and the load inertia for the observer function.

H	4	7		M	1	–	O	B	S	–	P		
H	4	8		M	2	–	O	B	S	–	P		
H	1	2	5	M	3	–	O	B	S	–	P		
H	4	9		M	1	–	O	B	S	–	I		
H	5	0		M	2	–	O	B	S	–	I		
H	1	2	6	M	3	–	O	B	S	–	I		
H	5	1		M	1	–	I	N	E	R	T	I	A
H	5	2		M	2	–	I	N	E	R	T	I	A
H	1	2	7	M	3	–	I	N	E	R	T	I	A

Setting range
H47, H48, H125: 0.00 to 1.00 (times)
H49, H50, H126: 0.005 to 1.000 (s)
H51, H52, H127: 0.001 to 50.000 (kg•m^2)

To H51, H52 and H127 (Load inertia), set the motor shaft conversion value in kg•m^2. The load inertia can be also measured by ASR tuning specified by H01 (Auto-tuning). Using H228 can switch the magnification of the load inertia setting.

H53 Line Speed Feedback Selection

You can select an element for the speed feedback

H53 N-FB SEL

Set value: 0: Line speed disabled (integrated PG enabled)
However, with UPAC, Ai input or PG(LD) high select
1: Analog line speed detection ***LINE-N***
2: Digital line speed detection (optional OPC-VG1-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 command corresponding the maximum torque (torque limiter value if you use it) to accelerate the motor to the maximum speed to follow up the speed command. 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.

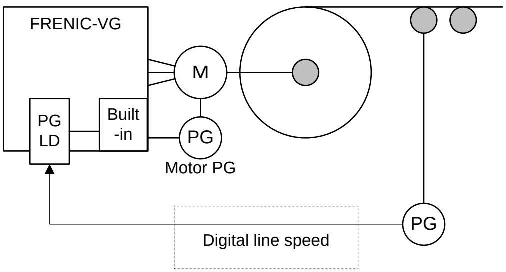
Note: When you use a motor PG and the optional OPC-VG1-PG (LD), a protective function of "PG disconnection alarm" becomes available.

If P01 (M1 control method) is set at “2” (simulation mode), the line speed feedback automatically becomes invalid.

<Application example of line speed control>

The right figure illustrates an example of line speed control with PG.

When the line PG output is digital pulse, then use Fuji PG card (OPC-VG1-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"

H55 ZERO-GAIN

Setting range: 0 to 100 (times)

H56 ZERO-HISS

Setting range: 0 to 100 (pulse)

H57 Overvoltage Suppression

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"

H57 OU PREVENT

Set value: 0: Disabled
1: Enabled

Note: The torque generated by the motor may decrease under a suppressed voltage state. Do not use this function for vertical transportation applications.

In case of V/f control, too short a deceleration setting may disable overvoltage suppression. If overvoltage suppression is disabled, extend the deceleration time.

H58	Overcurrent Suppression

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 torque generated by the motor may decrease under a suppressed voltage state. Do not use this function for vertical transportation applications.

H60 to H66	Load Adaptive Control

This function is related with the load adaptive control (H201 to H227). Refer to Section 4.1 "Control Block Diagrams."

Use this function to lift faster in case of small loads when compared with the speed at the rated load, thereby improving the efficiency of operation of the equipment.

Internal calculation of the inverter estimates the load during acceleration up to the rated (base) motor speed to calculate the maximum operable speed and perform speed limit control. Operation at the same speed in the up- and down-winding cycles with the same load is a major feature. As well, the maximum speed calculation correction function is added so that the up-/down-winding operation at the rated load is always at the rated (base) motor speed. The function can be used for lifting equipment equipped with a counterweight.

H	6	0	L	O	A	D		C	O	N	1	
H	6	1	L	O	A	D		C	O	N	2	
H	6	2	L	I	F	T		S	P	E	E	D
H	6	3	C		W	E	I	G	H	T		
H	6	4	S	A	F	E		C	O	E	F	
H	6	5	M		E	F	F	I	C	I	E	N
H	6	6	R		L	O	A	D				

Note: The load adaptive control is valid with the M1 motor only. Specify the same torque limit value for driving and braking.

Use acceleration/deceleration time 1 during operation under load adaptive control. Do not change the acceleration/deceleration time setting during load adaptive control operation.

This function is related with the multi-limit speed pattern function (H214 to H227). For load adaptive control and multi-limit speed pattern, refer to Section 4.1 "Control Block Diagrams."

H51 Observer setting (load inertia of M1): 0.001 to 50.000 (kg•m^2)

H202, H205, H208, H211 Load inertia: 0.001 to 50.000 (kg•m^2)

Specify the inertia without a load converted to the M1 motor shaft.

Note: In a multi-winding system, specify the quotient of the total inertia divided by the number of windings. For example, for a motor with two windings, specify a half the total inertia.

H60 Load adaptive control definition 1

Select the control method.

Setting 0: The load adaptive control is made invalid.
1: Speed limit at almost same speed in up- and down-winding cycles
2: Regular speed limit
3: Limit invalid during driving operation and speed limit during braking operation

H61 Load adaptive control definition 2

Define the relationship between the direction of rotation of motor and lifting direction.

Setting 0: Winding up during forward rotation of motor
1: Winding down during forward rotation of motor

Note: Setting H201 data to "0" also reverses the torque polarity in travel torque calculation.

H62 Up-winding speed: 0.0 to 999.9 (m/min)

Specify the lifting speed at the rated (base) motor speed. Note that this is not the maximum speed.

H63 Weight of counterweigh: 0 to 600.00 (t)

Specify for lifting equipment equipped with a counterweight. Specify the weight of the counterweight.

H64, H203, H206, H209, H212 Safety coefficient: 0.50 to 1.20

Use the safety coefficient to adjust the motor output that is the basis of calculation of the speed limit value. Lowering the safety coefficient to less than 1.00 decreases the speed limit value.

H65, H204, H207, H210, H213 Machine efficiency: 0.500 to 1.000

Specify the total efficiency of the equipment.

H66 Rated load: 0 to 600.00 (t)

The parameter is necessary for the correction of the maximum speed calculation so that operation at the rated (base) motor speed is assured during up-/down-winding cycles at the rated load. Using H228 can switch the magnification of the setting.

Note: Include the mass of the spreader and head block, too, in the setting. For a multi-winding system, specify the quotient of the total mass divided by the number of windings. For example, for a motor with two windings, specify a half the total mass.

Specify H51, H202, H205, H208, H211 (Observer setting (M1 load inertia)), H61 (Load adaptive control definition 2), H62 (Winding-up speed), H63 (Weight of counterweight), and H65, H204, H207, H210, H213 (Machine efficiency) according to the specification of the machine. The speed limit is set in a constant-output pattern according to the rated motor output. The rated motor output serving as a basis for the calculation of the speed limit can be adjusted with H65, H203, H206, H209, H212 (Safety coefficient).

To operate at almost the same speed in the winding-up and winding-down cycles of the same load, specify setting “1” as H60 (Load adaptive control definition 1).

To operate at the rated (basic) motor speed in the winding-up and winding-down cycles of the rated load, specify H66 (Rated load). If the estimated inverter load exceeds the rated load, limit the motor speed using the rated speed (Basic speed).

To determine the maximum speed under consideration for the machine efficiency, specify setting "2" as H60 (Load adaptive control definition 1). The down-winding speed (during braking operation) becomes higher by the machine efficiency when compared with the winding-up speed (driving operation).

To invalidate load adaptive control during driving operation and validate the control only during braking operation, specify setting "3" as H60 (Load adaptive control definition 1). The control becomes invalid in the winding-up cycle (during driving operation) and the control becomes valid in the winding-down cycle.

To invalidate load adaptive control, set the H60 data (Load adaptive control definition 1) to "0" or turn ON the ***N-LIM*** (Cancel speed limiter) of the X terminal function. Doing so disables only the speed limiter triggered by load adaptive control. The estimated load and the speed limit value are calculated so that the speed limit value calculation result obtained with option monitor 6 mentioned later is also effective.

The limit value calculation result can be checked by using option monitor 6, M220 (Load compensating speed control value), M221 (Hoisting load calculation result monitor (kg)) or M222 (Travel torque calculation monitor (%)). (Valid if H60 (Load adaptive control, Definition 1) is set at "1," "2" or "3.")

The load adaptive control activation state can be checked by the Y terminal function.

ANL (In limiting under load adaptive control)

This signal comes ON when the reference speed is limited with the speed limit value calculated under load adaptive control.

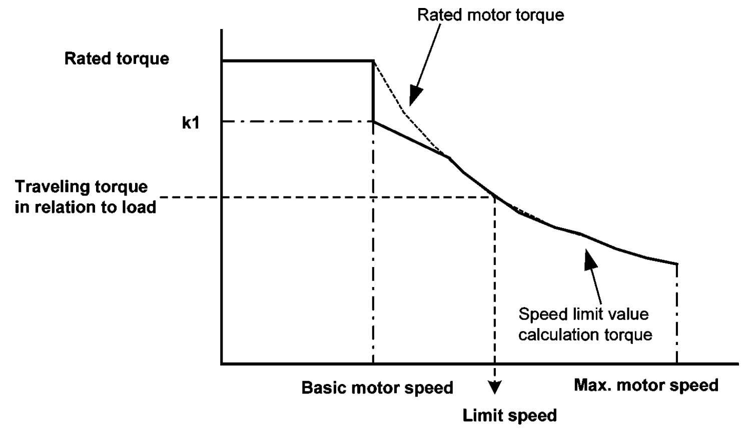
ANC (In calculation under load adaptive control)

This signal is ON during calculation of live load and speed limit value under load adaptive control. Turning this signal OFF updates the limit value calculation result obtained with option monitor 6 to the latest data.

For details about ***ANL*** and ***ANC*** signals, refer to the description of E15 to E27 (Y terminal function).

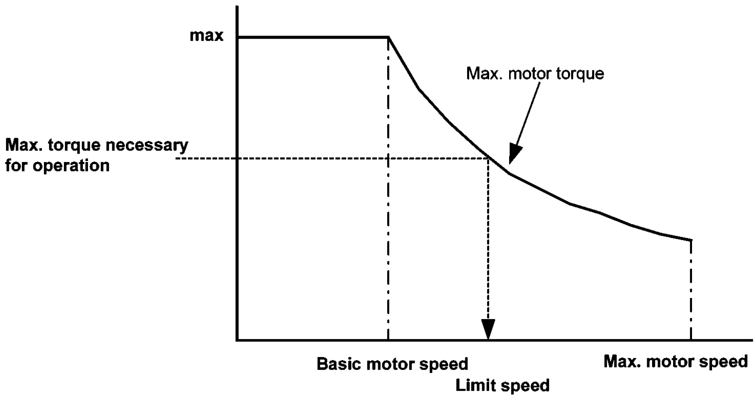
Speed limit pattern diagrams

<u>If H60 (Load adaptive control definition 1) = 1</u>



k1 indicates the motor torque determined from H66 (Rated load) and H62 (Rated lifting speed). The motor speed is limited by the base speed with the loads exceeding the rated load. The rated motor torque can be operated, using H64, H203, H206, H209, H212 (Safety coefficient).

<u>If H60 (Load adaptive control definition 1) = 2 or 3</u>



The limit speed is obtained from the relationship between the maximum motor torque and maximum torque necessary for acceleration/deceleration. The maximum motor torque can be operated, using H64, H203, H206, H209, H212 (Safety coefficient).

H68 Alarm Data Deletion

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.

Setting the H68 data to "1" clears all data and automatically returns to "0."

H	6	8	A	L	A	R	M		D	A	T	A

H70 Reserved 1

These functions are reserved for makers to adjust the inverter.

H	7	0	M	A	K	E	R	1				

⚠WARNING

Do not change.

Accident and/or injury may result.

H71 Reserved 2

When you mount a PG on the motor or replace the PG at the site for motors having no magnetic pole position offset label, perform automatic adjustment with the tuning function (H71 = 5)

H	7	1	M	A	K	E	R	2				

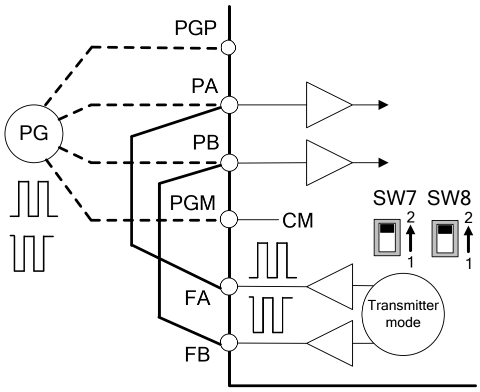
Setting 5: Magnetic pole position offset tuning

H74 PG Detection Circuit Self-diagnosis

H74 performs self-diagnosis of the pulse generator 2-phase signal input terminals (PA and PB) and output terminals (FA and FB). Follow the procedure given below.

H	7	4	P	G		S	E	L	F			

Setting 0: Disable
1: Perform PG detection circuit self-diagnosis



Preparation

(1) Set the 1000's digit of H104 (PG wire break alarm) to "0" (Disable).

(2) Set the E29 data (PG output pulse selection) to "7."

(3) Disable the following functions and revert the following function codes to the defaults.

Functions to be disabled:
Jogging operation ***JOG***, ASR acceleration/ deceleration time, and Pre-excitation

Function codes to be reverted to factory defaults:
F23 (Starting speed) = 0.0
F24 (Starting speed, Holding time) = 0.00

(4) Check that contact outputs ***BX***, ***STOP1***, ***STOP2***, ***STOP3*** and ***BPS*** are OFF.

(5) Shut down the inverter power.

(6) After making sure that the inverter power is OFF, make a connection between PA and FA and between PB and FB with external wiring.

Set the pulse generator output (FA and FB) in complementary output (SW7 = 2, SW8 = 2).
(Refer to Section 3.3.3.9 "Setting up the slide switches.")

(7) Turn the inverter power ON.

Starting diagnosis

(1) Set the H74 data to "1."

The inverter outputs an automatically generated speed pattern from the pulse generator output terminals (FA and FB) and detects the speed pattern via the pulse generator 2-phase signal input terminals (PA and PB). It compares the detected speed pattern with the output one for diagnosis of the PG detection circuit.

(2) If the diagnosis result is normal, the "COMPLETE OK!" appears on the LCD monitor.

If it is abnormal, the "PG CIR ERR" or "A/B PHASE ERR" appears.

After completion of diagnosis, the H74 data automatically reverts to "0."

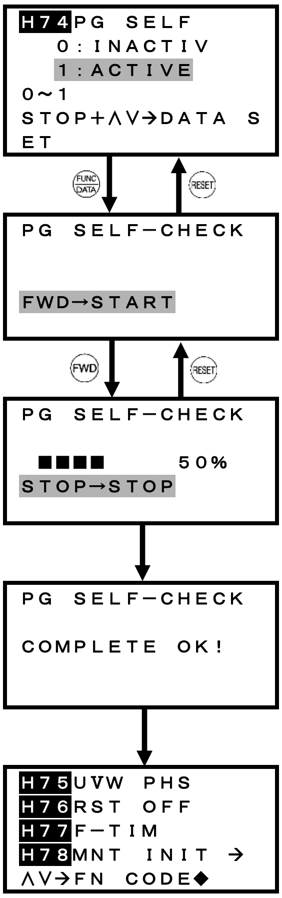
The time required for the diagnosis is approximately 12 seconds. Pressing the STOP or RESET key during diagnosis cancels the diagnosis in midway.

After completion of diagnosis

(1) Revert the settings of H104 and E29 to their original values.
(2) Shut down the inverter power (including R0 and T0).
(3) Remove the external wiring (connection between PA and FA and between PB and FB).
(4) If the settings (SW7 and SW8) of the pulse generator output (FA and FB) have been modified, revert them to the original settings.

Notes
- When the optional PG(SD)/PGo(SD) card is mounted on the inverter, this function cannot be used. (Er-6 will result.)
- The diagnosis can be performed only with the control power (R0 and T0) ON.
- The diagnosis temporarily changes particular function code data, so be sure to shut down the inverter power after completion of diagnosis.

Display during PG detection circuit self-diagnosis



Change the data of the function code with the ∧/∨ keys.

After "STOP+∧∨→DATA SET" appears, the FWD/STOP key operations appear alternately.

Start PG detection circuit self diagnosis with FWD key ON.

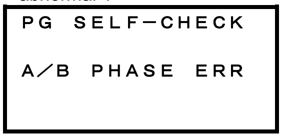
When 100% appears, PG detection circuit self diagnosis is finished.
Forcible stop is possible with STOP key or RESET key ON.

If the diagnosis result is normal, "COMPLETE OK!" appears.

After about 1.5 seconds, the function code list screen appears.

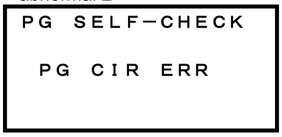
The H74 setting automatically returns to "0".

<Screen when the result is abnormal 1>



If the polarity of the detected speed value is reversed, "A/B PHASE ERR" appears.
Move to the function code setting screen with RESET key or STOP key ON.

<Screen when the result is abnormal 2>



If the speed detection circuit is abnormal, "PG CIR ERR" appears.
Move to the function code setting screen with RESET key or STOP key ON.

H75 Phase Sequence Configuration of Main Circuit Output Wires

H75 switches the phase sequence of the main circuit to invert the phase without changing the motor wiring.

For vector control with a PG, it is necessary to replace the PG signal wires PA and PB.

This function is available only under induction motor control.

Note: For vector control with a PG, it is necessary to match the motor rotation direction with the phase sequence of PG signals.

H	7	5	U	V	W		P	H	S			

Setting 0: UVW normal phase connection
1: UVW reverse phase connection

H76 Main Power Down Detection

The main power break detection function monitors the main power of the inverter (RST AC voltage input). When set to "1", the monitor functions below operate.

If a main power break is detected while the inverter is stopped, the charge resistance bypass circuit in the inverter opens. If a brief main power break occurs while the inverter is stopped, charging will take place through the charge resistance circuit when the power is restored, enabling the suppression of surge current.

Note: If "0" (No main power AC input monitor) is set and the main power is turned off/on quickly while the inverter is stopped, the charge resistance in the inverter will be bypassed and excessive surge current may damage the inverter.

When the main power is OFF, a power interruption will be detected and inverter output will not start even if the DC link bus voltage is above the undervoltage level. During inverter output, a power interruption is detected based on the DC link bus voltage only.

When a main power break is detected, ________ (underline) will appear in the LED monitor of the display.

However, when DC power is supplied and inverter AC input power is not supplied, such as when a power regeneration converter is connected, always set to "0" (No main power AC input monitor".

H	7	6	R	S	T		O	F	F			

Setting 0: No main power AC input monitor
1: Main power AC input monitor

H77 Cooling Fan ON/OFF Control Continuation Timer

This sets the condition for the cooling fan ON-OFF function by H06. While the inverter is stopped, if the detected fan temperature is below a fixed value for the time set with this setting, the cooling fan turns OFF.

H	7	7	F	–	T	I	M					

Setting: 0 to 600 sec

H78	Initialization of Startup Counter/Total Run Time

This function initializes the M1 - M3 start counts and M1 - M3 cumulative run times (clear to zero). When doing maintenance work on the motor or machine, you can individually initialize the data of each.

H	7	8	M	N	T		I	N	I	T		

Setting 0: No operation
1: Initialize M123 "M1 start count"
2: Initialize M124 "M2 start count"
3: Initialize M125 "M3 start count"
4: Initialize M126 "M1 cumulative run time"
5: Initialize M127 "M2 cumulative run time"
6: Initialize M128 "M3 cumulative run time"

H79	Initialization of Cumulative Run Time of Cooling Fan

The data for the initial value setting of the cooling fan aggregate run time can be changed. When the cooling fan is replaced, set "1". When "1" is set, "0" is written to the aggregate time internally. When replacing the inverter control board, write down the data of this function code before replacing the board, and then reset the data after replacement to continue the aggregate run time. The setting automatically reverts to "0" after it is written.

H	7	9	F	A	N		T	–	I	N	I	

Setting: 0 to 65535 (units of 10 hours)

H80	Capacitance Measurement of DC Link Bus Capacitor

When the capacitor capacitance measurement method is user mode (1's digit of H104 is 1), this function code is used. Read and understand the following explanation.

When initial value measurement of the user setting capacitor capacitance is started, the measurement result is written. When the inverter power is shut off with this setting set to "1", initial value measurement of the user setting capacitor capacitance starts and the measurement result is written to this code.

User mode capacitor capacitance measurement is performed when the power is shut off if the AND conditions below are met.

- Inverter is stopped
- Undervoltage alarm has not occurred
- Cooling fan is running (will be forcibly stopped by the inverter when the power is shut off)

H	8	0	C	C	–	I	N	I	T			

Setting: 0 to 32767

<u>When the capacitor capacitance measurement method is the factory default standard (1's digit of H104 is 0)</u>

Measurement is performed when the power is shut off if all measurement conditions in the table below are ○. The measurement conditions vary depending on whether or not the predicted life (LIFE) is selected with Y function selection. The measurement result is shown in M46 "main circuit capacitor capacitance (%)" and M121 "main circuit capacitor life (elapsed time)". In the M121 elapsed time, the capacitance decrease rate and capacitor life time obtained by capacitor capacitance measurement are converted to an elapsed time that overwrites the previous value.

When the capacitor capacitance measurement method is the user measurement value standard (1's digit of H104 is 1)

The measurement conditions are different from the factory default standard. Refer to the table below.

Measurement condition	Factory default standard (H104=***0)		User measurement value standard (H104=***1)
	No LIFE assignment	LIFE assignment	
Gate signal OFF	○	○	○
Cooling fan running	○	○	○
Not undervoltage	○	○	○
Terminal inputs all OFF	○ *1	○ *1	-
Option card not installed	○	- *2	-

*1 Terminal information after normal open/close processing.

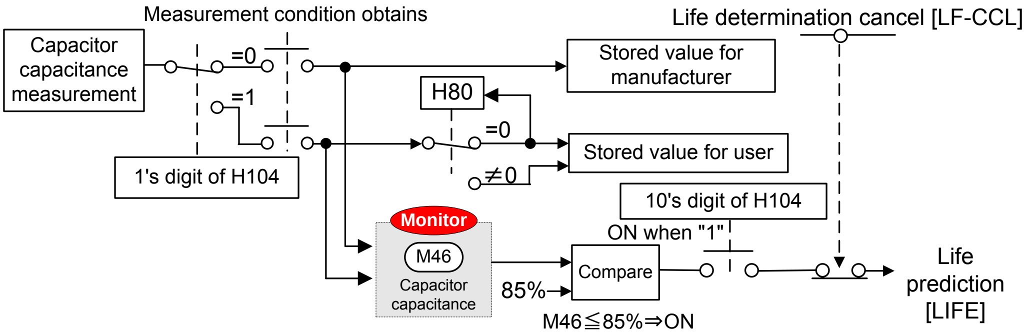
*2 When life information (LIFE) is assigned, measurement is also performed when an option card other than UPAC is installed.

Measurement will take place under the following conditions, however, the result will not be correct.

- When a breaking unit or other inverter is connected to the P (+), N (-) main circuit terminals by DC bus connection.
- RS-485 communication is used.
- Power is supplied from the R0, T0 auxiliary power.

By assigning the life prediction (LIFE) signal to one of the function codes of the Y function selection setting (E15 to E19), a life prediction signal is output to the general-purpose output (Y1 to Y5) when all of the conditions below are met.

- M46 "main circuit capacitor capacitance (%)" is 85% or lower
- The 10's digit of H104 is 1 (default value)
- Life determination cancel LF-CCL is OFF



H81	Initialization of Service Life of DC Link Bus Capacitor

The data for the initial value setting of the main circuit capacitor life aggregate time can be changed. When the main circuit capacitor is replaced, set "1". When "1" is set, "0" is written to the aggregate time internally. When replacing the inverter control board, write down this function code before replacing the board, and then reset after replacement to continue the aggregate time. The setting automatically reverts to "0" after it is written.

H	8	1	C	–	T	I	M	E		I	N	I

Setting: 0 to 65535 (units of 10 hours)

H82	Startup Count for Maintenance

When the total value of M123 "M1 start count" to M125 "M3 start count" becomes larger than this setting, a maintenance prediction (MNT) signal is output. By setting a start count for machine maintenance, external notification of maintenance timing is possible. The function code is the same for each motor. When the setting is "0", the start count stops.

H	8	2	M	N	T		S	T	R	T		

Setting: 0 to 65535
0: No operation
1 to 65535: Set startup times

H83	Maintenance Interval

This sets the inverter run time for performing machine maintenance. When the total value of M126 "M1 cumulative run time" to M128 "M3 cumulative run time" becomes larger than this setting, a maintenance prediction (MNT) signal is output. The function code is the same for each motor.

H	8	3	M	N	T		T	I	M	E		

Setting: 0 to 65535 (units of 10 hours)
0: No operation
1 to 65535: Set time

H84	Speed calculation period when extremely low speed (For maker)

This function is reserved for makers to adjust the inverter.

H	8	4	S	P	D		P	E	R	I	O	D

H85-H88 Calendar Clock

This is primarily used to set the date and time in the internal clock of the inverter via the communication option. The date and time can be displayed regularly on the LCD. The date and time are also used as a time stamp for detailed alarm information and the support loader trace-back function

The date and time can be easily set using the keyboard from "12. DATE TIME" in the menu of program mode.

By setting the date and time in H85 to H87 and then setting "1" in H88, the date and time are applied to the internal clock. The setting of H88 automatically reverts to "0" after the date and time are written.

H	8	5	Y	／	M		S	E	T			
H	8	6	D	／	H		S	E	T			
H	8	7	M	／	S		S	E	T			

Setting: 0 to FFFF

H	8	8	W	R	–	T	I	M	E			

Setting 0: No operation
1: Write time

The setting range is January 1, 2000, 00:00:00 to December 31, 2099, 23:59:59.

For example to set April 1, 2011, 13:15:00, write the values below.

Set H85 = 0B04, H86 = 010D, H87 = 0F00 in hexadecimal.
Set H88 = 1 to write the above values to the internal clock.

Valid numbers for each item are shown below.

Year: 00h - 63h, Month: 01h - 0Ch, Day: 01h - 1Fh, Hour: 00h - 17h, Min: 00h - 3Bh, Sec: 00h - 3Bh

* If values other than the above are set and "write time" is performed with H88, the individual values that are out of range are invalidated and not applied to the clock. Values that are valid are applied to the clock.

H90 Overspeed Alarm Detection Level

H90 specifies the detection level of the overspeed alarm (OS). The data 100% represents the maximum speed.

Under V/f control, this setting is invalid.

H	9	0	O	S		L	V	L				

Setting: 100 to 160%

Note: If "Maximum speed > Rated speed" and the rated output range is wide, set the H90 data under the following condition.
(Maximum speed/Rated speed) x H90 $\leq$ 720%

H96	ASR operation selecting

H96 specifies the operation of torque limit when ASR is saturated

H	9	6	A	S	R		O	P	E			

Setting: 0 to 3

0: P priority (VG1)
1: I priority (compatible with VM5)
2: P priority (compatible with VM5)
3: For maker (do not select this)
*If H96 is set as 0, speed detection may not match with speed command when torque limit level is low. Therefore for P priority use please set it as 2.

P priority mode

The limit level of integration(I) output is calculated as torque limit level minus proportion(P) output.

$\tau lim\_I = \tau lim - \tau P$

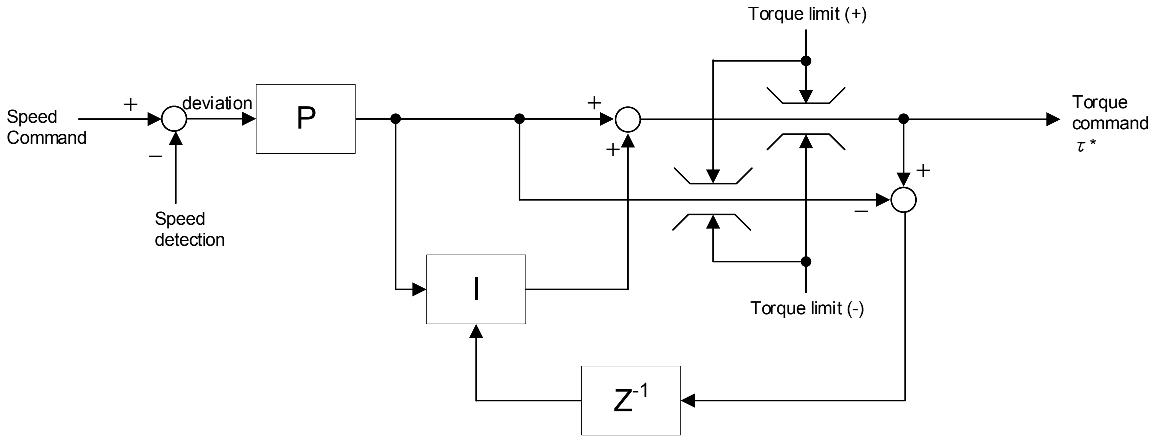
ASR is able to escape from saturation quickly in this mode.

I priority mode

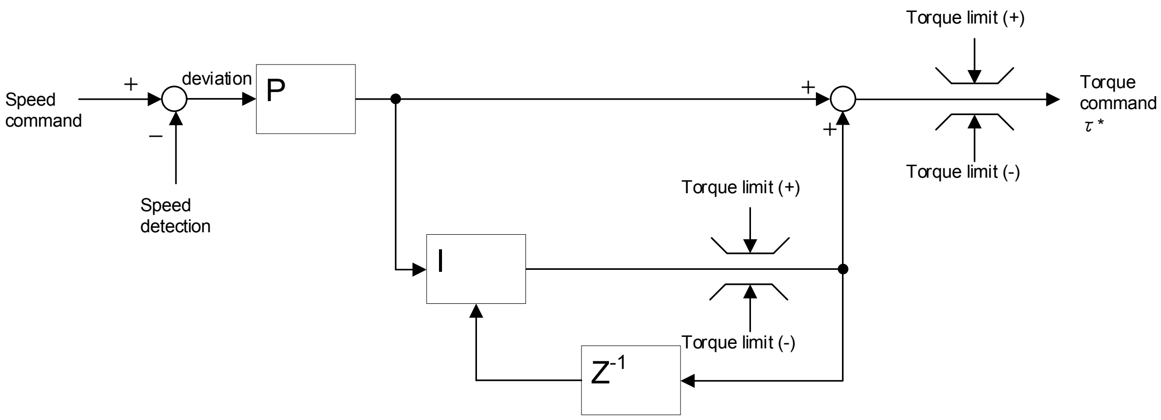
The limit level of integration(I) output equals torque limit level.

$\tau lim\_I = \tau lim$

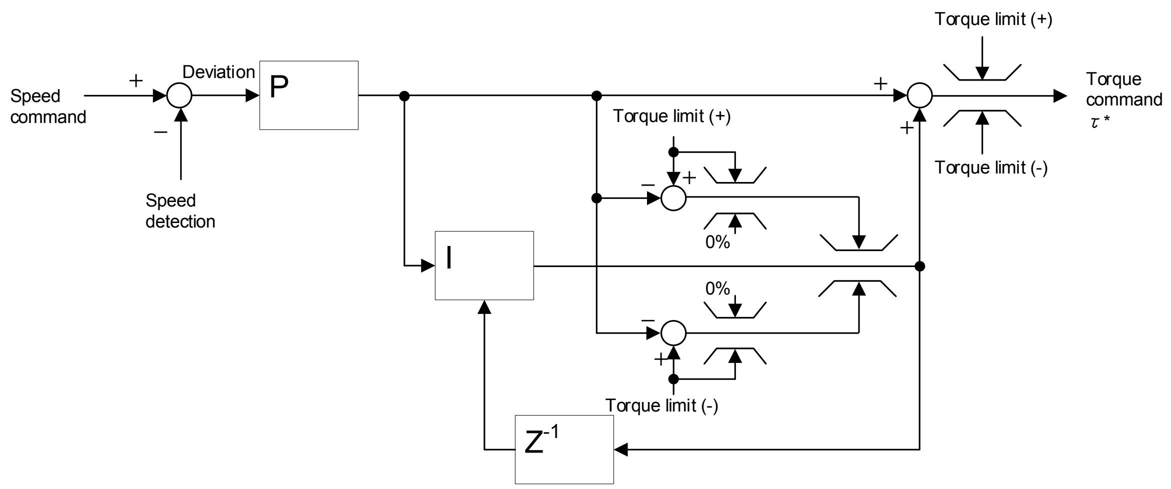
In this mode, because ASR I output limit level equals torque limit level, fluctuation of torque command is well restrained even when speed detection is fluctuating.



H96=0 : P priority (VG1)



H96=1 : I priority (compatible with VM5)



H96=2 : P priority (compatible with VM5)

H101 PID Command Filter Time Constant

H101 specifies the time constant for the PID command (after H21 switching) filter.

H101 PID FILT

Setting: 0 to 5000 ms

H103 Protective/Maintenance Function Selection 1

Protection operations can be individually selected.

To enable a protection operation, refer to the table below and set the appropriate digit to "1".

H103 PROT OPE1

Setting: 0000 to 1111

1000's digit:	Start delay alarm operation selection (LOC)	[0: Disable, 1: Enable] (default: 0)
100's digit:	Grounding fault alarm operation selection (EF)	[0: Disable, 1: Enable] (default: 1)
10's digit:	Output open-phase alarm operation selection (OPL)	[0: Disable, 1: Enable] (default: 0)
1's digit:	Braking transistor error operation selection (dbA)	[0: Disable, 1: Enable] (default: 1)

Braking transistor error (1's digit)

Selects whether errors of the braking transistor for braking resistor drive are detected.

If you are not using a braking resistor and do not want this alarm to occur, set to "0".

Output open-phase (10's digit)

Select whether the output open-phase alarm operates.

Grounding fault (100's digit)

Select whether the grounding fault alarm operates.

Start delay (1000's digit)

Select whether the start delay alarm operates.

H104	Protective/Maintenance Function Selection 2

Protection operations and main circuit capacitor life determination operations can be individually selected.

To enable a protection operation, refer to the table below and set the appropriate digit to "1".

H	1	0	4	P	R	O	T		O	P	E	2	

Setting: 0000 to 1111

1000's digit:	PG power break alarm (PG) operation selection	[0: Disable, 1: Enable] (default: 1)
100's digit:	Carrier frequency reduction function selection	[0: Disable, 1: Enable] (default: 1)
10's digit:	Main circuit capacitor life determination selection	[0: Disable, 1: Enable] (default: 1)
1's digit:	Main circuit capacitor capacitance measurement selection (0: Factory default standard, 1: User measurement standard)	[0: Disable, 1: Enable] (default: 0)

Main circuit capacitor capacitance measurement selection (1's digit)

Select whether the standard level for determining the life of the main circuit capacitor capacitance is the factory default standard or the user set standard. Also see the explanation of function code H80.

Main circuit capacitor life determination selection (10's digit)

Select whether decreased main circuit capacitor capacitance is the factor for the life prediction signal (LIFE).

Also see the explanation of function code H80.

Carrier frequency auto reduction selection (100's digit)

This function automatically reduces the carrier frequency before an inverter cooling fan overheating (OH1) or inverter internal overheating (OH3) alarm occurs in order to avoid the alarm. Select the operation of this function. When the carrier frequency is reduced, motor noise increases.

Note: When a synchronous motor is driven, the inverter carrier frequency is sometimes set higher to prevent overheating of the permanent magnet and demagnetization of the magnet due to inverter high frequency output current (excluding our GNF2 model). Carefully check the carrier frequency allowed by the motor before deciding the carrier frequency (F26) and carrier frequency auto reduction selection (H104) settings. If you cancel the carrier frequency auto reduction selection function (H104), exercise caution as the carrier frequency setting may cause a reduction of the unit's continuous rated current (for rated current reduction characteristics, refer to section 2.1.4). The setting of this digit cannot be changed during operation.

PG power break alarm selection (1000's digit)

Select whether the PG power loss alarm (PG) operates.

H105	Protective/Maintenance Function Selection 3 (Available soon)

Protection operations can be individually selected.

To enable a protection operation, refer to the table below and set the appropriate digit to "1".

H105 PROT OPE3

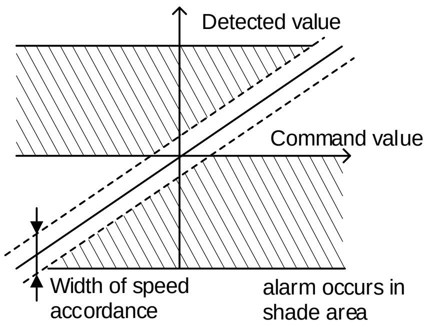
Setting: 0000 to 1111

1000's digit: Not used
100's digit: Speed disaccord alarm Er-9 operation 1
10's digit: Speed disaccord alarm Er-9 operation 2
1's digit: Save the integrated value of motor electronic thermal

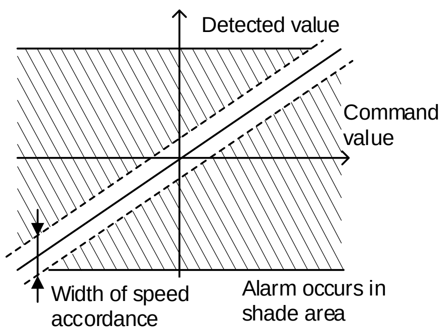
Specification of Er-9 alarm detection according to the combination of function codes

E45	H105	Er-9 detection conditions	Remarks
E45 = *0	H105 = ****	Er-9 is disabled	
E45 = *1	H105 = *00*	"Speed disaccord exists" and "speed command value and detected value are in opposite polarity" or "speed command value < speed detected value "	The same detection conditions of Er-9 with the old ROM
	H105 = *01*	"Speed disaccord exists"	
	H105 = *10*	"Speed disaccord exists" and " In run state " and "speed command value and detected value are in opposite polarity" or "speed command value < speed detected value "	Recommended
	H105 = *11*	"Speed disaccord exists" and " In run state "	

Relationship between speed command value and detected value in Er-9 alarm detection specification.



H105 = *00* ,*10*



H105 = *01* ,*11*

Note) The definition of 100's and 10's digit of H105 is only valid in software version later than H1/2 0067.

H106 to H111	Light Alarm Object Definition 1 to 6

When an error is detected and the error is a minor error, the light alarm (L -AL) display can be shown and operation can be continued without tripping the inverter.

"1" can be set in bits corresponding to any of the light alarm causes to treat those causes as light alarms and not have the alarm relay output (30RY) operate.

H	1	0	6	L	–	A	L	M		1			

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- External alarm [OH2]
- NTC thermistor wire break [nrb]
- Motor overload [OL1] [OL2] [OL3] (same for M1-M3)
- Motor overheat [OH4]

H	1	0	7	L	–	A	L	M		2			

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- Toggle error [ArF]
- Reserved
- Network error [Er4]
- RS-485 error [Er5]

H	1	0	8	L	–	A	L	M		3			

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- E-SX error [ArE]
- Speed does not match [Er9], start delay [LOC]
- DC fan lock [daft]
- Mock alarm [Err]

H	1	0	9	L	–	A	L	M		4			

Setting: 0000 to 1111

□□□□ (0: Heavy alarm, 1: Light alarm)
- Reserved
- Reserved
- Reserved
- Reserved

H	1	1	0	L	–	A	L	M		5			

Setting: 0000 to 1111

□□□□ (0: Cancel light alarm, 1: Light alarm)
- Fan overheat prediction [OH], inverter overload prediction [OL]
- Life prediction [LiF]
- Battery life [BaT]
- Motor overheat prediction [MOH], motor overload prediction [MOL]

Set whether the LED display shows [L-AL] when a light alarm occurs.

H	1	1	1	L	–	A	L	M		6			

Setting: 0 to 1
0: Disable (L-AL not displayed)
1: Enable (L-AL displayed)

H112 to H118 — M1 Magnetic Saturation Extension Coefficients 6-12

The excitation current (current that creates magnetic flux in the induction motor) and magnetic flux are in a non-linear relationship to maintain the saturation characteristics. When the saturation characteristics are significant in an application that exceeds a fixed output range of 1:2, set a correction factor.

For normal use, do not change.

(These become function codes that expand the characteristics of P15 to P19.)

Only valid when vector control with speed sensor (induction motor) is selected. Only applies to the M1 motor. The M2 and M3 motors do not have a function code that is equivalent to this function code.

H	1	1	2	M	1	–	S	A	T	6			
H	1	1	3	M	1	–	S	A	T	7			
H	1	1	4	M	1	–	S	A	T	8			
H	1	1	5	M	1	–	S	A	T	9			
H	1	1	6	M	1	–	S	A	T	1	0		
H	1	1	7	M	1	–	S	A	T	1	1		
H	1	1	8	M	1	–	S	A	T	1	2		

Setting: 0.0 to 100.0%

H134 — Speed Drop Detection Delay Timer

Adds speed drop detection signal and speed setting detection signal conditions to the ON/OFF conditions of the break release signal (***BRK***). For details on ***BRK***, refer to the explanation of 18: brake release signal (***BRK***) in function codes E01 - E13 (X terminal function).

Function code H134 sets the time interval from the point that the inverter is running until the speed drop detection function starts operating.

H	1	3	4	D	E	L	A	Y		T	I	M	

Setting range: 0.000 to 10.000 s

H135	Speed Command Detection Level (forward)
H136	**Speed Command Detection Level (reverse)**

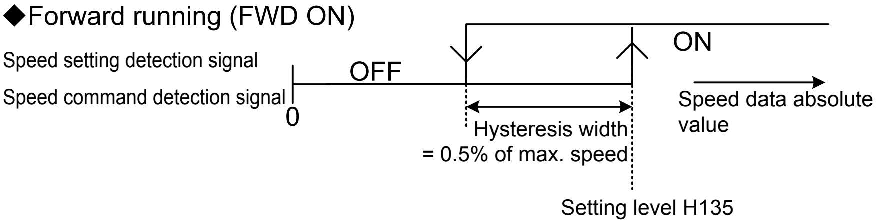
When speed setting 2 (before acceleration/deceleration calculation) rises higher than this setting, the speed setting detection signal turns ON. This is included in the brake release signal ON (brake release) conditions.

When speed setting 2 (before acceleration/deceleration calculation) or speed setting 3 (after acceleration/deceleration calculation) drops lower than this setting, the speed setting detection signal turns OFF. This is included in the brake release signal OFF (brake on) conditions. While running by run forward command, the H135 level is valid, and while running by run reverse command, the H136 level is valid.

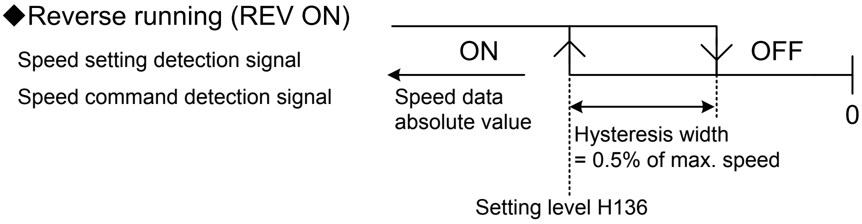
H	1	3	5	N	R	E	F		L	E	V	L	F
H	1	3	6	N	R	E	F		L	E	V	L	R

Setting range: 0.0 to 150.0 r/min

◆Forward running (FWD ON)



◆Reverse running (REV ON)

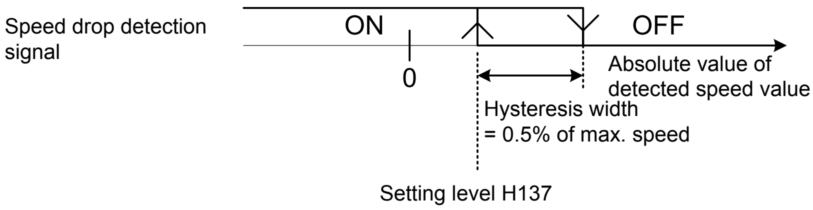


H137	Speed Drop Detection Level

When the absolute value of the detected speed value falls below this setting, the speed drop detection signal turns ON and the brake release signal turns OFF (brake on).

H	1	3	7	N	D	E	C		L	E	V	L	

Setting range: 0.0 to 150.0 r/min



H138 Speed Drop Detection Delay Timer

On delay timer for the speed drop detection signal. When the on delay timer is operating, the speed drop detection signal does not turn ON when the detected speed value is higher than H138 + 1%.

H	1	3	8	N	D	E	C		T	I	M	R	

Setting range: 0.000 to 10.000 s

H140 Start Delay Detection (Detection level)

H141 Start Delay Detection (Detection timer)

When the torque current command value is higher than the level set with this function code, and the actual speed value or estimated speed value is lower than the speed set with function code F37 "Stop speed" over the time set in function code H141, the start delay alarm (LOC) occurs.

H	1	4	0	S	R	T		D	L	Y		L	

Setting range: 0.0 to 300.0%

H	1	4	1	S	R	T		D	L	Y		T	

Setting range: 0.000 to 10.000 s

Note: Under vector control without speed sensor, whether the speed is less than the stop speed (F37) is judged by the estimated speed value. There may be deviations in alarm detection due to error in the estimated speed. The effect of estimated speed error is greater when the stop speed is low. Be aware of this when using this function code.

H142 Mock Alarm

During setup, an alarm can be simulated to check the external sequence.

<u>Setting method</u>

Press the STOP and ∧ keys simultaneously or the STOP and ∨ keys simultaneously, change to any set value, and then enter with the FUNC/DATA key. After the mock alarm occurs, the set value automatically reverts to 0 and alarm reset can be performed.

If the mock alarm has been defined as a "light alarm" in function code H108 "light alarm definition 3", light alarm (L-ALM) can be assigned to one of the function codes of the Y function selection settings (E15 to E19) to allow the mock alarm status to be output to a general purpose output (Y1 to Y5). When this is done, the alarm relay output relay (30RY) does not operate. When defined as a "heavy alarm", the mock alarm status shows "Err".

Alarm data of the mock alarm (alarm history and other information related to the alarm) is recorded in the same way as alarm data during normal operation, and you can check the data.

To erase the alarm data after you have completed setup, use H68 "delete alarm data" in the same way as when deleting alarm data of an alarm that occurred during operation.

A mock alarm also occurs if you hold down STOP and FUNC/DATA at least 3 seconds on the touch panel.

H	1	4	2	S	I	M		A	L	M			

Setting 0: No operation
1: Mock alarm occurs

H144 Toggle Data Error Timer

The error detection time for the toggle signal can be set.

Refer to the explanation of 72, 73: toggle signal 1, 2 in X function selection.

H	1	4	4	T	G	L		E	R	R		T	

Setting range: 0.01 to 20.00 (sec)

H145 Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency selection)

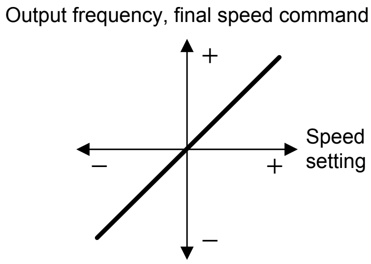
To improve speed control characteristics of ultra-low speed under vector control without speed sensor, a lower limit frequency can be set for the speed command value and estimated speed value (primary estimated frequency value).

H	1	4	5	L	–	L	I	M		S	E	L	

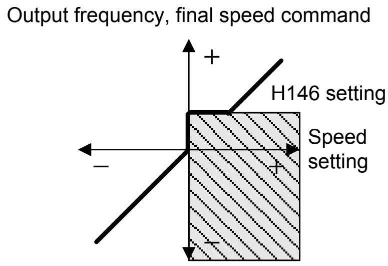
Setting range: 0 to 3

0: Disable
1: Enable for FWD polarity operation (enable in start delay during hoisting operation (FWD command, speed command+))
2: Enable for REV polarity operation (enable in start delay during lowering operation (REV command, speed command+))
3: Enable for both FWD and REV polarities (enable in start delay of both hoisting and lowering)

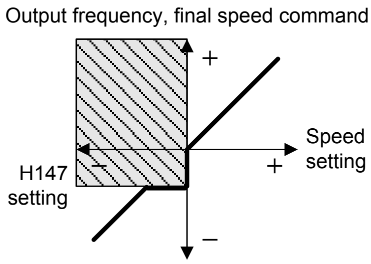
Limiting takes place in the shaded areas shown below. When the estimated speed value (primary estimated frequency value) is in a shaded area, the speed command is limited by the lower limit frequency.



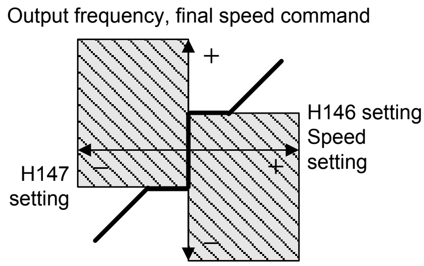
H145 = 0 (function disabled)



H145 = 1 (FWD polarity enabled)



H145 = 2 (REV polarity enabled)



H145 = 3 (FWD/REV both enabled)

⚠CAUTION

When enabling this function, set the start characteristic (H09) to 0 (no operation). When using the function with the speed setting by analog input near 0 (V), deviations in the analog voltage polarity will cause the limiting operation to become unstable. Take measures such as setting a dead zone (F82). There are restrictions on this function as noted above. Understand these restrictions before using the function.

H146 Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency, FWD)

Set the lower limit frequency when H145 = 1 is set. As a guideline, set the motor slippage frequency.

H	1	4	6	L	–	L	I	M		F	W	D	

Setting range: 0.000 to 10.000 Hz

H147 Reverse Run Prevention for Vector Control without Speed Sensor (Lower limit frequency, REV)

Set the lower limit frequency when H145 = 2 is set. As a guideline, set the motor slippage frequency.

H	1	4	7	L	–	L	I	M		R	E	V	

Setting range: 0.000 to 10.000 Hz

H148 Estimated Primary Frequency Filter

Set the primary delay filter time constant for the estimated speed value (primary estimated frequency value). Use for speed changes under vector control without speed sensor.

H	1	4	8	P	R	I	–	F		F	I	L	

Setting range: 0 to 100 ms

H149 Machine Runaway Detection Speed Setting

This function is valid only when the ***BRK*** (Brake release signal) is assigned to a Y terminal.

If the deviation of the actual speed from the speed command (Speed setting 4: ASR input) exceeds the value specified by H149 when the inverter is running and after the brake release signal is turned ON, then the inverter regards it as a machine runaway and outputs a speed mismatch alarm (Er-9).

No delay timer is provided for detection, so the inverter immediately causes an alarm.

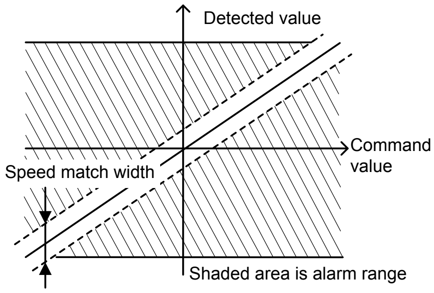
If a false detection is made due to a speed deviation immediately following brake releasing, increase the H149 data.

The data 100% represents the maximum speed.

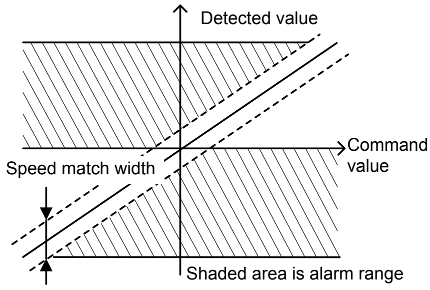
The detection conditions are different between this alarm and the speed disagreement alarm (E43 to E45). The speed disagreement alarm does not occur when the polarity of the speed command (Speed setting 4: ASR input) and that of the actual speed match with each other and the actual speed is less than the speed command. See the graphs given below.

H	1	4	9	M	–	S	P	D					

Setting 0.0: Disable
0.1 to 20.0%



Speed mismatch alarm conditions
(machine runaway detection)



Speed disagreement alarm conditions (by E43 - E4)

Note: The operation of the speed mismatch alarm is defined by the function code E45 operation definition.

H160	M1 Initial Magnetic Pole Position Detection Mode
H170	M2 Initial Magnetic Pole Position Detection Mode
H180	M3 Initial Magnetic Pole Position Detection Mode

Function codes for the synchronous motor. These set the initial magnetic pole position detection method.

H	1	6	0	M	1	–	S	M		I	N	I	
H	1	7	0	M	2	–	S	M		I	N	I	
H	1	8	0	M	3	–	S	M		I	N	I	

Setting 0: Pull-in by current for IPMSM (Interior Permanent Magnet Synchronous Motor)

Related function codes

Pull-in by current: Pull-in current command (H161, H171, and H181)
Pull-in frequency (H162, H172, and H182)

For the operating procedure of pull-in by current, refer to Chapter 3, Section 3.5.4.2 "Test run procedure for permanent magnet synchronous motor (PMSM)."

H161	M1 Pull-in Current Command
H171	M2 Pull-in Current Command
H181	M3 Pull-in Current Command

Current command value for magnetic pole position detection. Normally there is no need to change the factory default value.

H	1	6	1	M	1	–	D	R	A	W		I	
H	1	7	1	M	2	–	P	R	A	W		I	
H	1	8	1	M	3	–	P	R	A	W		I	

Setting: 10 to 200% (100% / motor rated current)

H162	M1 Pull-in Frequency
H172	M2 Pull-in Frequency
H182	M3 Pull-in Frequency

Frequency command value for magnetic pole position detection. Normally there is no need to change the factory default value.

H	1	6	2	M	1	–	D	R	A	W		F	
H	1	7	2	M	2	–	D	R	A	W		F	
H	1	8	2	M	3	–	P	R	A	W		F	

Setting: 0.1 to 10.0 Hz

H201 to H213	Load Adaptive Control Parameter Settings 1 (Available soon)

Parameters used for load compensation control.

For details, refer to the explanation of functions H60 to H66.

H	2	0	1	L	D		A	D	P		S	W	

Settings 0: H51, H64, H65 enabled, H202-H213 disabled
1: H51, H64, H65 enabled, H202-H213 disabled

Set the inertia for M1 motor axis conversion not including the applied load.

For multi-winding systems, or for synchronous driving of a load with multiple motors, divide the total inertia by the number of windings or the number of motors and set the resulting value. For example, for a two-winding motor, set 1/2 the value of the total inertia.

Using H228 can switch the magnification of the load inertia setting.

H202, H205: Load inertia (hoisting 1, 2); H208, H211: Load inertia (lowering 1, 2)

H	2	0	2	L	D	–	J		U	P	1		
H	2	0	5	L	D	–	J		U	P	2		
H	2	0	8	L	D	–	J		U	P	1		
H	2	1	1	L	D	–	J		U	P	2		

Setting: 0.001 to 50.000 kg•m^2

H203, H206: Safety coefficient (hoisting 1, 2); H209, H212: Safety coefficient (lowering 1, 2)

H	2	0	3	S	A	F	E		U	P	1		
H	2	0	6	S	A	F	E		U	P	2		
H	2	0	9	S	A	F	E		D	N	1		
H	2	1	2	S	A	F	E		D	N	2		

Setting: 0.5 to 1.20

H204, H207: Machine efficiency (hoisting 1, 2); H210, H213: Machine efficiency (lowering 1, 2)

Set the total efficiency of the machine.

H	2	0	4	M	–	E	F		U	P	1		
H	2	0	7	M	–	E	F		U	P	2		
H	2	1	0	M	–	E	F		D	N	1		
H	2	1	3	M	–	E	F		D	N	2		

Setting: 0.500 to 1.000

H214 to H227	Load Adaptive Control Parameter Settings 2 (Available soon)

H214 = 1 enables the multi restriction speed pattern function. For the relation to the H201 - H213 load compensation control function, refer to the explanation of functions H60 - H66.

Set the torque level of each limit speed point as indicated below.

H215 - H224: Multi limit speed pattern (*)

* H215: Maximum speed, H216: Rated speed, H217: Rated speed × 1.1, H218: Rated speed × 1.2
H219: Rated speed × 1.4, H220: Rated speed × 1.6, H221: Rated speed × 1.8, H222: Rated speed × 2.0
H223: Rated speed × 2.5, H224: Rated speed × 3.0

H	2	1	5	M	U	L	−	N	M	A	X		
H	2	1	6	M	U	L	−	N	R	A	T		
H	2	1	7	M	U	L	−	L	1	.	1		
H	2	1	8	M	U	L	−	L	1	.	2		
H	2	1	9	M	U	L	−	L	1	.	4		
H	2	2	0	M	U	L	−	L	1	.	6		
H	2	2	1	M	U	L	−	L	1	.	8		
H	2	2	2	M	U	L	−	L	2	.	0		
H	2	2	3	M	U	L	−	L	2	.	5		
H	2	2	4	M	U	L	−	L	3	.	0		

Setting: 0.1 to 100.0%

<Setting notes>

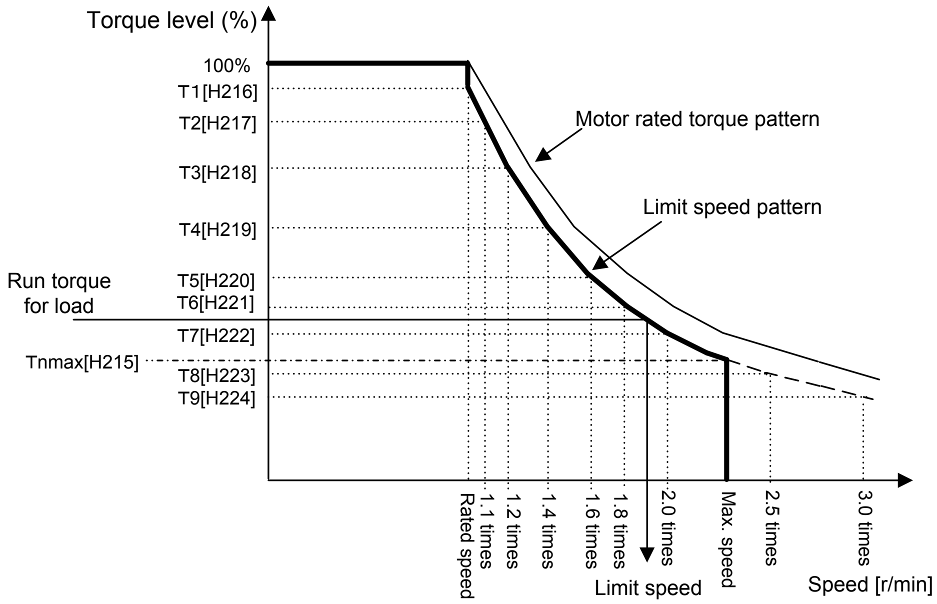
A torque level setting for a limit speed point that exceeds the maximum speed will be invalid.

The settings for T1 to T9 should increase in order from T1 (T1 < T2 < ...T9).

Set the torque level Tnmax for the maximum speed to a smaller value than the torque levels set for the limit speed points less than the maximum speed.

The multi limit speed pattern (bold line below) is limited to within the rated motor torque pattern (fine line below).

<Limit pattern graph>

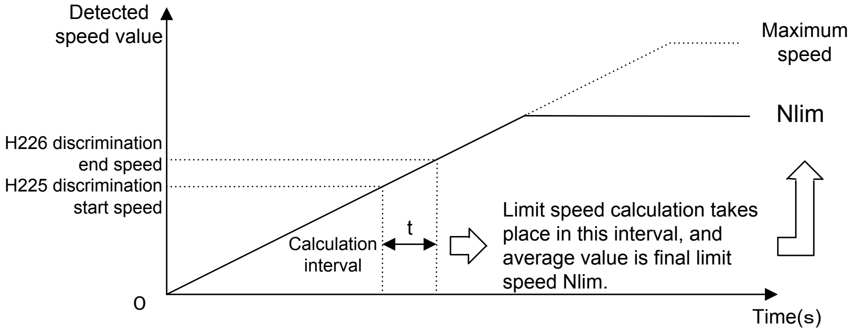


H225: Limit speed discrimination interval (start speed), H226: Limit speed discrimination interval (end speed)

The limit speed is calculated within the discrimination speed interval. Set with the rated speed 100%.

H	2	2	5	L	I	M	—	N		S	R	T	
H	2	2	6	L	I	M	—	N		E	N	T	

Setting: 0.1 to 100.0%



Within the calculation interval, the limit speed is calculated from the torque command that occurs and the instantaneous value of the acceleration data. When the speed reaches the limit completion speed, the average value of the calculated results is used as the final limit speed.

Example: When rated speed F04 = 1500 r/min, H225 = 75.0%, H226 = 93.7%, acceleration time F07 = 5 s, maximum speed F03 = 3000 r/min,

- Discrimination start speed = 1125.0 r/min (1500×0.75)
- Discrimination end speed = 1405.5 r/min (1500×0.937)
- Calculation interval t = (1405.5 - 1125)/3000 × 5 s = 0.935 s

* In this example, operation takes place according to the speed command value. If a torque restriction is triggered or the detected speed value does not accord with the speed command, the time t will be different.

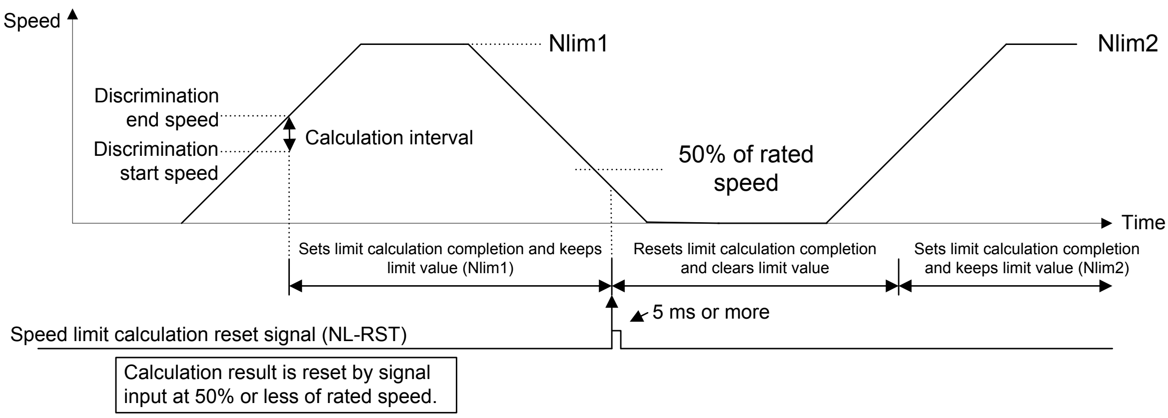
- When the discrimination start speed is greater than the discrimination end speed (H225 > H226), load compensation calculation is performed when the speed set for the discrimination end speed is reached.
- When the discrimination interval is short or the torque command value varies widely, deviations occur in the calculation results.
- When there are wide variations in the torque command value, adjust the speed control factor (ASR) to decrease the variations in the torque command value.

When a speed limit calculation reset signal (***NL-RST***) is assigned to the digital input signal and turned ON, the load compensation calculation result is cleared and the limit speed is recalculated the next time reacceleration occurs in the same direction.

Calculation result clear conditions

The speed command value has dropped to under 50% of the rated speed.

Input the speed limit calculation reset signal (***NL-RST***) 5 ms or more.



Each time the polarity of the speed command value changes (hoisting ⇔ lowering), the limit speed is calculated when acceleration takes place, regardless of the speed limit calculation reset signal (NL-RST).

H227: Load compensation control definition 3

H	2	2	7	L	O	A	D		C	O	N	3	

Setting value 0: Separate limit speed calculation for hoisting and lowering

1: A limit speed is calculated when hoisting. When lowering, the speed is limited by the result of the previous hoisting calculation.

However, when one of the following conditions obtains, limit speed calculation also takes place when lowering.

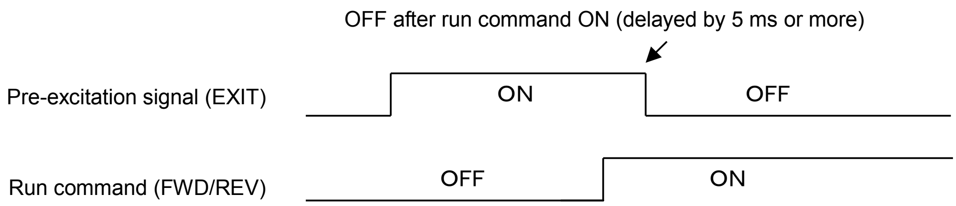
1) The first operation after powering on is lowering.
2) A limit speed was not calculated for the previous hoisting operation.
   ⇒ The previous hoisting took place at a speed under the H226 limit speed discrimination interval (end speed)
3) Lowering was performed after pre-excitation was stopped (Note 1)

2: A limit speed is calculated when hoisting. When lowering, the speed is limited by the result of the previous hoisting calculation.

However, when one of the following condition obtains, the lowering speed is limited by the rated speed.

1) The initial operation after powering on is lowering.
2) A limit speed was not calculated for the previous hoisting operation.
   ⇒ The previous hoisting took place at a speed under the H226 limit speed discrimination interval (end speed)
3) Lowering was performed after pre-excitation was stopped (Note 1)

Note 1: If the pre-excitation signal is turned OFF first when switching from pre-excitation operation to speed control operation (FWD/REV ON), condition (3) will obtain and the previous hoisting limit speed will be cleared. Use a sequence in which the pre-excitation signal is turned off after the run command is input, as shown below.



H228 Load Inertia Magnification Setting

H228 switches the magnification of "Load inertia" settings (H51, H52, H127, H202, H205, H208 and H211) and that of "Load adaptive control, Rated load" setting (H66).

H	2	2	8	I	N	R	T		1	0			

Setting: 0 x 1 (0.001 to 50.000 kg•m^2)
1 x 10 (0.01 to 500.00 kg• m^2)
2 x 100 (0.1 to 5,000.0 kg• m^2)

H322, H325	**Notch Filters 1 and 2 (Resonance frequency)**
H323, H326	**Notch Filters 1 and 2 (Attenuation level)**
H324, H327	**Notch Filters 1 and 2 (Frequency range)**

Set this to dampen resonance in the mechanical system. A maximum of 2 resonance points can be dampened.

The notch filter functions take effect only when motor M1 is selected. (No effect for M2 or M3.)

H	3	2	2	N	F	1	–	F	R	Q			
H	3	2	5	N	F	2	–	F	R	Q			

Setting: 10 to 2,000 Hz

The notch filter frequency is limited internally based on the setting of F26 "carrier frequency". Carrier frequencies and corresponding notch filter setting ranges are shown below. If the setting exceeds the upper limit, the upper limit is applied.

2 kHz, 5 kHz, 10 kHz, 11 kHz : 10 to 2000 Hz
4 kHz, 7 kHz, 8 kHz, 9 kHz, 15 kHz : 10 to 1500 Hz
3 kHz, 6 kHz, 12 kHz, 13 kHz, 14 kHz : 10 to 1000 Hz

H	3	2	3	N	F	1	–	A	T	T			
H	3	2	6	N	F	2	–	A	T	T			

Setting: 0 to 40 dB (Setting "0" disables the notch filter function.)

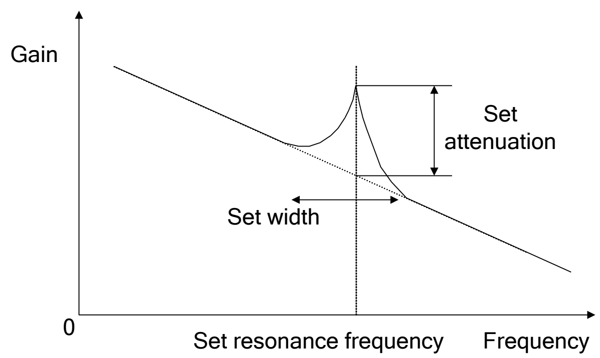
H	3	2	4	N	F	1	–	W	I	D			
H	3	2	7	N	F	2	–	W	I	D			

Setting: 0 to 3

<u>Setting method</u>

Set a notch filter frequency, attenuation, and width appropriate for the resonance point in the machine.

Four increments are available for the width setting. A larger setting allows a wider frequency band to be covered. Normally a setting of "2" is recommended.



Machine resonance point

⚠CAUTION

- Setting an attenuation that is too large may cause unstable control. Do not set higher than necessary.

Chap. 4 CONTROL AND OPERATION

4.3.6 A codes (Alternative Motor Functions)

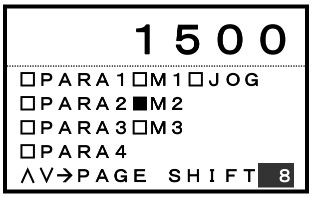
A codes are motor parameters that become available when motor M2 or M3 is selected. These codes are used when a single FRENIC-VG drives two or three motors while switching them.

Any of M1 to M3 can select vector control or V/f control.

A01 to A61	**M2 Drive Control**
A101 to A161	**M3 Drive Control**

To select M2 or M3, use F79 (Motor Selection) and terminal input signals ***M-CH2*** and ***M-CH3***.

See the individual descriptions and check in Menu #4 "I/O checking" that M2 or M3 is selected. ■ indicates "selected". Check that ■M2 or ■M3 is indicated.



A01 to A61 for M2 are functionally equivalent to A101 to A161 for M3 except that codes differ by one hundred. Those codes are functionally equivalent to P codes (M1).

There are no P02-equivalent code for M2 and M3, so M2 and M3 motor parameters cannot be set automatically. For FRENIC-VG dedicated motors or VG series conventional motors, this manual provides motor parameters. Set them manually. For other motors, perform auto-tuning.

Auto-tuning initiated by H01 applies to the currently selected motor.

Function codes to be configured for IM under vector control

The table below lists the function codes to be configured for IM when vector control is selected. Configure them sequentially from the top of the table. (For details, refer to P02 (M1 Motor Selection).

Function codes			
M1	M2	M3	Name
P01	A01	A101	Drive control
P02	-	-	Motor selection
F04	A05	A105	Rated speed
F05	A04	A104	Rated voltage
P03	A02	A102	Rated capacity
P04	A03	A103	Rated current
P05	A07	A107	No. of poles
P06	A08	A108	%R1
P07	A09	A109	%X
P08	A10	A110	Magnetic flux weakening current
P09	A11	A111	Torque current
P10, P11	A12, A13	A112, 113	Slip frequency of motor for driving and braking
P12-P14	A14-A16	A114-A116	Iron loss factors 1-3
P15-P19	A17-A21	A117-A121	Magnetic saturation factors 1-5
P20	A22	A122	Secondary time constant
P21	A23	A123	Induced voltage factor
P22-P24	A24-A26	A124-A126	R2 correction factors 1-3
P25	A27	A127	Exciting current correction factor
P26, P27	A28, A29	A128, A129	ACR P-gain, Integral constant
P28	A30	A130	Pulse resolution
P30	A31	A131	Thermistor selection
F10	A32	A132	Electronic thermal overload protection (Select motor characteristics)
H01	H01	H01	Auto-tuning

Note 1: FRENIC-VG dedicated motors are the same as the VG7 or VG5 standard motors in shape and electrical constants (motor parameters).

Function codes to be configured for PMSM under vector control

The table below lists the function codes to be configured for PMSM when vector control is selected. Configure them sequentially from the top of the table.

Function codes			
M1	M2	M3	Name
P01	A01	A101	Drive control
P03	A02	A102	Rated capacity
P04	A03	A103	Rated current
F05	A04	A104	Rated voltage
F04	A05	A105	Rated speed
F03	A06	A106	Maximum speed
P05	A07	A107	No. of poles
P06	A08	A108	%R1
P07	A09	A109	%X
P08	A10	A110	d-axis current
P09	A11	A111	q-axis current
P21	A23	A123	Induced voltage factor
P26, P27	A28, A29	A128, A129	ACR P-gain, Integral constant
P28	A30	A130	Pulse resolution
P30	A31	A131	Thermistor selection
F10	A32	A132	Electronic thermal overload protection (Select motor characteristics)
P33	A53	A153	Maximum voltage Limit
o09	A59	A159	Absolute signal input definition
o10	A60	A160	Magnetic pole position offset
o11	A61	A161	Salient pole rate (%Xq/%Xd)
P42	A62	A162	q-axis induction magnetic saturation coefficient
P43	A63	A163	Magnetic flux limiting value
P44	A64	A164	Overcurrent protection level
P45-P51	A65-A71	A165-A171	Torque correction gain 1 to 7

Function codes to be configured for IM under V/f control

The table below lists the function codes to be configured for IM when V/f control is selected. Configure them sequentially from the top of the table.

			Function codes
M1	M2	M3	Name
P01	A01	A101	Drive control
P03	A02	A102	Rated capacity
P04	A03	A103	Rated current
F03	A04	A104	Maximum speed
F04	A05	A105	Rated speed
F05	A06	A106	Rated voltage
P05	A07	A107	No. of poles
P06	A08	A108	%R1
P07	A09	A109	%X
P08	A10	A110	Magnetic flux weakening current
P33	A53	A153	Maximum voltage Limit
P34	A54	A154	Slip compensation
P35	A55	A155	Torque boost
P30	A31	A131	Thermistor selection
F10	A32	A132	Electronic thermal overload protection (Select motor characteristics)
	H01		Auto-tuning
	H02		Save all function

4.3.7 o codes (Option Functions)

OPC-VG1-DIA, DIB

Use this option to specify the digital speed command, torque limiter value, torque command, and torque current command. 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 command, torque limiter value, torque command, and torque current command.

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 command.
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 command selection" to use for the torque command.
4) See the function description of the function code H42 "Torque current command selection" to use for the torque current command.

Set value: 0 or 1
0: Binary
1: BCD

o03	DIA BCD Input Speed Setting
o04	DIB BCD Input Speed 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	N	D		A
o	0	4	B	C	D		C	M	N	D		B

Data setting range: 99 to 7,999

OPC-VG1-PG/PGo

Use this option for the following applications.

1) Place the switch in the PD position to use position control (orientation) through pulse calculation.
2) Set the switch to LD to detect the line speed.
3) Place the switch in the PR position to use the pulse train synchronous operation.
4) Place the switch in the SD position to use for speed detection.

⚠CAUTION

The model of the PG interface option varies according to the difference in the electric specification.

OPC-VG1-PG: 5V line driver
OPC-VG1-PGo: Open collector, voltage output

o05 — PG (PD) Option Setting (Feedback pulse)

Switches the source of the position detection signal between the integrated PG and the optional PG interface card. Use for synchronous operation and the position control for orientation.

o	0	5	P	L	S		F	E	D		S	L

Data setting range: 0 (Integrated PG (15, 12V complementary output))
(PG interface card OPC-VG1-PMPG for PMSM drive)
1 (PG interface card OPC-VG1-PG (PD) (5V line driver output))
2 (High-resolution serial PG interface card OPC-VG1-SPGT) (Available soon)

When function code P01, A01, A101 (M1/M2/M3 Drive Control) = 3 (Vector control of PMSM) and the PG interface card OPC-VG1-PMPG for PMSM drive is mounted, setting o05 at "0" enables signals to the OPC-VG1-PMPG.

o06 — PG (PD) Option Setting (Digital line speed detection definition, PG pulses)

o07 — PG (PD) Option Setting (Digital line speed detection definition, Detection pulse correction 1)

o08 — PG (PD) Option Setting (Digital line speed detection definition, Detection 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	L	S		C	P	1
o	0	8	L	S	–	P	L	S		C	P	2

Data setting range: o06 = 100 to 60,000 (P/R)
o07, o08 = 1 to 9,999

o09	M1 Absolute Signal Input Definition
A59	M2 ABS Signal Input Definition
A159	M3 ABS Signal Input Definition

These function codes are exclusive to PMSM. They select the interface system of encoder ABS signals.

	o	0	9	M	1	−	A	B	S		D	E	F
	A	5	9	M	2	−	A	B	S		D	E	F
A	1	5	9	M	3	−	A	B	S		D	E	F

Data setting range: 0 (1 bit (terminal: F0). Z-phase interface)
1 (3 bits (terminals: F0, F1 and F2). U-/V-/W-phase interface)
2 (4 bits (terminals: F0, F1, F2 and F3). Gray code interface)
3 to 5 (Not used.)
6 (SPGT 17-bit serial interface)
7 to 16 (Not used.)

o10	M1 Magnetic Pole Position Offset
A60	M2 Magnetic Pole Position Offset
A160	M3 Magnetic Pole Position Offset

These function codes are exclusive to PMSM. They define an offset value relative to the encoder reference position and actual motor magnetic pole position.

	o	1	0	M	1	−	S	M		O	F	S	
	A	6	0	M	2	−	S	M		O	F	S	
A	1	6	0	M	3	−	S	M		O	F	S	

Data setting range: 0.0 to 359.9 CCW

Enter the offset value printed on the corresponding motor test report or adjust the magnetic pole position according to the adjustment procedure.

o11	M1 Salient Pole Rate (%Xq/%Xd)
A61	M2 Salient Pole Ratio (%Xq/%Xd)
A161	M3 Salient Pole Ratio (%Xq/%Xd)

These function codes are exclusive to PMSM. They specify 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	M	1	−	X	q	／	X	d		
	A	6	1	M	2	−	X	q	／	X	d		
A	1	6	1	M	3	−	X	q	／	X	d		

Data setting range: 1.000 to 5.000

To drive an SPM motor, set 1,000.

It is necessary to calculate the salient pole ratio from the design value of each motor. When the design value is unknown, contact your Fuji Electric representative.

o12	Command Pulse Selection

o12 selects a command pulse source.

o	1	2	P	L	S		R	E	F		S	L

Data setting range: 0 (PG (PR) option)
1 (Internal speed command)

For details, see the control block diagram given in Section 4.1.5.

o13	Pulse Train Input Form

Select the input form of the signal supplied to the PG (PR) option.

o	1	3	P	L	S		S	T	A	T	E	

Data setting range: 0 (90° phase difference between phases A and B)
1 (Phase A: Command pulse, Phase B: Command code (sign))
2 (Phase A: Forward pulse, Phase B: Reverse pulse)

This pulse configuration choice takes effect only against the pulse train command (PG (PR)).

Line speed detection (PG (LD)) with 90° phase difference only can be received.

o14	Command Pulse Correction 1
o15	Command Pulse Correction 2

Set when you install the PG (PR) option card to conduct synchronized operation. You can change the position command 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

Data setting range: 1 to 9,999

Internal data = Input pulse× (Pulse correction 1/Pulse correction 2)

o16	APR Gain 1

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

Data setting range: 0.1 to 999.9

o17 Feedforward Gain 1

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		

Data setting range: 0.0 to 1.5

o18 Overdeviation Width

The difference (deviation) between the internal position command and actual motor revolutions exceeds 10 folds of this setting, an "excessive deviation alarm (dO)" is caused, letting the motor coast to stop.

o	1	8	D	E	V		O	V	E	R		W

Data setting range: 0 to 65,535

o19 Zero Deviation Width

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

Data setting range: 0 to 1,000

o20 APR Gain 2 (Available soon)

o21 F/F Gain 2 (Available soon)

o20 and o21 are functionally equivalent to o16 (APR Gain 1) and o17 (F/F Gain 1), respectively.

o	2	0	A	P	R		G	A	I	N	2	

Data setting range: 0.1 to 999.9

o	2	1	F	/	F		G	A	I	N	2	

Data setting range: 0.0 to 1.5

o22	Position Control Gain Switching (Available soon)

o22 specifies a factor that switches between gain 1 (o16, o17) and gain 2 (o20, o21) of the APR and F/F in a position control system.

Switching the gain can reduce noise or vibration at the time of a stop under position control.

o22 GAIN SEL

Data setting range: 0 (Disable)
1 (Positional deviation (x 10))
2 (Detected speed (10,000/maximum speed))
3 (Speed command (10,000/maximum speed))

When o22 = 0 (Disable), o16 (APR Gain 1) and o17 (F/F Gain 1) take effect.

o23	Position Control Gain Switching Level (Available soon)
o24	Position Control Gain Switching Time (Available soon)

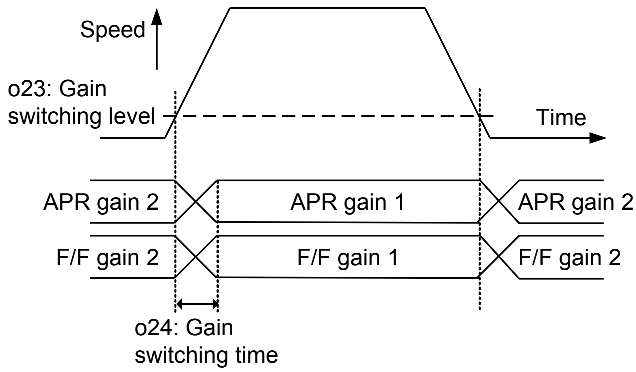
If the detected value of a factor selected by o22 drops below the switching level specified by o23, the APR and F/F gains are switched from 1 to 2 in accordance with the switching time specified by o24. The hysteresis width is 1% of the maximum speed (Setting: 10,000).

o23 SEL LVL

Data setting range: 0 to 10,000

In gain switching, the function codes are selected as follows.

	APR gain	F/F gain
Switching level or above	o16	o17
Switching level or below	o20	o21



o30	Link Option Configuration (Communications error processing)

o30 specifies error processing to be performed if a communications link error occurs.

o30 MODE ON ER

Data setting range: 0 to 3
0 (Immediately trip with Er-4.)
1 (Continue to run for the time specified by o31 and then trip with Er-4.)
2 (If a communications error has persisted for the time specified by o31, trip with Er-4.)
3 (Continue to run even if a communications error occurs. Removing the error factor automatically restores the run command transferred via the communication link.)

o31 Link Option Configuration (Timer)

If a communications link error occurs and persists during the period specified by o31, the inverter causes an alarm.

o	3	1	T	I	M	E	R		T	L		

Data setting range: 0.01 to 20.00 (s)

o32 Link Option Configuration (Link format selection)

o32 specifies the link format to be used by a link option (OPC-VG1-TL, OPC-VG1-CCL).

The setting content differs depending on options. For details, refer to Chapter 6, Section 6.4 "T-Link Interface Card" and Section 6.7 "CC-Link Interface Card."

o	3	2	F	O	R	M	A	T		S	E	L

Data setting range: 0 to 4
0 (Link format 1)
1 (Link format 2)
2 (Link format 3)
3 (Link format 4)
4 (Link format 5)

<u>OPC-VG1-TBSI</u>

Using this option can connect two or more inverters via the high-speed serial communications link, enabling multiwinding motors or motors in direct parallel connection to be driven.

o33 Multiplex System (Control mode)

o33 specifies one of the following multiplex systems.

Refer to ***MT-CCL*** (Cancel multiplex system) in the description of E01 to E13 (Terminal X Function).

o	3	3	M	W	S		A	C	T	I	V	E

Data setting range: 0 (Disable (single motor operation))
1 (Multiwinding motor control system)
2 (Multiplex system 1) (Direct parallel connection) *
3 (Multiplex system 2) (Not used.)
4 (Reserved 1)
5 (Reserved 2)

* Available in the ROM version H1/2 0020 or later.

o34 Multiplex System (No. of slave stations)

Specifies the number of slave stations for the multiplex system.

o	3	4	M	W	S		S	L	A	V	E	S

Data setting range: 1 to 5

o50	Multiplex System (Station number assignment)

o50 assigns the station number of the multiplex system (High-speed serial communications terminal block OPC-VG1-TBS1).

o	5	0	M	W	S		S	T	–	N	O	

Data setting range: 0 (Master)
1 to 5 (Slave)

4.3.8 L codes (Lift Functions)

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.

Password setting procedure

Change the current value to an arbitrary value by pressing the STOP and ∧ keys or STOP and ∨ keys simultaneously, and then press the FUNC/DATA key to establish it.

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

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.

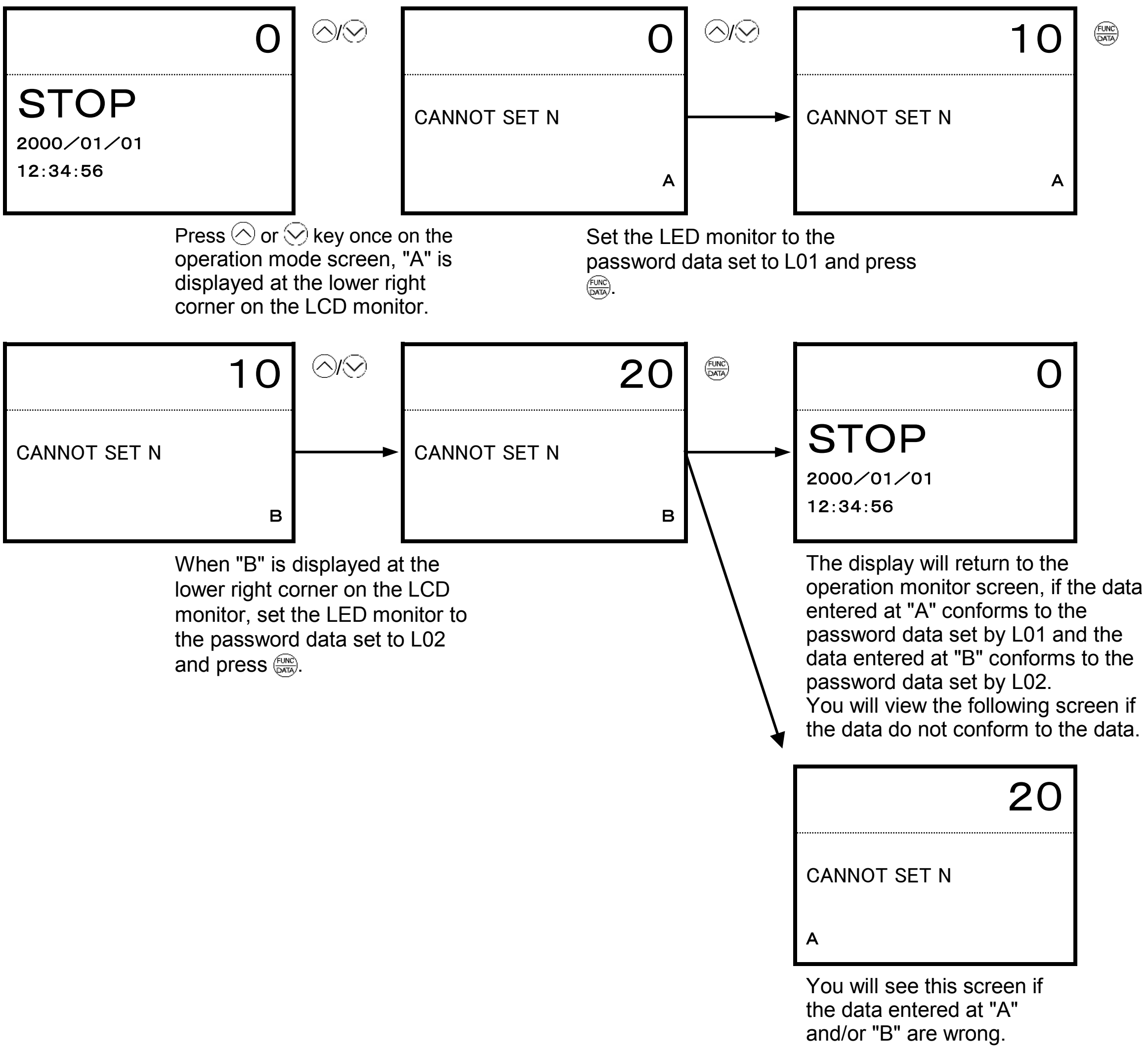
Usual program menu screen
(password is not specified or is disabled)

```
 0. LANGUAGE
 1. DATA SET
 2. DATA CHECK
 3. OPR MNTR
 4. I/O CHECK
 5. MAINTENANC
 6. LOAD FCTR
 7. ALM INF
 8. ALM CAUSE
 9. COMM INFO
10. DATA COPY
11. CHANGES
12. DATE/TIME
13. FORMER INV
14. LIMITED FC
```

Program menu screen
when password is enabled

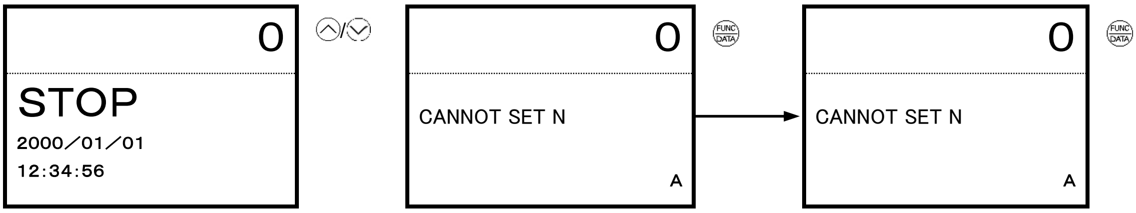
```
3. OPR MNTR
4. I/O CHECK
5. MAINTENANC
6. LOAD FCTR
7. ALM INF
8. ALM CAUSE
9. COMM INFO
```

To disable password (ex. password: L01=10, L02=20)



Note: Canceling password described above will become ineffective after you turn off the inverter

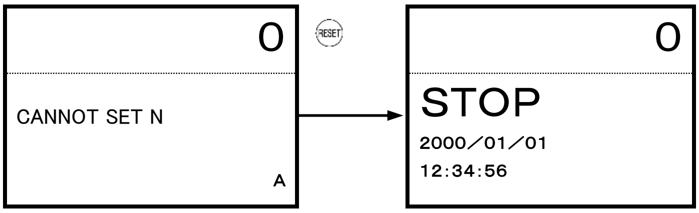
To enable password again after disabled



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 press FUNC/DATA.

Check if "0" appears on the LED monitor press FUNC/DATA.



Press RESET when "A" is displayed again at the lower right corner on the LCD monitor.

L03	Lift Rated Speed

This function code is necessary to calculate the estimated travel distance on deceleration.

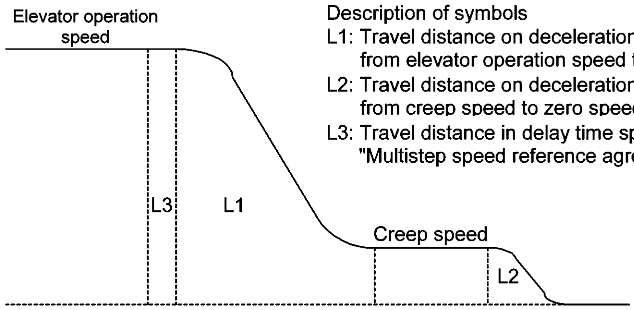
L 0 3 L I F T – B A S E

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 lift 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).



The estimated travel distance on deceleration appears on the "Option monitor 3, 4" on the LED monitor of the KEYPAD panel.

This function is effective when L04=1 or 2.
Option monitor 3: Travel distance from the operation speed 1 after deceleration operation.
Option monitor 4: 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
Lift rated speed	L03	Lift 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 Pattern

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

0: FRENIC-VG standard (VG7S-compatible) multistep speed and S-curve setting
   15 steps of multistep speed (C05 to C19)
   S-curve applied to four sections (F67 to F70)

1: Lift application compatible with VG3N and VG5N
   7 steps of multistep speed (C05 to C11)
   S-curve applied to eight sections (L05 to L12)

2: FRENIC-VG (VG7S-compatible) lift application original mode
   7 steps of multistep speed (C05 to C11)
   S-curve applied to ten sections (L05 to L14)

L05 to L14 S-curve Patterns 1 to 10

L	0	5	S	–	C	R	V		S	E	T	1

|

L	1	4	S	–	C	R	V		S	E	1	0

Setting range: 0 to 50 (%)

Introduction to an operation example in each mode

(A) FRENIC-VG standard (VG7S-compatible) multistep speed and S-curve setting

Since this operation mode uses the standard multistep speed and the S-curve, see the description of the individual function codes.

(B) Lift 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 7
ON	ON	OFF	C10	Multistep speed 6	Zero speed
ON	ON	ON	C11	Multistep speed 7	Operation speed 2

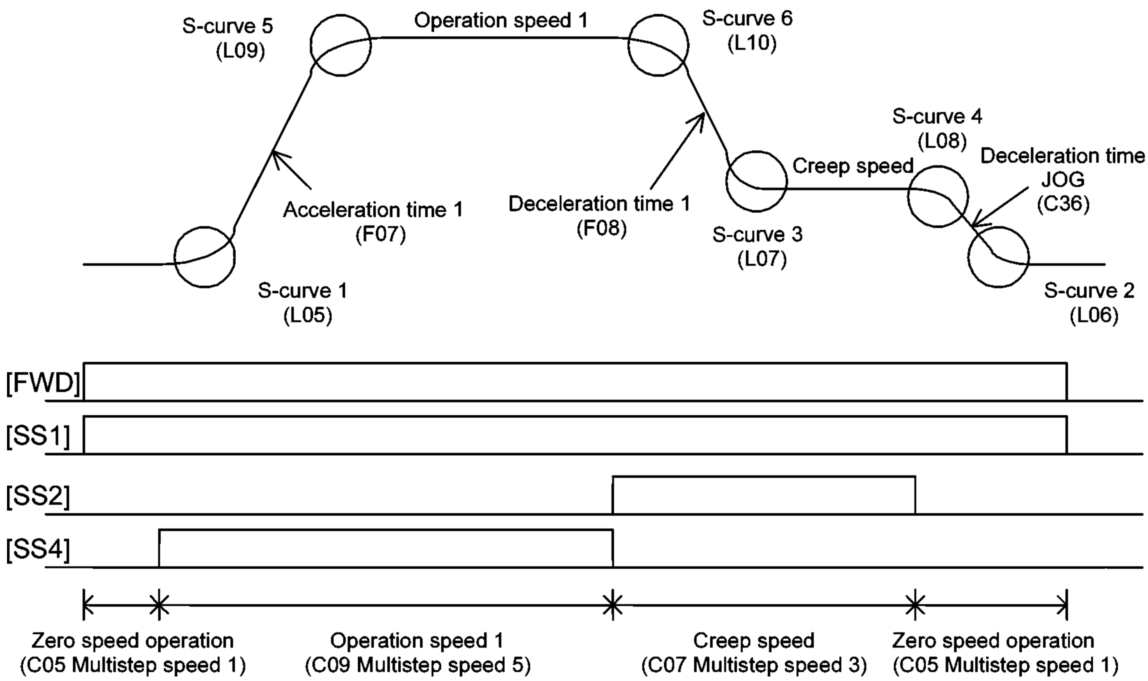
The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

Speed			Acceleration		Deceleration	
Code	Name	Description	Code	Name	Code	Name
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

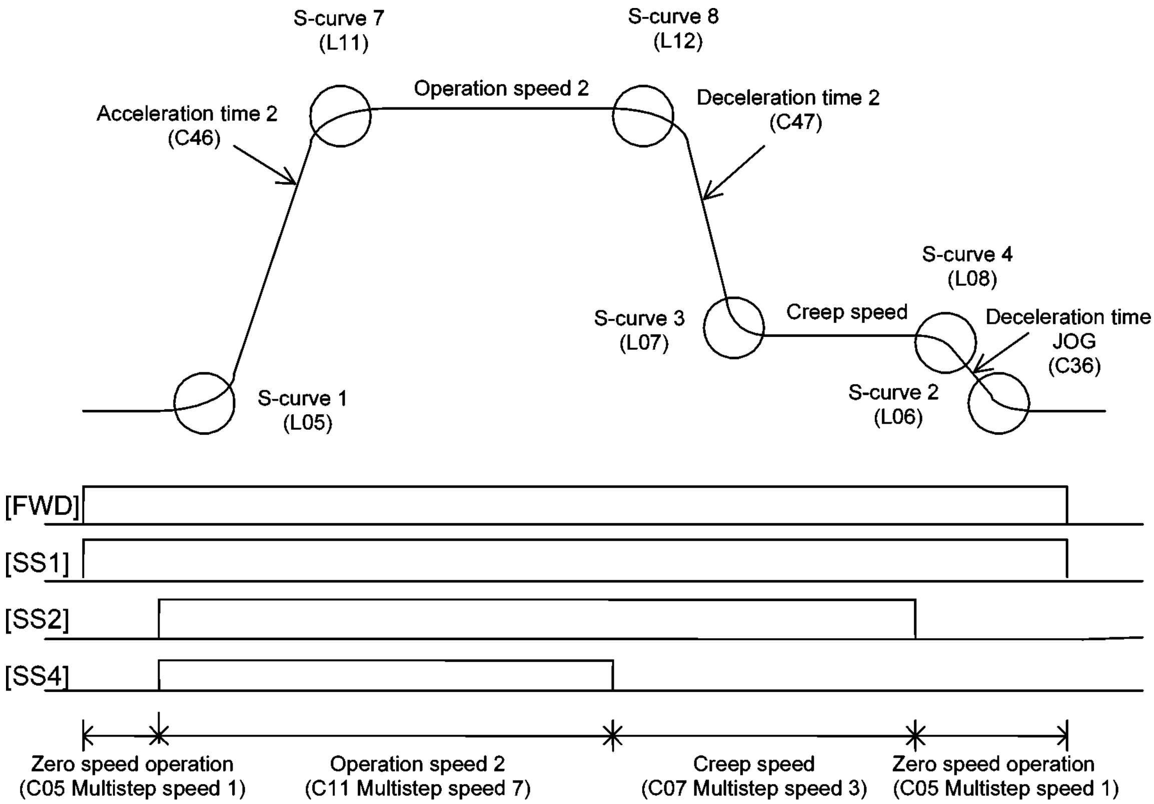
The following table shows how S-curve setting is applied to the multistep speed.

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

(1) Operation speed 1



(2) Operation speed 2



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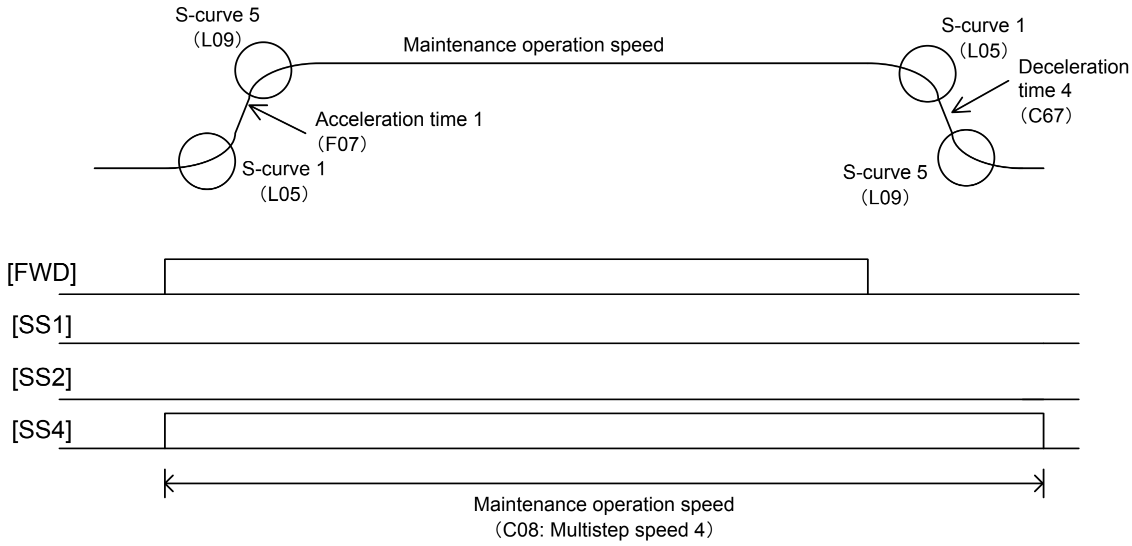
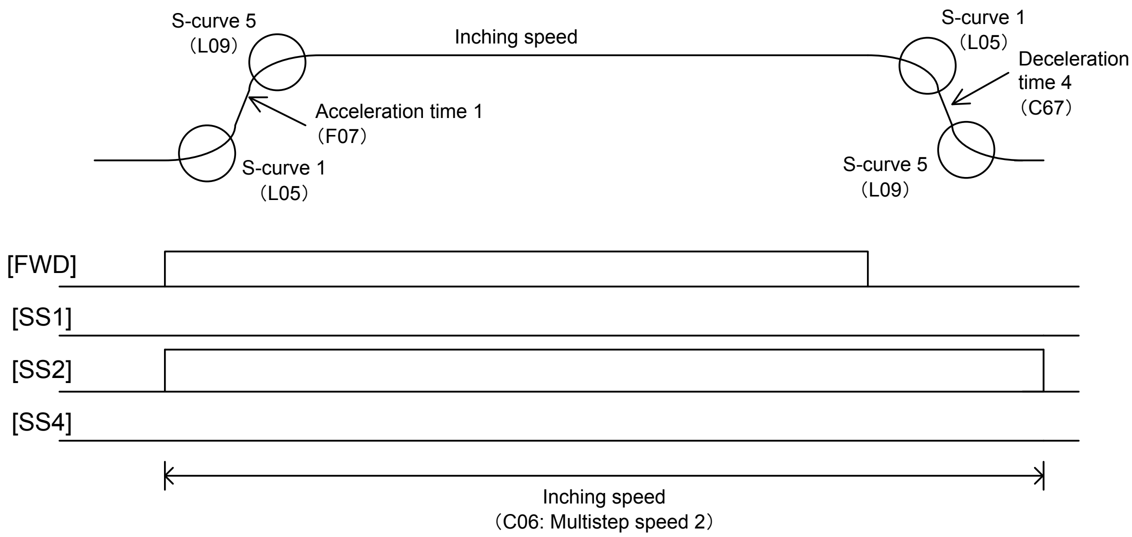
(3) Maintenance operation speed



(4) Inching speed



(C) FRENIC-VG (VG7S-compatible) lift application original 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 lift 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

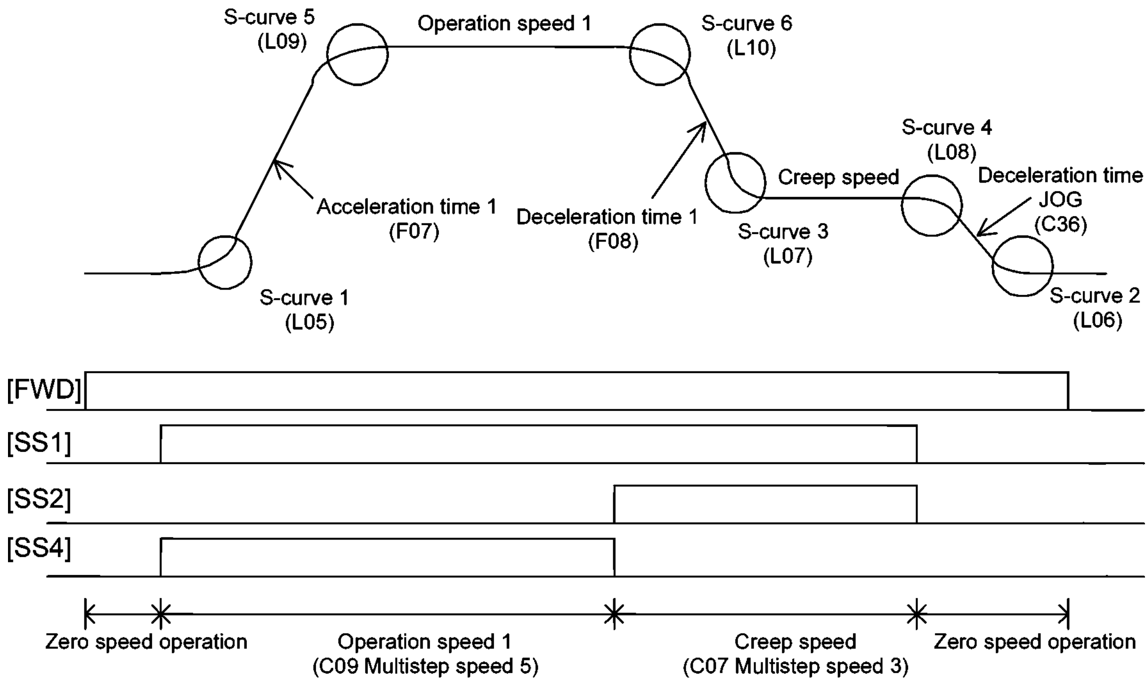
The following table shows how the acceleration/deceleration times are assigned to the multistep speed.

Speed			Acceleration		Deceleration	
Code	Name	Description	Code	Name	Code	Name
C05	Multistep speed 1	Emergency lift 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

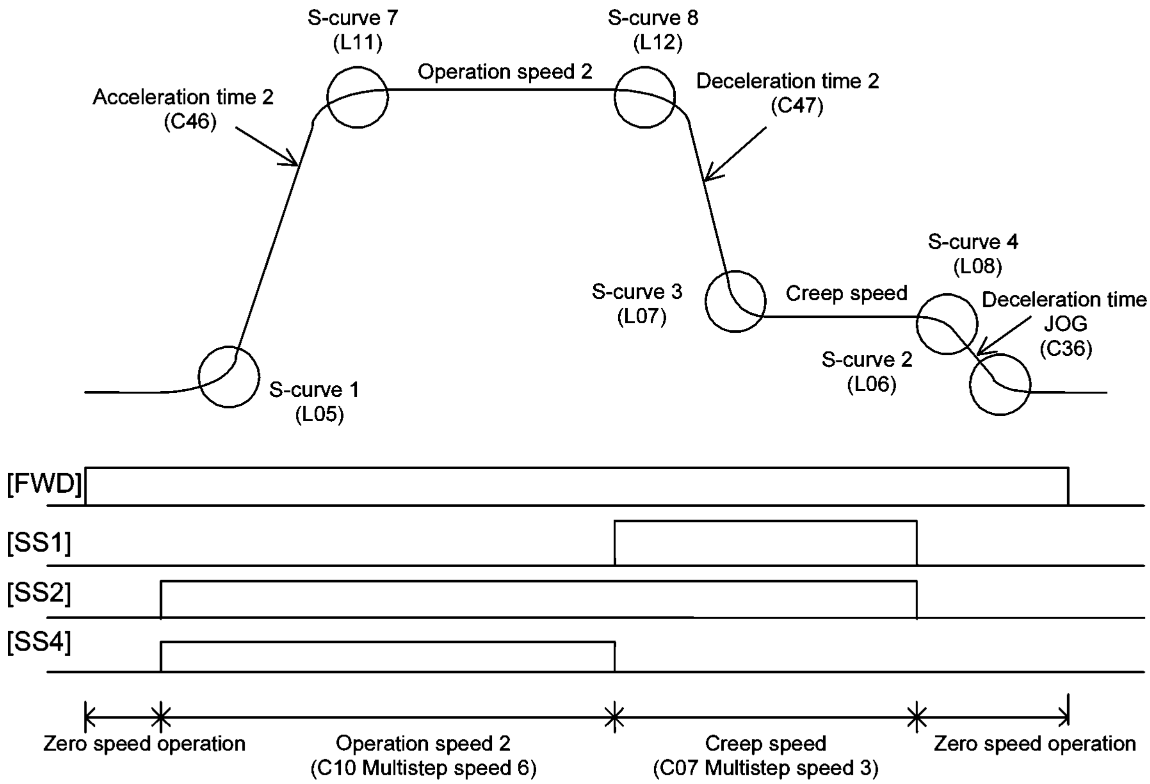
The following table shows how S-curve setting is applied to the multistep speed.

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 lift speed
L14	S-curve 10	Deceleration start side from Operation speed 3 or Emergency lift speed

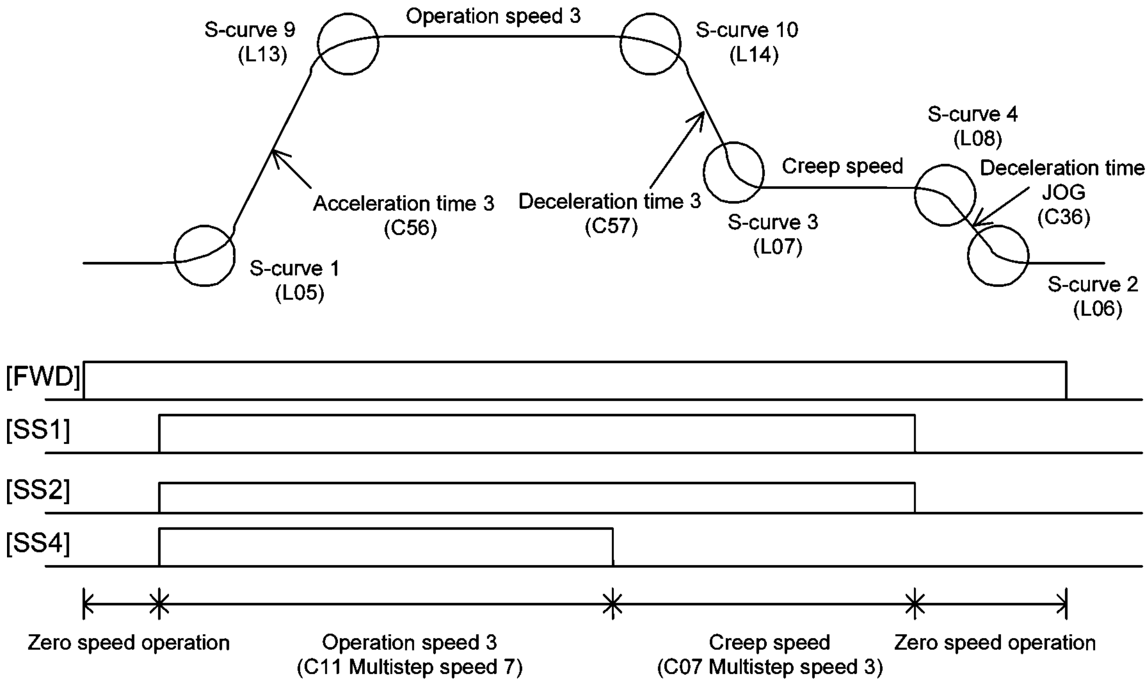
(1) Operation speed 1



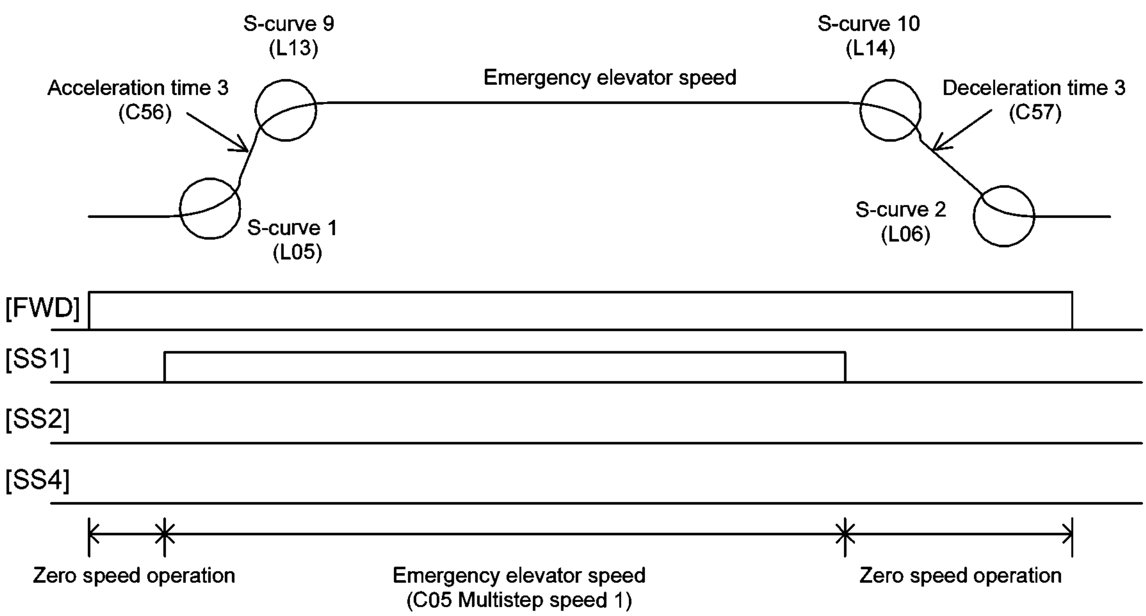
(2) Operation speed 2



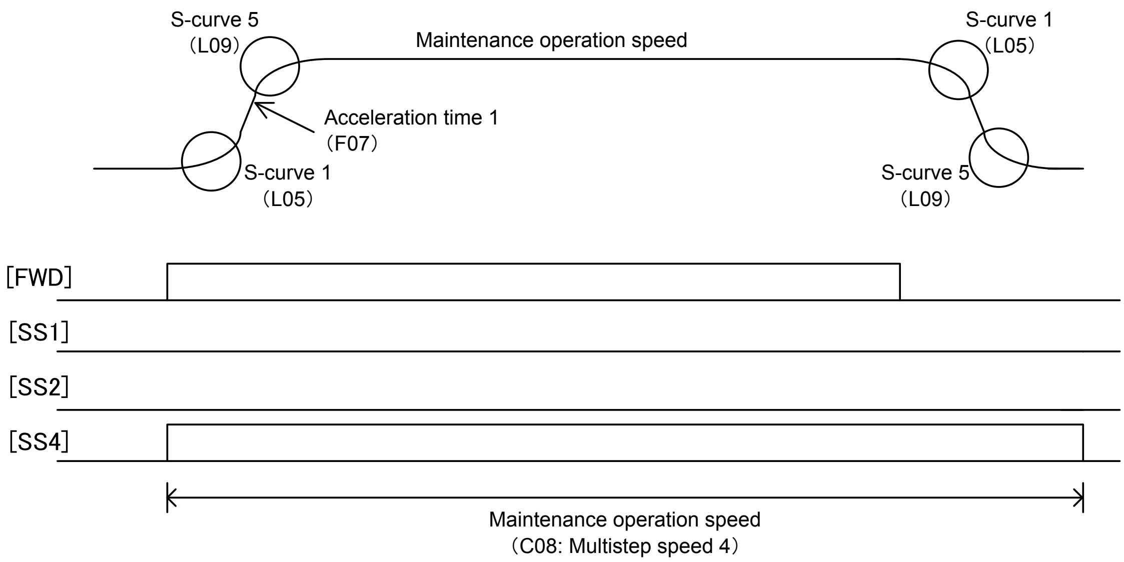
(3) Operation speed 3



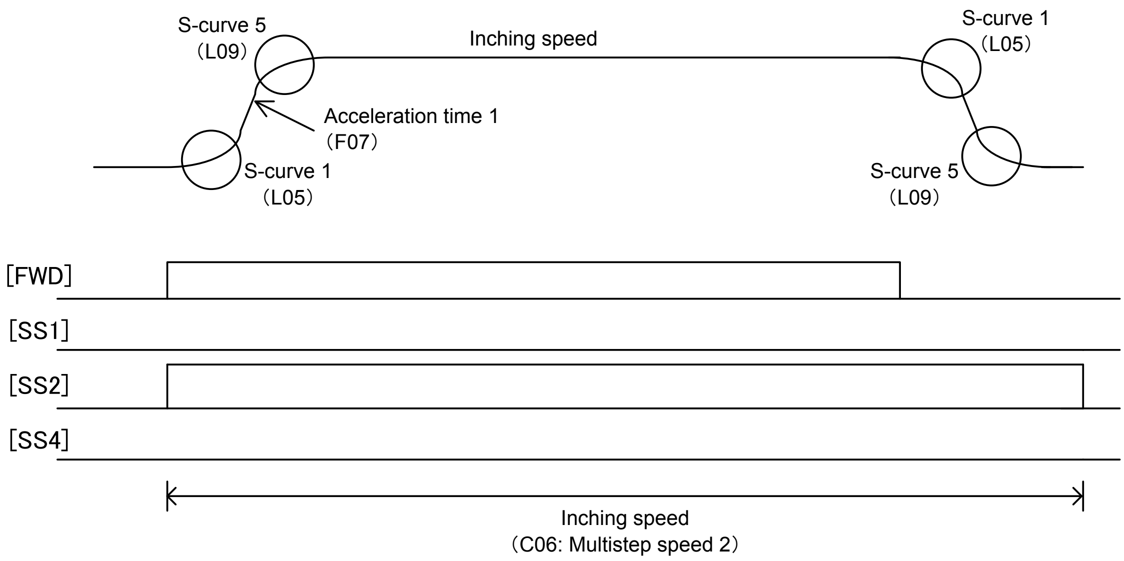
(4) Emergency lift speed



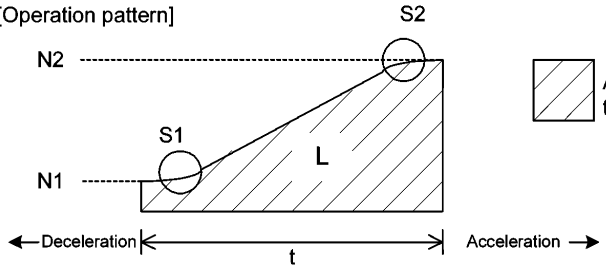
(5) Maintenance operation speed



(6) Inching speed



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

$$t = \left(\frac{N2-N1}{Nmax} + \frac{S1+S2}{100}\right) \times T$$ ………… [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

$$t = \frac{S1+S2}{50}\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}} \times T$$ ………… [Equation 3]

Travel distance

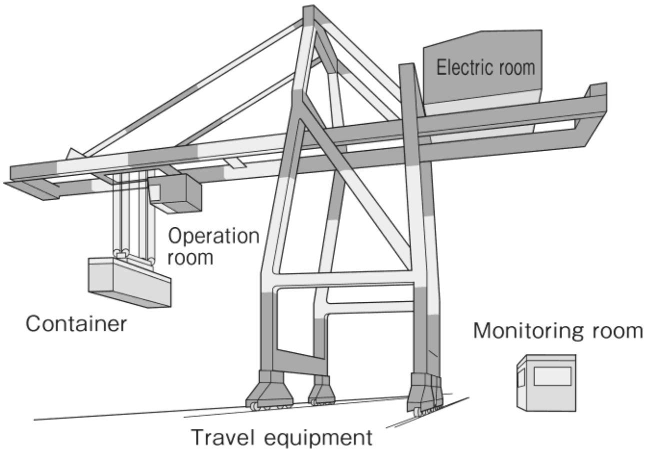
$$L = \left(\sqrt{\frac{N2-N1}{Nmax} \times \frac{100}{S1+S2}}\right)^3 \times \frac{T \times Vmax}{90} \times \frac{S1^2 + 2 \times S2^2 + 3 \times S1 \times S2}{10000} \times \frac{t \times Vmax}{60} \times \frac{N1}{Nmax}$$ ………… [Equation 4]

Chapter 7
APPLICATION EXAMPLES

This chapter gives application examples of the FRENIC-VG series of inverters.

Contents

7.1 Large Crane and Overhead Crane



High reliability

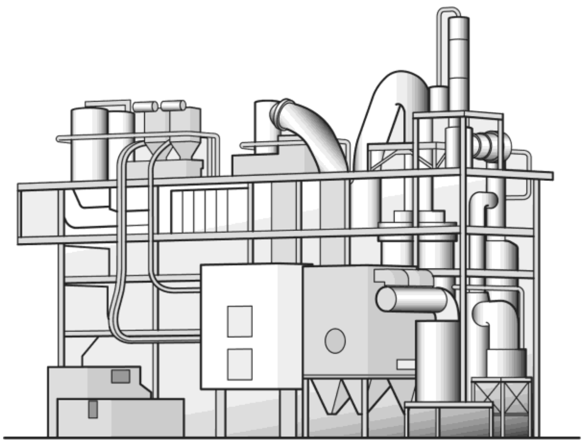
VG supports your facility with long life service and high reliability.

The trace back function allows easy fault diagnosis.

System support

The bus system is supported to allow centralized control of elevation, traverse, and trolley, as well as centralized monitoring of running conditions.

7.2 Application to Plants



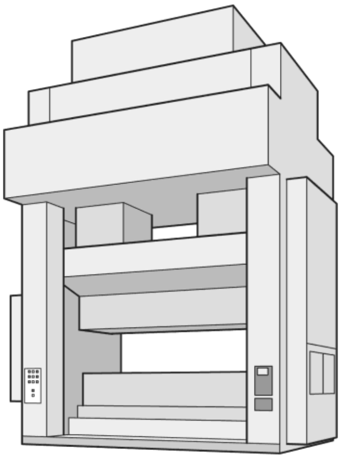
Control with high speed and high accuracy

In addition to high speed and high accuracy, VG contributes to stable facility operation with high reliability and long service life. The trace back function makes diagnosing the cause of problems easy when an abnormality arises.

System support

Centralized control and monitoring are achieved by supporting various fieldbuses.

7.3 Servo Press: Large Size for Automobiles, Small Size for Machines such as Crimping Terminal Processing Machines



Position control

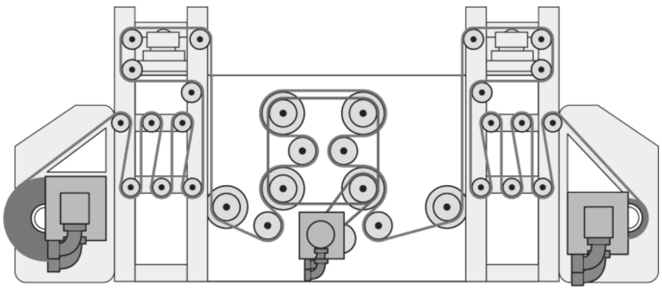
The press position is controlled based on an instantaneous position command given by the CNC of the high order.

Control with high responsibility contributes to shortening of the operation cycle.

Precision synchronization control

Large machines are driven with several motors to increase thrust. Precision synchronization control of several inverters and motors using the high-speed bus system can be applied.

7.4 Winding Equipment (Paper and Metal)



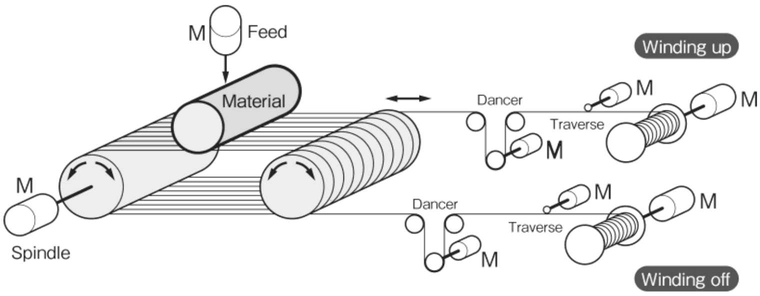
Tension control

Tension-type winding control capability with high accuracy torque control has been improved. Dancer-type winding control capability by the speed control with high speed response has been improved.

System support

The controller that calculates winding diameter achieves constant tension control.

7.5 Feeding Part of Semiconductor Manufacturing Device, Wire Saw



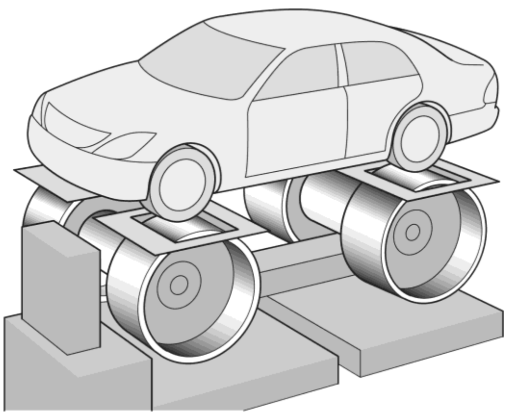
Smooth torque characteristic

The smooth drive characteristic in which torque ripple is suppressed contributes to machining quality.

System support

The system has been made simple and highly efficient by connecting and controlling the spindle that drives wires and the small-capacity servo that drives the traverse axis and winding up and off axes in the same bus system.

7.6 Test Equipment for Automobiles



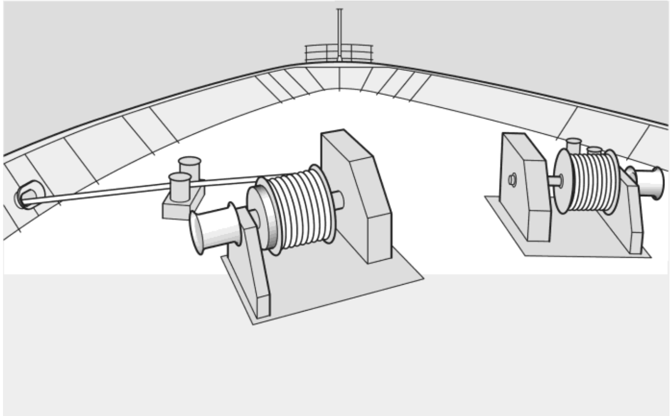
High-speed response control

High-speed rotation and torque control with high response are available for engine and transmission tests.

System support

The system can be supported in cases such as the vehicle body inertia simulation function for a brake test apparatus by combining with the controller.

7.7 Shipboard Winch

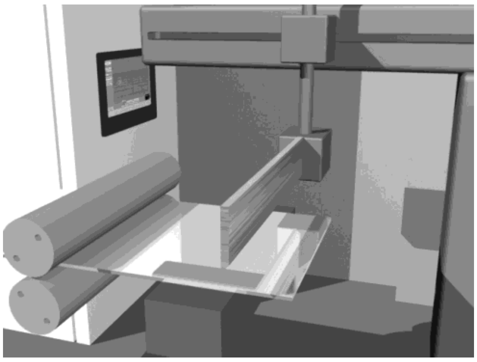


High reliability and tension control

Torque is controlled up to extra low speed using the sensorless feature.

Stable drive is maintained against load variation caused by waves.

7.8 Flying Shear



Position control

Position control is performed according to the position command given by the high-order CNC. The machine cuts the blank while moving at the same speed as the blank.

System support

The system is configured by a controller that calculates synchronous operation among the blank feed axis, cutter feed axis and cut axis.

Chapter 8
SELECTING PERIPHERAL EQUIPMENT

This chapter describes how to use a range of peripheral equipment and options, FRENIC-VG's configuration with them, and requirements and precautions for selecting wires and crimp terminals.

Contents

8.1 Configuring the FRENIC-VG

This section lists the names and features of peripheral equipment and options for the FRENIC-VG series of inverters and includes a configuration example for reference.

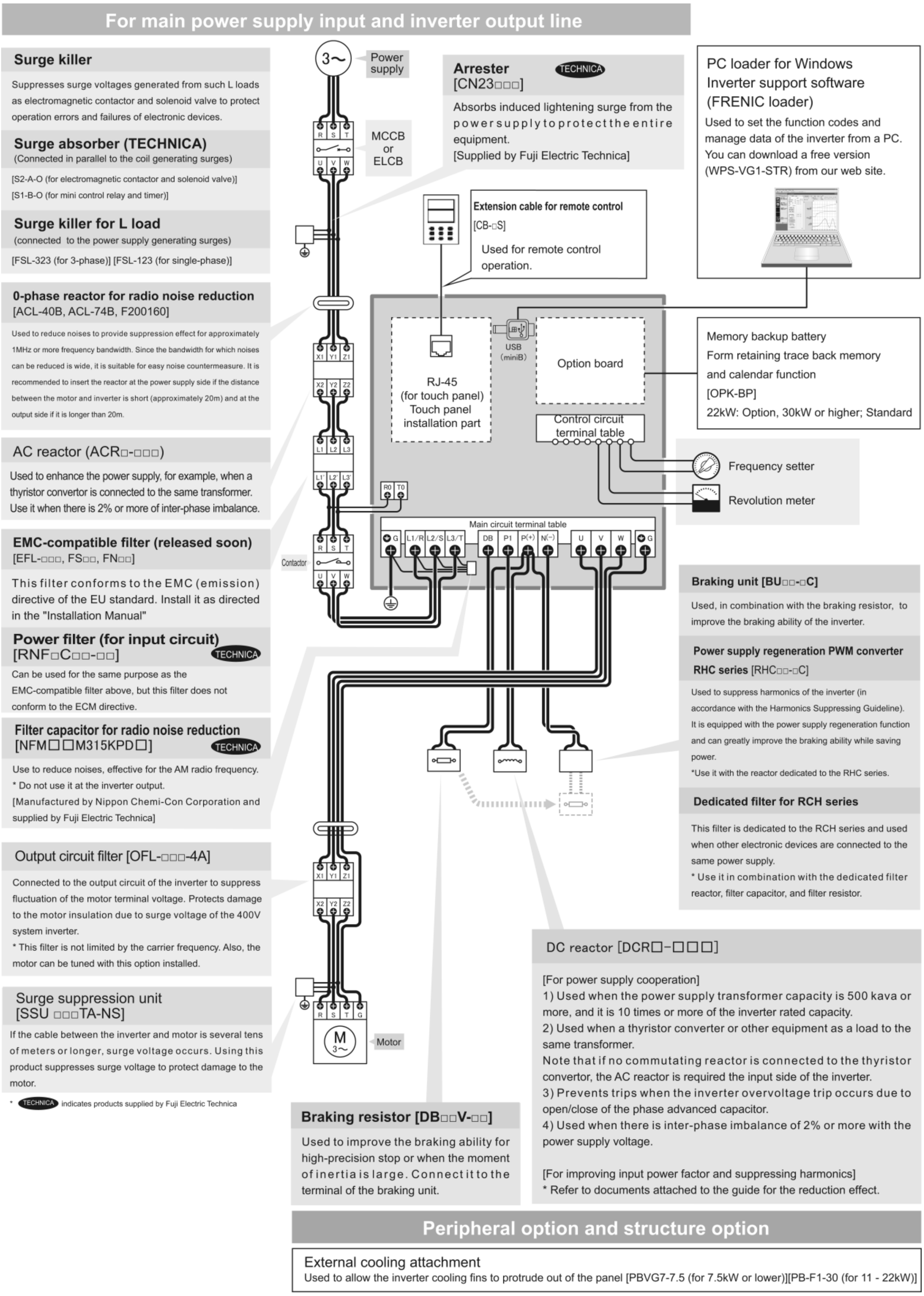


Figure 8.1 Quick Overview of Options

8.2 Selecting Wires and Crimp Terminals

This section contains information needed to select wires for connecting the inverter to commercial power lines, motor or any of the optional/peripheral equipment. The level of electric noise issued from the inverter or received by the inverter from external sources may vary depending upon wiring and routing. For more information about wiring and noise, refer to Appendix A "Advantageous Use of Inverters (Notes on electrical noise)" and the Fuji Electric technical information "Engineering Design of Panels."

Select wires that satisfy the following requirements:

- Sufficient capacity to flow the rated average current (allowable current capacity).
- Protective coordination with an MCCB or RCD/ELCB with overcurrent protection in the overcurrent zone.
- Voltage loss due to the wiring length is within the allowable range.
- Suitable for the type and size of terminals of the optional equipment to be used.

Recommended wires are listed below. Use these wires unless otherwise specified.

■ 600 V class of vinyl-insulated wires (IV wires)

Use this class of wire for the power circuits. This class of wire is hard to twist, so using it for the control signal circuits is not recommended. Maximum surrounding temperature for this wire is 60°C.

■ 600 V grade heat-resistant PVC insulated wires or 600 V polyethylene insulated wires (HIV wires)

As wires in this class are smaller in diameter and more flexible than IV wires and can be used at a higher surrounding temperature (75°C), they can be used for both of the main power and control signal circuits. To use this class of wire for the control circuits, you need to correctly twist the wires and keep the wiring length for equipment being connected as short as possible.

■ 600 V cross-linked polyethylene-insulated wires

Use this class of wire mainly for power and grounding circuits. These wires are smaller in diameter and more flexible than those of the IV and HIV classes of wires, meaning that these wires can be used to save on space and increase operation efficiency of your power system, even in high temperature environments. Maximum surrounding temperature for this wire is 90°C. The (Boardlex) wire range available from Furukawa Electric Co., Ltd. satisfies these requirements.

■ Shielded-Twisted cables for internal wiring of electronic/electric equipment

Use this category of cables for the control circuits of the inverter so as to prevent the signal lines from being affected by noise from external sources, including the power input/output lines of the inverter themselves. Even if the signal lines are inside the power control panel, always use this category of cables when the length of wiring is longer than normal. Cables satisfying these requirements are the Furukawa's BEAMEX S shielded cables of the XEBV and XEWV ranges.

Currents Flowing through Inverter Terminals

Table 8.1 summarizes average (effective) electric currents flowing across the terminals of each inverter model for ease of reference when selecting peripheral equipment, options and electric wires for each inverter--including supplied power voltage and applicable motor rating.

Table 8.1 Currents Flowing through Inverter

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	50 Hz, 200 V			60 Hz, 220 V		
				Input RMS current (A) DC reactor (DCR)		DC link bus current (A)	Input RMS current (A) DC reactor (DCR)		DC link bus current (A)
				w/ DCR	w/o DCR		w/ DCR	w/o DCR	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	3.2	5.3	4	3	4.9	3.7
	1.5	FRN1.5VG1□-2J		6.1	9.5	7.5	5.6	8.7	6.9
	2.2	FRN2.2VG1□-2J		8.9	13.2	11	8.1	12	10
	3.7	FRN3.7VG1□-2J		15	22.2	18.4	13.6	20	16.7
	5.5	FRN5.5VG1□-2J		21.1	31.5	25.9	19	28.4	23.3
	7.5	FRN7.5VG1□-2J		28.8	42.7	35.3	26	38.5	31.9
	11	FRN11VG1□-2J		42.2	60.7	51.7	38	54.7	46.6
	15	FRN15VG1□-2J		57.6	80.1	70.6	52	72.2	63.7
	18.5	FRN18.5VG1□-2J		71	97	87	64	87.4	78.4
	22	FRN22VG1□-2J		84.4	112	103	76	101	93.1
	30	FRN30VG1□-2J	HD	114	151	140	103	136	126
	37		LD	138	185	169	124	167	152
		FRN37VG1□-2J	HD	138	185	169	124	167	152
	45		LD	167	225	205	150	203	184
		FRN45VG1□-2J	HD	167	225	205	150	203	184
	55		LD	203	270	249	183	243	224
		FRN55VG1□-2J	HD	203	270	249	183	243	224
	75		LD	282		345	254		311
		FRN75VG1□-2J	HD	282		345	254		311
	90		LD	334	-	409	301	-	368
		FRN90VG1□-2J	HD	334		409	301		368
	110		LD	410		502	369		452

Note: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:
  [22 kW or below] Power supply capacity 500 kVA, Power supply impedance 5%
  [30 kW or above] Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 230 VAC.

Table 8.1 Currents Flowing through Inverter (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	50 Hz, 400 V Input RMS current (A) DC reactor (DCR) w/ DCR	50 Hz, 400 V Input RMS current (A) DC reactor (DCR) w/o DCR	50 Hz, 400 V DC link bus current (A)	60 Hz, 440 V Input RMS current (A) DC reactor (DCR) w/ DCR	60 Hz, 440 V Input RMS current (A) DC reactor (DCR) w/o DCR	60 Hz, 440 V DC link bus current (A)
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	7.5	13	9.2	6.9	11.8	8.5
	5.5	FRN5.5VG1□-4J	HD	10.6	17.3	13	9.6	15.7	11.8
	7.5	FRN7.5VG1□-4J	HD	14.4	23.2	17.7	13	21	16
	11	FRN11VG1□-4J	HD	21.1	33	25.9	19	29.8	23.3
	15	FRN15VG1□-4J	HD	28.8	43.8	35.3	26	39.5	31.9
	18.5	FRN18.5VG1□-4J	HD	35.5	52.3	43.5	32	47.1	39.2
	22	FRN22VG1□-4J	HD	42.2	60.6	51.7	38	54.6	46.6
	30	FRN30VG1□-4J	HD	57	77.9	69.9	51.4	70.2	63
	37	FRN30VG1□-4J	LD	68.5	94.3	83.9	61.8	85	75.7
	37	FRN37VG1□-4J	HD	68.5	94.3	83.9	61.8	85	75.7
	45	FRN37VG1□-4J	LD	83.2	114	102	75	103	91.9
	45	FRN45VG1□-4J	HD	83.2	114	102	75	103	91.9
	55	FRN45VG1□-4J	LD	102	140	125	91.9	126	113
	55	FRN55VG1□-4J	HD	102	140	125	91.9	126	113
	75	FRN55VG1□-4J	LD	138	-	169	124	-	152
	75	FRN75VG1□-4J	HD	138	-	169	124	-	152
	90	FRN75VG1□-4J	LD	164	-	201	148	-	181
	90	FRN90VG1□-4J	HD	164	-	201	148	-	181
	110	FRN90VG1□-4J	MD/LD	201	-	246	181	-	222
	110	FRN110VG1□-4J	HD	201	-	246	181	-	222
	132	FRN110VG1□-4J	MD/LD	238	-	292	214	-	263
	132	FRN132VG1□-4J	HD	238	-	292	214	-	263
	160	FRN132VG1□-4J	MD/LD	286	-	350	258	-	315
	160	FRN160VG1□-4J	HD	286	-	350	258	-	315
	200	FRN160VG1□-4J	MD/LD	357	-	437	321	-	394
	200	FRN200VG1□-4J	HD	357	-	437	321	-	394
	220	FRN200VG1□-4J	MD/LD	390	-	478	351	-	430
	220	FRN220VG1□-4J	HD	390	-	478	351	-	430
	250	FRN220VG1□-4J	MD	443	-	543	399	-	489
	280	FRN220VG1□-4J	LD	500	-	613	450	-	552
	280	FRN280VG1□-4J	HD	500	-	613	450	-	552
	315	FRN280VG1□-4J	MD	559	-	685	503	-	617
	355	FRN280VG1□-4J	LD	628	-	770	565	-	693

Note: □ in the inverter model represents an alphabet.
□
└─ S (Basic type)

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:
  [22 kW or below] Power supply capacity 500 kVA, Power supply impedance 5%
  [30 kW or above] Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 380 VAC.

Table 8.1 Currents Flowing through Inverter (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	50 Hz, 400 V			60 Hz, 440 V		
				Input RMS current (A)		DC link bus current (A)	Input RMS current (A)		DC link bus current (A)
				DC reactor (DCR)			DC reactor (DCR)		
				w/ DCR	w/o DCR		w/ DCR	w/o DCR	
Three-phase 400 V	315	FRN315VG1□-4J	HD	559		685	503		617
	355		MD	628		770	565		693
	400		LD	705		864	635		778
	355	FRN355VG1□-4J	HD	628		770	565		693
	400		MD	705		864	635		778
	450		LD	789		967	710		870
	400	FRN400VG1□-4J	HD	705	-	864	635	-	778
	450		MD	789		967	710		870
	500		LD	881		1080	793		972
		FRN500VG1□-4J	HD	881		1080	793		972
	630		LD	1115		1367	1004		1230
		FRN630VG1□-4J	HD	1115		1367	1004		1230
	710		LD	1256		1539	1130		1385

Note: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

- Inverter efficiency is calculated using values suitable for each inverter model. The input route mean square (RMS) current is calculated according to the following conditions:

  [22 kW or below] Power supply capacity 500 kVA, Power supply impedance 5%

  [30 kW or above] Power supply capacity and power supply impedance which are calculated using values matching the inverter capacity recommended by Fuji Electric.
- The input RMS current listed in the above table will vary in inverse proportion to the power supply voltage, such as 380 VAC.

8.3 Recommended Wires

The following tables list the recommended wires according to the internal temperature of your power control panel.

■If the internal temperature of your power control panel is 50°C or below

Table 8.2 Wire Size (for main circuit power input and inverter output)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires																			
				Main circuit power inputs L1/R, L2/S, L3/T								Inverter output U ,V, W											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 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		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	3.2	2.0	2.0	2.0	5.3	2.0	2.0	2.0	5	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J		2.0	2.0	2.0	6.1	2.0	2.0	2.0	9.5	2.0	2.0	2.0	8	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J		2.0	2.0	2.0	8.9	2.0	2.0	2.0	13.2	2.0	2.0	2.0	11	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J		2.0	2.0	2.0	15.0	5.5	2.0	2.0	22.2	3.5	2.0	2.0	18	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J		5.5	2.0	2.0	21.1	8.0	3.5	3.5	31.5	5.5	3.5	2.0	27	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J		8.0	3.5	2.0	28.8	14	5.5	5.5	42.7	14	5.5	3.5	37	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J		14	5.5	5.5	42.2	22	14	8.0 *3)	60.7	14	8.0 *3)	5.5	49	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J		22	14	8.0 *3)	57.6	38	22	14	80.1	22	14	8.0 *3)	63	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J		38 *1)	14	14	71.1	60 *2)	22	14	97.0	38 *1)	14	14	76	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J		38 *1)	22	14	84.4	60 *2)	38 *1)	22	112	38 *1)	22	14	90	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	60	38	22	114	-	60	38	151	60	38	22	119	-	-	-	-	-	-	-	-
	37		LD	-	38	38	138	-	60	38	185	-	-	-	-	-	-	-	-	-	38	38	146
		FRN37VG1□-2J	HD	100								100	38	38	146					-	-	-	-
	45		LD	100	60	38	167	-	100	60	225	-	-	-	-	-	-	-	-	-	60	38	180
		FRN45VG1□-2J	HD									-	60	38	180					-	-	-	-
	55		LD	-	100	60	203	-	100	100	270	-	-	-	-	-	-	-	-	-	100	60	215
		FRN55VG1□-2J	HD									-	100	60	215					-	-	-	-
	75		LD	-	150 *4)	100	282	-	-	-	-	-	-	-	-	-	-	-	-	-	150 *4)	100	283
		FRN75VG1□-2J	HD		150							-	150	100	283					-	-	-	-
	90		LD	-	150	100	334	-	-	-	-	-	-	-	-	-	-	-	-	-	150	150	346
		FRN90VG1□-2J	HD									-	150	150	346					-	-	-	-
	110		LD	-	200	150	410	-	-	-	-	-	-	-	-	-	-	-	-	-	200	150	415

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 60-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*4 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.2 Wire Size (for main circuit power input and inverter output) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires																			
				Main circuit power input L1/R, L2/S, L3/T								Inverter output U, V, W											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 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		60°C	75°C	90°C	
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	7.5	2.0	2.0	2.0	13.0	2.0	2.0	2.0	9	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	10.6	3.5	2.0	2.0	17.3	2.0	2.0	2.0	13.5	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	14.4	5.5	2.0	2.0	23.2	3.5	2.0	2.0	18.5	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	5.5	2.0	2.0	21.1	8.0 *1)	3.5	3.5	33	5.5	3.5	2.0	24.5	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	8.0 *1)	3.5	2.0	28.8	14	5.5	5.5	43.8	8.0 *1)	3.5	3.5	32	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	14	5.5	3.5	35.5	22	8.0 *1)	5.5	52.3	14	5.5	3.5	39	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	14	5.5	5.5	42.2	22	14	8.0 *1)	60.6	14	8.0 *1)	5.5	45	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	22	14	8.0	57.0	38	14	14	77.9	22	14	8.0	60	-	-	-	-	-	-	-	-
	37		LD	38	14	8.0	68.5	60	22	14	94.3	-	-	-	-	-	-	-	-	38	14	14	75
		FRN37VG1□-4J	HD									38	14	14	75					-	-	-	-
	45		LD	38	22	14	83.2	60	38	22	114	-	-	-	-	-	-	-	-	38	22	14	91
		FRN45VG1□-4J	HD									38	22	14	91					-	-	-	-
	55		LD	60	22	22	102	-	38	38	140	-	-	-	-	-	-	-	-	60	38	22	112
		FRN55VG1□-4J	HD									60	38	22	112					-	-	-	-
	75		LD	-	38	38	138	-	-	-	-	-	-	-	-	-	-	-	-	-	60	38	150
		FRN75VG1□-4J	HD	100								100	60	38	150					-	-	-	-
	90		LD	100	60	38	164	-	-	-	-	-	-	-	-	-	-	-	-	-	60	38	176
		FRN90VG1□-4J	HD									-	60	38	176					-	-	-	-
	110		MD/LD	-	100	60	201	-	-	-	-	-	-	-	-	-	100	60	210	-	100	60	210
		FRN110VG1□-4J	HD									-	100	60	210	-	-	-	-	-	-	-	-
	132		MD/LD	-	100	60	238	-	-	-	-	-	-	-	-	-	100	100	253	-	100	100	253
		FRN132VG1□-4J	HD									-	100	100	253	-	-	-	-	-	-	-	-
	160		MD/LD	-	150	100	286	-	-	-	-	-	-	-	-	-	150	100	304	-	150	100	304
		FRN160VG1□-4J	HD									-	150	100	304	-	-	-	-	-	-	-	-
	200		MD/LD	-	150	150	357	-	-	-	-	-	-	-	-	-	200	150	377	-	200	150	377
		FRN200VG1□-4J	HD									-	200	150	377	-	-	-	-	-	-	-	-
	220		MD/LD	-	200	150	390	-	-	-	-	-	-	-	-	-	200	150	415	-	200	150	415
		FRN220VG1□-4J	HD									-	200	150	415	-	-	-	-	-	-	-	-
	250		MD	-	250	150	443	-	-	-	-	-	-	-	-	-	250	200	468	-	-	-	-
	280		LD	-	250	200	500	-	-	-	-	-	-	-	-	-	-	-	-	-	325	200	520
		FRN280VG1□-4J	HD									-	325	200	520					-	-	-	-
	315		MD	-	2x150	250	559	-	-	-	-	-	-	-	-	-	325	250	585	-	-	-	-
	355		LD	-	2x200	250	628	-	-	-	-	-	-	-	-	-	-	-	-	-	2x200	325	650
	315	FRN315VG1□-4J	HD	-	2x150	250	559	-	-	-	-	-	325	250	585	-	-	-	-	-	-	-	-
	355		MD	-	2x200	250	628	-	-	-	-	-	-	-	-	-	2x200	325	650	-	-	-	-
	400		LD	-	2x200	325	705	-	-	-	-	-	-	-	-	-	-	-	-	-	2x250	325	740
	355	FRN355VG1□-4J	HD	-	2x200	250	628	-	-	-	-	-	2x200	325	650	-	-	-	-	-	-	-	-
	400		MD	-	2x200	325	705	-	-	-	-	-	-	-	-	-	2x250	325	740	-	-	-	-
	450		LD		2x250	2x200	789	-	-	-	-	-	-	-	-	-	-	-	-	-	2x250	2x200	840
	400	FRN400VG1□-4J	HD	-	2x200	325	705	-	-	-	-	-	2x250	325	740	-	-	-	-	-	-	-	-
	450		MD		2x250	2x200	789	-	-	-	-	-	-	-	-	-	2x250	2x200	840	-	-	-	-
	500		LD	-	2x325	2x200	881	-	-	-	-	-	-	-	-	-	-	-	-	-	2x325	2x250	960
		FRN500VG1□-4J	HD									-	2x325	2x250	960					-	-	-	-
	630		LD	-	3x325	2x325	1115	-	-	-	-	-	-	-	-	-	-	-	-	-	3x325	2x325	1170
		FRN630VG1□-4J	HD									-	3x325	2x325	1170					`	-	-	-
	710		LD	-	4x250	2x325	1256	-	-	-	-	-	-	-	-	-	-	-	-	-	4x325	3x325	1370

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Table 8.2 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²): For DC reactor connection [P1, P(+)] Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For control circuit Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit [R0, T0] Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply [R1, T1] Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding [⏚ G] Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	4.0	1.25	2.0	-	2.0
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	7.5	1.25	2.0	-	2.0
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	11.0	1.25	2.0	-	2.0
	3.7	FRN3.7VG1□-2J	HD	3.5	2.0	2.0	18.4	1.25	2.0	-	2.0
	5.5	FRN5.5VG1□-2J	HD	5.5	3.5	2.0	25.9	1.25	2.0	-	3.5
	7.5	FRN7.5VG1□-2J	HD	14	5.5	3.5	35.3	1.25	2.0	-	5.5
	11	FRN11VG1□-2J	HD	22	8.0 *3)	5.5	51.7	1.25	2.0	-	5.5
	15	FRN15VG1□-2J	HD	38 *1)	14	14	70.6	1.25	2.0	-	8.0
	18.5	FRN18.5VG1□-2J	HD	38 *1)	22	14	87.0	1.25	2.0	-	8.0
	22	FRN22VG1□-2J	HD	60 *2)	22	22	103	1.25	2.0	-	14
	30	FRN30VG1□-2J	HD	-	38	38	140	1.25	2.0	-	14
	37	FRN30VG1□-2J	LD	-	60	38	169	1.25	2.0	-	22
	37	FRN37VG1□-2J	HD	100	60	38	169	1.25	2.0	2.0 (37 kW or above)	22
	45	FRN37VG1□-2J	LD	-	100	60	205	1.25	2.0	2.0 (37 kW or above)	22
	45	FRN45VG1□-2J	HD	-	100	60	205	1.25	2.0	2.0 (37 kW or above)	22
	55	FRN45VG1□-2J	LD	-	100	60	249	1.25	2.0	2.0 (37 kW or above)	22
	55	FRN55VG1□-2J	HD	-	100	60	249	1.25	2.0	2.0 (37 kW or above)	22
	75	FRN55VG1□-2J	LD	-	150 *4)	150 *4)	345	1.25	2.0	2.0 (37 kW or above)	22
	75	FRN75VG1□-2J	HD	-	150	150	345	1.25	2.0	2.0 (37 kW or above)	22
	90	FRN75VG1□-2J	LD	-	200	150	409	1.25	2.0	2.0 (37 kW or above)	22
	90	FRN90VG1□-2J	HD	-	200	150	409	1.25	2.0	2.0 (37 kW or above)	22
	110	FRN90VG1□-2J	LD	-	250	200	502	1.25	2.0	2.0 (37 kW or above)	38

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└ S (Basic type)

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 60-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*4 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.2 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²): For DC reactor connection 〔P1,P(+)〕 Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For control circuit, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit 〔R0, T0〕 Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply 〔R1, T1〕 Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding 〔⏚ G〕 Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	9.2	1.25	2.0	-	2.0
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	13.0				
	7.5	FRN7.5VG1□-4J	HD	3.5	2.0	2.0	17.7				3.5
	11	FRN11VG1□-4J	HD	5.5	3.5	2.0	25.9				
	15	FRN15VG1□-4J	HD	14	5.5	3.5	35.3				5.5
	18.5	FRN18.5VG1□-4J	HD	14	5.5	5.5	43.5				
	22	FRN22VG1□-4J	HD	22	8.0 *1)	5.5	51.7				
	30	FRN30VG1□-4J	HD	38	14	8.0	69.9				8.0
	37		LD	38	22	14	83.9				
		FRN37VG1□-4J	HD								
	45		LD	60	22	22	102				
		FRN45VG1□-4J	HD								
	55		LD	60	38	22	125				
		FRN55VG1□-4J	HD								14
	75		LD	-	60	38	169				
		FRN75VG1□-4J	HD	100						2.0 (75 kW or above)	
	90		LD	-	100	60	201				
		FRN90VG1□-4J	HD								
	110		MD/LD	-	100	60	246				22
		FRN110VG1□-4J	HD								
	132		MD/LD	-	150	100	292				
		FRN132VG1□-4J	HD								
	160		MD/LD	-	150	150	350				
		FRN160VG1□-4J	HD								
	200		MD/LD	-	250	150	437				38
		FRN200VG1□-4J	HD								
	220		MD/LD	-	250	200	478				
		FRN220VG1□-4J	HD								
	250		MD	-	325	250	543				
	280		LD	-	2x200	250	612				
		FRN280VG1□-4J	HD								
	315		MD	-	2x200	325	685				60
	355		LD	-	2x250	2x200	769				
	315	FRN315VG1□-4J	HD	-	2x200	325	685				
	355		MD	-	2x250	2x200	769				
	400		LD	-	2x325	2x200	864				
	355	FRN355VG1□-4J	HD	-	2x250	2x200	769				
	400		MD	-	2x325	2x200	864				
	450		LD	-	2x325	2x250	966				
	400	FRN400VG1□-4J	HD	-	2x325	2x200	864				
	450		MD	-	2x325	2x250	966				
	500		LD	-	3x325	2x325	1079				100
		FRN500VG1□-4J	HD								
	630		LD	-	3x325	3x325	1366				
		FRN630VG1□-4J	HD								
	710		LD	-	4x325	3x325	1538				

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

■ If the internal temperature of your power control panel is 40°C or below

Table 8.3 Wire Size (for main circuit power input and inverter output)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm^2)																			
				Main circuit power input 〔L1/R, L2/S, L3/T〕								Inverter output 〔U, V, W〕											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 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		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	3.2	2.0	2.0	2.0	5.3	2.0	2.0	2.0	5	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	6.1	2.0	2.0	2.0	9.5	2.0	2.0	2.0	8	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	8.9	2.0	2.0	2.0	13.2	2.0	2.0	2.0	11	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J	HD	2.0	2.0	2.0	15	3.5	2.0	2.0	22.2	2.0	2.0	2.0	18	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J	HD	2.0	2.0	2.0	21.1	5.5	3.5	2.0	31.5	3.5	2.0	2.0	27	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J	HD	3.5	2.0	2.0	28.8	8.0	5.5	3.5	42.7	5.5	3.5	3.5	37	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J	HD	8.0 *2)	5.5	3.5	42.2	14	8.0 *2)	5.5	60.7	8.0 *2)	5.5	5.5	49	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J	HD	14	8.0 *2)	5.5	57.6	22	14	14	80.1	14	8.0 *2)	5.5	63	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J	HD	14	14	8.0 *2)	71	38 *1)	22	14	97.0	22	14	8.0 *2)	76	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J	HD	22	14	14	84.4	38 *1)	22	14	112	22	14	14	90	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	38	22	22	114	60	38	38	151	38	22	22	119	-	-	-	-	-	-	-	-
	37	FRN30VG1□-2J	LD	60	38	22	138	-	60	38	185	-	-	-	-	-	-	-	-	60	38	22	146
		FRN37VG1□-2J	HD					100				60	38	22	146					-	-	-	-
	45	FRN37VG1□-2J	LD	60	38	38	167	100	60	60	225	-	-	-	-	-	-	-	-	100	60	38	180
		FRN45VG1□-2J	HD									100	60	38	180					-	-	-	-
	55	FRN45VG1□-2J	LD	100	60	38	203	-	100	60	270	-	-	-	-	-	-	-	-	100	60	60	215
		FRN55VG1□-2J	HD									100	60	60	215					-	-	-	-
	75	FRN55VG1□-2J	LD	-	100	100	282	-	-	-	-	-	-	-	-	-	-	-	-	-	100	100	283
		FRN75VG1□-2J	HD	150 *3)								150	100	100	283					-	-	-	-
	90	FRN75VG1□-2J	LD	-	150	100	334	-	-	-	-	-	-	-	-	-	-	-	-	200	150	100	346
		FRN90VG1□-2J	HD									200	150	100	346					-	-	-	-
	110	FRN90VG1□-2J	LD	-	150	150	410	-	-	-	-	-	-	-	-	-	-	-	-	250	150	150	415

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 38-6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.3 Wire Size (for main circuit power input and inverter output) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²)																			
				Main circuit power input 〔L1/R, L2/S, L3/T〕								Inverter output 〔U, V, W〕											
				w/ DC reactor (DCR)				w/o DC reactor (DCR)				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 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		60°C	75°C	90°C	
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	7.5	2.0	2.0	2.0	13.0	2.0	2.0	2.0	9	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	10.6	2.0	2.0	2.0	17.3	2.0	2.0	2.0	13.5	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	14.4	3.5	2.0	2.0	23.2	2.0	2.0	2.0	18.5	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	2.0	2.0	2.0	21.1	5.5	3.5	2.0	33	3.5	2.0	2.0	24.5	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	3.5	2.0	2.0	28.8	8.0 *1)	5.5	3.5	43.8	5.5	3.5	2.0	32	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	5.5	3.5	3.5	35.5	14	8.0 *1)	5.5	52.3	5.5	3.5	3.5	39	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	8.0 *1)	5.5	3.5	42.2	14	8.0 *1)	5.5	60.6	8.0 *1)	5.5	3.5	45	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	14	8.0	5.5	57.0	22	14	8.0	77.9	14	8.0	5.5	60	-	-	-	-	-	-	-	-
	37		LD	14	14	8.0	68.5	38	14	14	94.3	-	-	-	-	-	-	-	-	22	14	8.0	75
		FRN37VG1□-4J	HD									22	14	8.0	75					-	-	-	-
	45		LD	22	14	14	83.2	38	22	22	114	-	-	-	-	-	-	-	-	22	14	14	91
		FRN45VG1□-4J	HD									22	14	14	91					-	-	-	-
	55		LD	38	22	14	102	60	38	22	140	-	-	-	-	-	-	-	-	38	22	14	112
		FRN55VG1□-4J	HD									38	22	14	112					-	-	-	-
	75		LD	60	38	22	138	-	-	-	-	-	-	-	-	-	-	-	-	60	38	38	150
		FRN75VG1□-4J	HD									60	38	38	150					-	-	-	-
	90		LD	60	38	38	164	-	-	-	-	-	-	-	-	-	-	-	-	60	60	38	176
		FRN90VG1□-4J	HD									60	60	38	176					-	-	-	-
	110		MD/LD	100	60	38	201	-	-	-	-	-	-	-	-	100	60	60	210	100	60	60	210
		FRN110VG1□-4J	HD									100	60	60	210	-	-	-	-	-	-	-	-
	132		MD/LD	100	100	60	238	-	-	-	-	-	-	-	-	150	100	60	253	150	100	60	253
		FRN132VG1□-4J	HD									150	100	60	253	-	-	-	-	-	-	-	-
	160		MD/LD	150	100	100	286	-	-	-	-	-	-	-	-	150	100	100	304	150	100	100	304
		FRN160VG1□-4J	HD									150	100	100	304	-	-	-	-	-	-	-	-
	200		MD/LD	200	150	100	357	-	-	-	-	-	-	-	-	200	150	100	377	200	150	100	377
		FRN200VG1□-4J	HD									200	150	100	377	-	-	-	-	-	-	-	-
	220		MD/LD	250	150	150	390	-	-	-	-	-	-	-	-	250	150	150	415	250	150	150	415
		FRN220VG1□-4J	HD									250	150	150	415	-	-	-	-	-	-	-	-
	250		MD	250	200	150	443	-	-	-	-	-	-	-	-	325	200	150	468	-	-	-	-
	280		LD	325	200	150	500	-	-	-	-	-	-	-	-	-	-	-	-	325	250	200	520
		FRN280VG1□-4J	HD									325	250	200	520					-	-	-	-
	315		MD	-	250	200	559	-	-	-	-	-	-	-	-	-	250	200	585	-	-	-	-
	355		LD	-	325	250	628	-	-	-	-	-	-	-	-	-	-	-	-	-	325	250	650
	315	FRN315VG1□-4J	HD	-	250	200	559	-	-	-	-	-	250	200	585	-	-	-	-	-	-	-	-
	355		MD	-	325	250	628	-	-	-	-	-	-	-	-	-	325	250	650	-	-	-	-
	400		LD	-	2x150	250	705	-	-	-	-	-	-	-	-	-	-	-	-	-	2x200	325	740
	355	FRN355VG1□-4J	HD	-	325	250	628	-	-	-	-	-	325	250	650	-	-	-	-	-	-	-	-
	400		MD	-	2x150	250	705	-	-	-	-	-	-	-	-	-	2x200	325	740	-	-	-	-
	450		LD	-	2x200	325	789	-	-	-	-	-	-	-	-	-	-	-	-	-	2x200	2x150	840
	400	FRN400VG1□-4J	HD	-	2x150	250	705	-	-	-	-	-	2x200	325	740	-	-	-	-	-	-	-	-
	450		MD	-	2x200	325	789	-	-	-	-	-	-	-	-	-	2x200	2x150	840	-	-	-	-
	500		LD	-	2x250	2x200	881	-	-	-	-	-	-	-	-	-	-	-	-	-	2x250	2x200	960
		FRN500VG1□-4J	HD									-	2x250	2x200	960					-	-	-	-
	630		LD	-	2x325	2x250	1115	-	-	-	-	-	-	-	-	-	-	-	-	-	3x250	2x250	1170
		FRN630VG1□-4J	HD									-	3x250	2x250	1170					-	-	-	-
	710		LD	-	3x250	2x325	1256	-	-	-	-	-	-	-	-	-	-	-	-	-	3x325	2x325	1370

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.3 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Recommended wires (mm²): For DC reactor connection 〔P1,P(+)〕 Maximum temperature (Note 1) 60°C	75°C	90°C	Cur-rent (A)	For control circuit, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit 〔R0, T0〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply 〔R1, T1〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding 〔⏚ G〕, Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	4.0	1.25	2.0	-	2.0
	1.5	FRN1.5VG1□-2J		2.0	2.0	2.0	7.5				
	2.2	FRN2.2VG1□-2J		2.0	2.0	2.0	11.0				
	3.7	FRN3.7VG1□-2J		2.0	2.0	2.0	18.4				
	5.5	FRN5.5VG1□-2J		3.5	2.0	2.0	25.9				3.5
	7.5	FRN7.5VG1□-2J		5.5	3.5	3.5	35.3				5.5
	11	FRN11VG1□-2J		14	5.5	5.5	51.7				
	15	FRN15VG1□-2J		14	14	8.0 *2)	70.6				8.0
	18.5	FRN18.5VG1□-2J		22	14	14	87.0				
	22	FRN22VG1□-2J		38 *1)	22	14	103				14
	30	FRN30VG1□-2J	HD	60	38	22	140				
	37		LD	60	38	38	169				22
		FRN37VG1□-2J	HD							2.0 (37 kW or above)	
	45		LD	100	60	38	205				
		FRN45VG1□-2J	HD								
	55		LD	150 *3)	100	60	249				
		FRN55VG1□-2J	HD								
	75		LD	-	150 *3)	100	345				
		FRN75VG1□-2J	HD		150						
	90		LD	-	150	150	409				
		FRN90VG1□-2J	HD								
	110		LD	-	200	150	502				38

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*2 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

*3 Use CB150-10 crimp terminals designed for low voltage appliances in JEM1399.

Table 8.3 Wire Size (for DC reactor, control circuit, and inverter grounding) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	For DC reactor connection 〔P1,P(+)〕 Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	For control circuit Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary power input for the control circuit 〔R0, T0〕 Maximum temperature (Note 1) 60°C / 75°C / 90°C	Auxiliary input for fan power supply 〔R1, T1〕 Maximum temperature (Note 1) 60°C / 75°C / 90°C	For inverter grounding 〔⏚ G〕 Maximum temperature (Note 1) 60°C / 75°C / 90°C
Three-phase 400 V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	9.2	1.25	2.0	-	2.0
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	13.0				
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	17.7				3.5
	11	FRN11VG1□-4J	HD	3.5	2.0	2.0	25.9				
	15	FRN15VG1□-4J	HD	5.5	3.5	3.5	35.3				5.5
	18.5	FRN18.5VG1□-4J	HD	8.0 *1)	5.5	3.5	43.5				
	22	FRN22VG1□-4J	HD	14	5.5	5.5	51.7				
	30	FRN30VG1□-4J	HD	14	14	8.0	69.9				8.0
	37	FRN30VG1□-4J	LD	22	14	14	83.9				
		FRN37VG1□-4J	HD								
	45	FRN37VG1□-4J	LD	38	22	14	102				
		FRN45VG1□-4J	HD								
	55	FRN45VG1□-4J	LD	38	38	22	125				14
		FRN55VG1□-4J	HD								
	75	FRN55VG1□-4J	LD	60	38	38	169				
		FRN75VG1□-4J	HD							2.0 (75 kW or above)	
	90	FRN75VG1□-4J	LD	100	60	38	201				
		FRN90VG1□-4J	HD								
	110	FRN90VG1□-4J	MD/LD	150	100	60	246				22
		FRN110VG1□-4J	HD								
	132	FRN110VG1□-4J	MD/LD	150	100	100	292				
		FRN132VG1□-4J	HD								
	160	FRN132VG1□-4J	MD/LD	200	150	100	350				
		FRN160VG1□-4J	HD								
	200	FRN160VG1□-4J	MD/LD	250	200	150	437				38
		FRN200VG1□-4J	HD								
	220	FRN200VG1□-4J	MD/LD	325	200	150	478				
		FRN220VG1□-4J	HD								
	250	FRN220VG1□-4J	MD	-	250	200	543				
	280	FRN220VG1□-4J	LD	-	325	250	612				
		FRN280VG1□-4J	HD								
	315	FRN280VG1□-4J	MD	-	2x150	250	685				60
	355	FRN280VG1□-4J	LD	-	2x200	325	769				
	315	FRN315VG1□-4J	HD	-	2x150	250	685				
	355	FRN315VG1□-4J	MD	-	2x200	325	769				
	400	FRN315VG1□-4J	LD	-	2x250	2x200	864				
	355	FRN355VG1□-4J	HD	-	2x200	325	769				
	400	FRN355VG1□-4J	MD	-	2x250	2x200	864				
	450	FRN355VG1□-4J	LD	-	2x250	2x200	966				
	400	FRN400VG1□-4J	HD	-	2x250	2x200	864				
	450	FRN400VG1□-4J	MD	-	2x250	2x200	966				
	500	FRN400VG1□-4J	LD	-	2x325	2x250	1079				100
		FRN500VG1□-4J	HD								
	630	FRN500VG1□-4J	LD	-	3x325	2x325	1366				
		FRN630VG1□-4J	HD								
	710	FRN630VG1□-4J	LD	-	4x325	3x325	1538				

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

*1 Use the crimp terminal model No. 8-L6 manufactured by JST Mfg. Co., Ltd., or equivalent.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

< Wire Size (for DC reactor, braking resistor >

■ If the internal temperature of your power control panel is 50°C or below

Table 8.4 Wire Size (for braking resistor)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product												20% ED product											
				For braking resistor connection 〔P(+),DB〕												For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (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		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	2.0	2.0	2.0	1.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1□-2J	HD	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.7	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1□-2J	HD	2.0	2.0	2.0	2.3	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.3	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1□-2J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-2J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-2J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	11	FRN11VG1□-2J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	15	FRN15VG1□-2J	HD	2.0	2.0	2.0	13.7	-	-	-	-	-	-	-	-	3.5	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-2J	HD	3.5	2.0	2.0	17.6	-	-	-	-	-	-	-	-	5.5	3.5	2.0	24.8	-	-	-	-	-	-	-	-
	22	FRN22VG1□-2J	HD	3.5	2.0	2.0	20.3	-	-	-	-	-	-	-	-	8.0	3.5	2.0	28.7	-	-	-	-	-	-	-	-
	30	FRN30VG1□-2J	HD	8.0	3.5	2.0	30.0	-	-	-	-	-	-	-	-	14	5.5	3.5	38.7	-	-	-	-	-	-	-	-
	37	FRN30VG1□-2J	LD	-	-	-	-	-	-	-	-	8.0	3.5	2.0	29.8	-	-	-	-	-	-	-	-	14	5.5	3.5	38.5
	37	FRN37VG1□-2J	HD	14	5.5	3.5	35.1					-	-	-	-	14	8.0	5.5	48.1					-	-	-	-
	45	FRN37VG1□-2J	LD	-	-	-	-	-	-	-	-	8.0	5.5	3.5	34.6	-	-	-	-	-	-	-	-	14	8.0	5.5	47.4
	45	FRN45VG1□-2J	HD	14	5.5	3.5	41.1					-	-	-	-	22	14	8.0	58.1					-	-	-	-
	55	FRN45VG1□-2J	LD	-	-	-	-	-	-	-	-	14	5.5	3.5	40.6	-	-	-	-	-	-	-	-	22	14	8.0	57.4
	55	FRN55VG1□-2J	HD	14	8.0	5.5	50.8					-	-	-	-	38	14	14	71.8					-	-	-	-
	75	FRN55VG1□-2J	LD	-	-	-	-	-	-	-	-	22	8.0	5.5	53.0	-	-	-	-	-	-	-	-	38	14	14	75.0
	75	FRN75VG1□-2J	HD	**14** (2)	**5.5** (2)	**3.5** (2)	68.5					-	-	-	-	**22** (2)	**8** (2)	**5.5** (2)	96.8					-	-	-	-
	90	FRN75VG1□-2J	LD	-	-	-	-	-	-	-	-	**14** (2)	**5.5** (2)	**3.5** (2)	67.1	-	-	-	-	-	-	-	-	**22** (2)	**14** (2)	**5.5** (2)	94.9
	90	FRN90VG1□-2J	HD	**14** (2)	**8** (2)	**5.5** (2)	82.2					-	-	-	-	**22** (2)	**14** (2)	**8** (2)	116					-	-	-	-
	110	FRN90VG1□-2J	LD	-	-	-	-	-	-	-	-	**14** (2)	**8** (2)	**5.5** (2)	81.2	-	-	-	-	-	-	-	-	**22** (2)	**14** (2)	**8** (2)	115

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Note 3: **Bolded values** (*n*) denote wire sizes to be applied when a braking unit (BU) or braking resistor (DBR) is connected in parallel.

Bolded values in upper position: Wire sizes per unit connected in parallel
(*n*) in lower position: Number of parallels. For example, (2) denotes two parallels.

When a relay terminal block is provided and branching from the terminal block to each braking unit (BU) or braking resistor (DBR) is made, the wire size between the inverter and the relay terminal block should be selected based on the current values.

The wire sizes are selected for parallel wiring, taking into account the safety coefficient.
- 2 units in parallel: Current value x 1/85%
- 3 units in parallel: Current value x 1/80%
- 4 units in parallel: Current value x 1/70%

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product, For braking resistor connection 〔P(+),DB〕												20% ED product, For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 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		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	1.7	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.4	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	2.5	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.6	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	2.0	2.0	2.0	8.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	12.4	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	2.0	2.0	2.0	15.0	-	-	-	-	-	-	-	-	3.5	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.9	-	-	-	-	-	-	-	-	3.5	2.0	2.0	19.2
	37	FRN37VG1□-4J	HD	3.5	2.0	2.0	17.6					-	-	-	-	5.5	3.5	2.0	24.8					-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	3.5	2.0	2.0	17.3	-	-	-	-	-	-	-	-	5.5	3.5	2.0	24.5
	45	FRN45VG1□-4J	HD	3.5	2.0	2.0	20.5					-	-	-	-	8.0	3.5	2.0	29.0					-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	3.5	2.0	2.0	20.3	-	-	-	-	-	-	-	-	8.0	3.5	2.0	28.7
	55	FRN55VG1□-4J	HD	5.5	3.5	2.0	25.2					-	-	-	-	14	5.5	3.5	35.6					-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	5.5	3.5	2.0	26.3	-	-	-	-	-	-	-	-	14	5.5	3.5	37.2
	75	FRN75VG1□-4J	HD	8.0	5.5	3.5	34.6					-	-	-	-	14	8.0	5.5	48.9					-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	8.0	5.5	3.5	33.9	-	-	-	-	-	-	-	-	14	8.0	5.5	47.9
	90	FRN90VG1□-4J	HD	14	5.5	3.5	41.6					-	-	-	-	22	14	8.0	58.8					-	-	-	-
	110		MD	-	-	-	-	14	8.0	5.5	50.8					-	-	-	-	38	14	14	71.8				
	110		LD					-	-	-	-	14	5.5	3.5	41.1					-	-	-	-	22	14	8.0	58.2
	110	FRN110VG1□-4J	HD	14	8.0	5.5	50.8					-	-	-	-	38	14	14	71.8					-	-	-	-
	132		MD	-	-	-	-	22	14	8.0	61.7					-	-	-	-	38	22	14	87.3				
	132		LD					-	-	-	-	14	8.0	5.5	49.7					-	-	-	-	38	14	14	70.4
	132	FRN132VG1□-4J	HD	22	14	8.0	61.7					-	-	-	-	38	22	14	87.3					-	-	-	-
	160		MD	-	-	-	-	38	14	14	73.9					-	-	-	-	60	38	22	104				
	160		LD					-	-	-	-	22	14	8.0	60.8					-	-	-	-	38	22	14	85.9
	160	FRN160VG1□-4J	HD	38	14	14	73.9					-	-	-	-	60	38	22	104					-	-	-	-
	200		MD	-	-	-	-	38	22	14	92.6					-	-	-	-	100	38	22	131				
	200		LD					-	-	-	-	38	14	14	73.9					-	-	-	-	60	38	22	104

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product, For braking resistor connection 〔P(+),DB〕												20% ED product, For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (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		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 400V	200	FRN200VG1□-4J	HD	**22** (2)	**8** (2)	**5.5** (2)	92.6	-	-	-	-	-	-	-	-	**38** (2)	**14** (2)	**14** (2)	131	-	-	-	-	-	-	-	-
	220		MD	-	-	-	-	**22** (2)	**14** (2)	**8** (2)	102	-	-	-	-	-	-	-	-	**38** (2)	**22** (2)	**14** (2)	144	-	-	-	-
	220		LD	-	-	-	-	-	-	-	-	**22** (2)	**8** (2)	**3.5** (2)	86.8	-	-	-	-	-	-	-	-	**38** (2)	**14** (2)	**14** (2)	123
	220	FRN220VG1□-4J	HD	**22** (2)	**14** (2)	**8** (2)	102	-	-	-	-	-	-	-	-	**38** (2)	**14** (2)	**14** (2)	144	-	-	-	-	-	-	-	-
	250		MD	-	-	-	-	**38** (2)	**14** (2)	**14** (2)	120	-	-	-	-	-	-	-	-	**60** (2)	**22** (2)	**14** (2)	170	-	-	-	-
	280		LD	-	-	-	-	-	-	-	-	**22** (2)	**14** (2)	**8** (2)	102	-	-	-	-	-	-	-	-	**38** (2)	**22** (2)	**14** (2)	145
	280	FRN280VG1□-4J	HD	**38** (2)	**22** (2)	**14** (2)	138	-	-	-	-	-	-	-	-	**60** (2)	**38** (2)	**22** (2)	195	-	-	-	-	-	-	-	-
	315		MD	-	-	-	-	**38** (2)	**22** (2)	**14** (2)	147	-	-	-	-	-	-	-	-	**60** (2)	**38** (2)	**22** (2)	207	-	-	-	-
	355		LD	-	-	-	-	-	-	-	-	**38** (2)	**22** (2)	**14** (2)	139	-	-	-	-	-	-	-	-	**60** (2)	**38** (2)	**22** (2)	197
	315	FRN315VG1□-4J	HD	**38** (2)	**22** (2)	**14** (2)	147	-	-	-	-	-	-	-	-	**60** (2)	**38** (2)	**22** (2)	207	-	-	-	-	-	-	-	-
	355		MD	-	-	-	-	**38** (3)	**14** (3)	**8** (3)	175	-	-	-	-	-	-	-	-	**60** (3)	**22** (3)	**14** (3)	248	-	-	-	-
	400		LD	-	-	-	-	-	-	-	-	**38** (2)	**22** (2)	**14** (2)	148	-	-	-	-	-	-	-	-	**100** (2)	**38** (2)	**38** (2)	235
	355	FRN355VG1□-4J	HD	**38** (3)	**14** (3)	**8** (3)	175	-	-	-	-	-	-	-	-	**60** (3)	**22** (3)	**14** (3)	248	-	-	-	-	-	-	-	-
	400		MD	-	-	-	-	**38** (3)	**14** (3)	**14** (3)	186	-	-	-	-	-	-	-	-	**60** (3)	**38** (3)	**22** (3)	263	-	-	-	-
	450		LD	-	-	-	-	-	-	-	-	**38** (3)	**14** (3)	**14** (3)	177	-	-	-	-	-	-	-	-	**60** (3)	**38** (3)	**22** (3)	250
	400	FRN400VG1□-4J	HD	**38** (2)	**22** (2)	**14** (2)	186	-	-	-	-	-	-	-	-	**60** (3)	**38** (3)	**22** (3)	263	-	-	-	-	-	-	-	-
	450		MD	-	-	-	-	**60** (3)	**22** (3)	**14** (3)	228	-	-	-	-	-	-	-	-	**100** (3)	**38** (3)	**38** (3)	322	-	-	-	-
	500		LD	-	-	-	-	-	-	-	-	**38** (3)	**14** (3)	**14** (3)	186	-	-	-	-	-	-	-	-	**60** (3)	**38** (3)	**22** (3)	263
	500	FRN500VG1□-4J	HD	**38** (4)	**22** (4)	**14** (4)	240	-	-	-	-	-	-	-	-	**60** (4)	**38** (4)	**22** (4)	340	-	-	-	-	-	-	-	-
	630		LD	-	-	-	-	-	-	-	-	**38** (4)	**14** (4)	**14** (4)	241	-	-	-	-	-	-	-	-	**60** (4)	**38** (4)	**22** (4)	341
	630	FRN630VG1□-4J	HD	**60** (4)	**38** (4)	**22** (4)	293	-	-	-	-	-	-	-	-	**100** (4)	**38** (4)	**38** (4)	381	-	-	-	-	-	-	-	-
	710		LD	-	-	-	-	-	-	-	-	**60** (4)	**22** (4)	**14** (4)	278	-	-	-	-	-	-	-	-	**100** (4)	**38** (4)	**38** (4)	394

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Note 3: **Bolded values** (*n*) denote wire sizes to be applied when a braking unit (BU) or braking resistor (DBR) is connected in parallel.

Bolded values in upper position: Wire sizes per unit connected in parallel
(*n*) in lower position: Number of parallels. For example, (2) denotes two parallels.

When a relay terminal block is provided and branching from the terminal block to each braking unit (BU) or braking resistor (DBR) is made, the wire size between the inverter and the relay terminal block should be selected based on the current values.

The wire sizes are selected for parallel wiring, taking into account the safety coefficient.
- 2 units in parallel: Current value x 1/85%
- 3 units in parallel: Current value x 1/80%
- 4 units in parallel: Current value x 1/70%

■ If the internal temperature of your power control panel is 40°C or below

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product												20% ED product											
				For braking resistor connection 〔P(+),DB〕												For braking resistor connection 〔P(+),DB〕											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (A)	Maximum temperature (Note 1)			Cur-rent (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		60°C	75°C	90°C		60°C	75°C	90°C	
Three-phase 200V	0.75	FRN0.75VG1☐-2J	HD	2.0	2.0	2.0	1.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-
	1.5	FRN1.5VG1☐-2J	HD	2.0	2.0	2.0	1.9	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.7	-	-	-	-	-	-	-	-
	2.2	FRN2.2VG1☐-2J	HD	2.0	2.0	2.0	2.3	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.3	-	-	-	-	-	-	-	-
	3.7	FRN3.7VG1☐-2J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1☐-2J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1☐-2J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	11	FRN11VG1☐-2J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	15	FRN15VG1☐-2J	HD	2.0	2.0	2.0	13.7	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1☐-2J	HD	2.0	2.0	2.0	17.6	-	-	-	-	-	-	-	-	3.5	2.0	2.0	24.8	-	-	-	-	-	-	-	-
	22	FRN22VG1☐-2J	HD	2.0	2.0	2.0	20.3	-	-	-	-	-	-	-	-	3.5	2.0	2.0	28.7	-	-	-	-	-	-	-	-
	30	FRN30VG1☐-2J	HD	3.5	3.5	2.0	30.0	-	-	-	-	-	-	-	-	5.5	3.5	3.5	38.7	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	3.5	3.5	2.0	29.8	-	-	-	-	-	-	-	-	5.5	3.5	3.5	38.5
	37	FRN37VG1☐-2J	HD	5.5	3.5	3.5	35.1	-	-	-	-	-	-	-	-	8.0	5.5	5.5	48.1	-	-	-	-	-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	5.5	3.5	3.5	34.6	-	-	-	-	-	-	-	-	8.0	5.5	5.5	47.4
	45	FRN45VG1☐-2J	HD	8.0	5.5	3.5	41.1	-	-	-	-	-	-	-	-	14	8.0	5.5	58.1	-	-	-	-	-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	8.0	5.5	3.5	40.6	-	-	-	-	-	-	-	-	14	8.0	5.5	57.4
	55	FRN55VG1☐-2J	HD	14	5.5	5.5	50.8	-	-	-	-	-	-	-	-	14	14	8.0	71.8	-	-	-	-	-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	14	8.0	5.5	53.0	-	-	-	-	-	-	-	-	22	14	8.0	75.0
	75	FRN75VG1☐-2J	HD	**8** (2)	**5.5** (2)	**3.5** (2)	68.5	-	-	-	-	-	-	-	-	**14** (2)	**8** (2)	**5.5** (2)	96.8	-	-	-	-	-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	**5.5** (2)	**5.5** (2)	**3.5** (2)	67.1	-	-	-	-	-	-	-	-	**14** (2)	**8** (2)	**5.5** (2)	94.9
	90	FRN90VG1☐-2J	HD	**8** (2)	**5.5** (2)	**5.5** (2)	82.2	-	-	-	-	-	-	-	-	**14** (2)	**8** (2)	**8** (2)	116	-	-	-	-	-	-	-	-
	110		LD	-	-	-	-	-	-	-	-	**8** (2)	**5.5** (2)	**5.5** (2)	81.2	-	-	-	-	-	-	-	-	**14** (2)	**14** (2)	**8** (2)	115

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: ☐ in the inverter model represents an alphabet.

☐
└── S (Basic type)

Note 3: **Bolded values** (*n*) denote wire sizes to be applied when a braking unit (BU) or braking resistor (DBR) is connected in parallel.

Bolded values in upper position: Wire sizes per unit connected in parallel
(*n*) in lower position: Number of parallels. For example, (2) denotes two parallels.

When a relay terminal block is provided and branching from the terminal block to each braking unit (BU) or braking resistor (DBR) is made, the wire size between the inverter and the relay terminal block should be selected based on the current values.

The wire sizes are selected for parallel wiring, taking into account the safety coefficient.
- 2 units in parallel: Current value x 1/85%
- 3 units in parallel: Current value x 1/80%
- 4 units in parallel: Current value x 1/70%

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product, For braking resistor connection 〔P(+),DB〕, HD, Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	MD, Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	LD, Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	20% ED product, For braking resistor connection 〔P(+),DB〕, HD, Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	MD, Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)	LD, Maximum temperature (Note 1) 60°C	75°C	90°C	Current (A)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	2.0	2.0	2.0	1.7	-	-	-	-	-	-	-	-	2.0	2.0	2.0	2.4	-	-	-	-	-	-	-	-
	5.5	FRN5.5VG1□-4J	HD	2.0	2.0	2.0	2.5	-	-	-	-	-	-	-	-	2.0	2.0	2.0	3.6	-	-	-	-	-	-	-	-
	7.5	FRN7.5VG1□-4J	HD	2.0	2.0	2.0	3.4	-	-	-	-	-	-	-	-	2.0	2.0	2.0	4.8	-	-	-	-	-	-	-	-
	11	FRN11VG1□-4J	HD	2.0	2.0	2.0	5.1	-	-	-	-	-	-	-	-	2.0	2.0	2.0	7.2	-	-	-	-	-	-	-	-
	15	FRN15VG1□-4J	HD	2.0	2.0	2.0	6.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	9.7	-	-	-	-	-	-	-	-
	18.5	FRN18.5VG1□-4J	HD	2.0	2.0	2.0	8.8	-	-	-	-	-	-	-	-	2.0	2.0	2.0	12.4	-	-	-	-	-	-	-	-
	22	FRN22VG1□-4J	HD	2.0	2.0	2.0	10.2	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.4	-	-	-	-	-	-	-	-
	30	FRN30VG1□-4J	HD	2.0	2.0	2.0	15.0	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19.4	-	-	-	-	-	-	-	-
	37		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	14.9	-	-	-	-	-	-	-	-	2.0	2.0	2.0	19.2
	37	FRN37VG1□-4J	HD	2.0	2.0	2.0	17.6					-	-	-	-	3.5	2.0	2.0	24.8					-	-	-	-
	45		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	17.3	-	-	-	-	-	-	-	-	3.5	2.0	2.0	24.5
	45	FRN45VG1□-4J	HD	2.0	2.0	2.0	20.5					-	-	-	-	3.5	3.5	2.0	29.0					-	-	-	-
	55		LD	-	-	-	-	-	-	-	-	2.0	2.0	2.0	20.3	-	-	-	-	-	-	-	-	3.5	2.0	2.0	28.7
	55	FRN55VG1□-4J	HD	3.5	2.0	2.0	25.2					-	-	-	-	5.5	3.5	3.5	35.6					-	-	-	-
	75		LD	-	-	-	-	-	-	-	-	3.5	2.0	2.0	26.3	-	-	-	-	-	-	-	-	5.5	3.5	3.5	37.2
	75	FRN75VG1□-4J	HD	5.5	3.5	3.5	34.6					-	-	-	-	8.0	5.5	5.5	48.9					-	-	-	-
	90		LD	-	-	-	-	-	-	-	-	5.5	3.5	2.0	33.9	-	-	-	-	-	-	-	-	8.0	5.5	5.5	47.9
	90	FRN90VG1□-4J	HD	8.0	5.5	3.5	41.6					-	-	-	-	14	8.0	5.5	58.8					-	-	-	-
	110		MD	-	-	-	-	14	5.5	5.5	50.8					-	-	-	-	14	14	8.0	71.8				
	110		LD					-	-	-	-	8.0	5.5	3.5	41.1					-	-	-	-	14	8.0	5.5	58.2
	110	FRN110VG1□-4J	HD	14	5.5	5.5	50.8					-	-	-	-	14	14	8.0	71.8					-	-	-	-
	132		MD	-	-	-	-	14	8.0	5.5	61.7					-	-	-	-	22	14	14	87.3				
	132		LD					-	-	-	-	8.0	5.5	5.5	49.7					-	-	-	-	14	14	8.0	70.4
	132	FRN132VG1□-4J	HD	14	8.0	5.5	61.7					-	-	-	-	22	14	14	87.3					-	-	-	-
	160		MD	-	-	-	-	22	14	8.0	73.9					-	-	-	-	38	22	14	104				
	160		LD					-	-	-	-	14	8.0	5.5	60.8					-	-	-	-	22	14	14	85.9
	160	FRN160VG1□-4J	HD	22	14	8.0	73.9					-	-	-	-	38	22	14	104					-	-	-	-
	200		MD	-	-	-	-	22	14	14	92.6					-	-	-	-	38	38	22	131				
	200		LD					-	-	-	-	22	14	8.0	73.9					-	-	-	-	38	22	14	104

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Table 8.4 Wire Size (for braking resistor) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	10% ED product, For braking resistor connection [P(+),DB]												20% ED product, For braking resistor connection [P(+),DB]											
				HD				MD				LD				HD				MD				LD			
				Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 1)			Current (A)	Maximum temperature (Note 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		60°C	75°C	90°C		60°C	75°C	90°C	
	200	FRN200VG1☐-4J	HD	**14** (2)	**5.5** (2)	**5.5** (2)	92.6	-	-	-	-	-	-	-	-	**22** (2)	**14** (2)	**8** (2)	131	-	-	-	-	-	-	-	-
	220	FRN200VG1☐-4J	MD	-	-	-	-	**14** (2)	**8** (2)	**5.5** (2)	102					-	-	-	-	**22** (2)	**14** (2)	**14** (2)	144				
	220	FRN200VG1☐-4J	LD					-	-	-	-	**14** (2)	**5.5** (2)	**5.5** (2)	86.8					-	-	-	-	**22** (2)	**14** (2)	**8** (2)	123
	220	FRN220VG1☐-4J	HD	**14** (2)	**8** (2)	**5.5** (2)	102					-	-	-	-	**22** (2)	**14** (2)	**14** (2)	144					-	-	-	-
	250	FRN220VG1☐-4J	MD	-	-	-	-	**14** (2)	**14** (2)	**8** (2)	120					-	-	-	-	**38** (2)	**22** (2)	**14** (2)	170				
	280	FRN220VG1☐-4J	LD					-	-	-	-	**14** (2)	**8** (2)	**5.5** (2)	102					-	-	-	-	**22** (2)	**14** (2)	**14** (2)	145
	280	FRN280VG1☐-4J	HD	**22** (2)	**14** (2)	**8** (2)	138					-	-	-	-	**38** (2)	**22** (2)	**14** (2)	195					-	-	-	-
	315	FRN280VG1☐-4J	MD	-	-	-	-	**22** (2)	**14** (2)	**14** (2)	147					-	-	-	-	**38** (2)	**22** (2)	**22** (2)	207				
	355	FRN280VG1☐-4J	LD					-	-	-	-	**22** (2)	**14** (2)	**14** (2)	139					-	-	-	-	**38** (2)	**22** (2)	**22** (2)	197
	315	FRN315VG1☐-4J	HD	**22** (2)	**14** (2)	**14** (2)	147					-	-	-	-	**38** (2)	**22** (2)	**22** (2)	207					-	-	-	-
	355	FRN315VG1☐-4J	MD	-	-	-	-	**14** (3)	**14** (3)	**8** (3)	175					-	-	-	-	**38** (3)	**22** (3)	**14** (3)	248				
	400	FRN315VG1☐-4J	LD					-	-	-	-	**22** (2)	**14** (2)	**14** (2)	148					-	-	-	-	**60** (2)	**38** (2)	**22** (2)	235
	355	FRN355VG1☐-4J	HD	**14** (3)	**14** (3)	**8** (3)	175					-	-	-	-	**38** (3)	**22** (3)	**14** (3)	248					-	-	-	-
	400	FRN355VG1☐-4J	MD	-	-	-	-	**22** (3)	**14** (3)	**8** (3)	186					-	-	-	-	**38** (3)	**22** (3)	**14** (3)	263				
	450	FRN355VG1☐-4J	LD					-	-	-	-	**14** (3)	**14** (3)	**8** (3)	177					-	-	-	-	**38** (3)	**22** (3)	**14** (3)	250
	400	FRN400VG1☐-4J	HD	**22** (3)	**14** (3)	**8** (3)	186	-	-	-	-	-	-	-	-	**38** (3)	**22** (3)	**14** (3)	263					-	-	-	-
	450	FRN400VG1☐-4J	MD	-	-	-	-	**38** (3)	**14** (3)	**14** (3)	228					-	-	-	-	**60** (3)	**38** (3)	**22** (3)	322				
	500	FRN400VG1☐-4J	LD	-	-	-	-	-	-	-	-	**22** (3)	**14** (3)	**8** (3)	186					-	-	-	-	**38** (3)	**22** (3)	**14** (3)	263
	500	FRN500VG1☐-4J	HD	**22** (4)	**14** (4)	**14** (4)	240					-	-	-	-	**38** (4)	**22** (4)	**22** (4)	340					-	-	-	-
	630	FRN500VG1☐-4J	LD	-	-	-	-	-	-	-	-	**22** (4)	**14** (4)	**14** (4)	241	-	-	-	-	-	-	-	-	**38** (4)	**22** (4)	**22** (4)	341
	630	FRN630VG1☐-4J	HD	**22** (4)	**14** (4)	**14** (4)	293					-	-	-	-	**38** (4)	**22** (4)	**22** (4)	381					-	-	-	-
	710	FRN630VG1☐-4J	LD	-	-	-	-	-	-	-	-	**38** (4)	**22** (4)	**14** (4)	278	-	-	-	-	-	-	-	-	**60** (4)	**38** (4)	**22** (4)	394

Note 1: Assuming the use of aerial wiring (without rack or duct): 600 V class of vinyl-insulated IV wires for 60°C, 600 V class of polyethylene-insulated HIV wires for 75°C, and 600 V cross-linked polyethylene insulated wires for 90°C.

Note 2: ☐ in the inverter model represents an alphabet.

☐
└── S (Basic type)

Note 3: **Bolded values** (*n*) denote wire sizes to be applied when a braking unit (BU) or braking resistor (DBR) is connected in parallel.

Bolded values in upper position: Wire sizes per unit connected in parallel
(*n*) in lower position: Number of parallels. For example, (2) denotes two parallels.

When a relay terminal block is provided and branching from the terminal block to each braking unit (BU) or braking resistor (DBR) is made, the wire size between the inverter and the relay terminal block should be selected based on the current values.

The wire sizes are selected for parallel wiring, taking into account the safety coefficient.
- 2 units in parallel: Current value x 1/85%
- 3 units in parallel: Current value x 1/80%
- 4 units in parallel: Current value x 1/70%

8.4 Peripheral Equipment

8.4.1 Molded case circuit breaker or residual-current-operated protective device/earth leakage circuit breaker/magnetic contactor

8.4.1.1 Functional overview

■ **MCCBs and RCDs/ELCBs*** * With overcurrent protection

Molded Case Circuit Breakers (MCCBs) are designed to protect the power circuits between the power supply and inverter's main circuit terminals ([L1/R], [L2/S] and [L3/T]) from overload or short-circuit, which in turn prevents secondary accidents caused by the broken inverter.

Residual-Current-Operated Protective Devices (RCDs)/Earth Leakage Circuit Breakers (ELCBs) function in the same way as MCCBs.

Built-in overcurrent/overload protective functions protect the inverter itself from failures related to its input/output lines.

■ **MCs**

An MC can be used at both the power input and output sides of the inverter. At each side, the MC works as described below. Use as needed. When inserted in the output circuit of the inverter, the MC can also switch the motor drive power supply between the inverter output and commercial power lines.

At the power supply side

Insert an MC in the power supply side of the inverter in order to:

(1) Forcibly cut off the inverter from the power supply (generally, commercial/factory power lines) with the protective function built into the inverter, or with the external signal input.

(2) Stop the inverter operation in an emergency when the inverter cannot interpret the stop command due to internal/external circuit failures.

(3) Cut off the inverter from the power supply when the MCCB inserted in the power supply side cannot cut it off for maintenance or inspection purpose. For the purpose only, it is recommended that you use an MC capable of turning the MC ON/OFF manually.

Note Avoid frequent ON/OFF operation of the magnetic contactor (MC) in the input circuit; otherwise, the inverter failure may result.

The frequency of the MC's ON/OFF should not be more than once per 30 minutes. To assure 10-year or longer service life of the inverter, it should not be more than once per hour.

If frequent start/stop of the motor is required, use FWD/REV terminal signals or the FWD / REV / STOP keys on the inverter's keypad.

At the output side

Insert an MC in the power output side of the inverter in order to:

(1) Prevent externally turned-around current from being applied to the inverter power output terminals ([U], [V], and [W]) unexpectedly. An MC should be used, for example, when a circuit that switches the motor driving power supply between the inverter output and commercial power lines is connected to the inverter.

Tip If a magnetic contactor (MC) is inserted in the inverter's output (secondary) circuit for switching the motor to a commercial power or for any other purposes, it should be switched on and off when both the inverter and motor are completely stopped. This prevents the contact point from getting rough due to a switching arc of the MC. The MC should not be equipped with any main circuit surge killer (Fuji SZ-ZM☐, etc.).

Applying a commercial power to the inverter's output circuit breaks the inverter. To avoid it, interlock the MC on the motor's commercial power line with the one in the inverter output circuit so that they are not switched ON at the same time.

(2) Drive more than one motor selectively by a single inverter.

(3) Selectively cut off the motor whose thermal overload relay or equivalent devices have been activated.

Driving the motor using commercial power lines

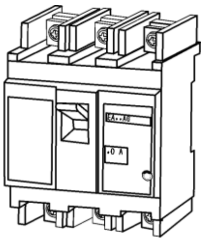
MCs can also be used to switch the power supply of the motor driven by the inverter to a commercial power supply.

Select the MC so as to satisfy the rated currents listed in Table 8.1, which are the most critical RMS currents for using the inverter. (Refer to Table 8.4) For switching the motor drive source between the inverter output and commercial power lines, use the MC of class AC3 specified by JIS C8325 in the commercial line side.

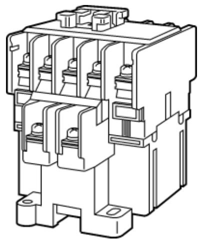
8.4.1.2 Connection example and criteria for selection of circuit breakers

Figure 8.2 shows a connection example for MCCB or RCD/ELCB (with overcurrent protection) and MC in the inverter input circuit. Table 8.5 lists the rated current for the MCCB and corresponding inverter models. Table 8.6 lists the applicable grades of RCD/ELCB sensitivity.

⚠WARNING
Insert an MCCB or RCD/ELCB (with overcurrent protection) recommended for each inverter for its input circuits. Do not use an MCCB or RCD/ELCB of a higher rating than that recommended. **Doing so could result in a fire.**



Molded case circuit breaker or residual-current-operated protective device/ earth leakage circuit breaker



Magnetic contactor

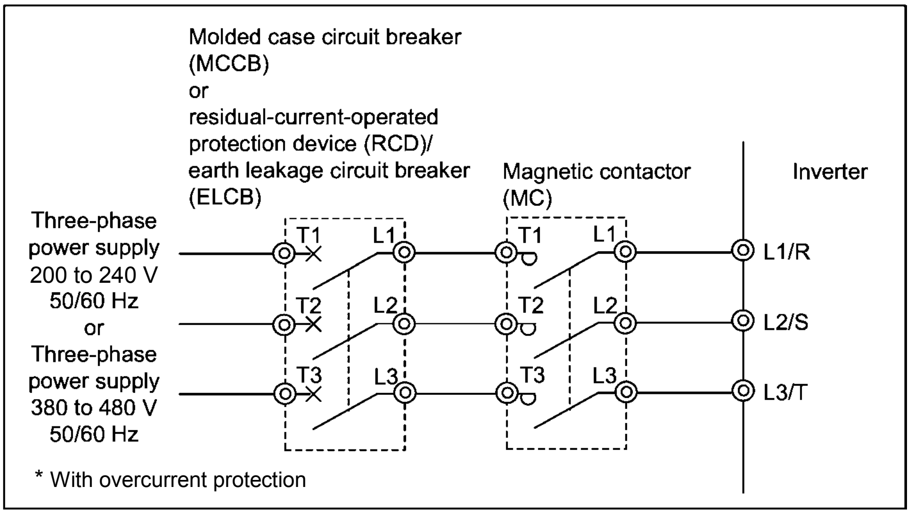


Figure 8.2 External Views of MCCB or RCD/ELCB and MC and Connection Example

Table 8.5 Rated Current of Molded Case Circuit Breaker (MCCB), Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) and Magnetic Contactor (MC)

HD (High Duty) mode: Heavy duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	MCCB, ELCB Rated current(A)		Magnetic contactor (MC)			
				DC reactor (DCR)		For input circuit		For output circuit	
						DC reactor (DCR)			
				w/ DCR	w/o DCR	w/ DCR	w/o DCR	HD	LD
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	5	10	SC-05	SC-05	SC-05	-
	1.5	FRN1.5VG1□-2J		10	15				
	2.2	FRN2.2VG1□-2J			20				
	3.7	FRN3.7VG1□-2J		20	30		SC-5-1		
	5.5	FRN5.5VG1□-2J		30	50		SC-N1	SC-4-0	
	7.5	FRN7.5VG1□-2J		40	75	SC-5-1	SC-N2	SC-N1	-
	11	FRN11VG1□-2J		50	100	SC-N1	SC-N2S	SC-N1	-
	15	FRN15VG1□-2J		75	125	SC-N2	SC-N3	SC-N2	-
	18.5	FRN18.5VG1□-2J		100	150	SC-N2S	SC-N4	SC-N2S	-
	22	FRN22VG1□-2J			175		SC-N5	SC-N3	-
	30	FRN30VG1□-2J		150	200	SC-N4	SC-N7	SC-N4	-
	37		LD	175	250	SC-N5	SC-N8	-	SC-N5
		FRN37VG1□-2J	HD					SC-N5	-
	45		LD	200	300	SC-N7		-	SC-N7
		FRN45VG1□-2J	HD					SC-N7	-
	55		LD	250	350	SC-N8	SC-N11	-	SC-N8
		FRN55VG1□-2J	HD					SC-N8	-
	75		LD	350	-	SC-N11	-	-	SC-N10
		FRN75VG1□-2J	HD					SC-N11	-
	90		LD	400				-	SC-N11
		FRN90VG1□-2J	HD					SC-N11	-
	110		LD	500		SC-N12		-	SC-N12

Note: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

- Install the MCCB or RCD/ELCB at the input side of the inverter. They cannot be installed at the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C. The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in a surrounding temperature of 40°C or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the 600 V HIV (allowable surrounding temperature: 75°C) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 8.5 Rated Current of Molded Case Circuit Breaker (MCCB), Residual-Current-Operated Protective Device (RCD)/Earth Leakage Circuit Breaker (ELCB) and Magnetic Contactor (MC) (continued)

HD (High Duty) mode: Heavy duty load applications
MD (Medium Duty) mode: Medium duty load applications
LD (Low Duty) mode: Light duty load applications

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	MCCB, ELCB Rated current(A)		Magnetic contactor (MC)				
						For input circuit		For output circuit		
				DC reactor (DCR)		DC reactor (DCR)		HD	MD	LD
				w/ DCR	w/o DCR	w/ DCR	w/o DCR			
Three-phase 400V	3.7	FRN3.7VG1□-4	HD	10	20	SC-05	SC-05	SC-05	-	-
	5.5	FRN5.5VG1□-4		15	30		SC-4-0			
	7.5	FRN7.5VG1□-4		20	40		SC-5-1	SC-05		-
	11	FRN11VG1□-4		30	50		SC-N1	SC-4-0		-
	15	FRN15VG1□-4		40	60	SC-5-1		SC-5-1		-
	18.5	FRN18.5VG1□-4			75	SC-N1	SC-N2	SC-N1		-
	22	FRN22VG1□-4		50	100		SC-N2S	SC-N1		-
	30	FRN30VG1□-4		75	125	SC-N2	SC-N3	SC-N2		-
	37		LD	100		SC-N2S	SC-N4	-		SC-N2S
		FRN37VG1□-4	HD					SC-N2S		-
	45		LD		150	SC-N3		-		SC-N3
		FRN45VG1□-4	HD					SC-N3		-
	55		LD	125	200		SC-N5	-		SC-N4
		FRN55VG1□-4	HD					SC-N4		-
	75		LD	175	-	SC-N4	-	-		SC-N5
		FRN75VG1□-4	HD					SC-N5		-
	90		LD	200		SC-N7		-		SC-N7
		FRN90VG1□-4	HD					SC-N7		-
	110		MD/LD	250		SC-N8		-	SC-N8	SC-N8
		FRN110VG1□-4	HD					SC-N8	-	-
	132		MD/LD	300				-	SC-N8	SC-N8
		FRN132VG1□-4	HD					SC-N8	-	-
	160		MD/LD	350		SC-N11		-	SC-N11	SC-N11
		FRN160VG1□-4	HD					SC-N11	-	-
	200		MD/LD	500		SC-N12		-	SC-N12	SC-N12
		FRN200VG1□-4	HD					SC-N12	-	-
	220		MD/LD					-	SC-N12	SC-N12
		FRN220VG1□-4	HD					SC-N12	-	-
	250		MD	600				-	SC-N14	
	280		LD			SC-N14			-	SC-N14
		FRN280VG1□-4	HD					SC-N14		-
	315		MD	800				-	SC-N14	
	355		LD						-	SC-N14
	315	FRN315VG1□-4	HD					SC-N14		-
	355		MD					-	SC-N14	
	400		LD	1200		SC-N16			-	SC-N16
	355	FRN355VG1□-4	HD	800		SC-N14		SC-N14		-
	400		MD	1200		SC-N16		-	SC-N16	
	450		LD						-	610CM*
	400	FRN400VG1□-4	HD					SC-N16		-
	450		MD					-	610CM*	
	500		LD			610CM*			-	610CM*
		FRN500VG1□-4	HD					610CM*		-
	630		LD	1400		612CM*		-		612CM*
		FRN630VG1□-4	HD					612CM*		-
	710		LD	1600		616CM*		-		616CM*

* 610CM, 612CM and 616CM: Please contact us for further informations.

Note: □ in the inverter model represents an alphabet.

□ └── S (Basic type)

- Install the MCCB or RCD/ELCB at the input side of the inverter. They cannot be installed at the output side of the inverter.
- The above table lists the rated current of MCCBs and RCD/ELCBs to be used in the power control panel with an internal temperature of lower than 50°C. The rated current is factored by a correction coefficient of 0.85 as the RCDs'/MCCBs' and ELCBs' original rated current is specified when using them in a surrounding temperature of 40°C or lower. Select an MCCB and/or RCD/ELCB suitable for the actual short-circuit breaking capacity needed for your power systems.
- For the selection of the MC type, it is assumed that the 600 V HIV (allowable surrounding temperature: 75°C) wires for the power input/output of the inverter are used. If an MC type for another class of wires is selected, the wire size suitable for the terminal size of both the inverter and the MC type should be taken into account.
- Use ELCBs with overcurrent protection.
- To protect your power systems from secondary accidents caused by the broken inverter, use an MCCB and/or RCD/ELCB with the rated current listed in the above table. Do not use an MCCB or RCD/ELCB with a rating higher than that listed.

Table 8.6 lists the relationship between the rated leakage current sensitivity of RCDs/ELCBs (with overcurrent protection) and wiring length of the inverter output circuits. Note that the sensitivity levels listed in the table are estimated values based on the results obtained by the test setup in the Fuji laboratory where each inverter drives a single motor.

Table 8.6 Rated Current Sensitivity of Residual-Current-Operated Protective Devices (RCDs)/Earth Leakage Circuit Breakers (ELCBs)

Power supply voltage	Standard application motor (kW)	Wire distance/current sensitivity					
		10 m	30 m	50 m	100 m	200 m	300 m
Three-phase 200V	0.75						
	1.5						
	2.2		30 mA				
	3.7						
	5.5						
	7.5				100 mA		
	11						
	15						
	18.5					200 mA	
	22						
	30						
	37						
	45						
	55						
	75						500 mA
	90						
	110						
Three-phase 400V	3.7						
	5.5						
	7.5	30 mA					
	11			100 mA			
	15						
	18.5						
	22				200 mA		
	30						
	37						
	45					500 mA	
	55						
	75						
	90						
	110						
	132						1000 mA
	160						(Special)
	200						
	220						
	250						
	280						
	315						
	355						3000 mA
	400						(Special)
	450						
	500						
	630						
	710						

- Values listed above were obtained using Fuji ELCB EG or SG series applied to the test setup.
- The rated current of applicable motor rating indicates values for Fuji standard motor (4 poles, 50 Hz and 200 V three-phase).
- The leakage current is calculated based on grounding of the single wire for 200 V class delta connection and neutral grounding for 400 V class Y-connection power lines.
- Values listed above are calculated based on the static capacitance to the earth when the 600 V class of vinyl-insulated IV wires are used in a wiring through metal conduit pipes.
- Wiring length is the total length of wiring between the inverter and motor. If more than one motor is to be connected to a single inverter, the wiring length should be the total length of wiring between the inverter and motors.

8.4.2 Surge killer for L-load

A surge killer absorbs surge voltage induced by L-load of an electro magnetic switch or solenoid valve. Use of a surge killer is effective in preventing the electronic equipment, including inverters, from damage or malfunctioning caused by such surges.

Install a surge killer near the power coil of the surge source. Connected to the inverter's power source side, as shown in Figure 8.3, a surge killer absorbs the surge voltage, preventing the electronic equipment, from damage or malfunctioning. (The maximum capacity is 3.7 kW.)

Refer to the catalog "Fuji Surge Killers/Absorbers (HS118: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.

Note: Do not use the capacitor in the inverter secondary (output) line.

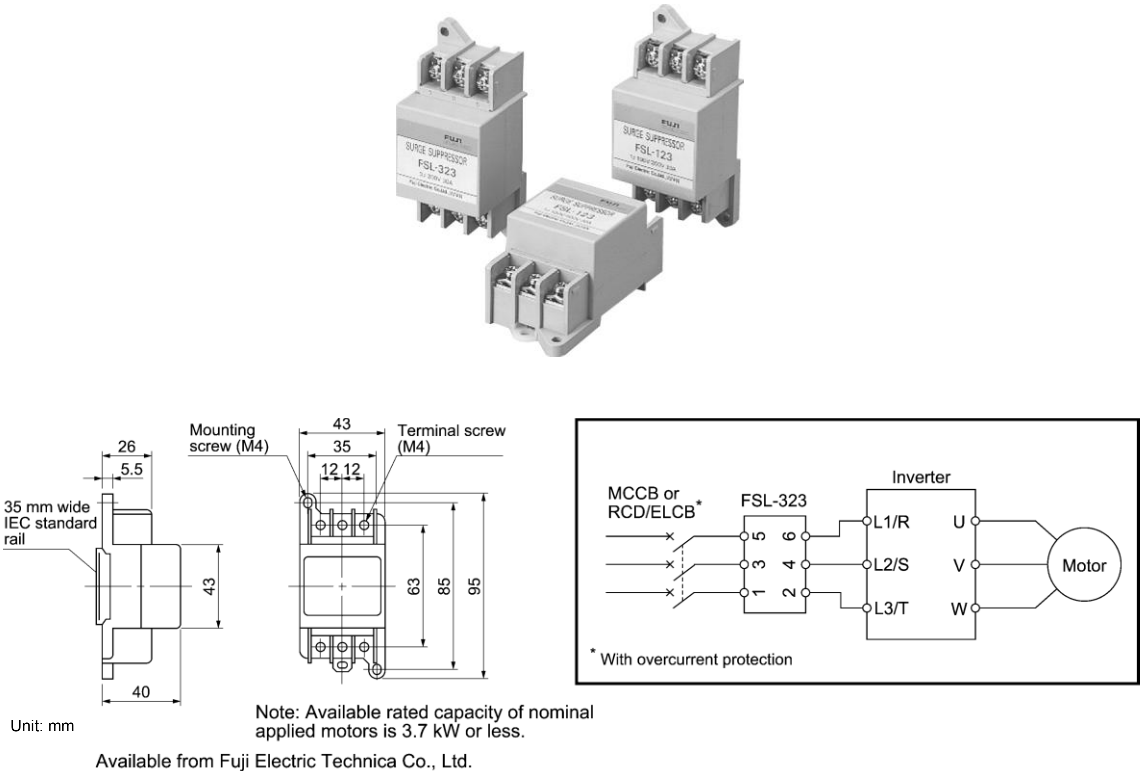


Figure 8.3 Dimensions of Surge Killer and Connection Example

8.4.3 Arrester

An arrester suppresses surge currents induced by lightning invaded from the power supply lines. Common use of the grounding wire that is used for electric equipment in the panel, with the arrester, is effective in preventing electronic equipment from damage or malfunctioning caused by such surges.

Applicable arrester models are CN5132 for three-phase 200 V class series, and CN5134 for three-phase 400 V class series. (The CN5232 and CN5234 series with 20 kA of discharge withstand current rating are also available.)

Figure 8.4 shows their external dimensions and connection examples. Refer to the catalog "Fuji Surge Killers/Absorbers (HS118: Japanese edition only)" for details. These products are available from Fuji Electric Technica Co., Ltd.

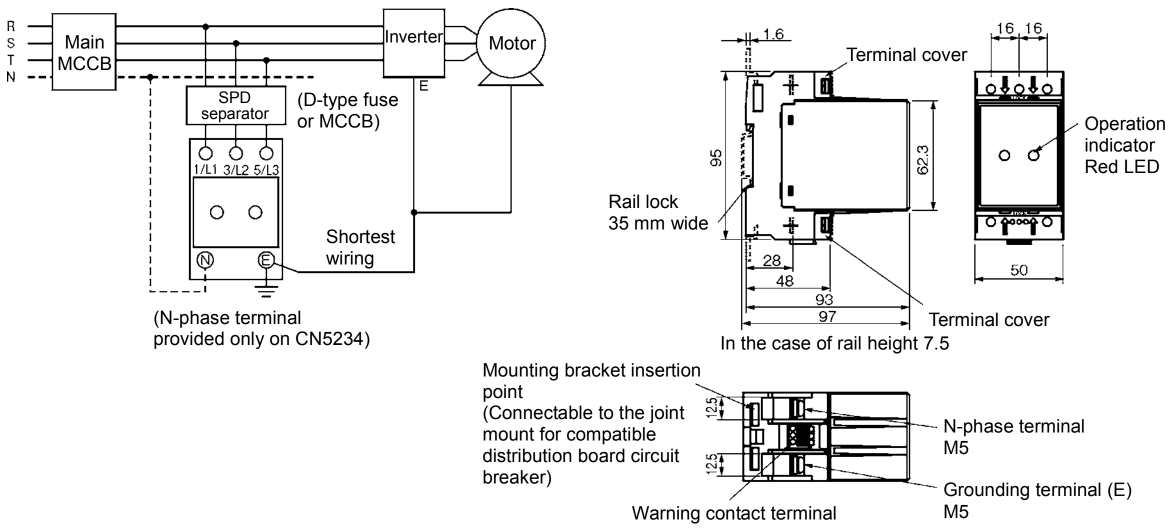


Figure 8.4 Arrester Dimensions and Connection Examples

8.4.4 Surge absorber

A surge absorber absorbs surges or noises generated by a magnetic contactor (MC) or solenoid valve in the power system to effectively protect electronic equipment in the panel from malfunctions or breakdown. Installed parallel to a coil of an MC, solenoid valve, or L load, a surge absorber absorbs a surge voltage.

The type of surge absorber is S2-A-O and S1-B-O. Figure 8.5 shows their external dimensions.

The surge absorbers are available from Fuji Electric Technica Co., Ltd.

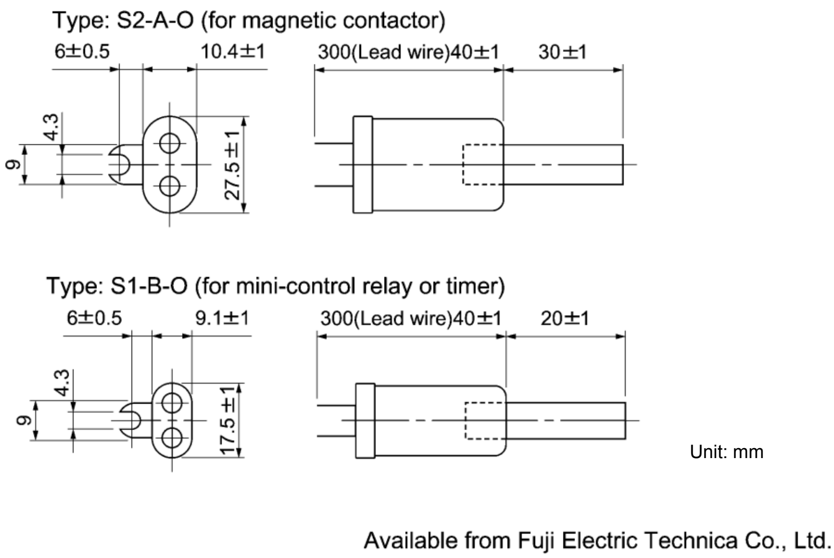


Figure 8.5 Surge Absorber Dimensions

8.4.5 Filter capacitor for radio noise reduction

These capacitors are effective to suppress AM radio band (less than 1 MHz) noises. Using them with Zero-phase reactors upgrades capability.

Applicable models are NFM25M315KPD1 for 200 V class series inverters and NFM60M315KPD for 400 V class. Use one of them no matter what the inverter capacity. Figure 8.6 shows their external dimensions. The surge absorbers are available from Fuji Electric Technica Co., Ltd.

Note: Do not use the capacitor in the inverter secondary (output) line.

NFM25M315KPD1 NFM60M315KPD

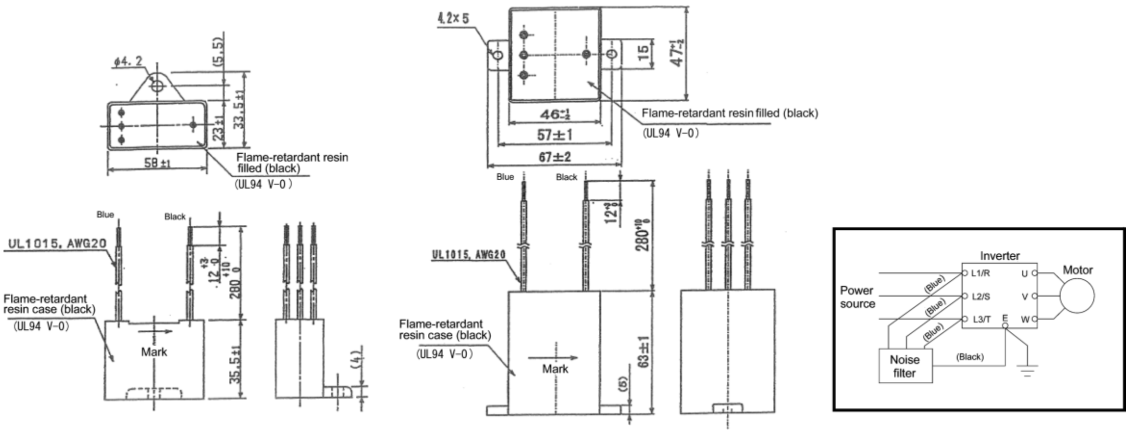


Figure 8.6 Filtering Capacitors Dimensions

8.5 Peripheral Equipment Options

8.5.1 Braking resistors (DBRs) and braking units

8.5.1.1 Braking resistors (DBRs)

A braking resistor converts regenerative energy generated from deceleration of the motor to heat for consumption. Use of a braking resistor results in improved deceleration performance of the inverter. FRENIC-VG provides 2 types: Standard 10% ED product and 20% ED product.

📖 Refer to Chapter 9, Section 9.2 "Selecting a Braking Resistor."

(1) 10% ED product, 20% ED product

The standard model of a braking resistor integrates a facility that detects the temperature on the heat sink of the resistor and outputs a digital ON/OFF signal if the temperature exceeds the specified level (as an overheating warning signal). To ensure that the signal is recognized at one of the digital input terminals of the FRENIC-VG, assign the external alarm THR to any of terminals [X1] to [X9]. Connect the assigned terminals to terminals [1] and [2] of the braking resistor. Upon detection of the warning signal, the inverter simultaneously transfers to Alarm mode, displays alarm 0h2 on the LED monitor and shuts down its power output.

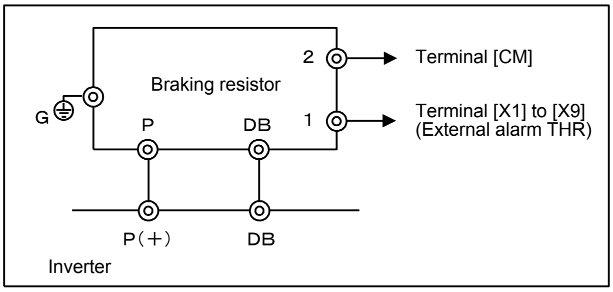


Figure 8.7 Braking Resistor (Standard Model) and Connection Example

📖 For the specifications and external dimensions of the braking units, refer to [3] and [4] in this Section.

8.5.1.2 Braking units

Add a braking unit to the braking resistor to upgrade the braking capability of inverters with the followings.

HD mode: 75 kW or above (200V series), 200 kW or above (400V series)
LD mode: 75 kW or above (200V series), 200 kW or above (400V series)
MD mode: 200 kW or above (400V series)

Inverters other than above have built-in IGBTs for the braking resistor.

Figure 8.8 Braking Unit

📖 For the specifications and external dimensions of the braking units, refer to [3] and [4] in this Section.
For details, refer to the Instruction Manual (INR-HF51196).

8.5.1.3 Specifications and connection example

Table 8.7 Generated Loss in Braking Unit

Model	Generated loss (W)	
	Standard model	With fan unit
BU55-2C	50	150
BU90-2C	60	180
BU220-4C	80	240

■HD-mode Inverters

Table 8.8 (a) Braking Unit/Braking Resistor (Standard ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options					Maximum braking torque (%)			Continuous braking (converted to 150% torque value)		Repetitive braking (at 100s interval or less)	
				Braking unit		Braking resistor				Torque (N·m)					
				Model	Qty. (units)	Model	Qty. (units)	Resistance value (Ω)		50 Hz	60 Hz	Braking time (s)	Discharging capability (kWs)	Duty cycle (%ED)	Average loss (kW)
Three-phase 200V	0.75	FRN0.75VG1S-2J	A			DB2.2V-21B	1	30	150	7.16	5.97	10	16.5	10	0.165
	1.5	FRN1.5VG1S-2J				DB2.2V-21B	1	30	150	14.3	11.9	10	16.5	10	0.165
	2.2	FRN2.2VG1S-2J				DB2.2V-21B	1	30	150	21.0	17.5	10	16.5	10	0.165
	3.7	FRN3.7VG1S-2J				DB3.7V-21B	1	24	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG1S-2J				DB5.5V-21B	1	16	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG1S-2J				DB7.5V-21B	1	12	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG1S-2J		–	–	DB11V-21B	1	8.0	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG1S-2J				DB15V-21B	1	6.0	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG1S-2J				DB18.5V-21B	1	4.5	150	177	147	10	139	10	1.39
	22	FRN22VG1S-2J				DB22V-21B	1	4.0	150	210	175	10	165	10	1.65
	30	FRN30VG1S-2J				DB30V-21B	1	2.5	150	286	239	10	225	10	2.25
	37	FRN37VG1S-2J				DB37V-21B	1	2.25	150	353	294	10	278	10	2.78
	45	FRN45VG1S-2J				DB45V-21B	1	2.0	150	430	358	10	338	10	3.38
	55	FRN55VG1S-2J				DB55V-21C	1	1.6	150	525	438	10	413	10	4.13
	75	FRN75VG1S-2J	B	BU55-2C	2	DB75V-21C	1	2.4/2	150	716	597	10	563	10	5.63
	90	FRN90VG1S-2J		BU90-2C	2	DB90V-21C	1	2.0/2	150	859	716	10	675	10	6.75
Three-phase 400V	3.7	FRN3.7VG1S-4J	A			DB3.7V-41B	1	96	150	35.3	29.4	10	27.8	10	0.278
	5.5	FRN5.5VG1S-4J				DB5.5V-41B	1	64	150	52.5	43.8	10	41.3	10	0.413
	7.5	FRN7.5VG1S-4J				DB7.5V-41B	1	48	150	71.6	59.7	10	56.3	10	0.563
	11	FRN11VG1S-4J				DB11V-41B	1	32	150	105	87.5	10	82.5	10	0.825
	15	FRN15VG1S-4J				DB15V-41B	1	24	150	143	119	10	113	10	1.13
	18.5	FRN18.5VG1S-4J				DB18.5V-41B	1	18	150	177	147	10	139	10	1.39
	22	FRN22VG1S-4J				DB22V-41B	1	16	150	210	175	10	165	10	1.65
	30	FRN30VG1S-4J		–	–	DB30V-41B	1	10	150	286	239	10	225	10	2.25
	37	FRN37VG1S-4J				DB37V-41B	1	9.0	150	353	294	10	278	10	2.78
	45	FRN45VG1S-4J				DB45V-41B	1	8.0	150	430	358	10	338	10	3.38
	55	FRN55VG1S-4J				DB55V-41C	1	6.5	150	525	438	10	413	10	4.13
	75	FRN75VG1S-4J				DB75V-41C	1	4.7	150	716	597	10	563	10	5.63
	90	FRN90VG1S-4J				DB90V-41C	1	3.9	150	859	716	10	675	10	6.75
	110	FRN110VG1S-4J				DB110V-41C	1	3.2	150	1050	875	10	825	10	8.25
	132	FRN132VG1S-4J				DB132V-41C	1	2.6	150	1261	1050	10	990	10	9.90
	160	FRN160VG1S-4J	C			DB160V-41C	1	2.2	150	1528	1273	10	1200	10	12.0
	200	FRN200VG1S-4J	D	BU220-4C	2	DB200V-41C	1	3.5/2	150	1910	1592	10	1500	10	15.0
	220	FRN220VG1S-4J		BU220-4C	2	DB220V-41C	1	3.2/2	150	2101	1751	10	1650	10	16.5
	280	FRN280VG1S-4J	E	BU220-4C	2	DB160V-41C	2	2.2/2	150	2674	2228	10	2100	10	21.0
	315	FRN315VG1S-4J		BU220-4C	2	DB160V-41C	2	2.2/2	150	3008	2507	10	2363	10	23.6
	355	FRN355VG1S-4J	F	BU220-4C	3	DB132V-41C	3	2.6/3	150	3390	2825	10	2663	10	26.6
	400	FRN400VG1S-4J		BU220-4C	3	DB132V-41C	3	2.6/3	150	3820	3183	10	3000	10	30.0
	500	FRN500VG1S-4J	G	BU220-4C	4	DB132V-41C	4	2.6/4	150	4775	3979	10	3750	10	37.5
	630	FRN630VG1S-4J	H	BU220-4C	4	DB160V-41C	4	2.2/4	150	6016	5013	10	4725	10	47.3

Note: • Refer to notes on and procedure of selection.
For DB160V-41C - DB220V-41C, two braking resistors are used per one unit.
Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

■MD-mode Inverters

Table 8.8 (b) Braking Unit/Braking Resistor (Standard 10%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty. (units)	Resistance value (Ω)	Maximum braking torque (%)	Torque (N·m) 50 Hz	Torque (N·m) 60 Hz	Continuous braking (converted to 150% torque value): Braking time (s)	Discharg-ing capacity (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
	110	FRN90VG1S-4J	A			DB110V-41C	1	3.2	150	1050	875	10	825	10	8.25
	132	FRN110VG1S-4J				DB132V-41C	1	2.6	150	1261	1050	10	990	10	9.90
	160	FRN132VG1S-4J	C	-	-	DB160V-41C	1	2.2	150	1528	1273	10	1200	10	12.0
	200	FRN160VG1S-4J	J			DB200V-41C	1	3.5/2	150	1910	1592	10	1500	10	15.0
Three-phase 400V	220	FRN200VG1S-4J	D	BU220-4C	2	DB220V-41C	1	3.2/2	150	2101	1751	10	1650	10	16.5
	250	FRN220VG1S-4J	I	BU220-4C	2	DB132V-41C	2	2.6/2	150	2388	1990	10	1875	10	18.8
	315	FRN280VG1S-4J	E	BU220-4C	2	DB160V-41C	2	2.2/2	150	3008	2507	10	2363	10	23.6
	355	FRN315VG1S-4J	F	BU220-4C	3	DB132V-41C	3	2.6/3	150	3390	2825	10	2663	10	26.6
	400	FRN355VG1S-4J		BU220-4C	3	DB132V-41C	3	2.6/3	150	3820	3183	10	3000	10	30.0
	450	FRN400VG1S-4J	G	BU220-4C	4	DB132V-41C	4	2.6/4	150	4297	3581	10	3375	10	33.8

Note: • Refer to notes on and procedure of selection.

For DB160V-41C - DB220V-41C, two braking resistors are used per one unit.

Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

■LD-mode Inverters

Table 8.8 (c) Braking Unit/Braking Resistor (Standard 10%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty. (units)	Resistance value (Ω)	Maximum braking torque (%)	Torque (N·m) 50 Hz	Torque (N·m) 60 Hz	Continuous braking (converted to 150% torque value): Braking time (s)	Discharg-ing capacity (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
	37	FRN30VG1S-2J	A			DB30V-21B	1	2.5	110	259	216	10	204	10	2.25
	45	FRN37VG1S-2J				DB37V-21B	1	2.25	110	315	263	10	248	10	2.78
Three-phase 200V	55	FRN45VG1S-2J		-	-	DB45V-21B	1	2.0	110	385	321	10	303	10	3.38
	75	FRN55VG1S-2J				DB55V-21C	1	1.6	110	525	438	10	413	10	4.13
	90	FRN75VG1S-2J	B	BU55-2C	2	DB75V-21C	1	2.4/2	110	630	525	10	495	10	5.63
	110	FRN90VG1S-2J		BU90-2C	2	DB90V-21C	1	2.0/2	110	770	642	10	605	10	6.75
	37	FRN30VG1S-4J	A			DB30V-41B	1	10	110	259	216	10	204	10	2.25
	45	FRN37VG1S-4J				DB37V-41B	1	9.0	110	315	263	10	248	10	2.78
	55	FRN45VG1S-4J				DB45V-41B	1	8.0	110	385	321	10	303	10	3.38
	75	FRN55VG1S-4J				DB55V-41C	1	6.5	110	525	438	10	413	10	4.13
	90	FRN75VG1S-4J		-	-	DB75V-41C	1	4.7	110	630	525	10	495	10	5.63
	110	FRN90VG1S-4J				DB90V-41C	1	3.9	110	770	642	10	605	10	6.75
	132	FRN110VG1S-4J				DB110V-41C	1	3.2	110	924	770	10	726	10	8.25
	160	FRN132VG1S-4J				DB132V-41C	1	2.6	110	1120	934	10	880	10	9.9
Three-phase 400V	200	FRN160VG1S-4J	C			DB160V-41C	1	2.2	110	1401	1167	10	1100	10	12.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB200V-41C	1	3.5/2	110	1541	1284	10	1210	10	15.0
	280	FRN220VG1S-4J		BU220-4C	2	DB220V-41C	1	3.2/2	110	1961	1634	10	1540	10	16.5
	355	FRN280VG1S-4J	E	BU220-4C	2	DB160V-41C	2	2.2/2	110	2486	2072	10	1953	10	21.0
	400	FRN315VG1S-4J		BU220-4C	2	DB160V-41C	2	2.2/2	110	2801	2334	10	2200	10	23.6
	450	FRN355VG1S-4J	F	BU220-4C	3	DB132V-41C	3	2.6/3	110	3151	2626	10	2475	10	26.6
	500	FRN400VG1S-4J		BU220-4C	3	DB132V-41C	3	2.6/3	110	3501	2918	10	2750	10	30.0
	630	FRN500VG1S-4J	G	BU220-4C	4	DB132V-41C	4	2.6/4	110	4412	3677	10	3465	10	37.5
	710	FRN630VG1S-4J	H	BU220-4C	4	DB160V-41C	4	2.2/4	110	4972	4143	10	3905	10	47.3

Note: • Refer to notes on and procedure of selection.

For DB160V-41C - DB220V-41C, two braking resistors are used per one unit.

Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

■HD-mode Inverters

Table 8.9 (a) Braking Unit/Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options: Braking unit Model	Braking unit Qty. (units)	Braking resistor Model	Braking resistor Qty.(units)	Resistance value(Ω)	Maximum braking torque (%)	Torque (N·m) 50 Hz	Torque (N·m) 60 Hz	Continuous braking (converted to 150% torque value): Braking time(s)	Discharging capability (kWs)	Repetitive braking (at 100s interval or less): Duty cycle (%ED)	Average loss (kW)
Three-phase 200V	0.75	FRN0.75VG1S-2J	A	–	–	DB2.2V-22B	1	30	150	7.16	5.97	20	33.0	20	0.330
	1.5	FRN1.5VG1S-2J				DB2.2V-22B	1	30	150	14.3	11.9	20	33.0	20	0.330
	2.2	FRN2.2VG1S-2J				DB2.2V-22B	1	30	150	21.0	17.5	20	33.0	20	0.330
	3.7	FRN3.7VG1S-2J				DB3.7V-22B	1	24	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG1S-2J				DB5.5V-22B	1	16	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG1S-2J				DB7.5V-22B	1	12	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG1S-2J				DB11V-22B	1	8.0	150	105	87.5	20	165	20	1.65
	15	FRN15VG1S-2J				DB15V-22B	1	6.0	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG1S-2J				DB18.5V-22B	1	4.5	150	177	147	20	278	20	2.78
	22	FRN22VG1S-2J				DB22V-22B	1	4.0	150	210	175	20	330	20	3.30
	30	FRN30VG1S-2J				DB30V-22C	1	3.0	150	286	239	20	450	20	4.50
	37	FRN37VG1S-2J				DB37V-22C	1	2.4	150	353	294	20	555	20	5.55
	45	FRN45VG1S-2J				DB45V-22C	1	2.0	150	430	358	20	675	20	6.75
	55	FRN55VG1S-2J				DB55V-22C	1	1.6	150	525	438	20	825	20	8.25
	75	FRN75VG1S-2J	B	BU55-2C	2	DB37V-22C	2	2.4/2	150	716	597	20	1125	20	11.3
	90	FRN90VG1S-2J		BU90-2C	2	DB45V-22C	2	2.0/2	150	859	716	20	1350	20	13.5
Three-phase 400V	3.7	FRN3.7VG1S-4J	A	–	–	DB3.7V-42B	1	96	150	35.3	29.4	20	55.5	20	0.555
	5.5	FRN5.5VG1S-4J				DB5.5V-42B	1	64	150	52.5	43.8	20	82.5	20	0.825
	7.5	FRN7.5VG1S-4J				DB7.5V-42B	1	48	150	71.6	59.7	20	113	20	1.13
	11	FRN11VG1S-4J				DB11V-42B	1	32	150	105	87.5	20	165	20	1.65
	15	FRN15VG1S-4J				DB15V-42B	1	24	150	143	119	20	225	20	2.25
	18.5	FRN18.5VG1S-4J				DB18.5V-42B	1	18	150	177	147	20	278	20	2.78
	22	FRN22VG1S-4J				DB22V-42B	1	16	150	210	175	20	330	20	3.30
	30	FRN30VG1S-4J				DB30V-42C	1	12	150	286	239	20	450	20	4.50
	37	FRN37VG1S-4J				DB37V-42C	1	9.0	150	353	294	20	555	20	5.55
	45	FRN45VG1S-4J				DB45V-42C	1	8.0	150	430	358	20	675	20	6.75
	55	FRN55VG1S-4J				DB55V-42C	1	6.5	150	525	438	20	825	20	8.25
	75	FRN75VG1S-4J				DB75V-42C	1	4.7	150	716	597	20	1125	20	11.3
	90	FRN90VG1S-4J				DB90V-42C	1	3.9	150	859	716	20	1350	20	13.5
	110	FRN110VG1S-4J				DB110V-42C	1	3.2	150	1050	875	20	1650	20	16.5
	132	FRN132VG1S-4J				DB132V-42C	1	2.6	150	1261	1050	20	1980	20	19.8
	160	FRN160VG1S-4J				DB160V-42C	1	2.2	150	1528	1273	20	2400	20	24.0
	200	FRN200VG1S-4J	D	BU220-4C	2	DB200V-42C	1	3.5/2	150	1910	1592	20	3000	20	30.0
	220	FRN220VG1S-4J		BU220-4C	2	DB220V-42C	1	3.2/2	150	2101	1751	20	3300	20	33.0
	280	FRN280VG1S-4J	I	BU220-4C	2	DB160V-42C	2	2.2/2	150	2674	2228	20	4200	20	42.0
	315	FRN315VG1S-4J		BU220-4C	2	DB160V-42C	2	2.2/2	150	3008	2507	20	4725	20	47.3
	355	FRN355VG1S-4J	F	BU220-4C	3	DB132V-42C	3	2.6/3	150	3390	2825	20	5325	20	53.3
	400	FRN400VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	150	3820	3183	20	6000	20	60.0
	500	FRN500VG1S-4J	G	BU220-4C	4	DB132V-42C	4	2.6/4	150	4775	3979	20	7500	20	75.0
	630	FRN630VG1S-4J		BU220-4C	4	DB160V-42C	4	2.2/4	150	6016	5013	20	9450	20	94.6

Note) • This option is built to order.
• The braking unit requires the fan unit (BU-F).
For DB200V-42C and DB220V-42C, two braking resistors are used per one unit.
Example) For the model: DB200V-42C, quantity: 1, two braking resistors are used.

■MD-mode Inverters

Table 8.9 (b) Braking Unit/Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options					Maximum braking torque (%)			Continuous braking (converted to 150% torque value)		Repetitive braking (at 100s interval or less)	
				Braking unit		Braking resistor				Torque (N·m)					
				Model	Qty. (units)	Model	Qty. (units)	Resistance value(Ω)		50 Hz	60 Hz	Braking time (s)	Discharging capability (kWs)	Duty cycle (%ED)	Average loss (kW)
Three-phase 400V	110	FRN90VG1S-4J	A	-	-	DB110V-42C	1	3.2	150	1050	875	20	1650	20	16.5
	132	FRN110VG1S-4J				DB132V-42C	1	2.6	150	1261	1050	20	1980	20	19.8
	160	FRN132VG1S-4J				DB160V-42C	1	2.2	150	1528	1273	20	2400	20	24.0
	200	FRN160VG1S-4J	J			DB200V-42C	1	3.5/2	150	1910	1592	20	3000	20	30.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB220V-42C	1	3.2/2	150	2101	1751	20	3300	20	33.0
	250	FRN220VG1S-4J	I	BU220-4C	2	DB132V-42C	2	2.6/2	150	2388	1990	20	3750	20	37.5
	315	FRN280VG1S-4J		BU220-4C	2	DB160V-42C	2	2.2/2	150	3008	2507	20	4725	20	47.3
	355	FRN315VG1S-4J	F	BU220-4C	3	DB132V-42C	3	2.6/3	150	3390	2825	20	5325	20	53.3
	400	FRN355VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	150	3820	3183	20	6000	20	60.0
	450	FRN400VG1S-4J	G	BU220-4C	4	DB132V-42C	4	2.6/4	150	4297	3581	20	6750	20	67.5

■LD-mode Inverters

Table 8.9 (c) Braking Unit/Braking Resistor (20%ED)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Fig	Selecting Options					Maximum braking torque(%)			Continuous braking (converted to 150% torque value)		Repetitive braking (at 100s interval or less)	
				Braking unit		Braking resistor				Torque (N·m)					
				Model	Qty. (units)	Model	Qty. (units)	Resistance value (Ω)		50 Hz	60 Hz	Braking time (s)	Discharging capability (kWs)	Duty cycle (%ED)	Average loss (kW)
Three-phase 200V	37	FRN30VG1S-2J	A	-	-	DB30V-22C	1	3.0	110	259	216	20	407	20	4.50
	45	FRN37VG1S-2J				DB37V-22C	1	2.4	110	315	263	20	495	20	5.55
	55	FRN45VG1S-2J				DB45V-22C	1	2.0	110	385	321	20	605	20	6.75
	75	FRN55VG1S-2J				DB55V-22C	1	1.6	110	525	438	20	825	20	8.25
	90	FRN75VG1S-2J	B	BU55-2C	2	DB37V-22C	2	2.4/2	110	630	525	20	990	20	11.3
	110	FRN90VG1S-2J		BU90-2C	2	DB45V-22C	2	2.0/2	110	770	642	20	1210	20	13.5
Three-phase 400V	37	FRN30VG1S-4J	A	-	-	DB30V-42C	1	12	110	259	216	20	407	20	4.50
	45	FRN37VG1S-4J				DB37V-42C	1	9.0	110	315	263	20	495	20	5.55
	55	FRN45VG1S-4J				DB45V-42C	1	8.0	110	385	321	20	605	20	6.75
	75	FRN55VG1S-4J				DB55V-42C	1	6.5	110	525	438	20	825	20	8.25
	90	FRN75VG1S-4J				DB75V-42C	1	4.7	110	630	525	20	990	20	11.3
	110	FRN90VG1S-4J				DB90V-42C	1	3.9	110	770	642	20	1210	20	13.5
	132	FRN110VG1S-4J				DB110V-42C	1	3.2	110	924	770	20	1452	20	16.5
	160	FRN132VG1S-4J				DB132V-42C	1	2.6	110	1120	934	20	1760	20	19.8
	200	FRN160VG1S-4J				DB160V-42C	1	2.2	110	1401	1167	20	2200	20	24.0
	220	FRN200VG1S-4J	D	BU220-4C	2	DB200V-42C	1	3.5/2	110	1541	1284	20	2420	20	30.0
	280	FRN220VG1S-4J		BU220-4C	2	DB220V-42C	1	3.2/2	110	1961	1634	20	3080	20	33.0
	355	FRN280VG1S-4J	I	BU220-4C	2	DB160V-42C	2	2.2/2	110	2486	2072	20	3905	20	47.3
	400	FRN315VG1S-4J	F	BU220-4C	3	DB132V-42C	3	2.6/3	110	2801	2334	20	4400	20	53.3
	450	FRN355VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	110	3151	2626	20	4950	20	53.3
	500	FRN400VG1S-4J		BU220-4C	3	DB132V-42C	3	2.6/3	110	3501	2918	20	5500	20	60.0
	630	FRN500VG1S-4J	G	BU220-4C	4	DB132V-42C	4	2.6/4	110	4412	3677	20	6930	20	75.0
	710	FRN630VG1S-4J		BU220-4C	4	DB160V-42C	4	2.2/4	110	4972	4143	20	7810	20	94.6

Note) • This option is built to order.

• The braking unit requires the fan unit (BU-F).

For DB200V-42C and DB220V-42C, two braking resistors are used per one unit.

Example) For the model: DB200V-42C, quantity: 1, two braking resistors are used.

Connection examples

Figure A

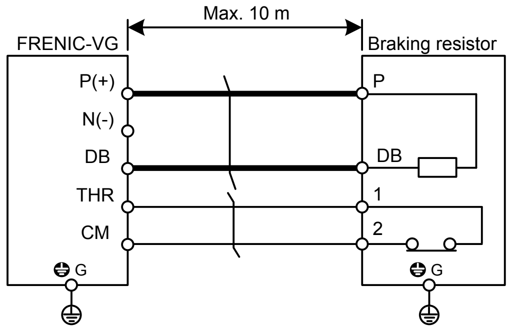
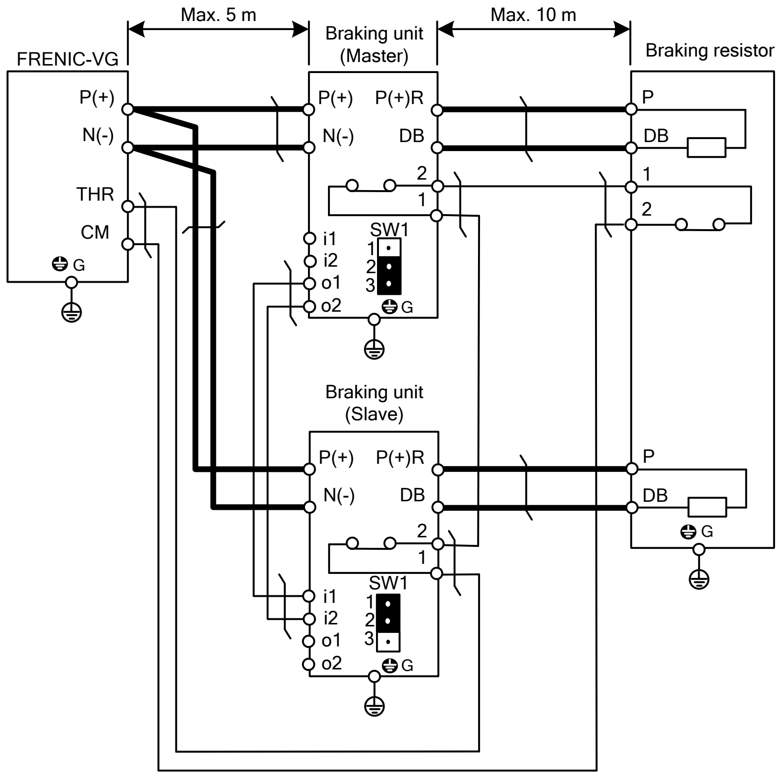


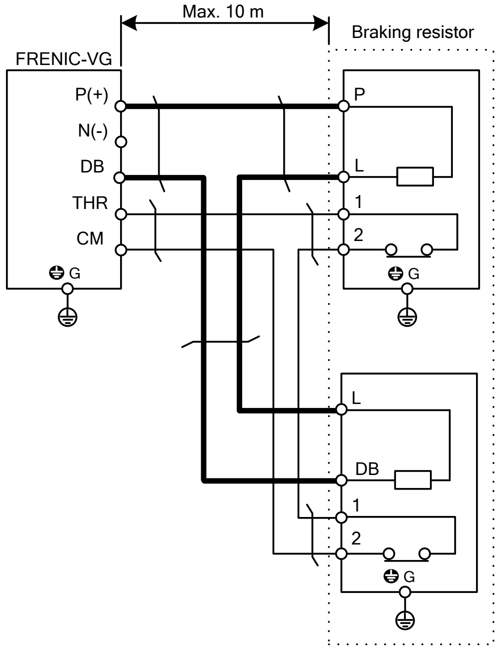
Figure B



Note 1: To use the 20%ED braking resistor (DB☐☐☐V-☐2C), the braking unit requires the fan unit (BU-F).

Note 2: In Figure B, main circuit wires should be branched from inverter's P and N terminals and the wiring distances from the inverter to braking resistors (Master and slave) should be the same.
When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

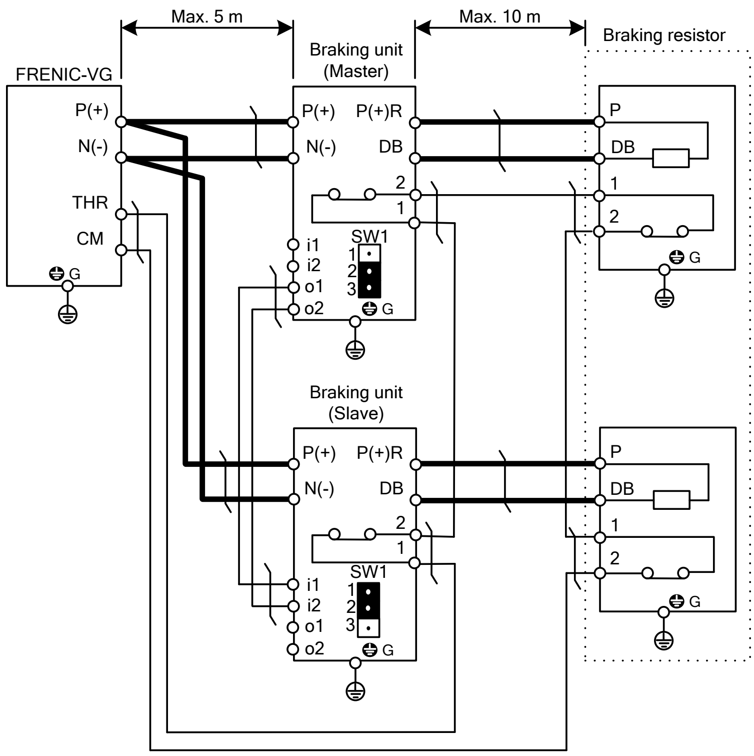
Figure C



Note 1: For DB160V-41C and DB200V-42C, two braking resistors are used per one unit.

Note 2: To use the 20%ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

Figure D

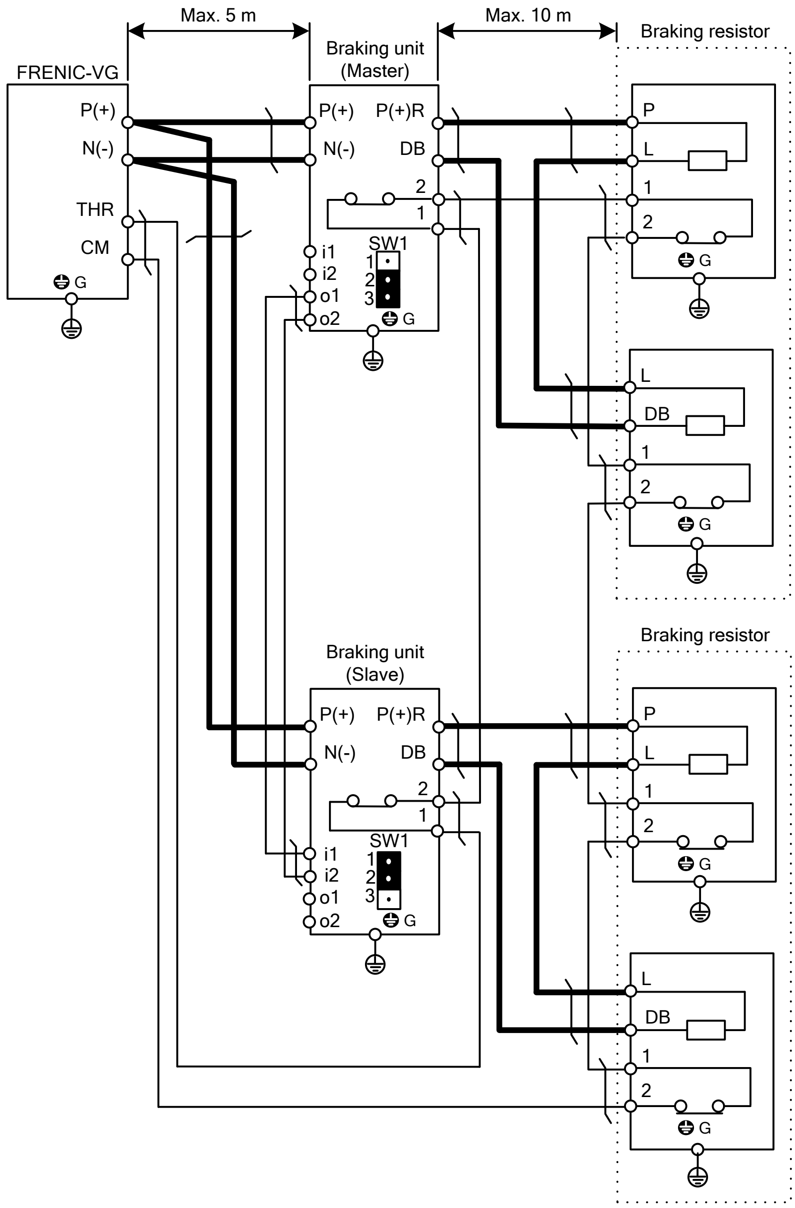


Note 1: For DB200V-41C, DV220V-41C, DB200V-42C and DB220-42C, two braking resistors are used per one unit.

Note 2: To use the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

Note 3: In Figure D, main circuit wires should be branched from inverter's P and N terminals and the wiring distances from the inverter to braking resistors (Master and slave) should be the same.
When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

Figure E

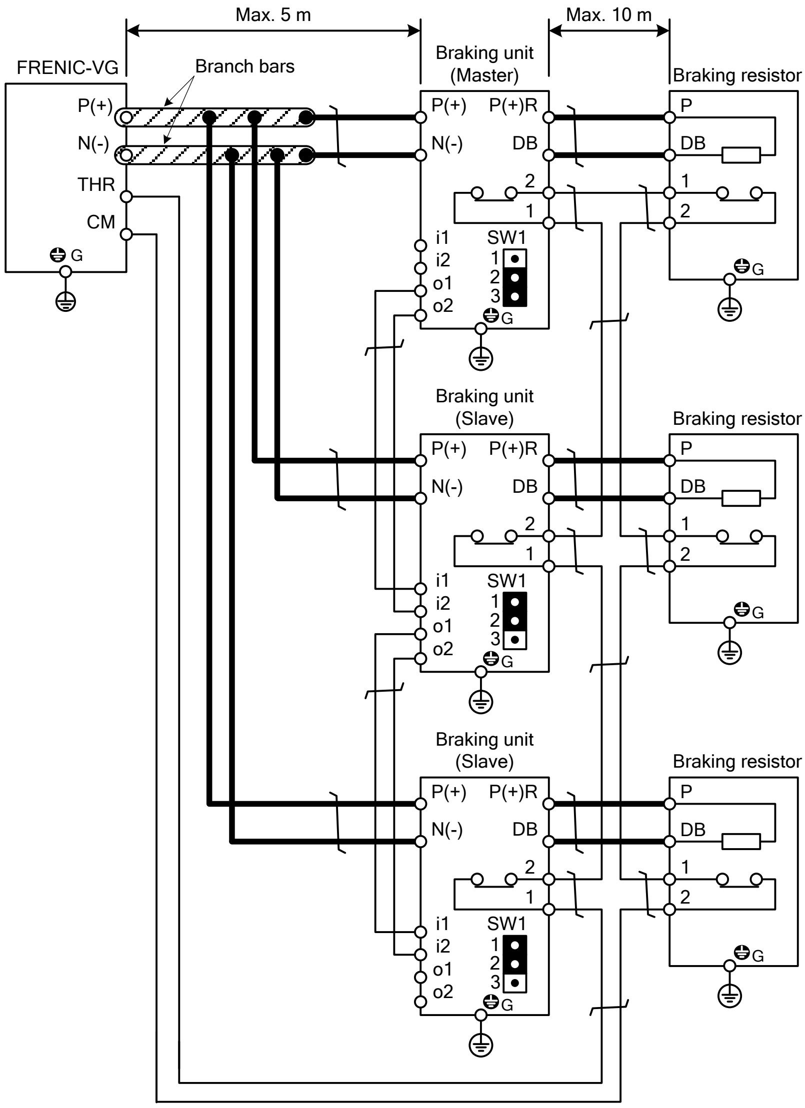


Note 1: For DB160V-41C, two braking resistors are used per one unit.
Example) For the model: DB160V-41C, quantity: 2, four braking resistors are used.

Note 2: To use the 20% ED braking resistor (DB☐☐☐V-☐2C), the braking unit requires the fan unit (BU-F).

Note 3: In Figure E, main circuit wires should be branched from inverter's P and N terminals and the wiring distances from the inverter to braking resistors (Master and slave) should be the same.
When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

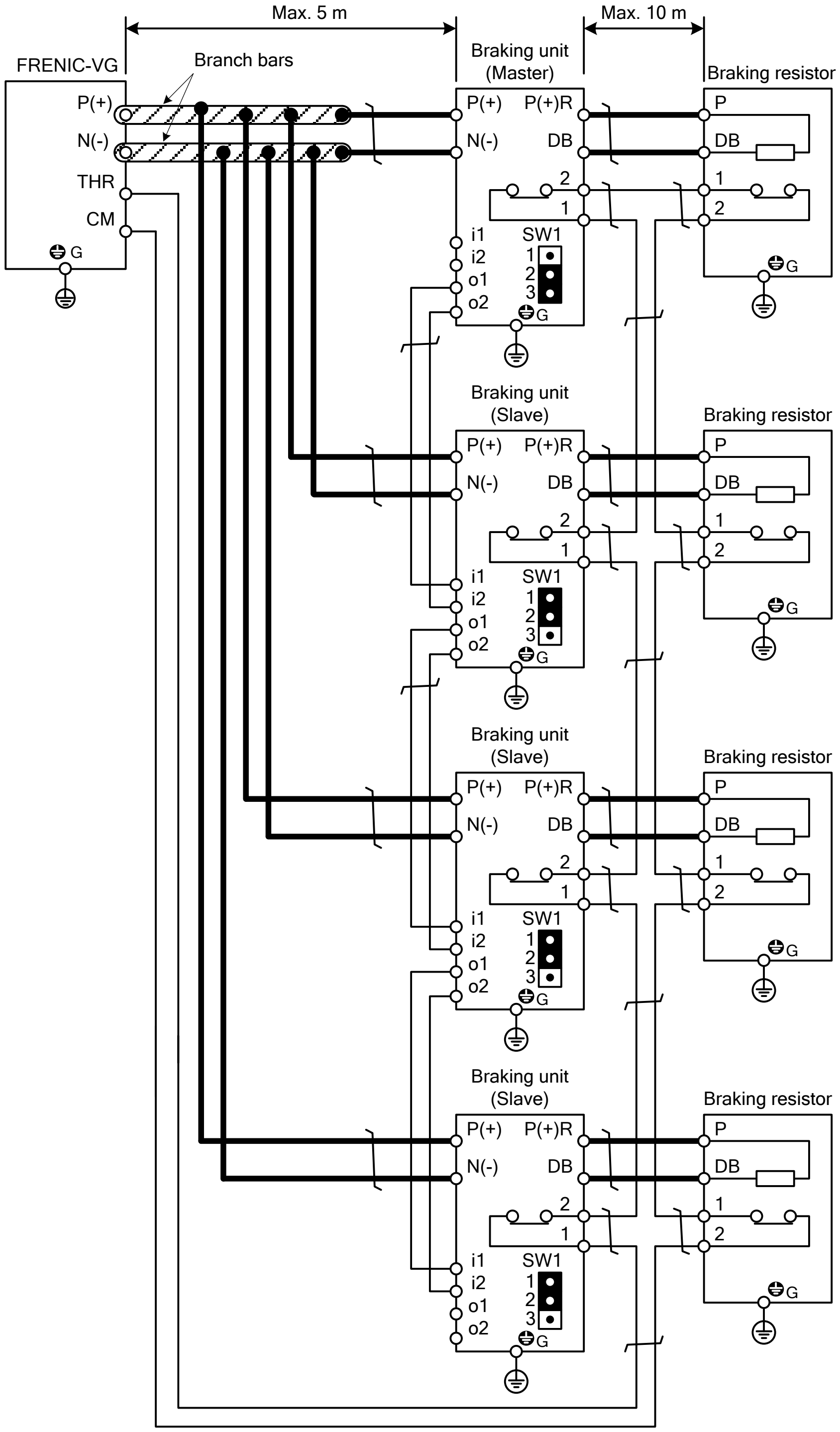
Figure F



Note 1: To use the 20% ED braking resistor (DB☐☐☐V-☐2C), the braking unit requires the fan unit (BU-F).

Note 2: In Figure F, main circuit wires should be branched by installing branch bars on inverter's P and N terminals. The wiring distances from the inverter to braking resistors (Master and slave) should be the same. When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

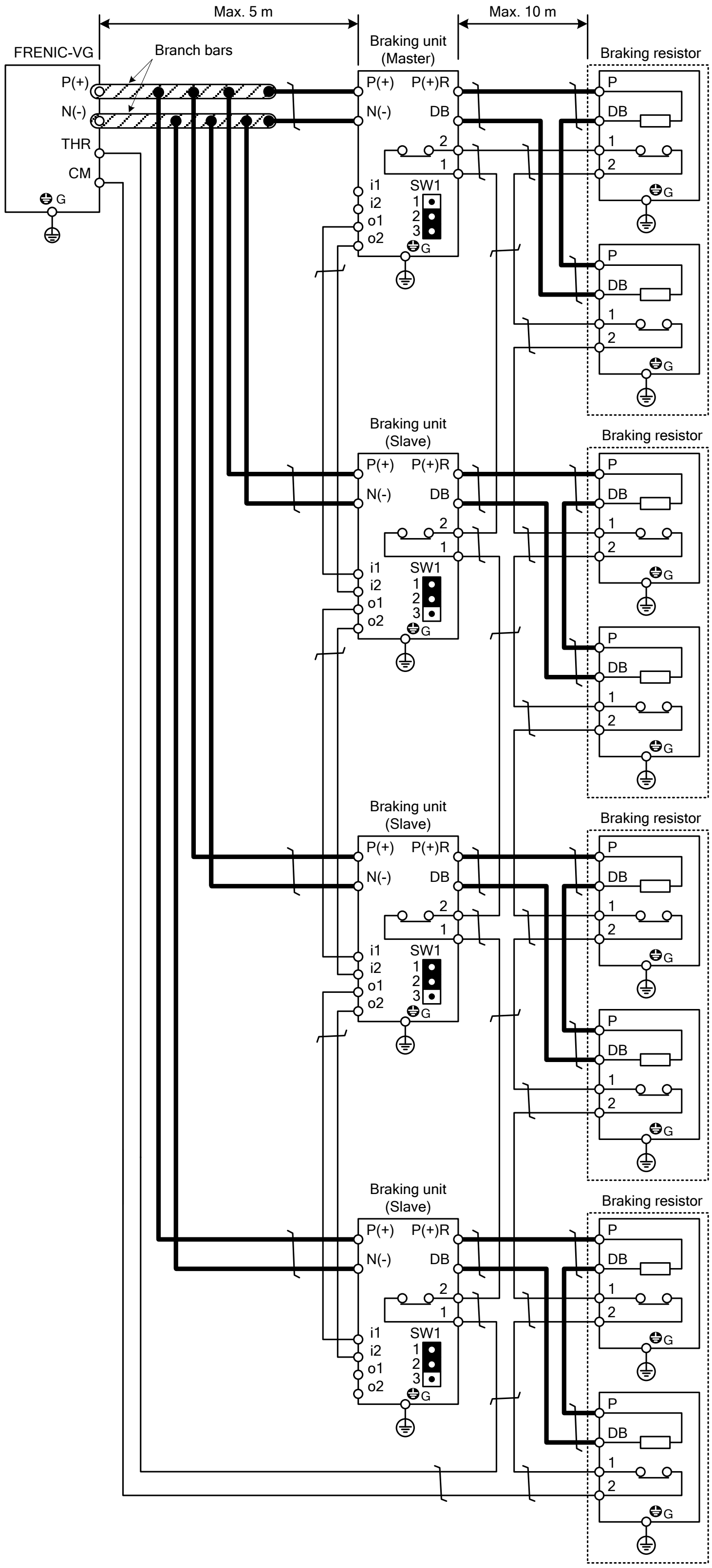
Figure G



Note 1: To use the 20% ED braking resistor (DB☐☐☐V-☐2C), the braking unit requires the fan unit (BU-F).

Note 2: In Figure G, main circuit wires should be branched by installing branch bars on inverter's P and N terminals.
The wiring distances from the inverter to braking resistors (Master and slave) should be the same.
When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

Figure H



Note 1: For DB160V-41C, two braking resistors are used per one unit.

Example) For the model: DB160V-41C, quantity: 4, eight braking resistors are used.

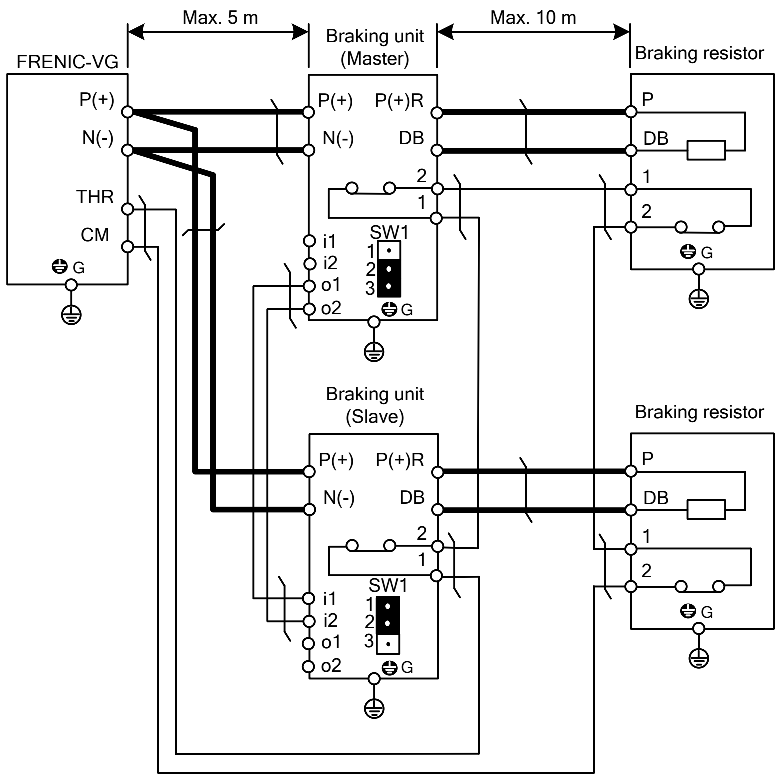
Note 2: To use the 20% ED braking resistor (DB☐☐☐V-☐2C), the braking unit requires the fan unit (BU-F).

Note 3: In Figure H, main circuit wires should be branched by installing branch bars on inverter's P and N terminals.

The wiring distances from the inverter to braking resistors (Master and slave) should be the same.

When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

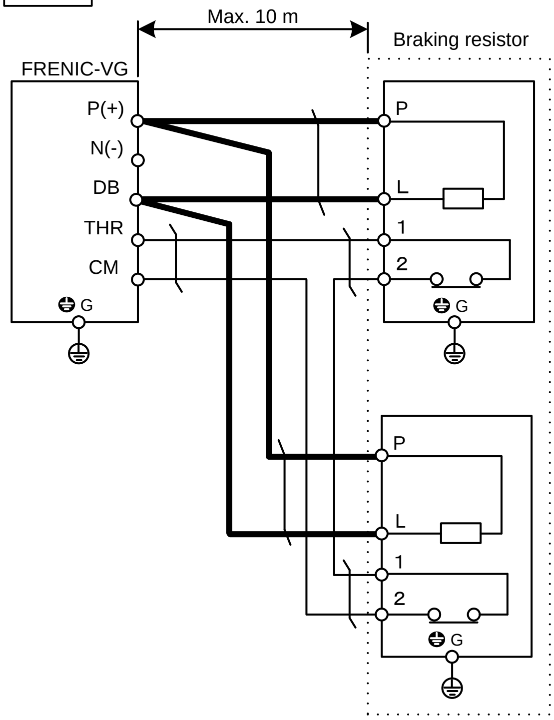
Figure I



Note 1: To use the 20% ED braking resistor (DB□□□V-□2C), the braking unit requires the fan unit (BU-F).

Note 2: In Figure I, main circuit wires should be branched from inverter's P and N terminals and the wiring distances from the inverter to braking resistors (Master and slave) should be the same.
When direct branching from the inverter is not made, install a relay terminal block for branch wiring.

Figure J



Note 1: For DB160V-41C and DB200V-42C, two braking resistors are used per one unit.

8.5.1.4 External dimensions

Braking resistors, 10% ED models

Figure A

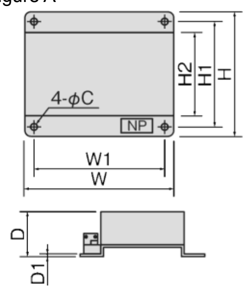
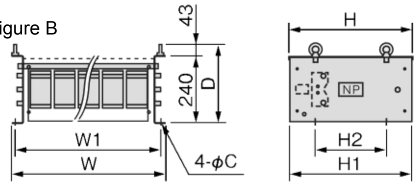


Figure B



200V series (10% ED product)

Model	Fig.	Dimensions (mm)								Screw size		Max. connection wire size (mm²) *1	Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	P, DB	G		
DB2.2V-21B		330	298	242	210	165	140	1.6	8	M4	M4	5.5/5.5	4
DB3.7V-21B		400	368	280	248	203							5
DB5.5V-21B													
DB7.5V-21B				480	448	377			10				6
DB11V-21B													7
DB15V-21B	A			660	628	557				M5	M5	14/14	10
DB18.5V-21B													
DB22V-21B							240						13
DB30V-21B										M6	M6	22/22	18
DB37V-21B		405		750	718	647							22
DB45V-21B							340						26
DB55V-21C		450	420	440	430	250	283	-	12	M10	M6	100/22	35
DB75V-21C	B	600	570										33
DB90V-21C		700	670										43

400V series (10% ED product)

Model	Fig.	Dimensions (mm)								Screw size		Max. connection wire size (mm²) *1	Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	P, DB	G		
DB3.7V-41B		420	388	280	248	203	140	1.6	8	M4	M4	5.5/5.5	5
DB5.5V-41B				480	448	377			10				7
DB7.5V-41B													
DB11V-41B													8
DB15V-41B				660	628	557							11
DB18.5V-41B	A												
DB22V-41B							240						14
DB30V-41B										M5	M5	14/14	19
DB37V-41B		425		750	718	647							21
DB45V-41B							340						26
DB55V-41C		550	520	440	430	250	283	-	12	M8	M6	60/22	26
DB75V-41C										M10		100/22	30
DB90V-41C		650											41
DB110V-41C		750	720										57
DB132V-41C	B												43
*2 **DB160V-41C**		600	570										74
*2 **DB200V-41C**		725	695										50(x2)
*2 **DB220V-41C**													51(x2)

*1 The max. connection wire size is expressed by: □□□ / □□□.
- First □□□: Max. connection wire size for P and DB terminals
- Second □□□: Max. connection wire size for G terminal

*2 For DB160V-41C - DB220V-41C, two resistors of the same shape are used in a pair, and enough space for them should be considered.
When this model is ordered, a set of two resistors will be shipped.

Braking resistor 20% ED product

Figure A

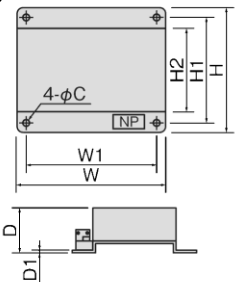
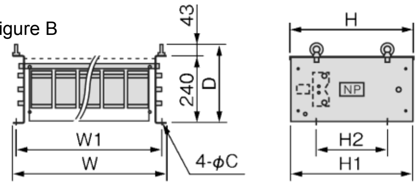


Figure B



200 V series (20% ED product)

Model	Fig.	Dimensions (mm)								Screw size		Max. connection wire size (mm²) *1	Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	P, DB	G		
DB2.2V-22B		400	368	280	248	203	140	1.6	8	M4	M4	5.5/5.5	5
DB3.7V-22B				480	448	377			10				6
DB5.5V-22B													7
DB7.5V-22B	A			660	628	557				M5	M5	14/14	10
DB11V-22B							240						13
DB15V-22B		405		750	718	647				M6	M6	22/22	22
DB18.5V-22B													
DB22V-22B							340						26
DB30V-22C		450	420	440	430	250	283	-	12	M10	M6	100/22	
DB37V-22C	B	550	520										41
DB45V-22C		650	620										36
DB55V-22C		700	670										43

400 V series (20% ED product)

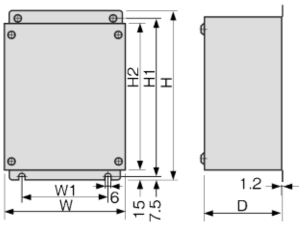
Model	Fig.	Dimensions (mm)								Screw size		Max. connection wire size (mm²) *1	Approx. weight (kg)
		W	W1	H	H1	H2	D	D1	C	P, DB	G		
DB3.7V-42B		420	388	480	448	377	140	1.6	10	M4	M4	5.5/5.5	8
DB5.5V-42B				660	628	557							11
DB7.5V-42B													11
DB11V-42B	A						240						14
DB15V-42B				750	718	647				M5	M5	14/14	21
DB18.5V-42B													21
DB22V-42B							340						26
DB30V-42C		600	570	440	430	250	283	-	12	M8	M6	60/22	24
DB37V-42C		700	670										32
DB45V-42C													34
DB55V-42C		750	720							M10	M6	100/22	45
DB75V-42C		550	520	440	430	250	483						68
DB90V-42C	B	650	620										65
DB110V-42C		700	670										82
DB132V-42C													86
DB160V-42C													100
*2 **DB200V-42C**													85(x2)
*2 **DB220V-42C**													83(x2)

*1 The max. connection wire size is expressed by: □□□ / □□□.
- Max. connection wire size for P and DB terminals
- Max. connection wire size for G terminal

*2 For DB200V-42C and DB220V-42C, two resistors of the same shape are used in a pair, and enough space for them should be considered.
When this model is ordered, a set of two resistors will be shipped.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Braking unit

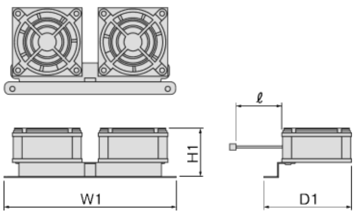


Voltage	Model	Dimensions (mm)						Terminal screw		Max. connection wire size (mm^2)	Approx. weight (kg)
		W	W1	H	H1	H2	D	Main terminal	Grounding (G)		
200V series	BU55-2C	230	130	240	225	210	160	M8	M8	22	6
	BU90-2C	250	150	370	355	340		M8	M8	38	9
400V series	BU220-4C	250	150	450	435	420	160	M10	M10	100	13

Fan units for braking units

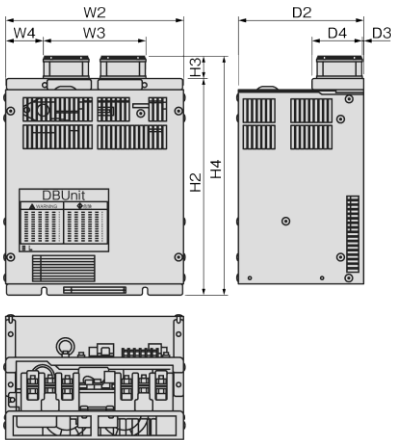
Using this option improves the duty cycle [%ED] of a model using the external braking unit from 10%ED to 30%ED.

■ Fan unit



Model	Dimensions(mm)			
	W1	H1	D1	ℓ (fan power supply line)
BU-F	149	44	76	320

■ Braking unit + fan unit



Voltage	Model	Dimensions(mm)								
		W2	W3	W4	H2	H3	H4	D2	D3	D4
200V series	BU55-2C+BU-F	230	135	47.5	240	30	270	160	1.2	64
	BU90-2C+BU-F	250		57.5	370		400			
400V series	BU220-4C+BU-F	250	135	57.5	450	30	480	160	1.2	64

8.5.2 Power regenerative PWM converters (RHC series)

8.5.2.1 Features

■ Conforms to harmonics suppressing guideline

Since this product converts the power supply current into sine waves by PWM control to greatly reduce the harmonics current, the conversion coefficient defined in the "Guideline of Harmonics Reduction for Consumers who has High or Ultra-High Voltage Power Receiving Facilities" can be reduced to "0" (i.e., no harmonics occur) when used in combination with inverters.

■ Can reduce power supply facilities capacity

By flowing current with the same phase as the power supply phase voltage by power factor control, operation with the power factor of approximately 1 can be achieved. This results in smaller power supply transformer capacity and equipment size, compared with the standard inverter.

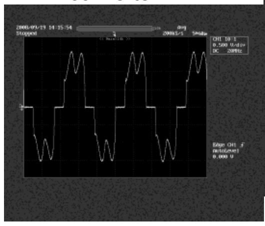
■ Greatly improves braking ability

In highly frequent acceleration/deceleration operation and elevator operation, regenerated energy is all returned to the power supply to save power in regeneration.
Also, there will be no trouble with the power supply system because the current waveform in regeneration is sine wave.

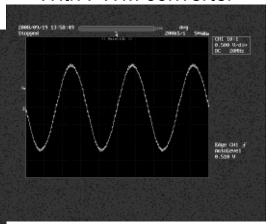
Continuous regeneration rating 100%
1-minute regeneration rating
150% (CT specification)
120% (VT specification)

Comparison of input current waveform

<Without PWM converter>



<With PWM converter>



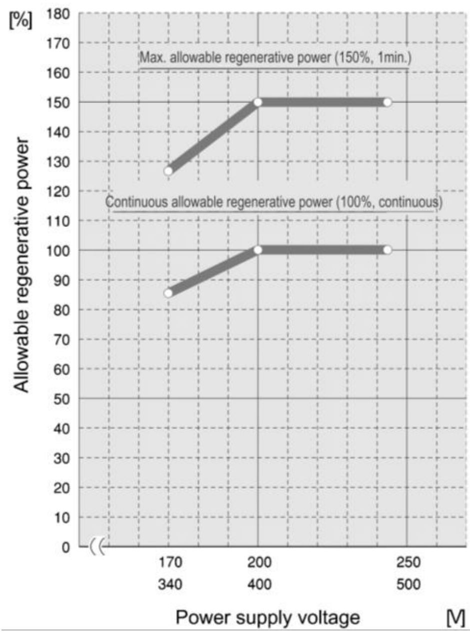
■ Rich protective and maintenance functionality

- Troubleshooting is made easier by the traceback (option).
  (1) Past alarm details (for the last 10 alarms) by the segment LEDs can be retrieved. This allows for easy alarm cause analysis and measure planning.
  (2) Upon a momentary power failure, the gate is shut down to ensure quick restart after the power comes back.
  (3) Predictive signals for overload, fin over temperature, and life, alarms can be generated before the converter slips.

■ Networking capability

- MICREX-SX, F series, and CC-Link master devices can be (optionally) connected. RS-485 is equipped by standard.

Allowable characteristics of the RHC unit



8.5.2.2 Specifications

(1) Standard specifications

■ 200 V series

Item			Standard specifications										
Model RHC□□□-2C			200 V series										
			7.5	11	15	18.5	22	30	37	45	55	75	90
CT application	Applicable inverter capacity (kW)		7.5	11	15	18.5	22	30	37	45	55	75	90
	Output	Continuous capacity (kW)	8.8	13	18	22	26	36	44	53	65	88	103
		Overload rating	150% of continuous rating for 1 minute										
		Voltage 200V	320-355 VDC (variable according to input power supply voltage) (*3)										
	Required power supply capacity (kVA)		9.5	14	19	24	29	38	47	57	70	93	111
	Carrier frequency		Standard 15 kHz									Standard 10 kHz	
VT application	Applicable inverter capacity(kW)		11	15	18.5	22	30	37	45	55	75	90	110
	Output	Continuous capacity (kW)	13	18	22	26	36	44	53	65	88	103	126
		Overload rating	120% of continuous rating for 1 minute										
		Voltage 200V	320-355 VDC (variable according to input power supply voltage) (*3)										
	Required power supply capacity (kVA)		14	19	24	29	38	47	57	70	93	111	136
	Carrier frequency		Standard 10 kHz									Standard 6 kHz	
Input power supply	Number of phases, voltage, and frequency		3-phase 3-wire, 200-220V 50 Hz, 220-230V 50 Hz(*1), 200-230V 60 Hz										
	Voltage and frequency fluctuation		Voltage: -15 to +10%, frequency: ±5%, Voltage imbalance: within 2% (*4)										

■ 400 V series

Item			Standard specifications																					
Model RHC□□□-4C			400V series																					
			7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
CT application	Applicable inverter capacity(kW)		7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500	630
	Output	Continuous capacity (kW)	8.8	13	18	22	26	36	44	53	65	88	103	126	150	182	227	247	314	353	400	448	560	705
		Overload rating	150% of continuous rating for 1 minute																					
		Voltage 400V	640-710 VDC (variable according to input power supply voltage) (*3)																					
	Required power supply capacity (kVA)		9.5	14	19	24	29	38	47	57	70	93	111	136	161	196	244	267	341	383	433	488	610	762
	Carrier frequency		Standard 15 kHz									Standard 10 kHz											Standard 6 kHz	
VT application	Applicable inverter capacity(kW)		11	15	18.5	22	30	37	45	55	75	90	110	132	160	200	220	280	315	355	400	500		
	Output	Continuous capacity (kW)	13	18	22	26	36	44	53	65	88	103	126	150	182	227	247	314	353	400	448	560		
		Overload rating	120% of continuous rating for 1 minute																					
		Voltage 400V	640-710 VDC (variable according to input power supply voltage) (*3)																					
	Required power supply capacity (kVA)		14	19	24	29	38	47	57	70	93	111	136	161	196	244	267	341	383	433	488	610		
	Carrier frequency		Standard 10 kHz									Standard 6 kHz												
Input power supply	Number of phases, voltage, and frequency		3-phase 3-wire, , 380-440V 50 Hz, 380-460V 60 Hz (*2)																					
	Voltage and frequency fluctuation		Voltage: -15 to +10%, frequency: ±5%, Voltage imbalance: within 2% (*4)																					

(*1) 220-230V/50 Hz model can be manufactured for a separate order.

(*2) When the power supply voltage is 380-398V/50 Hz or 380-430V/60 Hz, tap switching is required inside the converter. If the power supply voltage is lower than 400V, the capacity must be reduced.

(*3) The output voltage is approximately 320/640 VDC for the power supply voltage of 200/400V, 343/686 VDC for 220/440V, and 355/710 VDC for 230/460V.

(*4) Inter-phase voltage imbalance ratio [%] = (Maximum voltage [V] - minimum voltage [V]) / 3-phase average voltage x 67

(2) Common specifications

Item		Specifications
Control	Control method	AVR constant control with DC ACR minor
	Running/Stopping	Starts rectification when the converter is powered ON after connection. Starts boosting when it receives a run signal (terminals [RUN] and [CM] short-circuited or a run command via the communications link). After that, the converter is ready to run.
	Running status signal	Running, power running, regenerative operation, ready-to-run, alarm output (for any alarm), etc.
	CT/VT switching	CT: 150% of overload rating for 1 min VT: 120% of overload rating for 1 min (CT model only: 500 kW or above)
	Carrier frequency	Fixed to high carrier frequency
	Input power factor	0.99 or above (at full load) (*1)
	Input harmonics current	Conversion coefficient can be Ki = 0 according to the harmonics suppressing guideline by METI.
	Restart after momentary power failure	Shields the gate when the voltage level reaches the undervoltage level if a momentary power failure occurs, and the converter can automatically restart after the power recovers.
	Power limiting control	Controls the power not to exceed the preset limit value.
Indication	Alarm display (Protective functions)	AC fuse blown, AC overvoltage, AC undervoltage, AC overcurrent, AC input current error, input phase loss, synchronous power supply frequency error, DC fuse blown, DC overvoltage, DC undervoltage, charge circuit fault, heat sink overheat, external alarm, converter internal overheat, overload, memory error, keypad communications error, CPU error, network device error, operation procedure error, A/D converter error, optical network error, IPM error
	Alarm history	Saves and displays the most recent 10 alarms. Saves and displays the detailed information of the trip cause for the previous alarm.
	Monitor	Displays input power, input current in RMS, input voltage in RMS, DC link bus voltage and power supply frequency.
	Load factor	Allows the user to measure the load factor with the keypad.
	Language	Allows the user to specify or refer to function codes in any of the three languages--Japanese, English or Chinese.
	Charging lamp	Lights when the DC link bus capacitor is charged.

(*1) When the power supply voltage is 420V(210V) or higher and the operating load is 50% or higher, the power supply's power factor is reduced to approximately 0.095 (during regenerative operation only).

8.5.2.3 Function specifications

(1) Terminal functions

Classi-fication	Symbol	Name	Specifications
Main circuit	L1/R, L2/S, L3/T	Main circuit power inputs	Connects with the three-phase input power lines through a dedicated reactor.
	P(+), N(–)	Converter outputs	Connects with the power input terminals P(+) and N(-) on an inverter.
	E(G)	Grounding	Grounding terminal for the converter's chassis (or casing).
	R0, T0	Auxiliary power input for the control circuit	For a backup of the control circuit power supply, connect the power lines same as that of the main power input.
Voltage detection	R1, S1, T1	Synchronous power input for voltage detection	Voltage detection terminals for the internal control of the converter. Connect with the power supply side of the dedicated reactor or filter.
	R2, T2	Inputs for control monitoring	Detection terminal for AC fuse blown.
Input signal	RUN	Run command	Short-circuiting terminals [RUN] and [CM] runs the converter; opening them stops the converter.
	RST	Reset alarm command	When the converter stops due to an alarm, removing the alarm factor and short-circuiting the terminals [RST] and [CM] cancels the protective function, restarting the converter.
	X1	General-purpose transistor input	0: Enable external alarm trip THR 1: Cancel current limiter LMT-CCL 2: 73 answerback 73ANS 3: Switch current limiter I-LIM4: Option D IOPT-DI
	CM	Digital input common	Common terminal for digital input signals.
	PLC	PLC signal power	Connects to PLC output signal power supply. (Rated voltage: 24 VDC (22 to 27 VDC)
Output signal	30A, 30B, 30C	Batch output alarm	Outputs a signal when the converter protective function acts and the converter stops in an alarm state. (Contact: 1C, on error, 30A-30C: ON) (Contact capacity: 250 VAC 50 mA max.)
	Y1, Y2, Y3, Y11-Y18	General-purpose transistor output	0: Converter running RUN 1: Converter ready to run RDY 2: Power supply current limiting IL 3: Lifetime alarm LIFE 4: Heat sink overheat early warning PRE-OH 5: Overload early warning PRE-OL 6: Power running DRV 7: Regenerating REG 8: Current limiting early warning CUR 9: Restarting after momentary power failure U-RES 10: Synchronizing power supply frequency SY-HZ 11: Alarm content 1 AL1 12: Alarm content 2 AL2 13: Alarm content 4 AL4 14: Option DO OPT-DO * Mounting the OPC-VG7-DIOA option makes 8 points of DO extended functions available. (DI functions are not available.)
	CME	Digital output common	
	Y5A, Y5C	Relay output	
	A01, A04, A05	General-purpose analog output	0: Input power PWR 1: Input current in RMS I-AC 2: Input voltage in RMS V-AC 3: DC link bus voltage V-DC 4: Power supply frequency FREQ 5: +10 V test P106: -10 V test N10 * Mounting the OPC-VG7-DIOA option makes 2 points of DO extended functions available. (DI functions are not available.)
	M	Analog output common	Common terminal for analog output signal.
	73A, 73C	Charging resistor input relay outputs	Control output for the input relay of the external charging resistor (73).

(2) Communications specifications

Item			Specifications
Communications specifications	General communication specifications		Monitoring the running information, running status and function code data, and controlling (selecting) the terminals [RUN], [RST] and [X1]. * Writing to function codes is not possible.
	RS-485 (standard)		Communicating with a PC or PLC. (The converter supports the Fuji general-purpose inverter protocol and Modbus RTU protocol.)
	T-Link (option)		Mounting the OPC-VG7-TL option enables communication with a T-Link module of MICREX-F or MICREX-SX via a T-Link network.
	SX-bus (option)		Mounting the OPC-VG7-SX option enables communication with a MICREX-SX via an SX bus network.
	CC-Link (option)		Mounting the OPC-VG7-CCL option enables communication with a CC-Link master.
	Traceback (option)	Hardware	Mounting the OPC-RHC-TR option enables tracing back of the running status data of the converter. WPS-LD-TR software is required.
		Software	Installing the WPS-RHC-TR software enables collecting of traceback data on the PC.
	Optical communication (option)		The OPC-VG7-SI allows for load balancing control of a concurrent multi-processing system. This supports capacity of up to 2400 kW.

(3) Function settings

Function code	Name
F00	Data protection
F01	High frequency filter selection
F02	Restart upon momentary power failure (operation selection)
F03	Current rating switching
F04	LED monitor, item selection
F05	LCD monitor, item selection
F06	LCD monitor, language selection
F07	LCD monitor, contrast control
F08	Carrier frequency
E01	Terminal [X1] function
E02-13	Terminal [Y1], [Y2], [Y3,], [Y5], [Y11] to [Y18] function
E14	I/O function normal open/closed
E15	RHC overload early warning level
E16	Cooling fan ON/OFF control
E17	Under current limiting (Hysteresis width)
E18-20	A01, A04 and A05, function selection
E21-23	A01, A04 and A05, gain setting
E24-26	A01, A04 and A05, bias setting
E27	A01, A04 and A05, filter setting
H01	Station address
H02	Communications error processing
H03	Timer
H04	Baud rate
H05	Data length
H06	Parity bits
H07	Stop bits
H08	No-response error detection time
H09	Response interval
H10	Protocol selection
H11	TL transmission format
H12	Parallel system
H13	Number of slave stations in parallel system
H14	Clear alarm data
H15,16	Power supply current limiter (driving 1/2)
H17,18	Power supply current limiter (braking 1/2)
H19,20	Current limiting early warning (level/timer)
S01	Operation method
S02,03	Power supply current limiting (driving/braking)
M09	Power supply frequency
M10	Input power
M11	Input current in RMS
M12	Input voltage in RMS
M13	Run command
M14	Running status
M15	Output terminals [Y1] to [Y18]

(4) Protective functions

Item	Indication	Protective specifications	Remarks
AC fuse blown	ACF	Stops the converter output if the AC fuse (R-/T-phase only) is blown.	
AC overvoltage	AOV	Stops the converter output upon detection of an AC overvoltage condition.	
AC undervoltage	ALV	Stops the converter output upon detection of an AC undervoltage condition.	
AC overcurrent	AOC	Stops the converter output if the peak value of the input current exceeds the overcurrent level.	
AC input current error	ACE	Stops the converter output upon detection of the excessive deviation of the AC reactor from the AC input.	
Input phase loss	LPV	Stops the converter output upon detection of an input phase loss.	
Synchronous power frequency error	FrE	After the MC for charging circuit (73) is turned on, the converter checks the power frequency. If it detects a power frequency error, this function stops the converter output. An error during converter running (e.g., momentary power failure) triggers no alarm.	
DC fuse blown	dCF	Stops the converter output if the DC fuse (P side) is blown.	18.5 kW or above
DC overvoltage	dOV	Stops the converter output upon detection of a DC overvoltage condition. If a power failure continues for a long time and the control power source is shut down, this alarm is automatically reset.	200 V class series: 400 V ±3 V 400 V class series: 800 V ±5 V
DC undervoltage	dLV	Stops the converter output upon detection of a DC undervoltage condition. If a power failure continues for a long time and the control power source is shut down, this alarm is automatically reset.	200 V class series: Stops at 185 V, restarts at 208 V. 400V class series: Stops at 371V, restarts at 417V.
Charging circuit fault	PbF	Stops the converter output upon detection of a heat sink overheat.	Condition: 73ANS (Answerback from 73) is assigned to terminal [X1].
Heat sink overheat	OH1	Stops the converter output upon detection of an internal overheat of the converter.	
External alarm	OH2	Stops the converter output upon receipt of an external signal THR.	THR (Enable external alarm trip) is assigned to terminal [X1].
Converter internal overheat	OH3	Stops the converter output with the inverse-time characteristics due to the input current.	
Converter overload	OLU	Stops the converter output upon detection of a heat sink overheat.	Activate at 105%, 150% for 1 min
Memory error	Er1	Stops the converter output if a data writing error or any other memory error occurs (when the checksums of the EEPROM and RAM do not match).	
Keypad communications error	Er2	Displays Er2 upon detection of a wire break in initial communication with the keypad. This does not affect the converter operation.	
CPU error	Er3	Activated if a CPU error occurs.	
Network device error	Er4	Stops the converter output if a fatal error (including no power supply connection) occurs in the master unit in the network.	Applies to T-Link, SX-bus, and CC-Link devices.
Operation procedure error	Er6	Stops the converter output upon detection of an error in the operation procedure.	
A/D converter error	Er8	Stops the converter output upon detection of a failure in the A/D converter circuit.	
Optical network error	Erb	Stops the converter output upon detection of an optical cable break or a fatal error in the optical option.	
IPM error	IPE	Activated when the IPM's self-diagnosis function works due to an overcurrent or overheat.	15 kW or below

(5) Required structure and environment

Item		Required structure, environment and standards	Remarks
Structure	Structure	Mounting in a panel or mounting for external cooling	
	Enclosure	IP00	
	Cooling system	Forced air cooling	
	Installation	Vertical installation	
	Coating color	Munsell 5Y3/0.5, eggshell	
	Maintainability	Structure designed for easy parts replacement	
Environment	Site location	Shall be free from corrosive gases, flammable gases, dusts, and direct sunlight.	
	Surrounding temperature	-10 to 500°C	
	Relative humidity	5 to 95% RH (No condensation)	
	Altitude	3,000 m max. (For use in an altitude between 1,001 m to 3,000 m, the output current should be derated.)	
	Vibration	2 to 9 Hz: Amplitude = 3 mm, 9 to 20 Hz: 9.8 m/s^2 20 to 55 Hz: 2 m/s^2 (9 to 55 Hz: 2 m/s^2 for 90 kW or above), 55 to 200 Hz: 1 m/s^2	
	Storage temperature	-20 to 55°C	
	Storage humidity	5 to 95% RH	

8.5.2.4 Converter configuration

(1) CT mode

Power supply voltage	Applicable motor [kW]	PWM converter type	Charging circuit contactor (73)	Qty.	Power supply contactor (52)	Qty.	Charging circuit box (*1) (CU)	Qty.	Charger resistor (R0)	Qty.	Fuse (F)	Qty.	Boosting reactor (Lr)	Qty.	Filtering resistor (Lf)	Qty.	Filtering reactor (Lf)	Qty.	Filtering capacitor (Cf)	Qty.	Filter circuit contactor (6F)	Qty.
200V series	7.5	RHC7.5-2C	SC-5-1	1			CU7.5-2C	1	(80W 7.5Ω) (HF5C5504)	(3)	(CR2LS-50/UL)	(2)	LR2-7.5C	1	GRZG80 0.42Ω	3	LFC2-7.5C	1	CF2-7.5C	1		
	11	RHC11-2C	SC-N1	1			CU11-2C	1			(CR2LS-75/UL)	(2)	LR2-15C	1	GRZG150 0.2Ω	3	LFC2-15C	1	CF2-15C	1		
	15	RHC15-2C	SC-N2	1			CU15-2C	1			(CR2LS-100/UL)	(2)										
	18.5	RHC18.5-2C	SC-N3	1			CU18.5-2C	1	(GRZG120 2Ω)	(3)			LR2-22C	1	GRZG200 0.13Ω	3	LFC2-22C	1	CF2-22C	1		
	22	RHC22-2C					CU22-2C	1			(CR2L-150/UL)	(2)										
	30	RHC30-2C	SC-N4	1	-	-	CU30-2C	1			(CR2L-200/UL)	(2)	LR2-37C	1	GRZG400 0.1Ω	3	LFC2-37C	1	CF2-37C	1	-	-
	37	RHC37-2C	SC-N5	1			CU45-2C	1			(CR2L-260/UL)	(2)										
	45	RHC45-2C	SC-N7	1									LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	RHC55-2C	SC-N8	1			CU55-2C	1			(CR2L-400/UL)	(2)										
	75	RHC75-2C	SC-N11	1			CU75-2C	1					LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	RHC90-2C					CU90-2C	1	(GRZG400 1Ω)	(3)	(A50P600-4)	(2)	LR2-110C	1	GRZG400 0.12Ω [2 parallel]	6	LFC2-110C	1	CF2-110C	1		
400V series	7.5	RHC7.5-4C	SC-05	1			CU7.5-4C	1	(TK50B 30ΩJ) (HF5B0416)	(3)	(CR6L-30/UL)	(2)	LR4-7.5C	1	GRZG80 1.74Ω	3	LFC4-7.5C	1	CF4-7.5C	1		
	11	RHC11-4C	SC-4-0	1			CU15-4C	1			(CR6L-50/UL)	(2)	LR4-15C	1	GRZG150 0.79Ω	3	LFC4-15C	1	CF4-15C	1		
	15	RHC15-4C	SC-5-1	1																		
	18.5	RHC18.5-4C	SC-N1	1			CU18.5-4C	1	(80W 7.5Ω) (HF5C5504)	(3)			LR4-22C	1	GRZG200 0.53Ω	3	LFC4-22C	1	CF4-22C	1		
	22	RHC22-4C					CU22-4C	1			(CR6L-75/UL)	(2)										
	30	RHC30-4C	SC-N2	1			CU30-4C	1			(CR6L-100/UL)	(2)	LR4-37C	1	GRZG400 0.38Ω	3	LFC4-37C	1	CF4-37C	1		
	37	RHC37-4C	SC-N2S	1			CU45-4C	1			(CR6L-150/UL)	(2)										
	45	RHC45-4C	SC-N3	1	-	-							LR4-55C	1	GRZG400 0.26Ω	3	LFC4-55C	1	CF4-55C	1	-	-
	55	RHC55-4C	SC-N4	1			CU55-4C	1			(CR6L-200/UL)	(2)										
	75	RHC75-4C	SC-N5	1			CU75-4C	1					LR4-75C	1	GRZG400 0.38Ω	3	LFC4-75C	1	CF4-75C	1		
	90	RHC90-4C	SC-N7	1			CU90-4C	1			(CR6L-300/UL)	(2)	LR4-110C	1	GRZG400 0.53Ω [2 parallel]	6	LFC4-110C	1	CF4-110C	1		
	110	RHC110-4C	SC-N8	1			CU110-4C	1	(GRZG120 2Ω)	(3)												
	132	RHC132-4C					CU132-4C	1			(A50P400-4)	(2)	LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	RHC160-4C	SC-N11	1			CU160-4C	1			(A50P600-4)	(2)										
	200	RHC200-4C	SC-N12	1			CU200-4C	1	(GRZG400 1Ω)	(3)			LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	RHC220-4C		1			CU220-4C	1			(A70QS800-4)	(2)										
	280	RHC280-4C	SC-N3	1	SC-N14	1			GRZG400 1Ω [2 parallel]	6	A70QS800-4	2	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1	SC-N4	1
	315	RHC315-4C									A70P1600-4TA	2	LR4-315C	1	RR4-315C	1	LFC4-315C	1	CF4-315C	1		
	355	RHC355-4C											LR4-355C	1	RR4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	RHC400-4C			SC-N16	1							LR4-400C	1	RR4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	RHC500-4C			SC-N11	3							LR4-500C	1	RR4-500C	1	LFC4-500C	1	CF4-500C	(*2) 1	(*3) SC-N4	
	630	RHC630-4C			SC-N12	3					A70P2000-4T	2	LR4-630C	1	RR4-630C	1	LFC4-630C	1	CF4-630C	(*2) 1	(*3) SC-N7	1

(*1) The charging box (CU) contains a combination of a charging resistor (R0) and a fuse (F). If no CU is used, it is necessary to prepare the charging resistor (R0) and fuse (F) at your end.

(*2) The filtering capacitor consists of two pieces of capacitors. For an order of quantity "1," two pieces of capacitors are to be delivered.

(*3) When changing the carrier frequency from the factory default, it is necessary to change the filtering circuit contactor (6F). For details, refer to the PWM Converter Instruction Manual.

(2) VT mode

Power supply voltage	Applicable motor [kW]	PWM converter type	Charging circuit contactor		Power supply contactor		Charging circuit box (*1)		Charger resistor		Fuse		Boosting reactor		Filtering resistor		Filtering reactor		Filtering capacitor		Filter circuit contactor	
			(73)	Qty.	(52)	Qty.	(CU)	Qty.	(R0)	Qty.	(F)	Qty.	(Lr)	Qty.	(Lf)	Qty.	(Lf)	Qty.	(Cf)	Qty.	(6F)	Qty.
200V series	11	RHC7.5-2C	SC-N1	1	-	-	CU7.5-2C	1	(80W 7.5Ω) (HF5C5504)	(3)	(CR2LS-50/UL)	(2)	LR2-15C	1	GRZG150 0.2Ω	3	LFC2-15C	1	CF2-15C	1	-	-
	15	RHC11-2C	SC-N2	1			CU11-2C	1			(CR2LS-75/UL)	(2)										
	18.5	RHC15-2C	SC-N3	1			CU15-2C	1			(CR2LS-100/UL)	(2)	LR2-22C	1	GRZG200 0.13Ω	3	LFC2-22C	1	CF2-22C	1		
	22	RHC18.5-2C					CU18.5-2C	1	(GRZG120 2Ω)	(3)												
	30	RHC22-2C	SC-N4	1			CU22-2C	1			(CR2L-150/UL)	(2)	LR2-37C	1	GRZG400 0.1Ω	3	LFC2-37C	1	CF2-37C	1		
	37	RHC30-2C	SC-N5	1			CU30-2C	1			(CR2L-200/UL)	(2)										
	45	RHC37-2C	SC-N7	1			CU45-2C	1			(CR2L-260/UL)	(2)	LR2-55C	1			LFC2-55C	1	CF2-55C	1		
	55	RHC45-2C	SC-N8	1																		
	75	RHC55-2C	SC-N11	1			CU55-2C	1			(CR2L-400/UL)	(2)	LR2-75C	1			LFC2-75C	1	CF2-75C	1		
	90	RHC75-2C					CU75-2C	1					LR2-110C	1	GRZG400 0.12Ω [2 parallel]	6	LFC2-110C	1	CF2-110C	1		
	110	RHC90-2C	SC-N12	1			CU90-2C	1	(GRZG400 1Ω)	(3)	(A50P600-4)	(2)										
400V series	11	RHC7.5-4C	SC-4-0	1	-	-	CU7.5-4C	1	(TK50B 30ΩJ) (HF5B0416)	(3)	(CR6L-30/UL)	(2)	LR4-15C	1	GRZG150 0.79Ω	3	LFC4-15C	1	CF4-15C	1	-	-
	15	RHC11-4C	SC-5-1	1			CU15-4C	1			(CR6L-50/UL)	(2)										
	18.5	RHC15-4C	SC-N1	1									LR4-22C	1	GRZG200 0.53Ω	3	LFC4-22C	1	CF4-22C	1		
	22	RHC18.5-4C					CU18.5-4C	1	(80W 7.5Ω) (HF5C5504)	(3)												
	30	RHC22-4C	SC-N2	1			CU22-4C	1			(CR6L-75/UL)	(2)	LR4-37C	1	GRZG400 0.38Ω	3	LFC4-37C	1	CF4-37C	1		
	37	RHC30-4C	SC-N2S	1			CU30-4C	1			(CR6L-100/UL)	(2)										
	45	RHC37-4C	SC-N3	1			CU45-4C	1			(CR6L-150/UL)	(2)	LR4-55C	1	GRZG400 0.26Ω	3	LFC4-55C	1	CF4-55C	1		
	55	RHC45-4C	SC-N4	1																		
	75	RHC55-4C	SC-N5	1			CU55-4C	1			(CR6L-200/UL)	(2)	LR4-75C	1	GRZG400 0.38Ω	3	LFC4-75C	1	CF4-75C	1		
	90	RHC75-4C	SC-N7	1			CU75-4C	1					LR4-110C	1	GRZG400 0.53Ω [2 parallel]	6	LFC4-110C	1	CF4-110C	1		
	110	RHC90-4C	SC-N8	1			CU90-4C	1			(CR6L-300/UL)	(2)										
	132	RHC110-4C					CU110-4C	1	(GRZG120 2Ω)	(3)			LR4-160C	1	RF4-160C	1	LFC4-160C	1	CF4-160C	1		
	160	RHC132-4C	SC-N11	1			CU132-4C	1			(A50P400-4)	(2)										
	200	RHC160-4C	SC-N12	1			CU160-4C	1			(A50P600-4)	(2)	LR4-220C	1	RF4-220C	1	LFC4-220C	1	CF4-220C	1		
	220	RHC200-4C					CU200-4C	1	(GRZG400 1Ω)	(3)												
	280	RHC220-4C	SC-N14	1			CU220-4C	1			(A70QS800-4)	(2)	LR4-280C	1	RF4-280C	1	LFC4-280C	1	CF4-280C	1		
	315	RHC280-4C	SC-N3	1	SC-N14	1			GRZG400 1Ω [2 parallel]	6	A70QS800-4	2	LR4-315C	1	RR4-315C	1	LFC4-315C	1	CF4-315C	1	SC-N4	1
	355	RHC315-4C									A70P1600-4TA	2	LR4-355C	1	RR4-355C	1	LFC4-355C	1	CF4-355C	1		
	400	RHC355-4C			SC-N16	1							LR4-400C	1	RR4-400C	1	LFC4-400C	1	CF4-400C	1		
	500	RHC400-4C			SC-N11	3							LR4-500C	1	RR4-400C	1	LFC4-500C	1	CF4-500C	(*2) 1	SC-N4/SF	

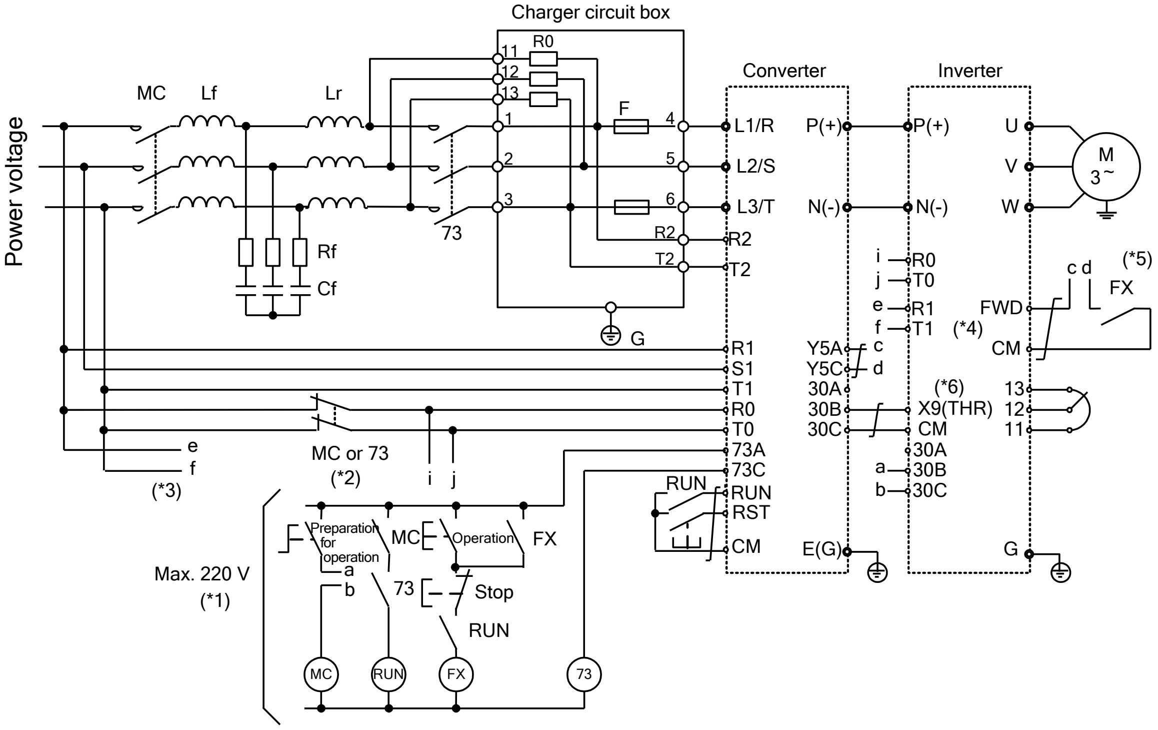
(*1) The charging box (CU) contains a combination of a charging resistor (R0) and a fuse (F). If no CU is used, it is necessary to prepare the charging resistor (R0) and fuse (F) at your end.

(*2) The filtering capacitor consists of two pieces of capacitors. For an order of quantity "1," two pieces of capacitors are to be delivered.

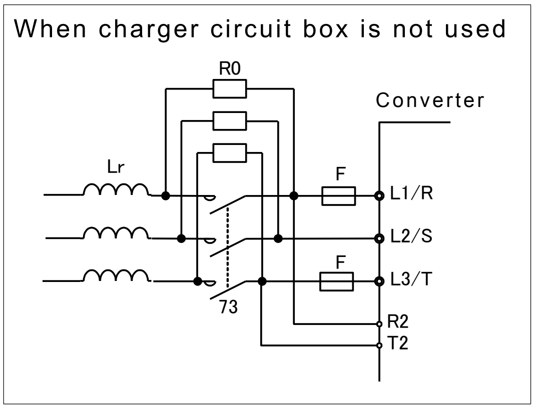
8.5.2.5 Basic connection diagrams

■RHC7.5-2C to RHC90-2C (Applicable inverters: FRN0.75VG1S-2J to FRN90VG1S-2J)

■RHC7.5-4C to RHC220-4C (Applicable inverters: FRN3.7VG1S-4J to FRN220VG1S-4J)



Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charger resistor
F	AC fuse
73	Magnetic contactor for charging circuit



(*1) For the 400 V class power supply, connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.
Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter to the main power input lines via B contacts of magnetic contactors of the charging circuit (73 or MC). Note that when applied to an ungrounded power supply, an insulated transformer is required. For the details, refer to the "PWM Converter Instruction Manual" (INR-HF51746☐).

(*2) For FRN37VG1S-2J or FRN75VG1S-2J, be sure to connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the MC's B contacts or 73.

(*3) For the fan power supply switching connectors, change "CN R" to the NC side and "CN W" to the FAN side.

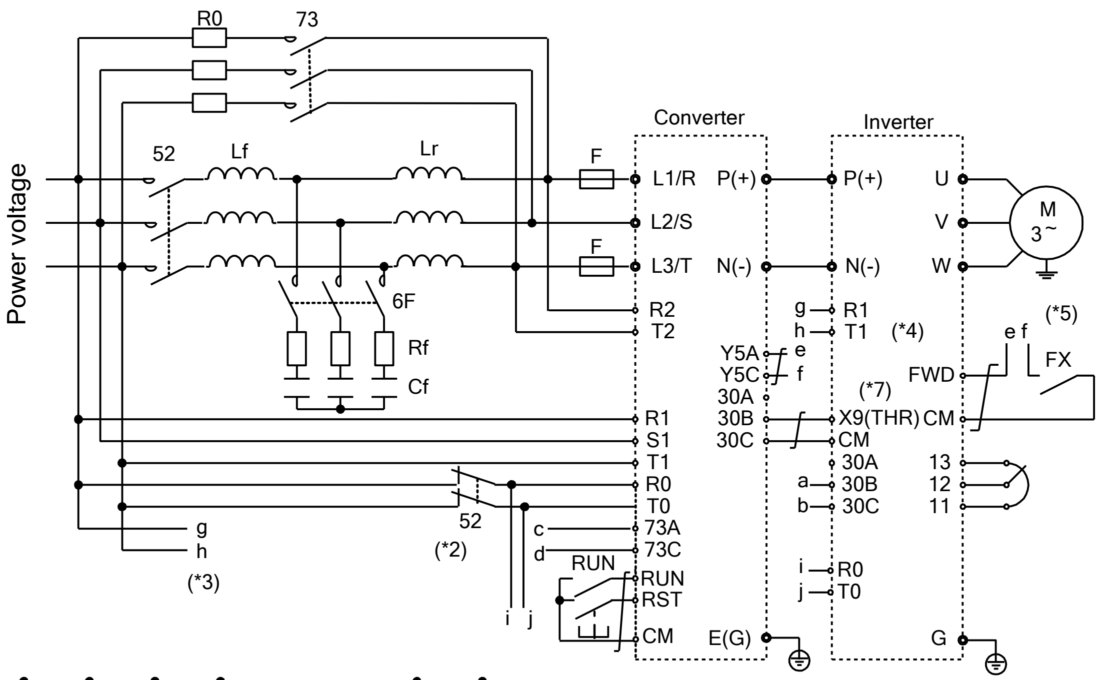
(*4) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

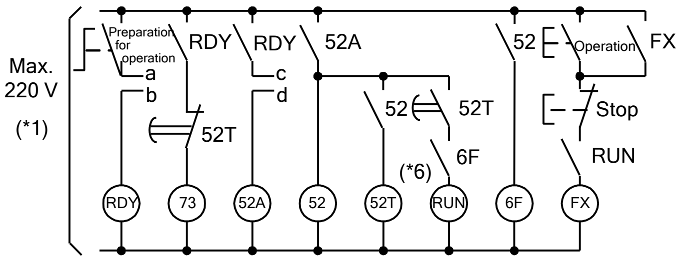
(*5) Assign the external alarm THR to any of terminals [X1] to [X9] on the inverter.

(*6) Wiring for terminals L1/R, L2/S, L3/T, R2, T2, R1, S1, and T1 should match with the phase sequence.

(*7) Remove the short-circuit bar or DC reactor connected to the P1, P(+) terminal of the inverter unit.

■RHC280-4C to RHC400-4C (Applicable inverters: FRN280VG1S-4J to FRN630VG1S-4J)





Symbol	Part name
Lr	Boosting reactor
Lf	Filtering reactor
Cf	Filtering capacitor
Rf	Filtering resistor
R0	Charger resistor
F	AC fuse
73	Magnetic contactor for charging circuit
52	Magnetic contactor for power supply
6F	Magnetic contactor for filtering circuit

(*1) Connect a stepdown transformer to limit the voltage of the sequence circuit to 220 V or below.

(*2) Be sure to connect the auxiliary power input terminals R0 and T0 of the PWM converter to the main power input lines via B contacts of magnetic contactors of the power supply circuit (52). Note that when applied to an ungrounded power supply, an insulated transformer is required. For the details, refer to the "PWM Converter Instruction Manual" (INR-HF51746☐).

(*3) Be sure to connect the fan power input terminals R1 and T1 of the inverter to the main power input lines without going through the MC's B contacts or 73.

(*4) For the fan power supply switching connectors, change "CN R" to the NC side and "CN W" to the FAN side.

(*5) Construct a sequence in which a run command is given to the inverter after the PWM converter becomes ready to run.

(*6) Set the timer 52T at 1 sec.

(*7) Assign the external alarm THR to any of terminals [X1] to [X9] on the inverter.

(*8) Wiring for terminals L1/R, L2/S, L3/T, R2, T2, R1, S1, and T1 should match with the phase sequence.

(*9) Remove the short-circuit bar or DC reactor connected to the P1, P(+) terminal of the inverter unit.

8.5.2.6 External dimensions

<PWM converter>

Figure A

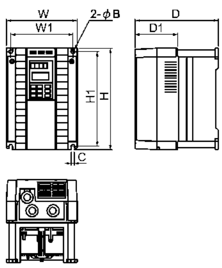


Figure B

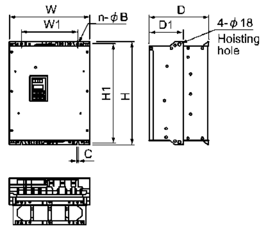


Figure C

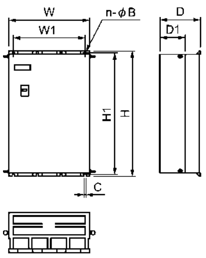
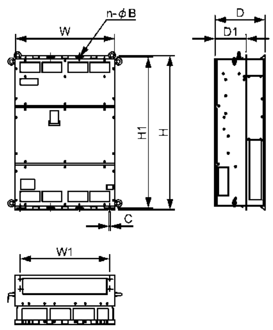


Figure D



PWM converter type		Fig	Dimensions(mm)									Approx. weight (kg)
			W	W1	H	H1	D	D1	n	B	C	
200V series	RHC7.5-2C	A	250	226	380	358	245	125	2	10	10	12.5
	RHC11-2C											
	RHC15-2C											
	RHC18.5-2C	B	340	240	480	460	255	145	2	10	10	24
	RHC22-2C											
	RHC30-2C	B	340	240	550	530	255	145	2	10	10	29
	RHC37-2C	B	375	275	615	595	270	145	2	10	10	36
	RHC45-2C	B	375	275	740	720	270	145	2	10	10	42
	RHC55-2C	B	375	275	740	720	270	145	2	10	10	44
	RHC75-2C	C	530	430	750	720	285	145	2	15	15	70
	RHC90-2C	C	680	580	880	850	360	220	3	15	15	115
400V series	RHC7.5-4C	A	250	226	380	358	245	125	2	10	10	12.5
	RHC11-4C											
	RHC15-4C											
	RHC18.5-4C	B	340	240	480	460	255	145	2	10	10	24
	RHC22-4C											
	RHC30-4C	B	340	240	550	530	255	145	2	10	10	29
	RHC37-4C	B	375	275	550	530	270	145	2	10	10	34
	RHC45-4C	B	375	275	675	655	270	145	2	10	10	38
	RHC55-4C	B	375	275	675	655	270	145	2	10	10	39
	RHC75-4C	B	375	275	740	720	270	145	2	10	10	48
	RHC90-4C	C	530	430	740	710	315	175	2	15	15	70
	RHC110-4C											
	RHC132-4C	C	530	430	1000	970	360	220	2	15	15	100
	RHC160-4C											
	RHC200-4C	C	680	580	1000	970	360	220	3	15	15	140
	RHC220-4C											
	RHC280-4C	C	680	580	1400	1370	450	285	3	15	15	320
	RHC315-4C											
	RHC355-4C	C	880	780	1400	1370	450	285	4	15	15	410
	RHC400-4C											
	RHC500-4C	D	999	900	1550	1520	500	313.2	4	15	15	525
	RHC630-4C											

< Boosting reactor >

Figure A

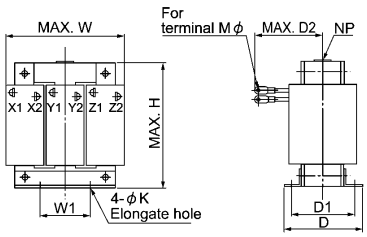


Figure B

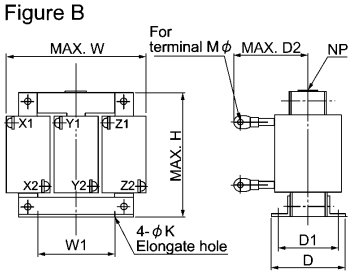


Figure C

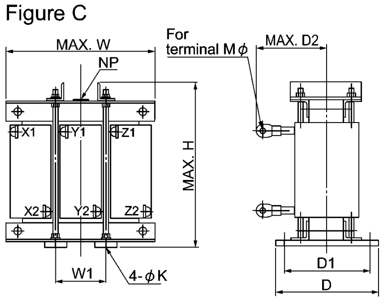
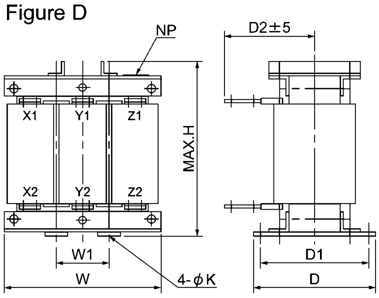


Figure D



Boosting reactor model		Fig	Dimensions(mm)								Approx. weight (kg)
			W	W1	H	D	D1	D2	K	M	
200 V Series	LR2-7.5C	A	180	75	205	105	85	95	7	M5	12
	LR2-15C	B	195	75	215	131	110	130	7	M8	18
	LR2-22C	C	240	80	340	215	180	145	10	M8	33
	LR2-37C	C	285	95	420	240	205	150	12	M10	50
	LR2-55C	C	285	95	420	250	215	160	12	M12	58
	LR2-75C	C	330	110	440	255	220	165	12	M12	70
	LR2-110C	C	345	115	500	280	245	185	12	M12	100
400 V Series	LR4-7.5C	B	180	75	205	105	85	90	7	M4	12
	LR4-15C	A	195	75	215	131	110	120	7	M5	18
	LR4-22C	C	240	80	340	215	180	120	10	M6	33
	LR4-37C	C	285	95	405	240	205	130	12	M8	50
	LR4-55C	C	285	95	415	250	215	145	12	M10	58
	LR4-75C	C	330	110	440	255	220	150	12	M10	70
	LR4-110C	C	345	115	490	280	245	170	12	M12	100
	LR4-160C	C	380	125	550	300	260	185	15	M12	140
	LR4-220C	C	450	150	620	330	290	230	15	M12	200
	LR4-280C	C	480	160	740	330	290	240	15	M16	250
	LR4-315C	C	480	160	760	340	300	250	15	M16	270
	LR4-355C	C	480	160	830	355	315	255	15	M16	310
	LR4-400C	C	480	160	890	380	330	260	19	M16	340
	LR4-500C	C	525	175	960	410	360	290	19	M16	420
	LR4-630C	D	600	200	64	440	390	290	19	4×M12	450

Note 1: CF4-500C to CF4-630C require two capacitors. (Figures above are for one capacitor.)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

< Filtering reactor >

Figure A

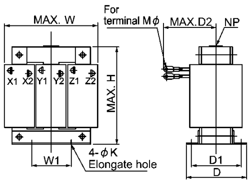


Figure B

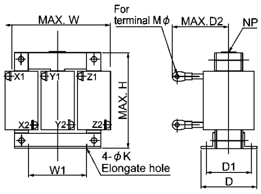


Figure C

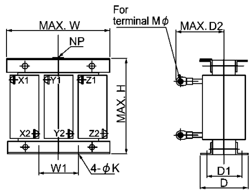


Figure D

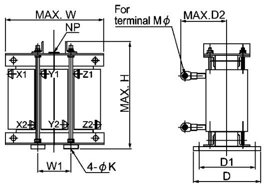
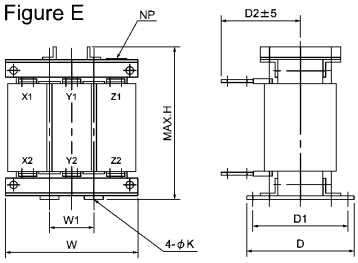


Figure E



Filtering reactor model		Fig	Dimensions(mm)								Approx. weight (kg)
			W	W1	H	D	D1	D2	K	M	
200V series	LFC2-7.5C	B	125	40	100	85	67	85	6	M5	2.2
	LFC2-15C	B	125	40	100	93	75	90	6	M8	2.5
	LFC2-22C	B	125	40	100	93	75	105	6	M8	3.0
	LFC2-37C	B	150	60	115	103	85	125	6	M10	5.0
	LFC2-55C	B	175	60	145	110	90	140	6	M12	8.0
	LFC2-75C	B	195	80	200	120	100	150	7	M12	13
	LFC2-110C	C	255	85	230	118	95	165	7	M12	20
400V series	LFC4-7.5C	A	125	40	100	85	67	75	6	M4	2.2
	LFC4-15C	A	125	40	100	93	75	90	6	M5	2.5
	LFC4-22C	A	125	40	100	93	75	95	6	M6	3.0
	LFC4-37C	B	150	60	115	108	90	110	6	M8	5.0
	LFC4-55C	B	175	60	145	110	90	120	6	M10	8.0
	LFC4-75C	B	195	80	200	113	93	130	7	M10	12
	LFC4-110C	C	255	85	220	113	90	145	7	M12	19
	LFC4-160C	C	255	85	245	137	110	150	7	M12	22
	LFC4-220C	D	300	100	320	210	180	170	10	M12	35
	LFC4-280C	D	330	110	320	230	195	195	12	M16	43
	LFC4-315C	D	315	105	365	230	195	200	12	M16	48
	LFC4-355C	D	315	105	395	235	200	210	12	M16	53
	LFC4-400C	D	345	115	420	235	200	235	12	M16	60
	LFC4-500C	D	345	115	480	240	205	240	12	M16	72
	LFC4-630C	E	435	145	550	295	255	205	15	4×M12	175

<Filtering capacitor>

Figure A

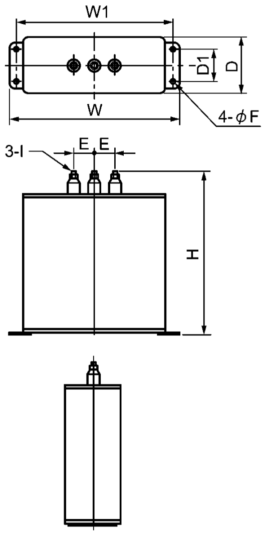
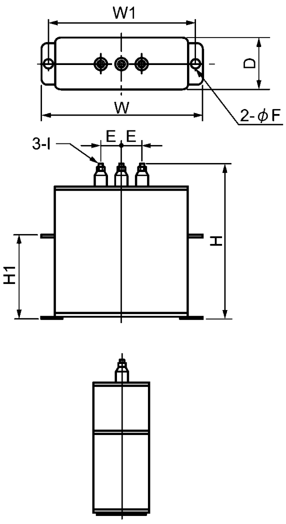


Figure B



Filtering capacitor model		Fig	Dimensions(mm)									Approx. weight (kg)
			W	W1	H	H1	D	D1	E	F	J	
200V series	CF2-7.5C	A	165	150	185	-	70	40	30	7	M5	1.9
	CF2-15C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF2-22C	A	280	265	215	-	90	55	30	7	M5	5.5
	CF2-37C	A	280	265	235	-	90	55	30	7	M5	6.0
	CF2-55C	A	280	265	340	-	90	55	80	7	M6	8.5
	CF2-75C	A	280	265	235	-	90	55	30	7	M5	6.0
	CF2-110C	A	280	265	340	-	90	55	80	7	M8	8.5
400V series	CF4-7.5C	A	165	150	135	-	70	40	30	7	M5	1.3
	CF4-15C	A	165	150	215	-	70	40	30	7	M5	2.3
	CF4-22C	A	205	190	185	-	70	40	30	7	M5	2.5
	CF4-37C	A	205	190	205	-	70	40	30	7	M5	2.9
	CF4-55C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF4-75C	A	205	190	205	-	70	40	30	7	M5	2.9
	CF4-110C	A	205	190	245	-	70	40	30	7	M5	3.5
	CF4-160C	A	280	265	260	-	90	55	80	7	M6	6.0
	CF4-220C	B	435	400	310	125	100	-	80	15x20 length hole	M12	13.0
	CF4-280C	B	435	400	350	165	100	-	80	15x20 length hole	M12	15.0
	CF4-315C	B	435	400	460	275	100	-	80	15x20 length hole	M12	20.0
	CF4-355C	B	435	400	520	335	100	-	80	15x20 length hole	M12	23.0
	CF4-400C	B	435	400	610	425	100	-	80	15x20 length hole	M12	27.0
	CF4-500C	B	435	400	310	125	100	-	80	15x20 length hole	M12	13.0
	CF4-630C	B	435	400	460	275	100	-	80	15x20 length hole	M12	20.0

< Filtering resistor >

Figure A

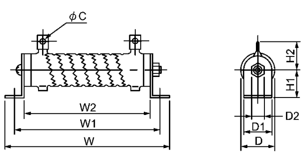


Figure B

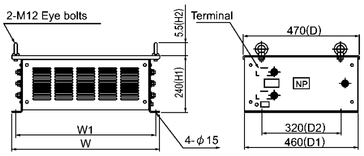
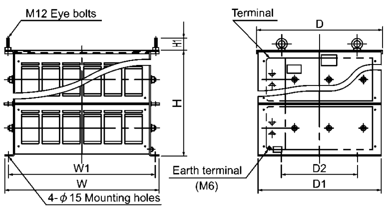


Figure C



Filtering resistor model		Fig	Dimensions(mm)									Approx. weight (kg)
			W	W1	W2	H1	H2	D	D1	D2	C	
200V series	GRZG80 0.42Ω	A	167	148	115	22	32	33	26	6	5.5	0.19
	GRZG150 0.2Ω	A	247	228	195	22	40	33	26	6	8.2	0.30
	GRZG200 0.13Ω	A	306	287	254	22	40	33	26	6	8.2	0.35
	GRZG400 0.1Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.12Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
400V series	GRZG80 1.74Ω	A	167	148	115	22	32	33	26	6	5.5	0.19
	GRZG150 0.79Ω	A	247	228	195	22	32	33	26	6	5.5	0.3
	GRZG200 0.53Ω	A	306	287	254	22	32	33	26	6	5.5	0.35
	GRZG400 0.38Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.26Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	GRZG400 0.53Ω	A	411	385	330	40	46	47	40	9.5	8.2	0.85
	RF4-160C	B	400	370	-	240	55	470	460	320	-	22
	RF4-220C											25
	RF4-280C	C	655	625	-	240	55	470	460	320	-	31
	RF4-315C											35
	RF4-355C											36
	RF4-400C											38
	RF4-500C											41
	RF4-630C	C	655	625	-	440	55	530	520	320	-	70

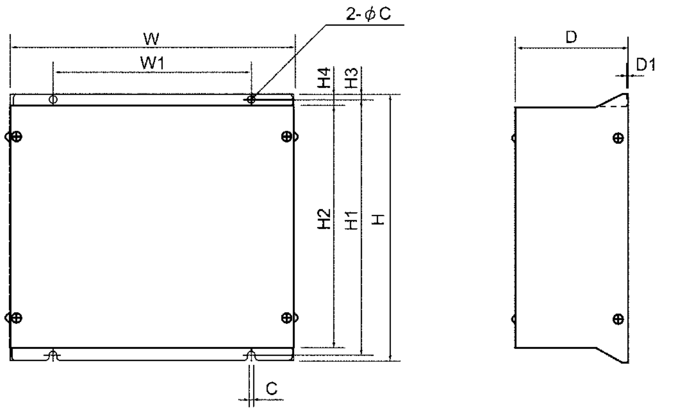
< Charging box >

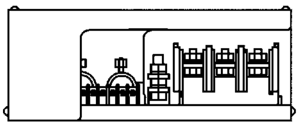
The charging box contains a combination of a charging resistor and a fuse, which is essential in the configuration of the RHC-C series of PWM converters. Using this charging box eases mounting and wiring jobs.

■ Capacity range

200 V series: 7.5 kW to 90 kW in 10 types, 400 V series: 7.5 kW to 220 kW in 14 types, Total 24 types

As for 400 V class series with a capacity of 280 to 400 kW, the charging resistor and the fuse are separately provided as before.





Fuse model		Dimensions(mm)										Mounting bolt	Approx. weight (kg)
		W	W1	H	H1	H2	H3	4	D	D1	C		
200V series	CU7.5-2C	270	170	300	285	270	7.5	15	100	2.4	6	M5	6
	CU11-2C												
	CU15-2C												
	CU18.5-2C												
	CU22-2C												
	CU30-2C	300	200	310	295	280	7.5	15	110	2.4	6	M5	7
	CU45-2C	330	230	310	295	280	7.5	15	130	2.4	6	M5	8
	CU55-2C												
	CU75-2C	430	330	560	536	510	12	25	150	3.2	10	M8	17
	CU90-2C												20
400V series	CU7.5-4C	270	170	300	285	270	7.5	15	100	2.4	6	M5	5.5
	CU15-4C												
	CU18.5-4C												6
	CU22-4C												
	CU30-4C	300	200	310	295	280	7.5	15	110	2.4	6	M5	7
	CU45-4C												
	CU55-4C												
	CU75-4C	330	230	310	295	280	7.5	15	130	2.4	6	M5	8
	CU90-4C												
	CU110-4C												
	CU132-4C	430	330	560	536	510	12	25	150	3.2	10	M8	18
	CU160-4C												
	CU200-4C												20
	CU220-4C												

<Charger resistor>

Figure A

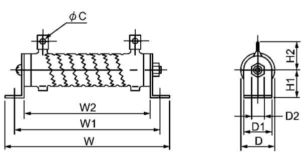


Figure B

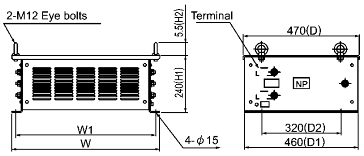
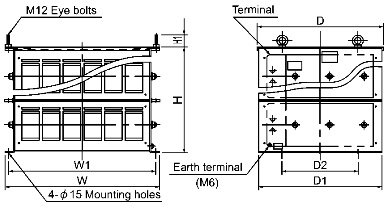


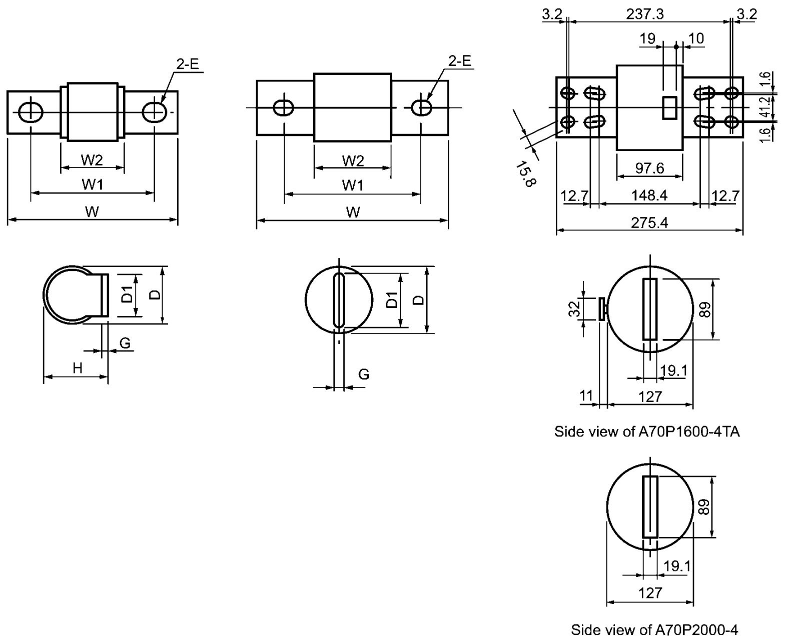
Figure C



Charger resistor model	Fig	Dimensions(mm)									Approx. weight (kg)
		W	W1	W2	H1	H2	D	D1	D2	C	
GRZG120 2Ω	A	217	198	165	22	32	33	22	6	5.5	0.25
GRZG400 1Ω	A	411	385	330	40	39	47	40	9.5	5.5	0.85
TK50B 30ΩJ (HF5B0416)	B	-	-	-	-	-	-	-	-	-	0.15
80W 7.5Ω (HF5C5504)	C	-	-	-	-	-	-	-	-	-	0.19

<fuse>

Figure A Figure B Figure C



Fuse model		Fig	Dimensions(mm)								Approx. weight (kg)
			W	W1	W2	H	D	D1	G	E	
200V series	CR2LS-50/UL	A	56	42	26	18.5	17.5	12	2	6.5x8.5	0.03
	CR2LS-75/UL										
	CR2LS-100/UL										
	CR2L-150/UL	A	80	58	29.5	30.5	27	20	3	9x11	0.10
	CR2L-200/UL	A	85	60	30	33.5	30	25	3.2	11x13	0.13
	CR2L-260/UL										
	CR2L-400/UL	A	95	70	31	42	37	30	4	11x13	0.22
	A50P600-4	B	113.5	81.75	56.4	-	50.8	38.1	6.4	10.3x18.2	0.60
400V series	CR6L-30/UL	A	76	62	47	18.5	17.5	12	2	6.5x8.5	0.04
	CR6L-50/UL										
	CR6L-75/UL	A	95	70	40	34	30	25	3.2	11x13	0.15
	CR6L-100/U										
	CR6L-150/UL										
	CR6L-200/UL	A	107	82	43	42	37	30	4	11x13	0.25
	CR6L-300/UL										
	A50P400-4	B	110	78.6	53.1	-	38.1	25.4	6.4	10.3x18.4	0.30
	A50P600-4	B	113.5	81.75	56.4	-	50.8	38.1	6.4	10.3x18.2	0.60
	A70QS800-4	B	180.2	129.4	72.2	-	63.5	50.8	9.5	13.5x18.3	1.1
	A70P1600-4T	C	-	-	-	-	-	-	-	-	8.0
	A70P2000-4	C	-	-	-	-	-	-	-	-	8.0

8.5.2.7 Generated loss

(1) In CT mode

Main unit		Boosting reactor		Filtering reactor		< Filtering resistor >		
Model	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Qty.**	**Generated loss (W)**
RHC7.5-2C	400	LR2-7.5C	95	LFC2-7.5C	10	GRZG80 0.42Ω	3	16
RHC11-2C	500	LR2-15C	150	LFC2-15C	19	GRZG150 0.2Ω	3	48
RHC15-2C	650							
RHC18.5-2C	700	LR2-22C	230	LFC2-22C	26	GRZG200 0.13Ω	3	68
RHC22-2C	800							
RHC30-2C	1000	LR2-37C	330	LFC2-37C	32	GRZG400 0.1Ω	3	107
RHC37-2C	1350							
RHC45-2C	1500	LR2-55C	450	LFC2-55C	43	GRZG400 0.1Ω	3	240
RHC55-2C	1750							
RHC75-2C	2050	LR2-75C	520	LFC2-75C	74	GRZG400 0.1Ω	3	137
RHC90-2C	2450	LR2-110C	720	LFC2-110C	115	GRZG400 0.12Ω (2 parallel)	6	374
RHC7.5-4C	400	LR4-7.5C	90	LFC4-7.5C	9	GRZG80 1.74Ω	3	15
RHC11-4C	500	LR4-15C	160	LFC4-15C	20	GRZG150 0.79Ω	3	48
RHC15-4C	600							
RHC18.5-4C	650	LR4-22C	230	LFC4-22C	22	GRZG200 0.53Ω	3	70
RHC22-4C	900							
RHC30-4C	1200	LR4-37C	350	LFC4-37C	36	GRZG400 0.38Ω	3	86
RHC37-4C	1550							
RHC45-4C	1800	LR4-55C	490	LFC4-55C	43	GRZG400 0.26Ω	3	130
RHC55-4C	2050							
RHC75-4C	2150	LR4-75C	520	LFC4-75C	78	GRZG400 0.38Ω	3	112
RHC90-4C	2600	LR4-110C	710	LFC4-110C	90	GRZG400 0.53Ω (2 parallel)	6	405
RHC110-4C	3050							
RHC132-4C	3500	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC160-4C	4150							
RHC200-4C	5100	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC220-4C	5600							
RHC280-4C	7100	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC315-4C	8000	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC355-4C	8900	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC400-4C	10100	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454
RHC500-4C	10000	LR4-500C	2470	LFC4-500C	450	RF4-500C	1	5463
RHC630-4C	12400	LR4-630C	2300	LFC4-630C	510	RF4-630C	1	4722

(2) In VT mode

Main unit		Boosting reactor		Filtering reactor		< Filtering resistor >		
Model	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Generated loss (W)**	**Model**	**Qty.**	**Generated loss (W)**
RHC7.5-2C	450	LR2-15C	150	LFC2-15C	19	GRZG150 0.2Ω	3	48
RHC11-2C	550							
RHC15-2C	650	LR2-22C	230	LFC2-22C	26	GRZG200 0.13Ω	3	68
RHC18.5-2C	750							
RHC22-2C	850	LR2-37C	330	LFC2-37C	32	GRZG400 0.1Ω	3	107
RHC30-2C	1200							
RHC37-2C	1500	LR2-55C	450	LFC2-55C	43	GRZG400 0.1Ω	3	240
RHC45-2C	1600							
RHC55-2C	2100	LR2-75C	520	LFC2-75C	74	GRZG400 0.1Ω	3	137
RHC75-2C	2300	LR2-110C	720	LFC2-110C	115	GRZG400 0.12Ω (2 parallel)	6	374
RHC90-2C	2650							
RHC7.5-4C	400	LR4-15C	160	LFC4-15C	20	GRZG150 0.79Ω	3	48
RHC11-4C	500							
RHC15-4C	600	LR4-22C	230	LFC4-22C	22	GRZG200 0.53Ω	3	70
RHC18.5-4C	600							
RHC22-4C	950	LR4-37C	350	LFC4-37C	36	GRZG400 0.38Ω	3	86
RHC30-4C	1200							
RHC37-4C	1450	LR4-55C	490	LFC4-55C	43	GRZG400 0.26Ω	3	130
RHC45-4C	1750							
RHC55-4C	2250	LR4-75C	520	LFC4-75C	78	GRZG400 0.38Ω	3	112
RHC75-4C	1950	LR4-110C	710	LFC4-110C	90	GRZG400 0.53Ω (2 parallel)	6	405
RHC90-4C	2400							
RHC110-4C	2900	LR4-160C	1000	LFC4-160C	160	RF4-160C	1	568
RHC132-4C	3250							
RHC160-4C	4100	LR4-220C	1240	LFC4-220C	200	RF4-220C	1	751
RHC200-4C	4400							
RHC220-4C	5600	LR4-280C	1430	LFC4-280C	220	RF4-280C	1	1027
RHC280-4C	6250	LR4-315C	1660	LFC4-315C	260	RF4-315C	1	1154
RHC315-4C	7000	LR4-355C	1910	LFC4-355C	300	RF4-355C	1	1286
RHC355-4C	8050	LR4-400C	2160	LFC4-400C	350	RF4-400C	1	1454
RHC400-4C	8950	LR4-500C	2470	LFC4-500C	450	RF4-500C	1	1821

* The generated loss for the filtering resistor above represent the value for all quantities.

8.5.3 DC reactor (DCR)

A DCR is mainly used for power supply matching and for input power factor correction (for reducing harmonic components).

For power supply matching

- Use a DCR when the capacity of a power supply transformer exceeds 500 kVA and is 10 times or more the rated inverter capacity. In this case, the percent reactance of the power supply decreases, and harmonic components and their peak value increase. These factors may break rectifiers or capacitors in the converter section of inverter, or decrease the capacitance of the capacitor (which can shorten the inverter's service life).
- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.
- Use a DCR when the interphase voltage unbalance ratio of the inverter power supply exceeds 2%.

$$\text{Interphase voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

For input power factor correction (for suppressing harmonics)

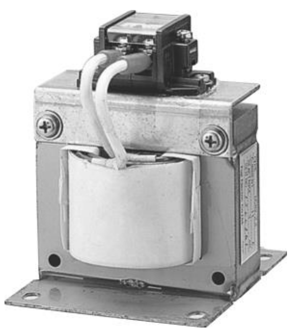
Generally a capacitor is used to improve the power factor of the load, however, it cannot be used in a system that includes an inverter. Using a DCR increases the reactance of inverter's power supply so as to decrease harmonic components on the power supply lines and improve the power factor of inverter. Using a DCR improves the input power factor to approximately 86% to 95%.

Note <HD class product: 55 kW or lower, LD class product: 45 kW or lower>

- At the time of shipping, a jumper bar is connected across terminals P1 and P (+) on the terminal block. Remove the jumper bar when connecting a DCR.
- If a DCR is not going to be used, do not remove the jumper bar.

<HD class product: 75 kW or higher, LD class product: 55 kW or higher, MD class product >

- At the time of shipping, a jumper bar is not connected across terminals P1 and P (+) on the terminal block. Be sure to connect the (supplied) DC reactor.



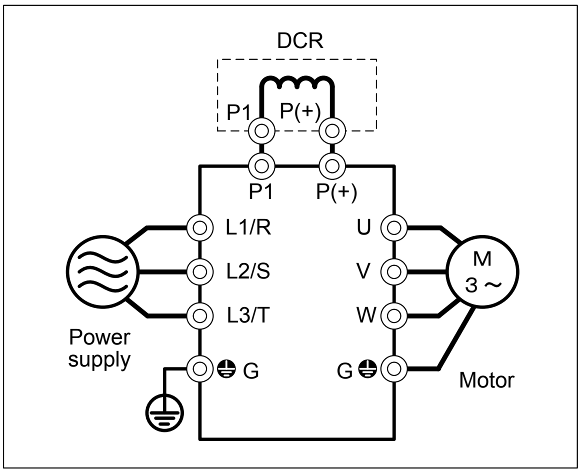


Figure 8.9 External View of a DC Reactor (DCR) and Connection Example

Table 8.10 DC reactor (DCR)

<table>
<tr><th>Power supply voltage</th><th>Nominal applicable motor (kW)</th><th>Inverter type</th><th>Specifi-cations</th><th>Reactor model</th><th>Rated current (A)</th><th>Inductance (mH)</th><th>Generated loss (W)</th></tr>
<tr><td rowspan="28">Three-phase 200V</td><td>0.75</td><td>FRN0.75VG1□-2J</td><td rowspan="10">HD</td><td>DCR2-0.75</td><td>5</td><td>7</td><td>2.8</td></tr>
<tr><td>1.5</td><td>FRN1.5VG1□-2J</td><td>DCR2-1.5</td><td>8</td><td>4</td><td>4.6</td></tr>
<tr><td>2.2</td><td>FRN2.2VG1□-2J</td><td>DCR2-2.2</td><td>11</td><td>3</td><td>6.7</td></tr>
<tr><td>3.7</td><td>FRN3.7VG1□-2J</td><td>DCR2-3.7</td><td>18</td><td>1.7</td><td>8.8</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-2J</td><td>DCR2-5.5</td><td>25</td><td>1.2</td><td>14</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-2J</td><td>DCR2-7.5</td><td>34</td><td>0.8</td><td>16</td></tr>
<tr><td>11</td><td>FRN11VG1□-2J</td><td>DCR2-11</td><td>50</td><td>0.6</td><td>27</td></tr>
<tr><td>15</td><td>FRN15VG1□-2J</td><td>DCR2-15</td><td>67</td><td>0.4</td><td>27</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-2J</td><td>DCR2-18.5</td><td>81</td><td>0.35</td><td>29</td></tr>
<tr><td>22</td><td>FRN22VG1□-2J</td><td>DCR2-22A</td><td>98</td><td>0.3</td><td>38</td></tr>
<tr><td>30</td><td rowspan="3">FRN30VG1□-2J</td><td>HD</td><td>DCR2-30B</td><td>136</td><td>0.23</td><td>37</td></tr>
<tr><td rowspan="4">37</td><td rowspan="2">LD</td><td>DCR2-37B</td><td>167</td><td>0.19</td><td>47</td></tr>
<tr><td>DCR2-37C</td><td>175</td><td>0.119</td><td>63</td></tr>
<tr><td rowspan="4">FRN37VG1□-2J</td><td rowspan="2">HD</td><td>DCR2-37B</td><td>167</td><td>0.19</td><td>47</td></tr>
<tr><td>DCR2-37C</td><td>175</td><td>0.119</td><td>63</td></tr>
<tr><td rowspan="4">45</td><td rowspan="2">LD</td><td>DCR2-45B</td><td>203</td><td>0.16</td><td>52</td></tr>
<tr><td>DCR2-45C</td><td>213</td><td>0.1</td><td>68</td></tr>
<tr><td rowspan="4">FRN45VG1□-2J</td><td rowspan="2">HD</td><td>DCR2-45B</td><td>203</td><td>0.16</td><td>52</td></tr>
<tr><td>DCR2-45C</td><td>213</td><td>0.1</td><td>68</td></tr>
<tr><td rowspan="4">55</td><td rowspan="2">LD</td><td>DCR2-55B</td><td>244</td><td>0.13</td><td>55</td></tr>
<tr><td>DCR2-55C</td><td>256</td><td>0.08</td><td>75</td></tr>
<tr><td rowspan="3">FRN55VG1□-2J</td><td rowspan="2">HD</td><td>DCR2-55B</td><td>244</td><td>0.13</td><td>55</td></tr>
<tr><td>DCR2-55C</td><td>256</td><td>0.08</td><td>75</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">DCR2-75C</td><td rowspan="2">358</td><td rowspan="2">0.05</td><td rowspan="2">96</td></tr>
<tr><td rowspan="2">FRN75VG1□-2J</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">DCR2-90C</td><td rowspan="2">431</td><td rowspan="2">0.042</td><td rowspan="2">100</td></tr>
<tr><td rowspan="2">FRN90VG1□-2J</td><td>HD</td></tr>
<tr><td>110</td><td>LD</td><td>DCR2-110C</td><td>552</td><td>0.034</td><td>126</td></tr>
</table>

Note 1: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

Note 2: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.10 DC reactor (DCR) (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Rated current (A)	Inductance (mH)	Generated loss (W)
Three-phase 400 V	3.7	FRN3.7VG1☐-4J	HD	DCR4-3.7	9	7	8.1
	5.5	FRN5.5VG1☐-4J		DCR4-5.5	13	4	10
	7.5	FRN7.5VG1☐-4J		DCR4-7.5	18	3.5	15
	11	FRN11VG1☐-4J		DCR4-11	25	2.2	21
	15	FRN15VG1☐-4J		DCR4-15	34	1.8	28
	18.5	FRN18.5VG1☐-4J		DCR4-18.5	41	1.4	29
	22	FRN22VG1☐-4J		DCR4-22A	49	1.2	35
	30	FRN30VG1☐-4J		DCR4-30B	71	0.86	35
	37		LD	DCR4-37B	88	0.70	40
				DCR4-37C	88	0.483	63
		FRN37VG1☐-4J	HD	DCR4-37B	88	0.70	40
				DCR4-37C	88	0.483	63
	45		LD	DCR4-45B	107	0.58	44
				DCR4-45C	107	0.4	69
		FRN45VG1☐-4J	HD	DCR4-45B	107	0.58	44
				DCR4-45C	107	0.4	69
	55		LD	DCR4-55B	131	0.47	55
				DCR4-55C	131	0.324	78
		FRN55VG1☐-4J	HD	DCR4-55B	131	0.47	55
				DCR4-55C	131	0.324	78
	75		LD	DCR4-75C	178	0.23	97
		FRN75VG1☐-4J	HD	DCR4-75C	178	0.23	97
	90		LD	DCR4-90C	214	0.2	111
		FRN90VG1☐-4J	HD				
	110		MD/LD	DCR4-110C	261	0.166	122
		FRN110VG1☐-4J	HD				
	132		MD/LD	DCR4-132C	313	0.148	159
		FRN132VG1☐-4J	HD				
	160		MD/LD	DCR4-160C	380	0.122	185
		FRN160VG1☐-4J	HD				
	200		MD/LD	DCR4-200C	475	0.098	218
		FRN200VG1☐-4J	HD				
	220		MD/LD	DCR4-220C	524	0.087	231
		FRN220VG1☐-4J	HD				
	250		MD	DCR4-250C	589	0.077	249
	280		LD	DCR4-280C	649	0.069	270
		FRN280VG1☐-4J	HD				
	315		MD	DCR4-315C	739	0.061	285
	355		LD	DCR4-355C	833	0.054	308
	315	FRN315VG1☐-4J	HD	DCR4-315C	739	0.061	285
	355		MD	DCR4-355C	833	0.054	308
	400		LD	DCR4-400C	938	0.048	323
	355	FRN355VG1☐-4J	HD	DCR4-355C	833	0.054	308
	400		MD	DCR4-400C	938	0.048	323
	450		LD	DCR4-450C	1056	0.043	338
	400	FRN400VG1☐-4J	HD	DCR4-400C	938	0.048	323
	450		MD	DCR4-450C	1056	0.043	338
	500		LD	DCR4-500C	1173	0.039	384
		FRN500VG1☐-4J	HD				
	630		LD	DCR4-630C	1477	0.031	620
		FRN630VG1☐-4J	HD				
	710		LD	DCR4-710C	1666	0.028	600

Note 1: ☐ in the inverter model represents an alphabet.

☐
└── S (Basic type)

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).
- An AC reactor (ACR) is not connected.

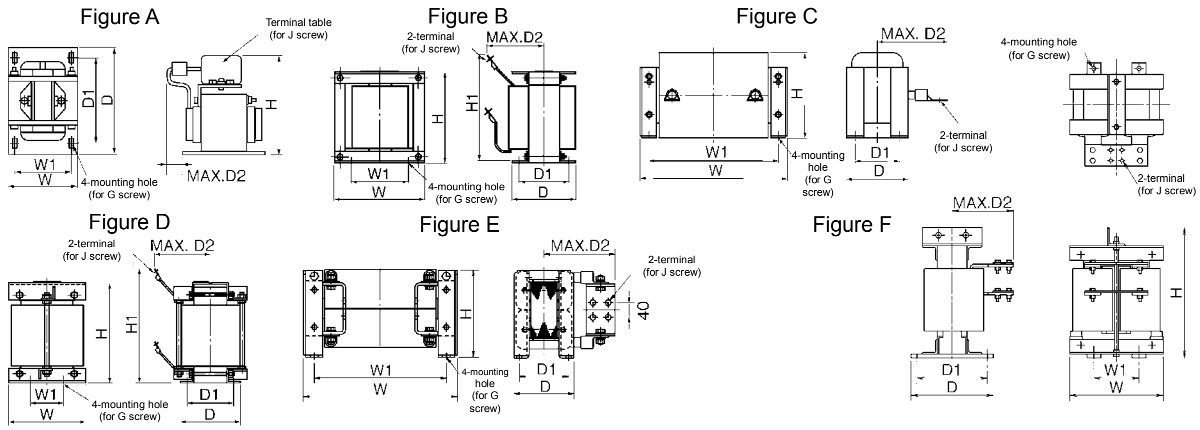


Table 8.11 DC Reactors (DCRs) External Dimensions

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Dimensions Fig	W	W1	D	D1	D2	G	H	H1	J	Approx. weight (kg)
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	DCR2-0.75	A	66	56	90	72	20	M4(5.2×8)	94	-	M4	1.4
	1.5	FRN1.5VG1□-2J		DCR2-1.5		66	56	90	72	20	M4(5.2×8)	94	-	M4	1.6
	2.2	FRN2.2VG1□-2J		DCR2-2.2		86	71	100	80	10	M5(6×9)	110	-	M4	1.8
	3.7	FRN3.7VG1□-2J		DCR2-3.7		86	71	100	80	20	M5(6×9)	110	-	M4	2.6
	5.5	FRN5.5VG1□-2J		DCR2-5.5		111	95	100	80	20	M6(7×11)	130	-	M5	3.6
	7.5	FRN7.5VG1□-2J		DCR2-7.5		111	95	100	80	23	M6(7×11)	130	-	M5	3.8
	11	FRN11VG1□-2J		DCR2-11		111	95	100	80	24	M6(7×11)	137	-	M6	4.3
	15	FRN15VG1□-2J		DCR2-15		146	124	120	96	15	M6(7×11)	180	-	M8	5.9
	18.5	FRN18.5VG1□-2J		DCR2-18.5		146	124	120	96	25	M6(7×11)	180	-	M8	7.4
	22	FRN22VG1□-2J		DCR2-22A		146	124	120	96	25	M6(7×11)	180	-	M8	7.5
	30	FRN30VG1□-2J	HD	DCR2-30B	B	152	90	156	116	115	M6(Φ8)	130	190	M10	12
	37		LD	DCR2-37B		171	110	151	110	115	M6(Φ8)	150	200	M10	14
				DCR2-37C	C	210	185	101	81	125	M6(7×13)	125	-	M10	7.4
		FRN37VG1□-2J	HD	DCR2-37B	B	171	110	151	110	115	M6(Φ8)	150	200	M10	14
				DCR2-37C	C	210	185	101	81	125	M6(7×13)	125	-	M10	7.4
	45		LD	DCR2-45B	B	171	110	166	125	120	M6(Φ8)	150	200	M10	16
				DCR2-45C	C	210	185	106	86	135	M6(7×13)	125	-	M12	8.4
		FRN45VG1□-2J	HD	DCR2-45B	B	171	110	166	125	120	M6(Φ8)	150	200	M10	16
				DCR2-45C	C	210	185	106	86	135	M6(7×13)	125	-	M12	8.4
	55		LD	DCR2-55B	D	190	160	131	90	100	M6(Φ8)	210	250	M12	16
				DCR2-55C	C	255	225	96	76	140	M6(7×13)	145	-	M12	11
		FRN55VG1□-2J	HD	DCR2-55B	D	190	160	131	90	100	M6(Φ8)	210	250	M12	16
				DCR2-55C	C	255	225	96	76	140	M6(7×13)	145	-	M12	11
	75		LD	DCR2-75C		255	225	106	86	145	M6(7×13)	145	-	M12	12
		FRN75VG1□-2J	HD												
	90		LD	DCR2-90C		255	225	116	96	155	M6(7×13)	145	-	M12	14
		FRN90VG1□-2J	HD												
	110		LD	DCR2-110C		300	265	116	90	185	M8(10×18)	160	-	M12	17

Note : □ in the inverter model represents an alphabet.
□
└── S (Basic type)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

Table 8.11 DC Reactors (DCRs) External Dimensions (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Dimensions										Approx. weight (kg)
					Fig	W	W1	D	D1	D2	G	H	H1	J	
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	DCR4-3.7	A	86	71	100	80	20	M5(6×9)	110	-	M4	2.6
	5.5	FRN5.5VG1□-4J		DCR4-5.5		86	71	100	80	20	M5(6×9)	110	-	M4	2.6
	7.5	FRN7.5VG1□-4J		DCR4-7.5		111	95	100	80	24	M6(7×11)	130	-	M5	4.2
	11	FRN11VG1□-4J		DCR4-11		111	95	100	80	24	M6(7×11)	130	-	M5	4.3
	15	FRN15VG1□-4J		DCR4-15		146	124	120	96	15	M6(7×11)	168	-	M5	5.9
	18.5	FRN18.5VG1□-4J		DCR4-18.5		146	124	120	96	25	M6(7×11)	171	-	M6	7.2
	22	FRN22VG1□-4J		DCR4-22A		146	124	120	96	25	M6(7×11)	171	-	M6	7.2
	30	FRN30VG1□-4J		DCR4-30B		152	90	157	115	100	M6(Φ8)	130	190	M8	13
	37		LD	DCR4-37B	B	171	110	150	110	100	M6(Φ8)	150	200	M8	15
				DCR4-37C	C	210	185	101	81	105	M6(7×13)	125	-	M8	7.4
		FRN37VG1□-4J	HD	DCR4-37B	B	171	110	150	110	100	M6(Φ8)	150	200	M8	15
				DCR4-37C	C	210	185	101	81	105	M6(7×13)	125	-	M8	7.4
	45		LD	DCR4-45B	B	171	110	165	125	110	M6(Φ8)	150	210	M8	18
				DCR4-45C	C	210	185	106	86	120	M6(7×13)	125	-	M8	8.4
		FRN45VG1□-4J	HD	DCR4-45B	B	171	110	165	125	110	M6(Φ8)	150	210	M8	18
				DCR4-45C	C	210	185	106	86	120	M6(7×13)	125	-	M8	8.4
	55		LD	DCR4-55B	B	171	110	170	130	110	M6(Φ8)	150	210	M8	20
				DCR4-55C	C	255	225	96	76	120	M6(7×13)	145	-	M10	11
		FRN55VG1□-4J	HD	DCR4-55B	B	171	110	170	130	110	M6(Φ8)	150	210	M8	20
				DCR4-55C	C	255	225	96	76	120	M6(7×13)	145	-	M10	11
	75		LD	DCR4-75C		255	225	106	86	125	M6(7×13)	145	-	M10	13
		FRN75VG1□-4J	HD	DCR4-75C		255	225	106	86	125	M6(7×13)	145	-	M10	13
	90		LD	DCR4-90C		255	225	116	96	140	M6(7×13)	145	-	M12	15
		FRN90VG1□-4J	HD												
	110		MD/LD	DCR4-110C		300	265	116	90	175	M8(10×18)	155	-	M12	19
		FRN110VG1□-4J	HD												
	132		MD/LD	DCR4-132C		300	265	126	100	180	M8(10×18)	160	-	M12	22
		FRN132VG1□-4J	HD												
	160		MD/LD	DCR4-160C		350	310	131	103	180	M10(12×22)	190	-	M12	26
		FRN160VG1□-4J	HD												
	200		MD/LD	DCR4-200C		350	310	141	113	185	M10(12×22)	190	-	M12	30
		FRN200VG1□-4J	HD												
	220		MD/LD	DCR4-220C		350	310	146	118	200	M10(12×22)	190	-	M12	33
		FRN220VG1□-4J	HD												
	250		MD	DCR4-250C		350	310	161	133	210	M10(12×22)	190	-	M12	35
	280		LD	DCR4-280C		350	310	161	133	210	M10(12×22)	190	-	M16	37
		FRN280VG1□-4J	HD												
	315		MD	DCR4-315C		400	345	146	118	200	M10(12×22)	225	-	M16	40
	355		LD	DCR4-355C	E	400	345	156	128	200	M10(12×22)	225	-	4×M12	49
	315	FRN315VG1□-4J	HD	DCR4-315C	C	400	345	146	118	200	M10(12×22)	225	-	M16	40
	355		MD	DCR4-355C	E	400	345	156	128	200	M10(12×22)	225	-	4×M12	49
	400		LD	DCR4-400C		445	385	145	117	213	M10(12×22)	245	-	4×M12	52
	355	FRN355VG1□-4J	HD	DCR4-355C		400	345	156	128	200	M10(12×22)	225	-	4×M12	49
	400		MD	DCR4-400C		445	385	145	117	213	M10(12×22)	245	-	4×M12	52
	450		LD	DCR4-450C		440	385	150	122	215	M10(12×22)	245	-	4×M12	62
	400	FRN400VG1□-4J	HD	DCR4-400C		445	385	145	117	213	M10(12×22)	245	-	4×M12	52
	450		MD	DCR4-450C		440	385	150	122	215	M10(12×22)	245	-	4×M12	62
	500		LD	DCR4-500C		445	390	165	137	220	M10(12×22)	245	-	4×M12	72
		FRN500VG1□-4J	HD												
	630		LD	DCR-630C	F	285	145	203	170	195	M12(14×20)	480	-	2×M12	75
		FRN630VG1□-4J	HD												
	710		LD	DCR-710C		340	160	295	255	225	M12(Φ15)	480	-	4×M12	95

Note: □ in the inverter model represents an alphabet.

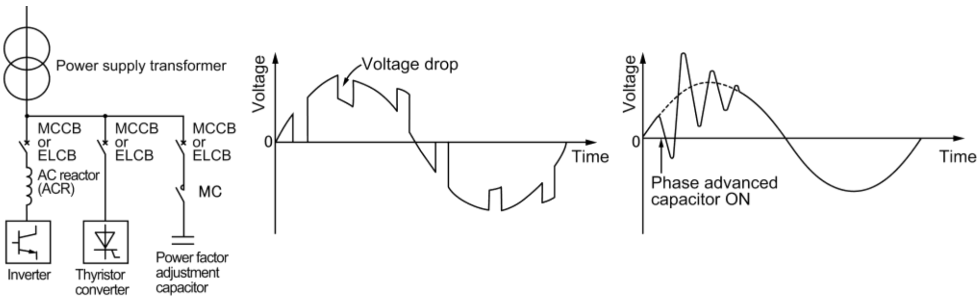
□
└── S (Basic type)

8.5.4 AC reactor (ACR)

Use an ACR when the converter part of the inverter should supply very stable DC power, for example, in DC link bus operation (shared PN operation). Generally, ACRs are used for correction of voltage waveform and power factor or for power supply matching, but not for suppressing harmonic components in the power lines. For suppressing harmonic components, use a DCR.

■For power supply matching

- Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.

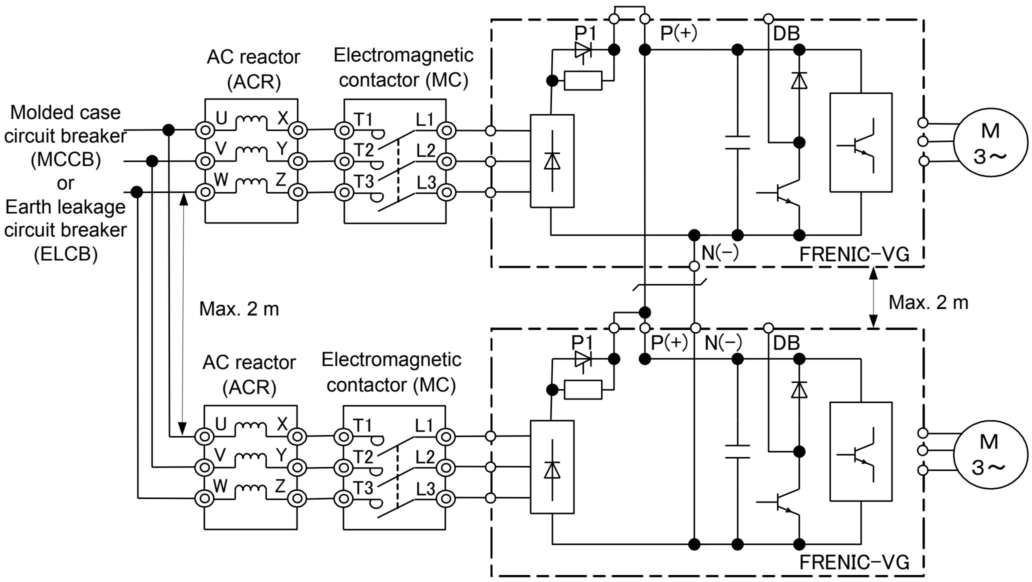


(a) Connection example (b) Voltage depression example with thyristor converter (c) Voltage fluctuation example with phase advanced capacitor

- Use a DCR when the interphase voltage unbalance ratio of the inverter power supply exceeds 2%.

$$\text{Interphase voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$

- When connecting multiple inverters to DC mother line



Note 1) Be sure to connect the AC rector when connecting to the DC mother line.

Note 2) When connecting to the DC mother line, use inverters of the same model and capacity.

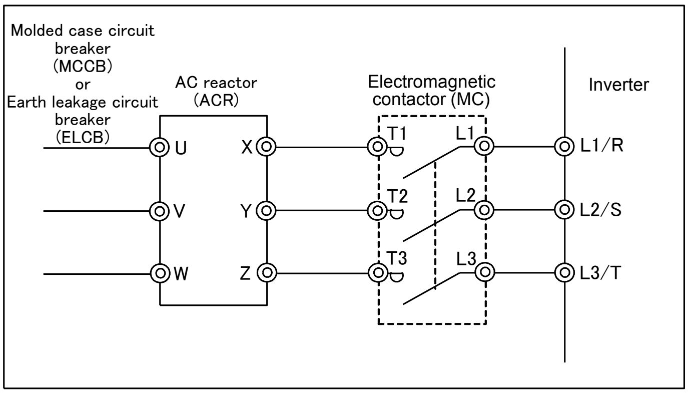


Figure 8.10 External View of AC Reactor (ACR) and Connection Example

Table 8.12 AC Reactor (ACR)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Reactor model	Rated current (A)	Reactance (mΩ/phase) 50 Hz	Reactance (mΩ/phase) 60 Hz	Winding resistor (mΩ)	Generated loss (W)
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	ACR2-0.75A	5	493	592	-	12
	1.5	FRN1.5VG1□-2J		ACR2-1.5A	8	295	354	-	14
	2.2	FRN2.2VG1□-2J		ACR2-2.2A	11	213	256	-	16
	3.7	FRN3.7VG1□-2J		ACR2-3.7A	17	218	153	-	23
	5.5	FRN5.5VG1□-2J		ACR2-5.5A	25	87.7	105	-	27
	7.5	FRN7.5VG1□-2J		ACR2-7.5A	33	65	78	-	30
	11	FRN11VG1□-2J		ACR2-11A	46	45.5	54.7	-	37
	15	FRN15VG1□-2J		ACR2-15A	59	34.8	41.8	-	43
	18.5	FRN18.5VG1□-2J		ACR2-18.5A	74	28.6	34.3	-	51
	22	FRN22VG1□-2J		ACR2-22A	87	24	28.8	-	57
	30	FRN30VG1□-2J	HD	ACR2-37	200	10.8	13	0.5	28.6
	37		LD	ACR2-37	200	10.8	13	0.5	40.8
		FRN37VG1□-2J	HD						
	45		LD	ACR2-55	270	7.5	9	0.375	47.1
		FRN45VG1□-2J	HD						
	55		LD	ACR2-55	270	7.5	9	0.375	66.1
		FRN55VG1□-2J	HD						
	75		LD	ACR2-75	390	5.45	6.54	0.25	55.1
		FRN75VG1□-2J	HD						
	90		LD	ACR2-90	450	4.73	5.67	0.198	61.5
		FRN90VG1□-2J	HD						
	110		LD	ACR2-110	500	4.25	5.1	0.18	83.4

Note 1: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

Table 8.12 AC Reactor (ACR) (continued)

<table>
<tr><th rowspan="2">Power supply voltage</th><th rowspan="2">Nominal applied motor (kW)</th><th rowspan="2">Inverter type</th><th rowspan="2">Specifi-cations</th><th rowspan="2">Reactor model</th><th rowspan="2">Rated current(A)</th><th colspan="2">Reactance (mΩ/phase)</th><th rowspan="2">Winding resistor (mΩ)</th><th rowspan="2">Generated loss (W)</th></tr>
<tr><th>50 Hz</th><th>60 Hz</th></tr>
<tr><td rowspan="46">Three-phase 400V</td><td>3.7</td><td>FRN3.7VG1□-4J</td><td rowspan="7">HD</td><td>ACR4-3.7A</td><td>9</td><td>512</td><td>615</td><td>-</td><td>17</td></tr>
<tr><td>5.5</td><td>FRN5.5VG1□-4J</td><td>ACR4-5.5A</td><td>13</td><td>349</td><td>418</td><td>-</td><td>22</td></tr>
<tr><td>7.5</td><td>FRN7.5VG1□-4J</td><td>ACR4-7.5A</td><td>18</td><td>256</td><td>307</td><td>-</td><td>27</td></tr>
<tr><td>11</td><td>FRN11VG1□-4J</td><td>ACR4-11A</td><td>24</td><td>183</td><td>219</td><td>-</td><td>40</td></tr>
<tr><td>15</td><td>FRN15VG1□-4J</td><td>ACR4-15A</td><td>30</td><td>139</td><td>167</td><td>-</td><td>46</td></tr>
<tr><td>18.5</td><td>FRN18.5VG1□-4J</td><td>ACR4-18.5 A</td><td>39</td><td>114</td><td>137</td><td>-</td><td>57</td></tr>
<tr><td>22</td><td>FRN22VG1□-4J</td><td>ACR4-22A</td><td>45</td><td>95.8</td><td>115</td><td>-</td><td>62</td></tr>
<tr><td>30</td><td rowspan="2">FRN30VG1□-4J</td><td>HD</td><td>ACR4-37</td><td>100</td><td>41.7</td><td>50</td><td>2.73</td><td>38.9</td></tr>
<tr><td rowspan="2">37</td><td>LD</td><td rowspan="2">ACR4-37</td><td rowspan="2">100</td><td rowspan="2">41.7</td><td rowspan="2">50</td><td rowspan="2">2.73</td><td rowspan="2">55.7</td></tr>
<tr><td rowspan="2">FRN37VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">45</td><td>LD</td><td rowspan="2">ACR4-55</td><td rowspan="2">135</td><td rowspan="2">30.8</td><td rowspan="2">37</td><td rowspan="2">1.61</td><td rowspan="2">50.2</td></tr>
<tr><td rowspan="2">FRN45VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">55</td><td>LD</td><td rowspan="2">ACR4-55</td><td rowspan="2">135</td><td rowspan="2">30.8</td><td rowspan="2">37</td><td rowspan="2">1.61</td><td rowspan="2">70.7</td></tr>
<tr><td rowspan="2">FRN55VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">75</td><td>LD</td><td rowspan="2">ACR4-75 *</td><td rowspan="2">160</td><td rowspan="2">25.8</td><td rowspan="2">31</td><td rowspan="2">1.16</td><td rowspan="2">65.3</td></tr>
<tr><td rowspan="2">FRN75VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">90</td><td>LD</td><td rowspan="2">ACR4-110</td><td rowspan="2">250</td><td rowspan="2">16.7</td><td rowspan="2">20</td><td rowspan="2">0.523</td><td rowspan="2">42.2</td></tr>
<tr><td rowspan="2">FRN90VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">110</td><td>MD/LD</td><td rowspan="2">ACR4-110</td><td rowspan="2">250</td><td rowspan="2">16.7</td><td rowspan="2">20</td><td rowspan="2">0.523</td><td rowspan="2">60.3</td></tr>
<tr><td rowspan="2">FRN110VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">132</td><td>MD/LD</td><td rowspan="2">ACR4-132 *</td><td rowspan="2">270</td><td rowspan="2">20.8</td><td rowspan="2">25</td><td rowspan="2">0.741</td><td rowspan="2">119</td></tr>
<tr><td rowspan="2">FRN132VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">160</td><td>MD/LD</td><td rowspan="2">ACR4-220</td><td rowspan="2">561</td><td rowspan="2">10</td><td rowspan="2">12</td><td rowspan="2">0.236</td><td rowspan="2">56.4</td></tr>
<tr><td rowspan="2">FRN160VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">200</td><td>MD/LD</td><td rowspan="2">ACR4-220</td><td rowspan="2">561</td><td rowspan="2">10</td><td rowspan="2">12</td><td rowspan="2">0.236</td><td rowspan="2">90.4</td></tr>
<tr><td rowspan="2">FRN200VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">220</td><td>MD/LD</td><td rowspan="2">ACR4-220</td><td rowspan="2">561</td><td rowspan="2">10</td><td rowspan="2">12</td><td rowspan="2">0.236</td><td rowspan="2">107</td></tr>
<tr><td rowspan="3">FRN220VG1□-4J</td><td>HD</td></tr>
<tr><td>250</td><td>MD</td><td rowspan="3">ACR4-280</td><td rowspan="3">825</td><td rowspan="3">6.67</td><td rowspan="3">8</td><td rowspan="3">0.144</td><td>96.4</td></tr>
<tr><td rowspan="2">280</td><td>LD</td><td rowspan="2">108</td></tr>
<tr><td rowspan="3">FRN280VG1□-4J</td><td>HD</td></tr>
<tr><td>315</td><td>MD</td><td rowspan="2">ACR4-355</td><td rowspan="2">825</td><td rowspan="2">6.67</td><td rowspan="2">8</td><td rowspan="2">0.144</td><td>194</td></tr>
<tr><td>355</td><td>LD</td><td>245</td></tr>
<tr><td>315</td><td rowspan="3">FRN315VG1□-4J</td><td>HD</td><td rowspan="2">ACR4-355</td><td rowspan="2">825</td><td rowspan="2">6.67</td><td rowspan="2">8</td><td rowspan="2">0.144</td><td>194</td></tr>
<tr><td>355</td><td>MD</td><td>245</td></tr>
<tr><td>400</td><td>LD</td><td>ACR4-450</td><td>950</td><td>6.67</td><td>8</td><td>0.136</td><td>380</td></tr>
<tr><td>355</td><td rowspan="3">FRN355VG1□-4J</td><td>HD</td><td>ACR4-355 *</td><td>825</td><td>6.67</td><td>8</td><td>0.144</td><td>245</td></tr>
<tr><td>400</td><td>MD</td><td rowspan="2">ACR4-450</td><td rowspan="2">950</td><td rowspan="2">6.67</td><td rowspan="2">8</td><td rowspan="2">0.136</td><td>380</td></tr>
<tr><td>450</td><td>LD</td><td>473</td></tr>
<tr><td>400</td><td rowspan="3">FRN400VG1□-4J</td><td>HD</td><td rowspan="2">ACR4-450</td><td rowspan="2">950</td><td rowspan="2">6.67</td><td rowspan="2">8</td><td rowspan="2">0.136</td><td>380</td></tr>
<tr><td>450</td><td>MD</td><td>473</td></tr>
<tr><td rowspan="2">500</td><td>LD</td><td rowspan="2">ACR4-530</td><td rowspan="2">1100</td><td rowspan="2">5.75</td><td rowspan="2">6.9</td><td rowspan="2">0.0824</td><td rowspan="2">340</td></tr>
<tr><td rowspan="2">FRN500VG1□-4J</td><td>HD</td></tr>
<tr><td rowspan="2">630</td><td>LD</td><td rowspan="2">ACR4-630</td><td rowspan="2">1300</td><td rowspan="2">4.87</td><td rowspan="2">5.84</td><td rowspan="2">0.0713</td><td rowspan="2">422</td></tr>
<tr><td rowspan="2">FRN630VG1□-4J</td><td>HD</td></tr>
<tr><td>710</td><td>LD</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

* Cool the fan (for 3m/s or more).

Note 1: □ in the inverter model represents an alphabet.

□
└── S (Basic type)

Note 2: Generated losses listed in the above table are approximate values that are calculated according to the following conditions:

- The power supply is three-phase 200 V/400 V 50 Hz with 0% interphase voltage unbalance ratio.
- The power supply capacity uses the larger of either 500 kVA or 10 times the rated capacity of the inverter.
- The motor is a 4-pole standard model at full load (100%).

Figure A

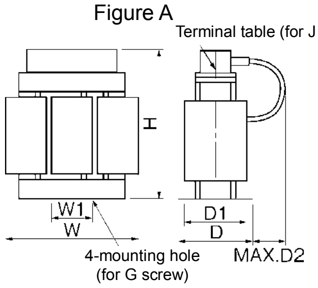


Figure B

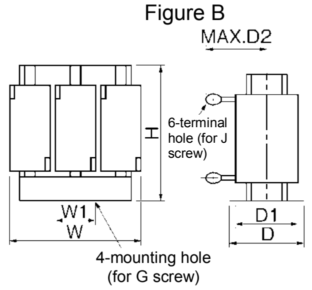


Figure C

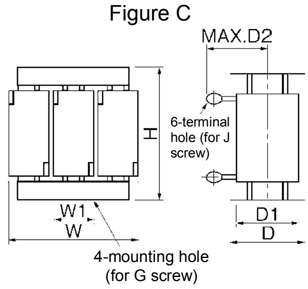


Figure D

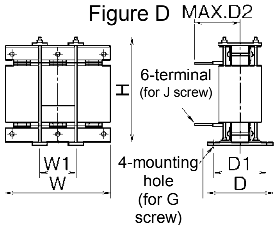


Figure E

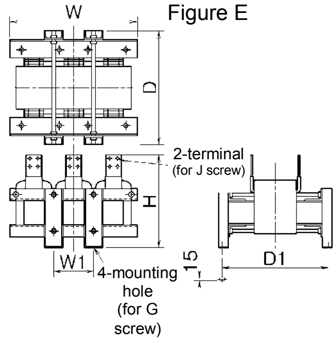


Table 8.13 AC Reactors (ACRs) External Dimensions

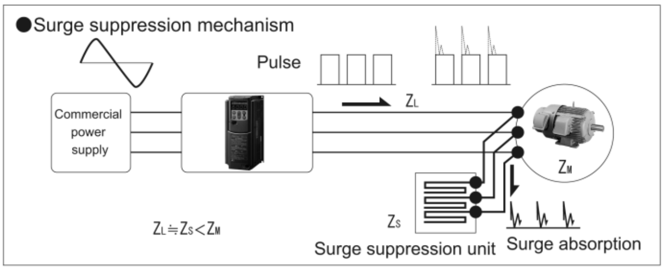
Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Reactor model	Dimensions (mm)									Approx. weight (kg)
					Fig	W	W1	D	D1	D2	G	H	J	
Three-phase 200V	0.75	FRN0.75VG1□-2J	HD	ACR2-0.75A	A	120	40	100	75	20	M5(6×10)	115	M4	1.9
	1.5	FRN1.5VG1□-2J		ACR2-1.5A		120	40	100	75	20	M5(6×10)	115	M4	2.0
	2.2	FRN2.2VG1□-2J		ACR2-2.2A		120	40	100	75	20	M5(6×10)	115	M4	2.0
	3.7	FRN3.7VG1□-2J		ACR2-3.7A		125	40	100	75	25	M5(6×10)	125	M4	2.4
	5.5	FRN5.5VG1□-2J		ACR2-5.5A		125	40	115	90	25	M5(6×10)	125	M4	3.1
	7.5	FRN7.5VG1□-2J		ACR2-7.5A	B	125	40	115	90	106	M5(6×10)	95	M5	3.1
	11	FRN11VG1□-2J		ACR2-11A		125	40	125	100	106	M5(6×10)	95	M6	3.7
	15	FRN15VG1□-2J		ACR2-15A		180	60	110	85	106	M6(7×11)	115	M6	4.8
	18.5	FRN18.5VG1□-2J		ACR2-18.5A		180	60	110	85	109	M6(7×11)	115	M6	5.1
	22	FRN22VG1□-2J		ACR2-22A		180	60	110	85	109	M6(7×11)	115	M6	5.1
	30	FRN30VG1□-2J	HD	ACR2-37		190	60	120	90	172	M6(7×11)	190	M8	11
	37		LD	ACR2-37		190	60	120	90	172	M6(7×11)	190	M8	11
		FRN37VG1□-2J	HD											
	45		LD	ACR2-55	C	190	60	120	90	200	M6(7×11)	190	M12	13
		FRN45VG1□-2J	HD											
	55		LD	ACR2-55		190	60	120	90	200	M6(7×11)	190	M12	13
		FRN55VG1□-2J	HD											
	75		LD	ACR2-75		250	100	120	90	200	M8(9×14)	250	M12	25
		FRN75VG1□-2J	HD											
	90		LD	ACR2-90		285	190	158	120	190	M10(12×20)	210	M12	26
		FRN90VG1□-2J	HD											
	110		LD	ACR2-110		280	150	138	110	200	M8(10×20)	270	M12	30

Table 8.13 AC Reactors (ACRs) External Dimensions (continued)

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifications	Reactor model	Dimensions (mm) Fig	W	W1	D	D1	D2	G	H	J	Approx. weight (kg)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	ACR4-3.7A	B	125	40	100	75	106	M5(6×10)	95	M4	2.4
Three-phase 400V	5.5	FRN5.5VG1□-4J	HD	ACR4-5.5A	B	125	40	115	90	106	M5(6×10)	95	M5	3.1
Three-phase 400V	7.5	FRN7.5VG1□-4J	HD	ACR4-7.5A	B	125	40	115	90	106	M5(6×10)	95	M5	3.7
Three-phase 400V	11	FRN11VG1□-4J	HD	ACR4-11A	B	180	60	110	85	106	M6(7×11)	115	M6	4.3
Three-phase 400V	15	FRN15VG1□-4J	HD	ACR4-15A	B	180	60	110	85	106	M6(7×11)	137	M6	5.4
Three-phase 400V	18.5	FRN18.5VG1□-4J	HD	ACR4-18.5A	B	180	60	110	85	106	M6(7×11)	137	M6	5.7
Three-phase 400V	22	FRN22VG1□-4J	HD	ACR4-22A	B	180	60	110	85	106	M6(7×11)	137	M6	5.9
Three-phase 400V	30	FRN30VG1□-4J	HD	ACR4-37	B	190	60	120	90	172	M6(7×11)	190	M8	12
Three-phase 400V	37	FRN30VG1□-4J	LD	ACR4-37	B	190	60	120	90	172	M6(7×11)	190	M8	12
Three-phase 400V	37	FRN37VG1□-4J	HD	ACR4-37	B	190	60	120	90	172	M6(7×11)	190	M8	12
Three-phase 400V	45	FRN37VG1□-4J	LD	ACR4-55	C	190	60	120	90	200	M6(7×11)	190	M10	14
Three-phase 400V	45	FRN45VG1□-4J	HD	ACR4-55	C	190	60	120	90	200	M6(7×11)	190	M10	14
Three-phase 400V	55	FRN45VG1□-4J	LD	ACR4-55	C	190	60	120	90	200	M6(7×11)	190	M10	14
Three-phase 400V	55	FRN55VG1□-4J	HD	ACR4-55	C	190	60	120	90	200	M6(7×11)	190	M10	14
Three-phase 400V	75	FRN55VG1□-4J	LD	ACR4-75	C	190	60	126	90	157	M6(7×10)	190	M10	16
Three-phase 400V	75	FRN75VG1□-4J	HD	ACR4-75	C	190	60	126	90	157	M6(7×10)	190	M10	16
Three-phase 400V	90	FRN75VG1□-4J	LD	ACR4-110	C	250	100	136	105	202	M8(9.5×18)	245	M12	24
Three-phase 400V	90	FRN90VG1□-4J	HD	ACR4-110	C	250	100	136	105	202	M8(9.5×18)	245	M12	24
Three-phase 400V	110	FRN90VG1□-4J	MD/LD	ACR4-110	C	250	100	136	105	202	M8(9.5×18)	245	M12	24
Three-phase 400V	110	FRN110VG1□-4J	HD	ACR4-110	C	250	100	136	105	202	M8(9.5×18)	245	M12	24
Three-phase 400V	132	FRN110VG1□-4J	MD/LD	ACR4-132	C	250	100	146	115	207	M8(10x16)	250	M12	32
Three-phase 400V	132	FRN132VG1□-4J	HD	ACR4-132	C	250	100	146	115	207	M8(10x16)	250	M12	32
Three-phase 400V	160	FRN132VG1□-4J	MD/LD	ACR4-220	C	320	120	150	110	240	M10(12×20)	300	M12	40
Three-phase 400V	160	FRN160VG1□-4J	HD	ACR4-220	C	320	120	150	110	240	M10(12×20)	300	M12	40
Three-phase 400V	200	FRN160VG1□-4J	MD/LD	ACR4-220	C	320	120	150	110	240	M10(12×20)	300	M12	40
Three-phase 400V	200	FRN200VG1□-4J	HD	ACR4-220	C	320	120	150	110	240	M10(12×20)	300	M12	40
Three-phase 400V	220	FRN200VG1□-4J	MD/LD	ACR4-220	C	320	120	150	110	240	M10(12×20)	300	M12	40
Three-phase 400V	220	FRN220VG1□-4J	HD	ACR4-220	C	320	120	150	110	240	M10(12×20)	300	M12	40
Three-phase 400V	250	FRN220VG1□-4J	MD	ACR4-280	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	280	FRN220VG1□-4J	LD	ACR4-280	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	280	FRN280VG1□-4J	HD	ACR4-280	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	315	FRN280VG1□-4J	MD	ACR4-355	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	355	FRN280VG1□-4J	LD	ACR4-355	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	315	FRN315VG1□-4J	HD	ACR4-355	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	355	FRN315VG1□-4J	MD	ACR4-355	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	400	FRN315VG1□-4J	LD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
Three-phase 400V	355	FRN355VG1□-4J	HD	ACR4-355	C	380	130	150	110	260	M10(12×20)	300	M12	52
Three-phase 400V	400	FRN355VG1□-4J	MD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
Three-phase 400V	450	FRN355VG1□-4J	LD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
Three-phase 400V	400	FRN400VG1□-4J	HD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
Three-phase 400V	450	FRN400VG1□-4J	MD	ACR4-450	D	460	155	290	230	200	M12(Φ15)	490	4×M12	95
Three-phase 400V	500	FRN400VG1□-4J	LD	ACR4-530	E	480	155	420	370	-	M12(15×25)	380	4×M12	100
Three-phase 400V	500	FRN500VG1□-4J	HD	ACR4-530	E	480	155	420	370	-	M12(15×25)	380	4×M12	100
Three-phase 400V	630	FRN500VG1□-4J	LD	ACR4-630	E	510	170	420	370	-	M12(15×25)	390	4×M12	110
Three-phase 400V	630	FRN630VG1□-4J	HD	ACR4-630	E	510	170	420	370	-	M12(15×25)	390	4×M12	110
Three-phase 400V	710	FRN630VG1□-4J	LD	-	-	-	-	-	-	-	-	-	-	-

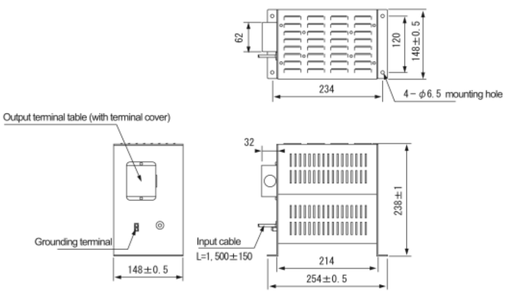
8.5.5 Surge suppression unit (SSU)

If the drive wire for the motor is long, an extremely low surge voltage (micro surge) occurs at the wire end connected to the motor. Surge voltage causes motor degradation, insulation breakdown, or increased noises. The surge suppression unit (SSU) suppresses the surge voltage. It features the connectivity for all motor capacities and easy wiring work.

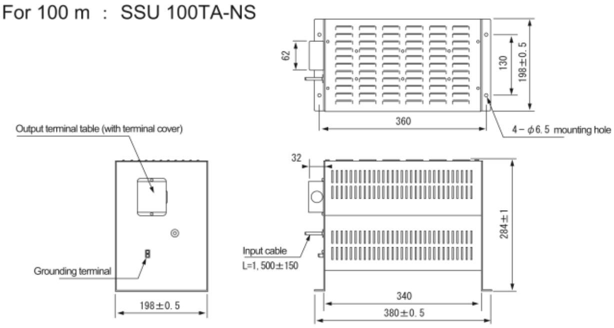


■External dimensions

・For 50 m : SSU 50TA-NS

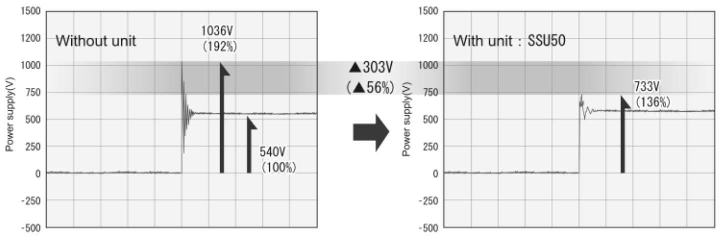


・For 100 m : SSU 100TA-NS

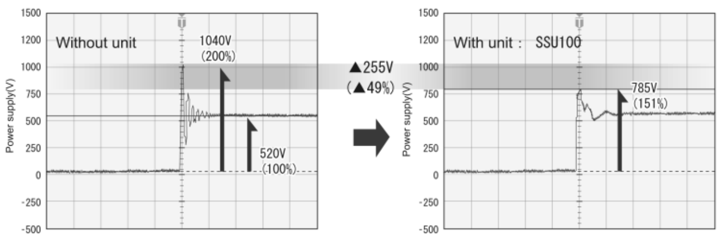


■Effect of surge suppression unit (voltage waveform between motor wires)

・Motor/inverter capacity: 3.7 kW
・Operation status: No load
・Wire length: 50 m
・Power supply voltage: 3-phase 400 V



・Motor/inverter capacity: 75 kW
・Operation status: No load
・Wire length: 100 m
・Power supply voltage: 3-phase 400 V



■Basic specifications

Item	Specifications	
Model	SSU 50TA-NS	SSU 100TA-NS
Applicable wire length	Up to 50 m	Up to 100 m
Power supply voltage	200V system, 400V system, PWM converter are applicable.	
Inverter capacity	Up to 75 kW	
Output frequency	Up to 400 Hz	
Carrier frequency	Up to 15 kHz (not available for 16 kHz)	
Protective structure	IP20	
Installation environment	Ambient temperature: -20 to 40℃, ambient humidity: 85%RH or lower, vibration: 0.7G or less, installation site: level	
Insulation voltage	2500 V AC, 1 min	

8.5.6 Output circuit filter (OFL)

(1) The output circuit filter (OFL) is an LC filter to be used at the output side of the inverter for the following purposes:

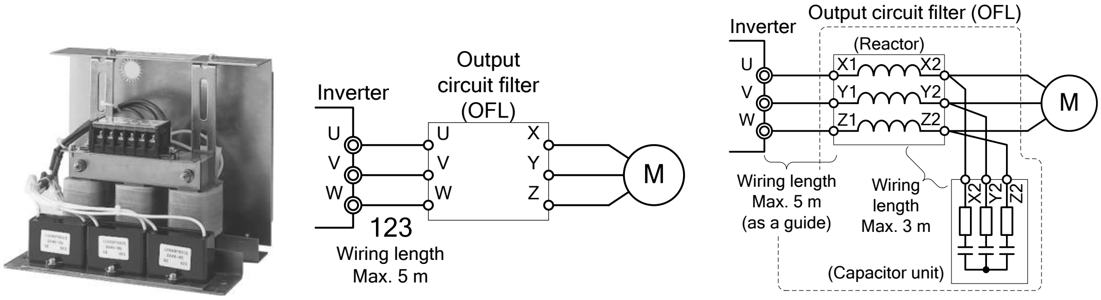
- Protecting the motor from insulation damage that could be caused by micro surge voltage from inverters.
- Suppressing leakage current (in-line leakage current) in long-distance wiring.
- Suppressing induction noise from the inverter output lines

  The OFL is effective for suppression of surge and in-line leakage current in long-distance wiring such as in plant facilities.

(2) An OFL to be used for motors of 30 kW or above is divided into a reactor and capacitor unit. Use them in combination.

(3) For wiring of 50 m or more, it is recommended that an OFL be used.

🕮 For details on the product, refer to the Output Circuit Filter (OFL-A) Instruction Manual:
• For OFL-22-4A or lower capacity, refer to INR-SI47-0547☐.
• For OFL-30-4A or higher capacity, refer to INR-HF52131☐.



(a) External appearance (photo) (b) Connection diagram for OFL-22-4A or lower capacity (c) Connection diagram for OFL-30-4A or higher capacity

Figure 8.11 External View of Output Circuit Filter (OFL) and Connection Examples

Table 8.14 (a) Specifications of Output Circuit Filter (OFL)

Environment	Site location	• Indoors (There must be no corrosive gas, flammable gas, dust, and oil mist.) Pollution degree 2: IEC60664-1 • Must not be exposed to direct sunlight.		
	Operating temperature	-10 to +50°C	Storage temperature	-25 to +65°C (30 °C or lower in the case of storage for long period of time)
	Ambient humidity	5 to 95% Rh (No dew condensation)	Storage humidity	5 to 95% Rh (No dew condensation)
	Altitude	1000 m or less		
Max. output wiring length		400 m or less		
Dielectric strength voltage, Insulation resistance		2500 VAC/min., 1 MΩ or more (500 VDC Megger)		

Note

1) The OFL-30-4A or higher models are delivered in sets with a reactor and a capacitor unit.
2) The OFL-30-4A or higher models generate heat from the resistors in the capacitor unit when the inverter is running. Mount the OFL not inside the cabinet but on top of the cabinet.
3) Under vector control, if an OFL is used in long-distance wiring, the inverter may not control the motor normally due to the inductance of the OFL or wiring, causing current vibration or torque shortage. To prevent such problems, select an installation location of the motor to keep the wiring distance between the inverter and motor within 100 m (as a guide) even if an OFL is used.
4) Under vector control, only OFL models having a suffix "A" (listed in Table 8.14 (b)) can be used. Other models without suffix "A" cannot be used.

Table 8.14 (b) Specifications of Output Circuit Filter (OFL)

OFL-□□□-4A

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Filter model	Rated current (A)	Overload resistance	Inverter input power supply voltage	Carrier frequency tolerance (kHz)	Maximum output frequency (Hz)	Generated loss (W)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	OFL-3.7-4A	9	HD model 150%-1 min 200%-3 s MD model 150%-1 min LD model 120%-1 min	Three-phase 380-480V 50/60 Hz	2-15 kHz	400 Hz	210
	5.5	FRN5.5VG1□-4J		OFL-7.5-4A	18					190
	7.5	FRN7.5VG1□-4J								
	11	FRN11VG1□-4J		OFL-15-4A	30					320
	15	FRN15VG1□-4J								
	18.5	FRN18.5VG1□-4J		OFL-22-4A	45					350
	22	FRN22VG1□-4J								
	30	FRN30VG1□-4J	HD	OFL-30-4A	60				120 Hz	570
	37		LD	OFL-37-4A	75					610
		FRN37VG1□-4J	HD							
	45		LD	OFL-45-4A	91					810
		FRN45VG1□-4J	HD							
	55		LD	OFL-55-4A	112					910
		FRN55VG1□-4J	HD							
	75		LD	OFL-75-4A	150			2-10 kHz		1200
		FRN75VG1□-4J	HD							
	90		LD	OFL-90-4A	176					1360
		FRN90VG1□-4J	HD							
	110		MD/LD	OFL-110-4A	210					1410
		FRN110VG1□-4J	HD							
	132		MD/LD	OFL-132-4A	253					1800
		FRN132VG1□-4J	HD							
	160		MD/LD	OFL-160-4A	304					2210
		FRN160VG1□-4J	HD							
	200		MD/LD	OFL-200-4A	377					2520
		FRN200VG1□-4J	HD							
	220		MD/LD	OFL-220-4A	415					2590
		FRN220VG1□-4J	HD							
	250		MD	OFL-280-4A	520					3570
	280		LD							
		FRN280VG1□-4J	HD							
	315		MD	OFL-315-4A	585					3290
	355		LD	OFL-355-4A	650					3320
	315	FRN315VG1□-4J	HD	OFL-315-4A	585					3290
	355		MD	OFL-355-4A	650					3320
	400		LD	OFL-400-4A	740					3390
	355	FRN355VG1□-4J	HD	OFL-355-4A	650					3320
	400		MD	OFL-400-4A	740					3390
	450		LD	OFL-450-4A	840					3390
	400	FRN400VG1□-4J	HD	OFL-400-4A	740					3390
	450		MD	OFL-450-4A	840					3390
	500		LD	OFL-500-4A	960			2-6 kHz		4250
		FRN500VG1□-4J	HD							
	630		LD	OFL-630-4A	1170					4700
		FRN630VG1□-4J	HD							

Note : □ in the inverter model replaces an alphabet.

□
└── S (Basic type)

Table 8.15 Output Circuit Filter (OFL) Dimensions

Power supply voltage	Nominal applied motor (kW)	Inverter type	Specifi-cations	Filter type	Fig	Dimensions(mm) A	B	C	D	E	F	G	Grounding screw H	Terminal screw J	Mounting screw K	Approx. weight (kg)
Three-phase 400V	3.7	FRN3.7VG1□-4J	HD	OFL-3.7-4A	A	220	225	220	200	115	-	-	M4	M4	M5	14
	5.5	FRN5.5VG1□-4J		OFL-7.5-4A		290	290	230	260	160	-	-	M5	M5	M6	22
	7.5	FRN7.5VG1□-4J														
	11	FRN11VG1□-4J		OFL-15-4A	B	330	275	310	300	145	-	-	M6	M6	M8	35
	15	FRN15VG1□-4J														
	18.5	FRN18.5VG1□-4J		OFL-22-4A		330	300	330	300	170	-	-	M6	M6	M8	45
	22	FRN22VG1□-4J														
	30	FRN30VG1□-4J	HD	OFL-30-4A	C/F	210	175	210	70	140	90	160	-	M5	M6	12
	37	FRN30VG1□-4J	LD	OFL-37-4A		220	190	220	75	150	95	160	-	M5	M6	15
		FRN37VG1□-4J	HD													
	45	FRN37VG1□-4J	LD	OFL-45-4A	D/F	220	195	265	70	155	140	160	-	M6	M8	17
		FRN45VG1□-4J	HD													
	55	FRN45VG1□-4J	LD	OFL-55-4A		260	200	275	85	160	150	160	-	M6	M8	22
		FRN55VG1□-4J	HD													
	75	FRN55VG1□-4J	LD	OFL-75-4A		260	210	290	85	170	150	233	-	M8	M10	25
		FRN75VG1□-4J	HD													
	90	FRN75VG1□-4J	LD	OFL-90-4A		260	210	290	85	170	155	233	-	M8	M10	28
		FRN90VG1□-4J	HD													
	110	FRN90VG1□-4J	MD/LD	OFL-110-4A		300	230	330	100	190	170	233	-	M8	M10	38
		FRN110VG1□-4J	HD													
	132	FRN110VG1□-4J	MD/LD	OFL-132-4A		300	240	340	100	200	170	233	-	M10	M10	42
		FRN132VG1□-4J	HD													
	160	FRN132VG1□-4J	MD/LD	OFL-160-4A		300	240	340	100	200	180	233	-	M10	M10	48
		FRN160VG1□-4J	HD													
	200	FRN160VG1□-4J	MD/LD	OFL-200-4A		320	270	350	105	220	190	333	-	M10	M12	60
		FRN200VG1□-4J	HD													
	220	FRN200VG1□-4J	MD/LD	OFL-220-4A		340	300	390	115	250	190	333	-	M10	M12	70
		FRN220VG1□-4J	HD													
	250	FRN220VG1□-4J	MD	OFL-280-4A		350	300	430	115	250	200	333	-	M10	M12	78
	280	FRN220VG1□-4J	LD													
		FRN280VG1□-4J	HD													
	315	FRN280VG1□-4J	MD	OFL-315-4A	E/G	440	275	450	150	230	170	-	-	M12	M12	90
	355	FRN280VG1□-4J	LD	OFL-355-4A		440	290	480	150	245	175	-	-	M12	M12	100
	315	FRN315VG1□-4J	HD	OFL-315-4A		440	275	450	150	230	170	-	-	M12	M12	90
	355	FRN315VG1□-4J	MD	OFL-355-4A		440	290	480	150	245	175	-	-	M12	M12	100
	400	FRN315VG1□-4J	LD	OFL-400-4A		440	295	510	150	240	175	-	-	M12	M12	110
	355	FRN355VG1□-4J	HD	OFL-355-4A		440	290	480	150	245	175	-	-	M12	M12	100
	400	FRN355VG1□-4J	MD	OFL-400-4A		440	295	510	150	240	175	-	-	M12	M12	110
	450	FRN355VG1□-4J	LD	OFL-450-4A		440	325	470	150	270	195	-	-	M12	M12	125
	400	FRN400VG1□-4J	HD	OFL-400-4A		440	295	510	150	240	175	-	-	M12	M12	110
	450	FRN400VG1□-4J	MD	OFL-450-4A		440	325	470	150	270	195	-	-	M12	M12	125
	500	FRN400VG1□-4J	LD	OFL-500-4A		440	335	500	150	280	210	-	-	M12	M12	145
		FRN500VG1□-4J	HD													
	630	FRN500VG1□-4J	LD	OFL-630-4A		480	355	560	150	280	245	-	-	M12	M12	170
		FRN630VG1□-4J	HD													

Note that the OFL-***-4A models have no restrictions on carrier frequency.

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

OFL-□□□-4A

■ Filter (for 22 kW or below)

Figure A

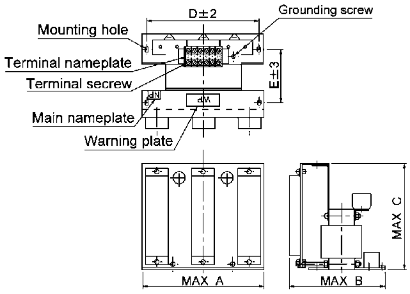
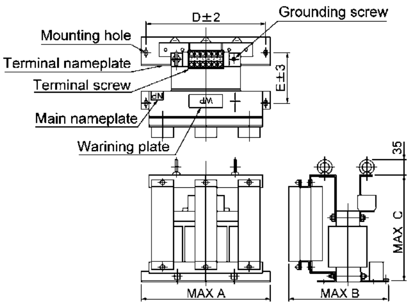


Figure B



■ Reactor (for 30 kW or above)

Figure C

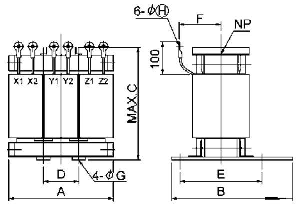


Figure D

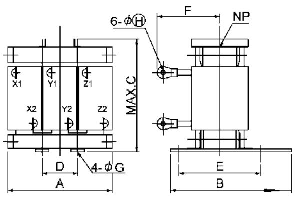
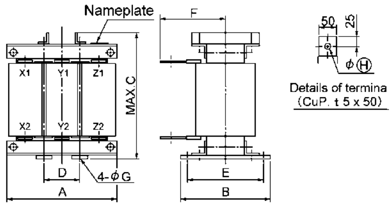


Figure E



■ Resistor and Capacitor (for 30 kW or above)

Figure F

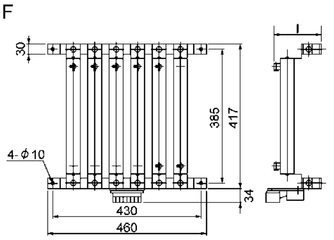
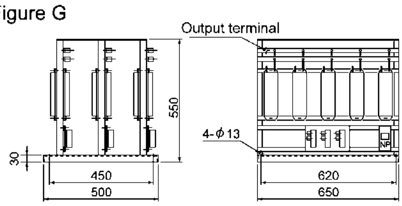


Figure G



8.5.7 Radio noise reducing zero phase reactor (ACL)

An ACL is used to reduce radio frequency noise emitted by the inverter.

An ACL suppresses the outflow of high frequency harmonics caused by switching operation for the power supply lines inside the inverter. Pass the power supply lines together through the ACL.

If wiring length between the inverter and motor is less than 20 m, insert an ACL to the power supply lines; if it is more than 20 m, insert it to the power output lines of the inverter.

Wire size is determined depending upon the ACL size (I.D.) and installation requirements.

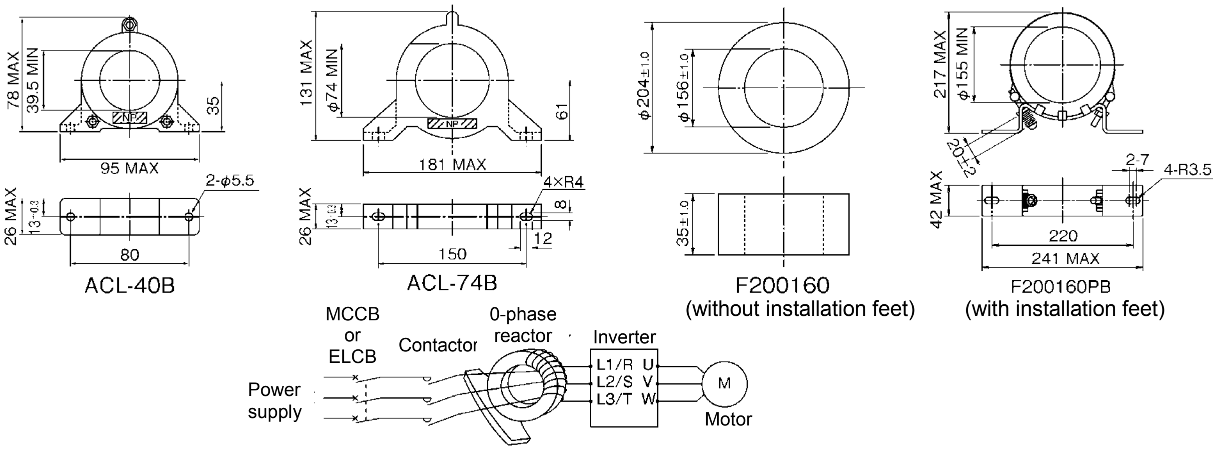


Figure 8.12 Dimensions of Zero-phase Reactor for Reducing Radio Noise (ACL) and Connection Example

Table 8.16 Zero-phase Reactors for Reducing Radio Noise (ACL)

Zero-phase reactor type	Installation requirements		Wire size (mm^2)
	Qty.	Number of turns	
ACL-40B	1	4	2.0, 3.5, 5.5
	2	2	8, 14
ACL-74B	1	4	8, 14
	2	2	22, 38, 60, 5.5×2, 8×2, 14×2, 22×2
	4	1	100, 150, 200, 250, 325, 38×2, 60×2, 100×2, 150×2
F200160	4	1	200×2, 250×2, 325×2, 325×3
F200160PB	4	1	200×2, 250×2, 325×2, 325×3

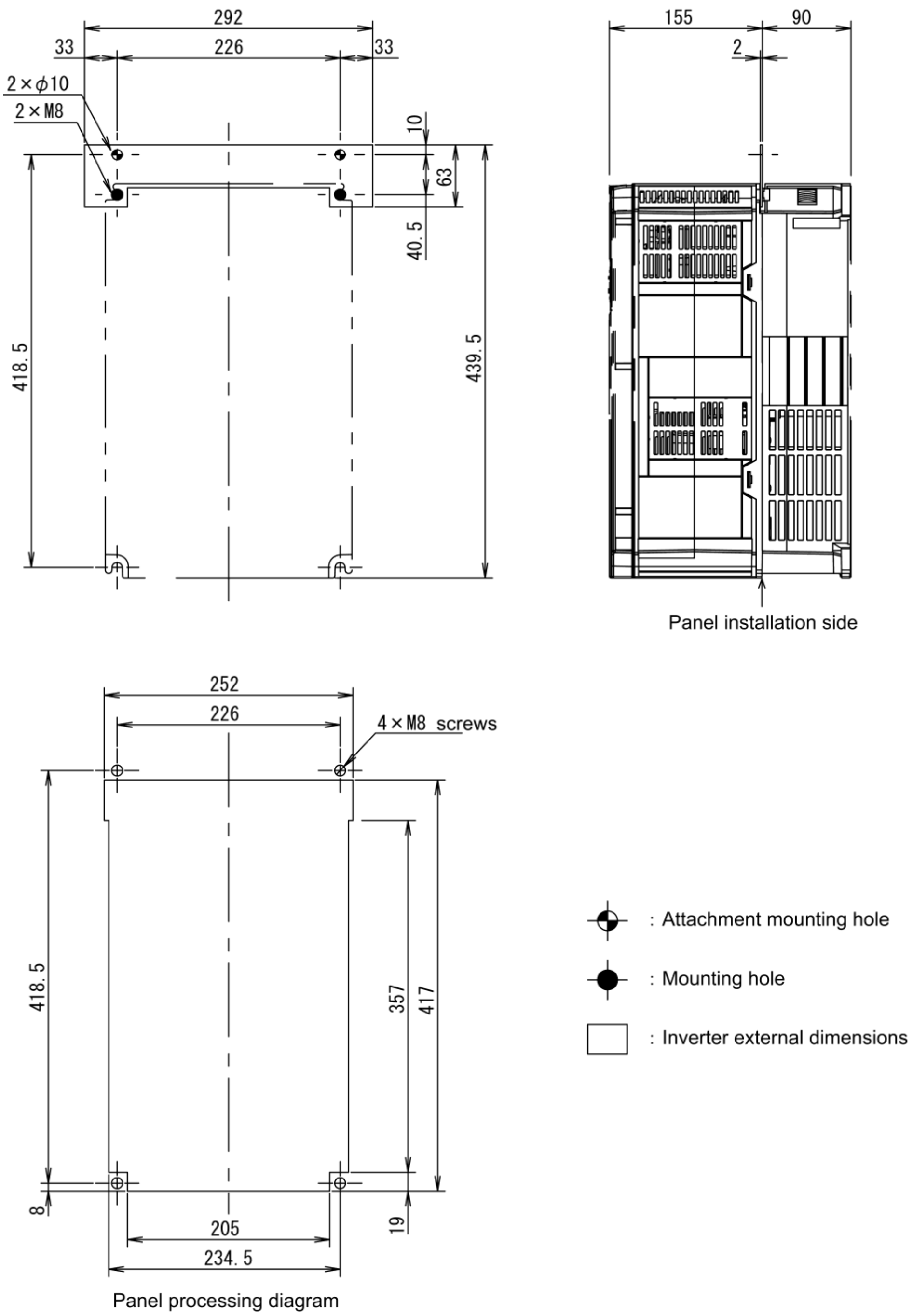
The selected wires are for use with 3-phase input/output lines (3 wires).

Note: Use the insulated wire of 75°C, 600 V, HIV-insulated.

8.5.8 External cooling attachment

This attachment is used to allow the inverter cooling fins to protrude out of the panel.

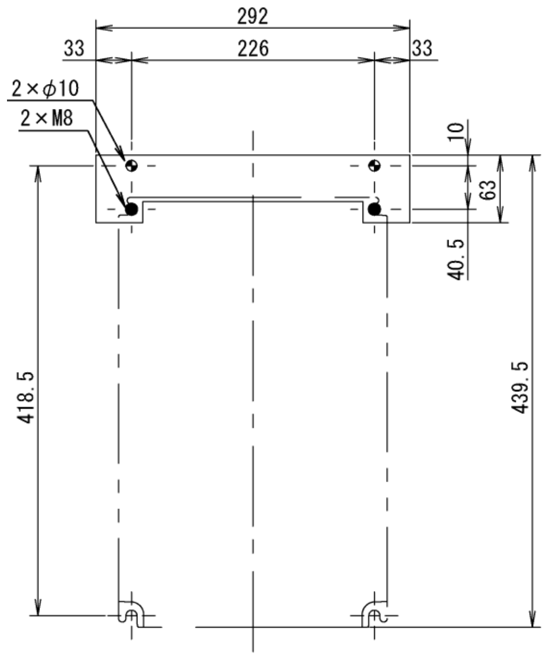
■PBVG7-7.5(FRN0.75VG1S-2J to FRN7.5VG1S-2J,FRN3.7VG1S-4J to FRN7.5VG1S-4J)

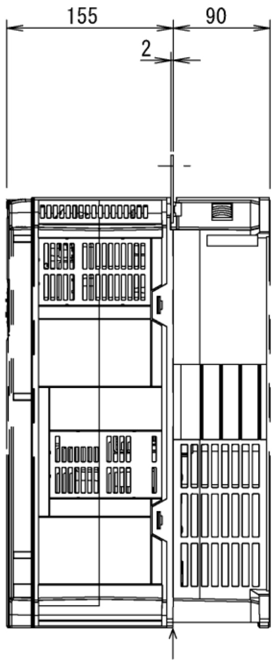


Unit：[mm]

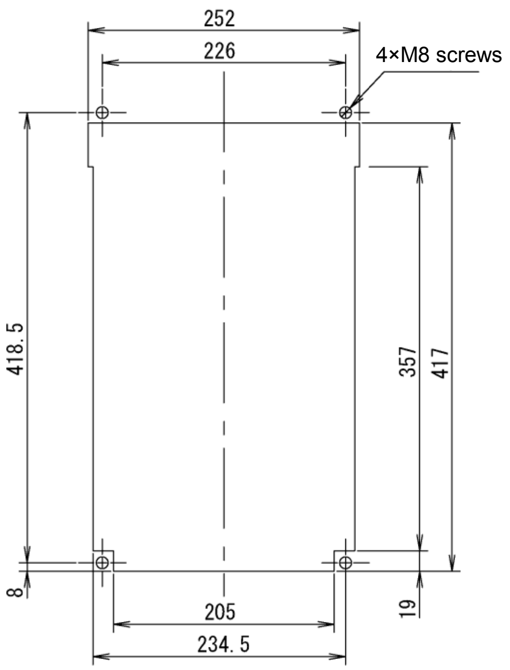
Figure 8.13 External Cooling Attachment External Dimensions

■PB-F1-30(FRN11VG1S-2J to FRN22VG1S-2J,FRN11VG1S-4J to FRN22VG1S-4J)





Panel installation side



Panel processing diagram

: Attachment mounting hole

: Mounting hole

: Inverter external dimensions

Unit : mm

Figure 8.13 External Cooling Attachment External Dimensions (continued)

Chap. 8 SELECTING PERIPHERAL EQUIPMENT

8.6 Battery

8.6.1 Overview of battery

Used to retain the trace back memory and calendar when the inverter is not powered.

- 22 kW or lower: Option
- 30 kW or higher: Included as standard

Model	**OPK-BP**
Voltage/capacity	3.6 V/1100 mAh
Type	Lithium Thionyl Chloride(Li-SOCl2) battery
Life	5 years (with ambient temperature of 60°C and inverter powered off)

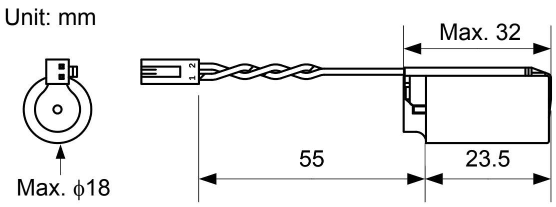


Figure 8.14 Overview of Battery

⚠WARNING

Safety Precautions

This battery contains lithium (dangerous substance) and thionyl chloride (very dangerous substance) to provide high energy. If you use it in a wrong way, the battery may be deformed, liquid inside the battery may leak, or heat generation, explosion, fire, and/or stimulative/corrosive gas generation may occur, resulting in a injury or device failure. Be sure to observe the following precautions:

- Do not swallow the battery.
- Do not apply excessive force to the positive terminal.
- Do not drop the battery.
- Do not short-circuit the battery.
- Do not charge the battery.
- Do not force the battery to discharge.
- Do not heat the battery.
- Do not throw the battery into fire.
- Do not disassemble the battery.
- Do not deform the battery.
- Insert the battery into the inverter in the correct direction.
- Do not allow liquid from the battery to touch your skin.
- Do not leave a damaged battery in the inverter.

⚠CAUTION

Keep the battery where it is not exposed to the direct sunlight, high temperature/humidity, and/or rain drop.

This battery belongs to the "primary battery class", which must be discarded in accordance with the defined method (law).

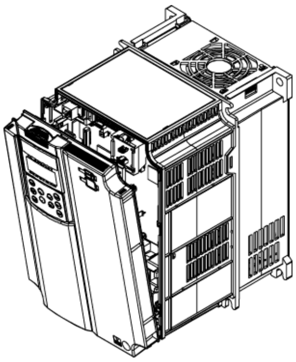
8.6.2 Installing battery

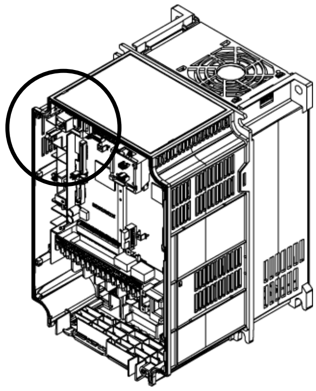
⚠CAUTION
Be sure to operate the inverter with the battery installed. **Afire or an accident might occur.**

Refer to "3.4.4.12 Setting Date/Time" for how to adjust the clock.

8.6.2.1 Installing battery (for 22 kW or lower)

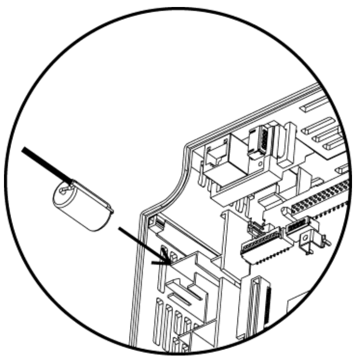
① Remove the outer cover.

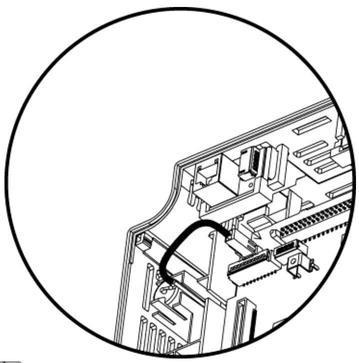




② Install the battery as shown in the figure.

③ Connect the battery cable to the connector CN7 on the control printed board.





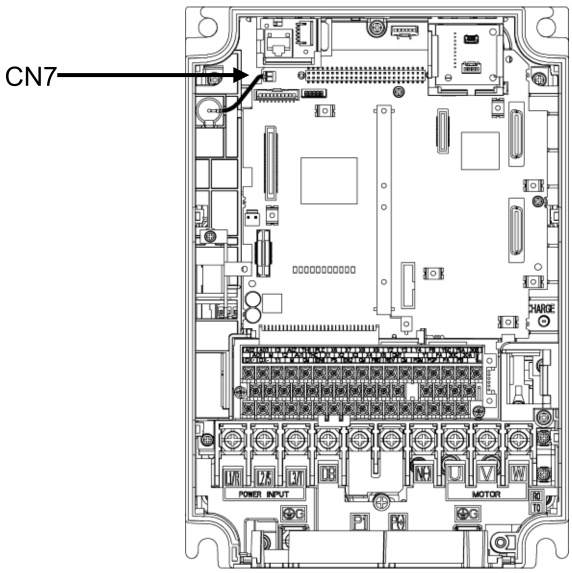
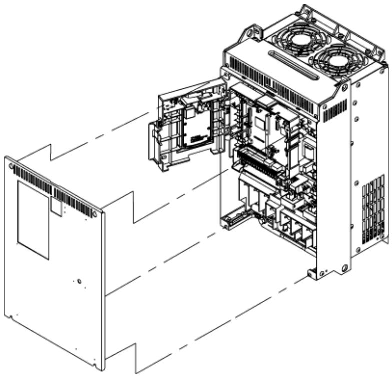


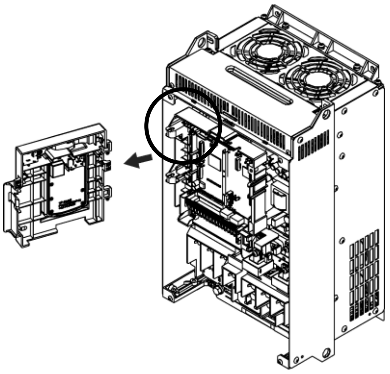
Figure 8.15 Battery Installed (22 kW or lower)

8.6.2.2 Installing battery (for 30 kW or higher)

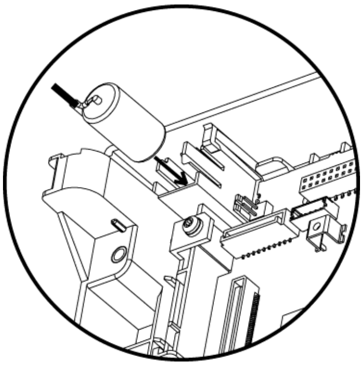
① Remove the front cover.
Open the touch panel case and disconnect the connectors CN5 and CN8 from the control printed board.



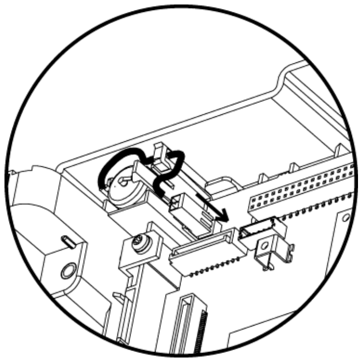
② Remove the touch panel case.



③ Install the battery as shown in the figure.



④ Connect the battery cable to the connector CN7 on the control printed board.



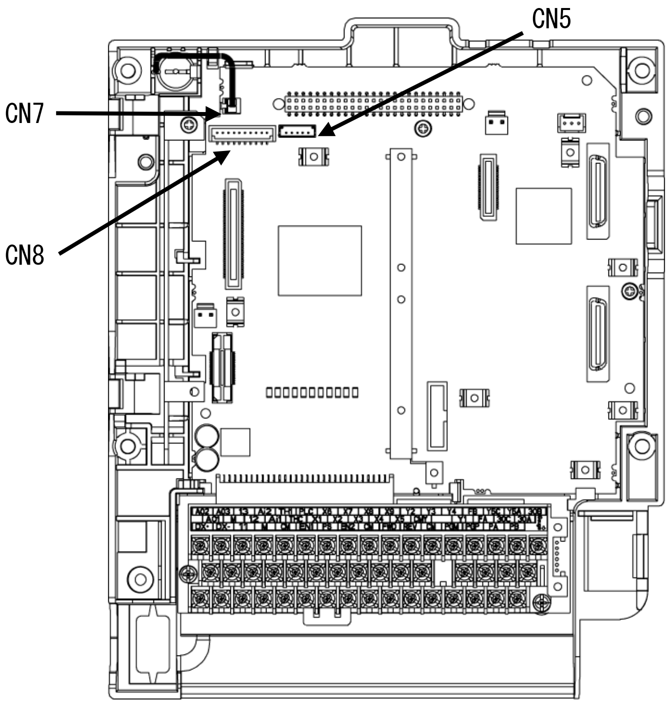


Figure 8.16 Battery Installed (30 kW or higher)

8.6.3 Replacing battery

Reverse the installation procedure to remove the battery, and then install the new battery.

⚠CAUTION
Be sure to operate the inverter with the battery installed. **Afire or an accident might occur.**

Refer to "3.4.4.12 Setting Date/Time" for how to adjust the clock.

8.6.4 About marine or air transport of a lithium-metal battery

When transporting a lithium-metal battery by itself, by packing it in a package of the inverter, or by incorporating it in the inverter, observe the following notes.

(1) To transport a lithium-metal battery incorporated in the inverter

When transporting a panel holding five or more inverters with a built-in battery, it is necessary to attach the label shown in Figure 8.17 and prepare the transportation documents.

(2) To transport a lithium-metal battery packed with the inverter

It is necessary to attach the label shown in Figure 8.17 and issue a drop test certificate together with the transportation documents.

To transport a lithium-metal battery by air, the number of batteries that can be contained in a package of the inverter is limited to the number of batteries required for device operation plus 2 batteries.

120 x 110 mm

Figure 8.17 Label to be Attached to Outer Wrapping

For details, contact your shipping company.

8.7 PG Amplifier (Isolated Signal Conditioner)

When the inverter cannot detect the motor speed normally due to distorted PG waveforms resulting from the long-distance wiring to the motor speed detection pulse generator (PG), the PG amplifier is used to shape or amplify PG waveforms.

8.7.1 Recommended Pulse Amplifier Models

- SHP-115150 (Heidenhain product)
- SHC-215150 (Same as above)

The difference in the above products is only in the control power supply specifications of the PG amplifier.

The PG voltage of the standard vector motor type is 15 V.

Contact us when purchasing these products.

Type description

SHP-□□□□□□

- Power supply voltage
  - 1: 100-110 VAC, 50/60 Hz
  - 2: 200-220 VAC, 50/60 Hz
- Detector power supply
  - 05: 5 VDC
  - 10: ±5 VDC
  - 12: 12 VDC
  - 15: 15 VDC
- Output voltage
  - 12: 12 VDC
  - 15: 15 VDC
- External power supply
  - 0: None
  - 1: Available (same as output voltage)

8.7.2 Specifications and description of terminals

Specifications

Item		Specifications		
Maximum input frequency		100 kHz		
Isolation between input and output signals		Isolator using photocoupler		
Input interface		Voltage input (Input impedance: 500 kΩ)		
	Signal level		H level	L level
		SHP-□05□□	3.5 to 18 V	0 to 0.8 V
		SHP-□10□□	3.5 to 6 V	-1 to -6 V
		SHP-□12□□	8 to 18 V	0 to 1 V
		SHP-□15□□	8 to 18 V	0 to 1 V
Phase of input and output signals		Same phase		
Delay between input and output signals		500 nS		
Output interface		Complementary (Loading impedance: Min. 500 Ω)		
	Signal level	H = 10 V or more, L = 1 V or below (Loading impedance: 10 kΩ)		
External power supply for PG*		5, 12, 15 VDC		
Control power supply*		100-110 VAC, 200-220 VAC, 50/60 Hz		
Dielectric strength		1500 VAC/1 minute (between input and output terminals, between power terminal and casing)		
Insulation resistance		Min. 100 MΩ (500 VDC, all terminals -casing)		
Operating temperature, humidity		0 to 50°C, 35 to 85% Rh (no dew condensation)		
Storage temperature, humidity		-10 to 60°C, 35 to 85% Rh (no dew condensation)		
Power consumption		Approximately 7 VA		

***These specifications are model-dependent.

Description of terminals

Terminal No.	Terminal description
1	N.C.
2	N.C.
3	A phase input (+ side)
4	A phase input (- side, common side)
5	B phase input (+ side)
6	B phase input (- side, common side)
7	PG power supply (+ side)
8	PG power supply (common side)
9	-5V terminal
11	A phase output (+ side)
12	A phase output (- side, common side)
13	B phase output (+ side)
14	B phase output (- side, common side)
15	External power supply (+ side)
16	External power supply (- side, common side)
17	Ground terminal
18	AC power supply input
19	

8.7.3 Notes for connection and use

8.7.3.1 Connection diagram

Make wiring as shown in Figure 8.18.

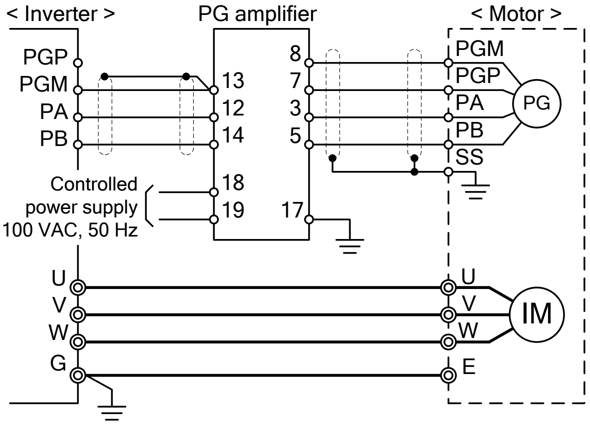


Figure 8.18 Connection Diagram

Connect the grounding terminal of the PG amplifier to the same ground section as the inverter. (When the PG amplifier is stored inside a cabinet, connect the grounding terminal to the common ground bus.)

For the pulse signals, use shielded lines between the motor and PG amplifier, and between the PG amplifier and the inverter.

- Inside cabinet: MVVS-3 core of 0.3 mm^2 or more
- Outside cabinet: CVVS-4 core of 2 mm^2 or more

Connect the shield layer of the shielded wires between the motor and PG amplifier to the SS (E) terminal dedicated for motor signals.

8.7.3.2 Notes for use

Using the PG amplifier causes the following problems for the inverter. For the solution of the problems, change the settings of function codes H104 and E45.

(1) Connection of the PG amplifier brings the inverter terminal [PGP] to an open state, resulting in a wire break alarm of the PG power line (PG). Disable the power wire break alarm function by changing the setting of H104 (Protective/maintenance function selection 2).

(2) The PG signal wire break alarm function cannot be enabled since the recommended PG amplifier has no wire break detection function and the inverter terminals [PA], [PB] and [PGM] are connected with the PG amplifier. Instead of the disabled PG wire break alarm functions, therefore, enable the speed agreement alarm function (Er-9) by changing the setting of E45 (Speed disagreement alarm).

For the function code settings, refer to Chapter 4, Section 4.3 "Details of Function Codes."

8.7.4 External dimensions

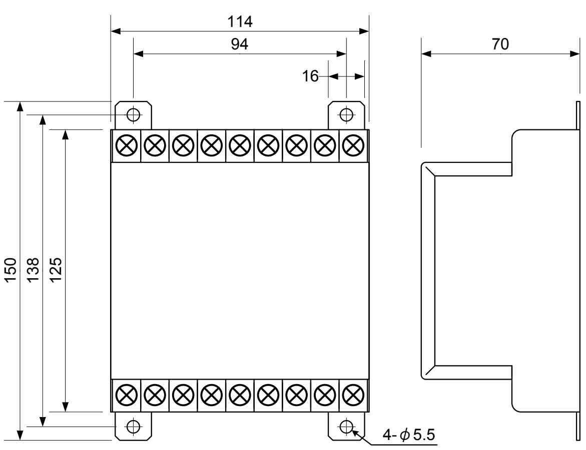


Figure 8.19 Outside Drawing

- Steel closed box (IP20 equivalent)
- Paint color: Cream color (Munsell 5Y7/1)
- Approx. mass: 1 kg
- Install the PG amplifier 10 mm away from instruments such as control relays and construction parts, and more than 100 mm away from main circuit instruments and wiring.

Chapter 9
SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

This chapter provides you with information about the inverter output torque characteristics, selection procedure, and equations for calculating capacities to help you select optimal motor and inverter models. It also helps you select braking resistors and inverter mode (HD, MD, or LD).

Contents

9.1 Selecting Motor and Inverter Capacities

First select a motor and then inverter as follows:

(1) Key point for selecting a motor: Determine what kind of load machine is to be used, calculate its moment of inertia, and then select the appropriate motor capacity.

(2) Key point for selecting an inverter: Taking into account the operation requirements (e.g., acceleration time, deceleration time, and frequency in operation) of the load machine to be driven by the motor selected in (1) above, calculate the acceleration/deceleration/braking torque.

This section describes the selection procedure for (1) and (2) above. First, it explains the output torque characteristics obtained by using the motor driven by the FRENIC-VG.

9.1.1 Motor output torque characteristics

Figure 9.1 shows the output torque characteristics of motors exclusive to the FRENIC-VG. The output torque is classified into the following quadrants by speed and torque-applied direction.

	(Speed)	(Torque)	
• First quadrant:	+	+	.... Driving in forward rotation
• Second quadrant:	−	+	..... Braking in reverse rotation
• Third quadrant:	−	−	..... Driving in reverse rotation
• Fourth quadrant:	+	−	..... Braking in forward rotation

In the figure below, the speed rate (%) is expressed assuming the base speed as 100%, and the torque rate (%), assuming the continuous rated torque as 100%.

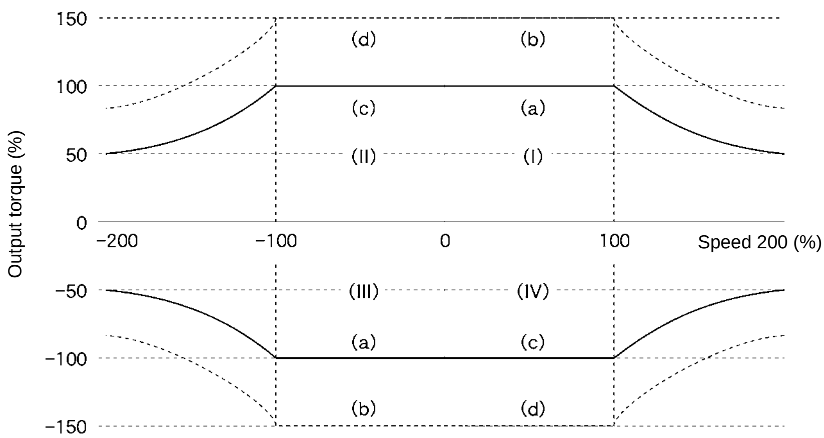


Figure 9.1 Output Torque Characteristics (HD mode)

(1) Allowable continuous driving torque (Curve (a) in the 1st and 3rd quadrants)

Curve (a) shows the output torque available continuously in the driving mode. In the domain below the base speed (100%) in the speed control range (0 to 200%), the rated output torque (100%) is obtained. In the domain above the base speed (100%), the constant output is obtained so that the output torque is in inverse proportion to the speed.

In particular, at very low speeds below the speed control range, due to the restriction on the inverter internal temperature rise, the allowable torque drops to 80% for the converted inverter output frequency of less than 1 Hz. It is necessary to take the torque loss into account.

(2) Maximum driving torque in a short time (Curve (b) in the 1st and 3rd quadrants)

Curve (b) shows the output torque allowed for a short time (60 seconds) in the driving mode. In general, this torque applies to acceleration and deceleration. The torque is 150% of the rated continuous torque.

In particular, at very low speeds below the speed control range, due to the restriction on the inverter internal temperature rise, the allowable torque drops to 100% for the converted inverter output frequency of less than 0.1 Hz.

(3) Starting torque (Around speed zero (0) in the 1st and 3rd quadrants)

The torque at around the speed zero (0) applies as starting torque. Although the continuous output torque is 80%, the starting torque becomes as high as 150% because the curve passes the very low speed range in a short period (30 seconds or less).

(4) Braking torque (2nd and 4th quadrants)

The 2nd and 4th quadrants are the braking mode range. Curve (c) shows the braking torque available in the rated continuous current range of the inverter; curve (d) is the braking torque available for 60-second rated current. In the very low speed range, the torque drops to 80% just as in the driving mode.

The time rating of the braking torque is dominantly determined by another condition--the energy processing time rating of an optional braking resistor or braking unit since the kinetic energy of mechanical load is regenerated in the braking mode.

For the time rating of the braking resistor, this manual and the associated catalogs list the allowable values (kW) in terms of the average discharging loss and the allowable values (kWs) in terms of the discharging capability that can be discharged at one time.

For braking-related values to be applied to the standard combination of the inverter and braking resistor or braking unit, refer to Chapter 8, Section 8.5.1.1 "Braking resistors (DBRs) and braking units."

9.1.2 Selection procedure

Figure 9.2 shows the general selection procedure for optimal inverters. Items numbered (1) through (5) are described on the following pages.

You may easily select inverter capacity if there are no restrictions on acceleration and deceleration times. If "there are any restrictions on acceleration or deceleration time" or "acceleration and deceleration are frequent," then the selection procedure is more complex.

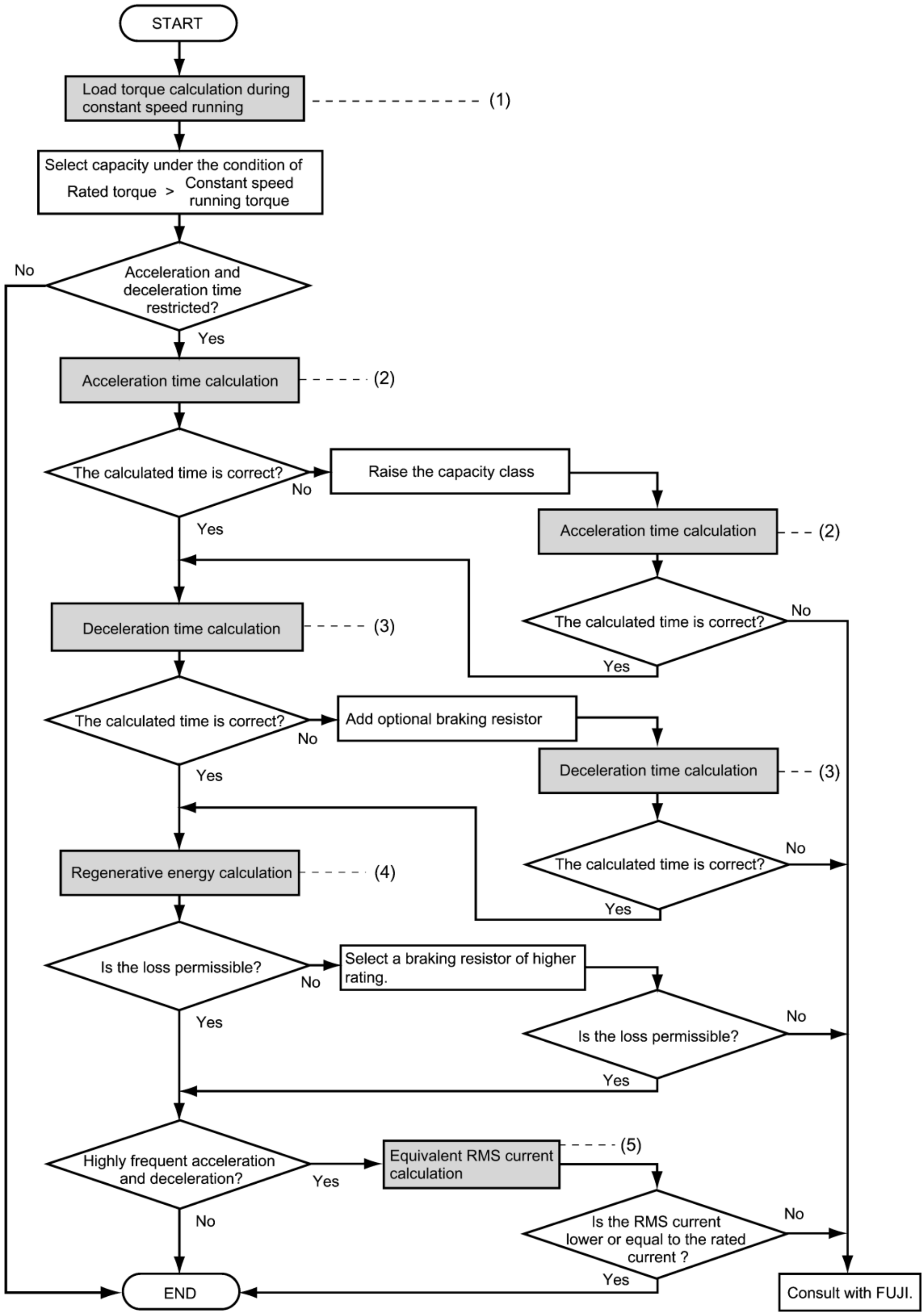


Figure 9.2 Selection Procedure

(1) Calculating the load torque during constant speed running (For detailed calculation, refer to Section 9.1.3.1)

The "load torque during constant speed running" refers to the torque required for rotating the load at the constant speed and converted to motor shaft. It can be calculated in consideration of the reducer rate (η_G).

<u>Driving mode</u>

"Load torque during constant speed running" = Actual load torque (τ_L) ÷ Reducer rate (η_G)

<u>Braking mode</u>

"Load torque during constant speed running" = Actual load torque (τ_L) x Reducer rate (η_G)

The above calculation is requisite for selecting capacities for all loads.

First calculate the load torque of the motor during constant speed running and then select a tentative capacity so that the continuous rated torque of the motor during constant speed running becomes higher than the load torque. To perform capacity selection efficiently, it is necessary to match the rated speeds (base speeds) of the motor and load each other. To do this, select an appropriate reducer (mechanical transmission) ratio and the number of motor poles.

If there is no restriction on acceleration or deceleration time and the load is not a lift load, the tentative capacity can apply as a defined capacity.

(2) Calculating the acceleration time (For detailed calculation, refer to Section 9.1.3.2)

When there are some specified requirements for the acceleration time, calculate it according to the following procedure:

1) Calculate the moment of inertia for the load and motor

   If the moment of inertia is large, the motor cannot accelerate easily, requiring longer acceleration time. Calculate the moment of inertia for the load, referring to Section 9.1.3.2, "Acceleration and deceleration time calculation." For the motor, refer to the related motor catalogs.

2) Calculate the minimum acceleration torque (See Figure 9.3)

   The acceleration torque is the difference between the "motor output torque allowed for one minute" explained in Section 9.1.1 (2) and the "load torque during constant speed running" calculated in the above (1). Calculate the minimum acceleration torque for the whole range of speed.

   At speeds higher than the motor rated speed, the output torque drops in inverse proportion to the speed.

3) Calculate the acceleration time

   Assign the value calculated above to the equation (9.15) in Section 9.1.3.2, "Acceleration and deceleration time calculation" to calculate the acceleration time. If the calculated acceleration time is longer than the expected time, select the inverter and motor having one class larger capacity and calculate it again.

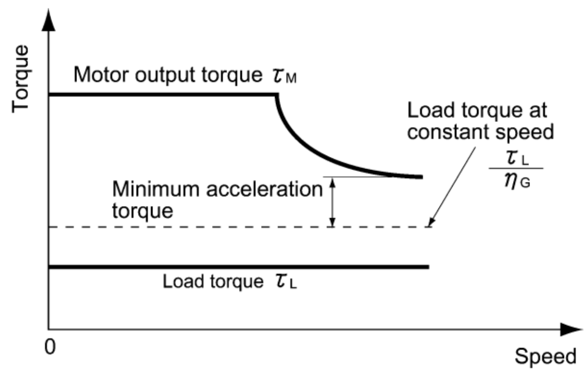


Figure 9.3 Example Study of Minimum Acceleration Torque

(3) Deceleration time (For detailed calculation, refer to 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 the moment of inertia for the load and motor

   Same as for the acceleration time. If the moment of inertia is large, the deceleration time increases.

2) Calculate the minimum deceleration torque (See Figures 9.4 and 9.5.)

   If the load torque is a positive value, Figure 9.4 applies.

   If the load is a braking load of a lift, etc. and the load torque is a negative value, Figure 9.5 applies. In this case, be careful with the minimum value of the braking torque that decreases due to energy regeneration.

3) Calculate the deceleration time

   Assign the value calculated above to the equation (9.16) to calculate the deceleration time in the same way as for the acceleration time. If the calculated deceleration time is longer than the requested time, select the inverter and motor having one class larger capacity and calculate it again.

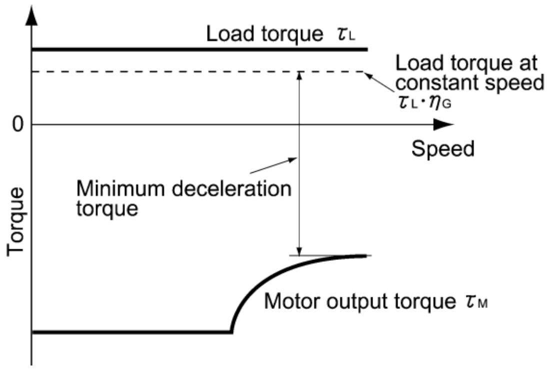


Figure 9.4 Example Study of Minimum Deceleration Torque (1)

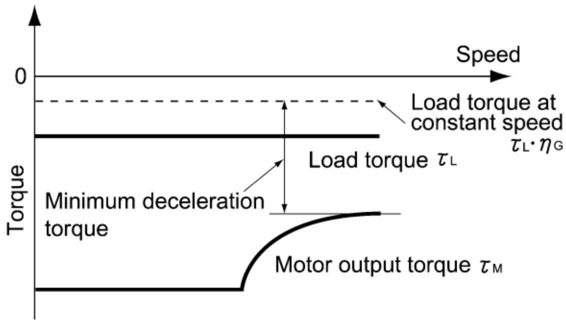


Figure 9.5 Example Study of Minimum Deceleration Torque (2)

(4) Braking resistor rating (For detailed calculation, refer to Section 9.1.3.3)

Braking resistor rating is classified into two types according to the braking periodic duty cycle.

1) When the periodic duty cycle is 100 sec or less:

   Calculate the average loss to determine rated values.

2) When the periodic duty cycle exceeds 100 sec:

   The allowable braking energy depends on the maximum regenerative braking capacity. The allowable values are listed in Chapter 8, Section 8.5.1.1 "Braking resistors (DBRs) and braking units."

(5) Motor RMS current (For detailed calculation, refer to Section 9.1.3.4)

In metal processing machine and materials handling machines requiring positioning control, highly frequent running for a short time is repeated. In this case, calculate the maximum equivalent RMS current value (effective value of current) not to exceed the allowable value (rated current) for the motor.

(6) Notes for examining inverter capacity

- When selecting an inverter for driving a FRENIC-VG dedicated motor, ensure that the root mean square of the motor torque is lower than 100% of the rated torque.
- 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.

9.1.3 Equations for selections

9.1.3.1 Load torque during constant speed running

[1] General equation

The frictional force acting on a horizontally moved 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 υ (m/s) is F (N) and the motor speed for driving this is N_M (r/min), the required motor output torque τ_M (N·m) is as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{F}{\eta_G} \quad (N \cdot m) \qquad (9.1)$$

where, η_G is Reduction-gear efficiency.

When the inverter brakes the motor, efficiency works inversely, so the required motor torque should be calculated as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot F \cdot \eta_G \quad (N \cdot m) \qquad (9.2)$$

$(60 \cdot \upsilon) / (2\pi \cdot N_M)$ in the above equation is an equivalent turning radius corresponding to speed υ (m/s) around the motor shaft.

The value F (N) in the above equations depends on the load type.

[2] Obtaining the required force F

■ Moving a load horizontally

A simplified mechanical configuration is assumed as shown in Figure 9.6. If the mass of the carrier table is W_0 (kg), the load is W (kg), and the friction coefficient of the ball screw is μ, then the friction force F (N) is expressed as follows, which is equal to a required force for driving the load:

$$F = (W_0 + W) \cdot g \cdot \mu \quad (N) \qquad (9.3)$$

where, g is the gravity acceleration (≈ 9.8 (m/s^2)).

Then, the driving torque around the motor shaft is expressed as follows:

$$\tau_M = \frac{60 \cdot \upsilon}{2\pi \cdot N_M} \cdot \frac{(W_0 + W) \cdot g \cdot \mu}{\eta_G} \quad (N \cdot m) \qquad (9.4)$$

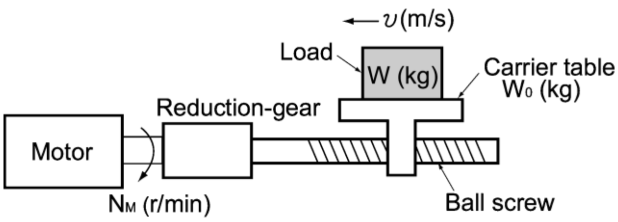


Figure 9.6 Moving a Load Horizontally

■ Vertical Lift Load

A simplified mechanical configuration is assumed as shown in Figure 9.7. If the mass of the cage is W_0 (kg), the load is W (kg), and the balance weight is W_B (kg), then the forces F (N) required for lifting the load up and down are expressed as follows:

$$F = (W_0 + W - W_B) \bullet g \text{ (N)} \quad \text{(For lifting up)} \quad (9.5)$$

$$F = (W_0 - W - W_B) \bullet g \text{ (N)} \quad \text{(For lifting down)} \quad (9.6)$$

Assuming the maximum load is W_{max}, the mass of the balance weight W_B (kg) is generally obtained with the expression $W_B = W_O + W_{max}/2$. Depending on the mass of load W (kg), the values of F (N) may be negative in both cases of lifting up and down, which means the lift is in braking mode. So, be careful in motor and inverter selection.

For calculation of the required output torque τ around the motor shaft, apply the expression (9.1) or (9.2) depending on the driving or braking mode of the lift, that is, apply the expression (9.1) if the value of F (N) is positive, and the (9.2) if negative.

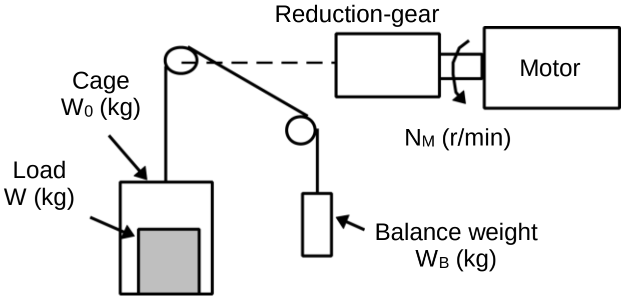


Figure 9.7 Vertical Lift Load

■ Inclined Lift Load

Although the mechanical configuration of an inclined lift load is similar to that of a vertical lift load, unignorable friction force in the inclined lift makes a difference; in an inclined lift load, there is a distinct difference between the expression to calculate the lift force F (N) for lifting up and that for lifting down.

If the incline angle is θ, and the friction coefficient is μ, as shown in the Figure 9.8, the driving force F (N) is expressed as follows:

$$F = ((W_0 + W)(\sin\theta + \mu \bullet \cos\theta) - W_B) \bullet g \text{ (N)} \quad \text{(For lifting up)} \quad (9.7)$$

$$F = ((W_B - (W_0 + W)(\sin\theta + \mu \bullet \cos\theta)) \bullet g \text{ (N)} \quad \text{(For lifting down)} \quad (9.8)$$

The braking mode applies to both lifting up and down as in the vertical lift load. And the calculation of the required output torque τ around the motor shaft is the same as in the vertical lift load; apply the expression (9.1) if the value of F (N) is positive, and the (9.2) if negative.

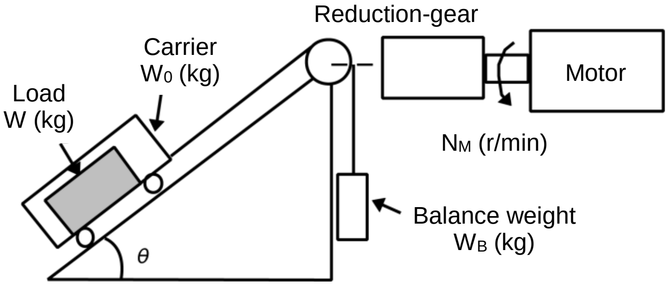


Figure 9.8 Inclined Lift Load

9.1.3.2 Acceleration and deceleration time calculation

When an object whose moment of inertia is J (kg·m²) rotates at the speed N (r/min), it has the following kinetic energy:

$$E = \frac{J}{2} \bullet \left(\frac{2\pi \bullet N}{60}\right)^2 \quad (J) \tag{9.9}$$

To accelerate the above rotational object, the kinetic energy will be increased; to decelerate the object, the kinetic energy must be discharged. The torque required for acceleration and deceleration can be expressed as follows:

$$\tau = J \bullet \frac{2\pi}{60} \left(\frac{dN}{dt}\right) \quad (N \bullet m) \tag{9.10}$$

This way, the mechanical moment of inertia is an important element in the acceleration and deceleration. First, calculation method of moment of inertia is described, then those for acceleration and deceleration time are explained.

[1] Calculation of moment of inertia

For an object that rotates around the shaft, virtually divide the object into small segments and square the distance from the shaft to each segment. Then, sum the squares of the distances and the masses of the segments to calculate the moment of inertia.

$$J = \sum (W_i \bullet r_i^2) \quad (kg \bullet m^2) \tag{9.11}$$

The following describes equations to calculate moment of inertia having different shaped loads or load systems.

(1) Hollow cylinder and solid cylinder

The common shape of a rotating body is hollow cylinder. The moment of inertia J (kg·m²) 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 mass is W [kg] in Figure 9.9.

$$J = \frac{W \bullet (D_1^2 + D_2^2)}{8} \quad (kg \bullet m^2) \tag{9.12}$$

For a similar shape, a solid cylinder, calculate the moment of inertia as D_2 is 0.

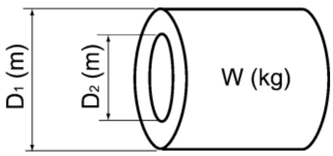


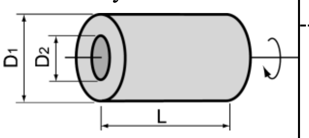
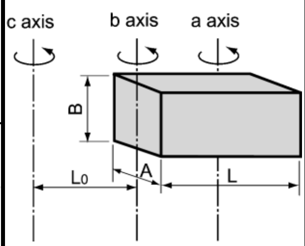
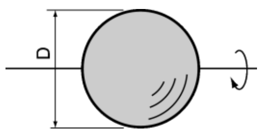
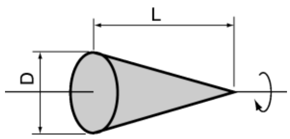
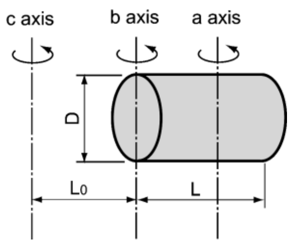
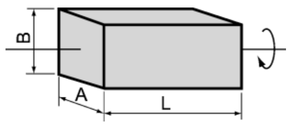
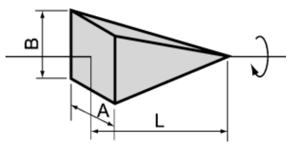
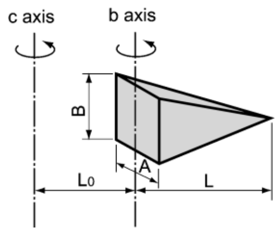
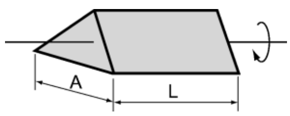
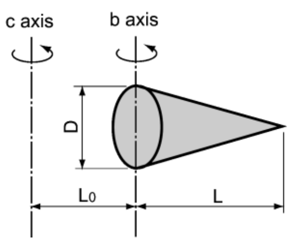
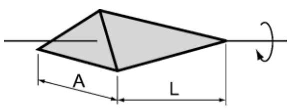
Figure 9.9 Hollow Cylinder

(2) For a general rotating body

Table 9.1 lists the calculation equations of moment of inertia of various rotating bodies including the above cylindrical rotating body.

Chap. 9 SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES

Table 9.1 Moment of Inertia of Various Rotating Bodies

Shape	Mass: W (kg) Moment of inertia: J ($kg \cdot m^2$)	Shape	Mass: W (kg) Moment of inertia: J ($kg \cdot m^2$)
Hollow cylinder  	$W = \frac{\pi}{4} \bullet (D_1^2 - D_2^2) \bullet L \bullet \rho$ $J = \frac{1}{8} \bullet W \bullet (D_1^2 + D_2^2)$	 	$W = A \bullet B \bullet L \bullet \rho$ $J_a = \frac{1}{12} \bullet W \bullet (L^2 + A^2)$ $J_b = \frac{1}{12} \bullet W \bullet (L^2 + \frac{1}{4} \bullet A^2)$ $J_c \approx W \bullet (L_0^2 + L_0 \bullet L + \frac{1}{3} \bullet L^2)$
Sphere  	$W = \frac{\pi}{6} \bullet D^3 \bullet \rho$ $J = \frac{1}{10} \bullet W \bullet D^2$		
Cone  	$W = \frac{\pi}{12} \bullet D^2 \bullet L \bullet \rho$ $J = \frac{3}{40} \bullet W \bullet D^2$	 	$W = \frac{\pi}{4} \bullet D^2 \bullet L \bullet \rho$ $J_a = \frac{1}{12} \bullet W \bullet (L^2 + \frac{3}{4} \bullet D^2)$ $J_b = \frac{1}{3} \bullet W \bullet (L^2 + \frac{3}{16} \bullet D^2)$ $J_c \approx W \bullet (L_0^2 + L_0 \bullet L + \frac{1}{3} \bullet L^2)$
Rectangular prism  	$W = A \bullet B \bullet L \bullet \rho$ $J = \frac{1}{12} \bullet W \bullet (A^2 + B^2)$		
Square cone (Pyramid, rectangular base)  	$W = \frac{1}{3} \bullet A \bullet B \bullet L \bullet \rho$ $J = \frac{1}{20} \bullet W \bullet (A^2 + B^2)$	 	$W = \frac{1}{3} \bullet A \bullet B \bullet L \bullet \rho$ $J_b = \frac{1}{10} \bullet W \bullet (L^2 + \frac{1}{4} \bullet A^2)$ $J_c \approx W \bullet (L_0^2 + \frac{3}{2} \bullet L_0 \bullet L + \frac{3}{5} \bullet L^2)$
Triangular prism  	$W = \frac{\sqrt{3}}{4} \bullet A^2 \bullet L \bullet \rho$ $J = \frac{1}{3} \bullet W \bullet A^2$	 	$W = \frac{\pi}{12} \bullet D^2 \bullet L \bullet \rho$ $J_b = \frac{1}{10} \bullet W \bullet (L^2 + \frac{3}{8} \bullet D^2)$ $J_c \approx W \bullet (L_0^2 + \frac{3}{2} \bullet L_0 \bullet L + \frac{3}{5} \bullet L^2)$
Tetrahedron with an equilateral triangular base  	$W = \frac{\sqrt{3}}{12} \bullet A^2 \bullet L \bullet \rho$ $J = \frac{1}{5} \bullet W \bullet A^2$		
Main metal density (at 20°C) ρ(kg/m^3) Iron: 7860, Copper: 8940, Aluminum: 2700			

(3) For a load running horizontally

Assume a carrier table driven by a motor as shown in Figure 9.6. If the table speed is υ (m/s) when the motor speed is N_M (r/min), then an equivalent distance from the shaft is equal to $60 \cdot \upsilon / (2\pi \cdot N_M)$ (m). The moment of inertia of the table and load to the shaft is calculated as follows:

$$J = \left(\frac{60 \bullet \upsilon}{2\pi \bullet N_M}\right)^2 \bullet (W_0 + W) \quad (kg \bullet m^2) \qquad (9.13)$$

(4) For a vertical or inclined lift load

The moment of inertia J ($kg \cdot m^2$) of the loads connected with a rope as shown in Figures 9.7 and 9.8 is calculated with the following equation using the mass of all moving objects, although the motion directions of those loads are different.

$$J = \left(\frac{60 \bullet \upsilon}{2\pi \bullet N_M}\right)^2 \bullet (W_0 + W + W_B) \quad (kg \bullet m^2) \qquad (9.14)$$

[2] Calculation of the acceleration time

Figure 9.10 shows a general load model. Assume that a motor drives a load via a reduction-gear with efficiency η_G. The time required to accelerate this load in stop state to a speed of N_M (r/min) is calculated with the following equation:

$$t_{ACC} = \frac{J_1 + J_2/\eta_G}{\tau_M - \tau_L/\eta_G} \bullet \frac{2\pi \bullet (N_M - 0)}{60} \quad (s) \qquad (9.15)$$

where,

J_1: Motor shaft moment of inertia ($kg \cdot m^2$)
J_2: Load shaft moment of inertia converted to motor shaft ($kg \cdot m^2$)
τ_M: Minimum motor output torque in driving motor ($N \cdot m$)
τ_L: Maximum load torque converted to motor shaft ($N \cdot m$)
η_G: Reduction-gear efficiency.

As clarified in the above equation, the equivalent moment of inertia becomes ($J_1 + J_2/\eta_G$) by considering the reduction-gear efficiency.

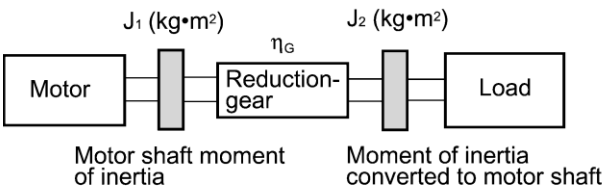


Figure 9.10 Load Model Including Reduction-gear

[3] Calculation of the deceleration time

In a load system shown in Figure 9.10, the time needed to stop the motor rotating at a speed of N_M (r/min) is calculated with the following equation:

$$t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot (0 - N_M)}{60} \quad (s) \qquad (9.16)$$

where,

J_1: Motor shaft moment of inertia (kg·m^2)
J_2: Load shaft moment of inertia converted to motor shaft (kg·m^2)
τ_M: Minimum motor output torque in braking (or decelerating) motor (N·m)
τ_L: Maximum load torque converted to motor shaft (N·m)
η_G: Reduction-gear efficiency

In the above equation, generally output torque τ_M is negative and load torque τ_L is positive. So, deceleration time becomes shorter. However, in the case of a lift load, τ_L may become a negative value in the braking mode so that the deceleration time becomes longer.

Tip For lift applications, calculate the deceleration time using the negative value of τ_L (maximum load torque converted to motor shaft).

[4] Calculating non-linear acceleration/deceleration time

In applications requiring frequent acceleration/deceleration, the inverter can accelerate/decelerate the motor in the shortest time utilizing all torque margins. The inverter in a vector control mode can easily perform this type of operation.

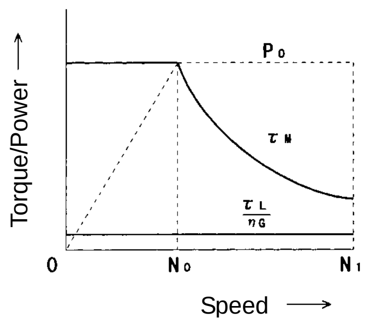


Figure 9.11 An Example of Driving Characteristics with a Constant Output Range

In this case, the acceleration/deceleration vs. speed curve will form a non-linear figure, and the acceleration/deceleration time cannot be calculated by a single expression.

Generally, the acceleration/deceleration time is obtained by calculating the acceleration/deceleration time of ΔN that is a difference of speed N broken into small parts, and then integrating it to obtain the total acceleration/deceleration time from start to end. Because the smaller ΔN provides higher accuracy, this numerical calculation needs an aid of a computer program.

The following is a guide for the numerical calculation method using a computer program.

Figure 9.11 illustrates an example of driving characteristics with a constant output range. In the figure, the range under N_0 is of constant torque characteristics, and the range between N_0 and N_1 is of a constant output with the non-linear acceleration/deceleration characteristics.

[4-1] Calculating non-linear acceleration time

The expression (9.17) gives an acceleration time Δt_{ACC} within a ΔN speed thread.

$$\Delta t_{ACC} = \frac{J_1 + J_2 / \eta_G}{\tau_M - \tau_L / \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \text{ (s)} \quad (9.17)$$

Before proceeding this calculation, obtain the motor shaft moment of inertia J_1, the load shaft moment of inertia converted to motor shaft J_2, maximum load torque converted to motor shaft τ_L, and the reduction-gear efficiency η_G. Apply the maximum motor output torque τ_M according to an actual speed thread ΔN as follows.

[τ_M in $N \le N_0$] Constant output torque range

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N_0} \text{ (N·m)} \quad (9.18)$$

[τ_M in $N_0 \le N \le N_1$] Constant output power range
(The motor output torque is inversely proportional to the motor speed)

$$\tau_M = \frac{60 \cdot P_O}{2\pi \cdot N} \text{ (N·m)} \quad (9.19)$$

If the result obtained by the above calculation does not satisfy the target value, select an inverter with one rank higher capacity.

[4-2] Calculating non-linear deceleration time

Use the following expression to obtain the non-linear deceleration time as well as for the acceleration time shown in [4-1].

$$\Delta t_{DEC} = \frac{J_1 + J_2 \cdot \eta_G}{\tau_M - \tau_L \cdot \eta_G} \cdot \frac{2\pi \cdot \Delta N}{60} \text{ (s)} \quad (9.20)$$

In this expression, both τ_M, and ΔN are generally negative values so that the load torque τ_L serves to assist the deceleration operation. For a lift load, however, the load torque τ_L is a negative value in some modes. In this case, the τ_M, and τ_L will take polarity opposite to each other and the τ_L will serve to prevent the deceleration operation of the lift.

9.1.3.3 Heat energy calculation of braking resistor

If the inverter brakes the motor, the kinetic energy of mechanical load is converted to electric energy to be regenerated into the inverter circuit. This regenerative energy is generally consumed in so-called braking resistors as heat. The following explains the braking resistor rating.

[1] Calculation of regenerative energy

In the inverter operation, the regenerative energy sources include the kinetic energy of a moving object and the potential energy of a lift.

(1) Kinetic energy of a moving object

When an object with moment of inertia J (kg·m²) rotates at a speed N_2 (r/min), its kinetic energy is as follows:

$$E = \frac{J}{2} \bullet \left(\frac{2\pi \bullet N_2}{60}\right)^2 \quad (J = Ws) \tag{9.21}$$

$$\approx \frac{1}{182.4} \bullet J \bullet N_2^2 \quad (J) \tag{9.21'}$$

When this object is decelerated to a speed N_1 (r/min), the output energy is as follows:

$$E = \frac{J}{2} \bullet \left[\left(\frac{2\pi \bullet N_2}{60}\right)^2 - \left(\frac{2\pi \bullet N_1}{60}\right)^2\right] \quad (J) \tag{9.22}$$

$$\approx \frac{1}{182.4} \bullet J \bullet (N_2^2 - N_1^2) \quad (J) \tag{9.22'}$$

The energy regenerated to the inverter as shown in Figure 9.11 is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E \approx \frac{1}{182.4} \bullet \left(J_1 + J_2 \bullet \eta_G\right) \bullet \eta_M \bullet \left(N_2^2 - N_1^2\right) \quad (J) \tag{9.23}$$

(2) Potential energy of a lift

When an object whose mass is W (kg) falls from the height h_2 (m) to the height h_1 (m), the output energy is as follows:

$$E = W \bullet g \bullet (h_2 - h_1) \ (J=Ws) \tag{9.24}$$

$$g \approx 9.8065 \ (m/s^2)$$

The energy regenerated to the inverter is calculated from the reduction-gear efficiency η_G and motor efficiency η_M as follows:

$$E = W \bullet g \bullet (h_2 - h_1) \bullet \eta_G \bullet \eta_M \ (J) \tag{9.25}$$

9.1.3.4 Calculating the RMS rating of the motor

In the case of a load which is repeatedly and very frequently driven by a motor, the motor current fluctuates largely and enters the short-time rating range of the motor repeatedly. Therefore, you have to review the allowable thermal rating of the motor. The heat value is assumed to be approximately proportional to the square of the motor current. The temperature of the forced cooling fan type of FRENIC-VG dedicated motors rises in proportion to the heat value.

If an inverter drives a motor in duty cycles that are much shorter than the thermal time constant of the motor, calculate the "equivalent RMS current" as mentioned below, and select the motor so that this RMS current will not exceed the rated current of the motor.

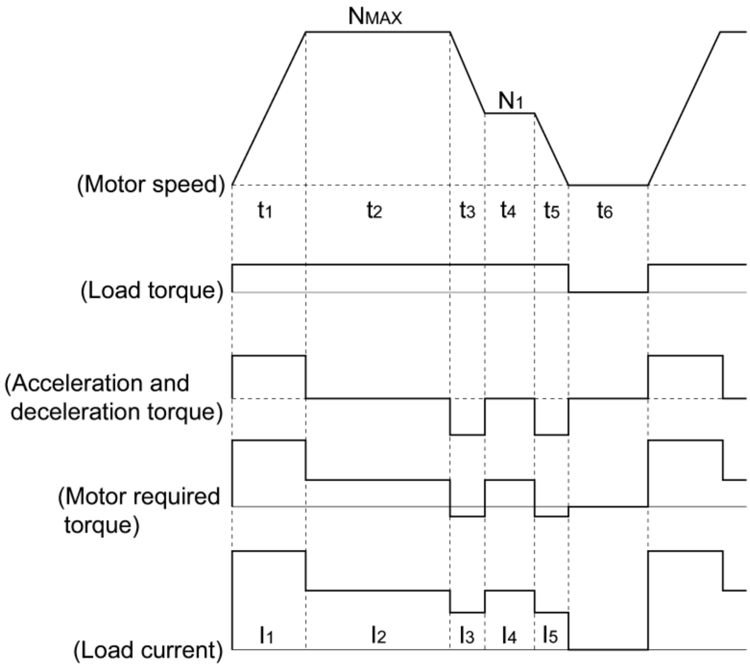


Figure 9.12 Sample of the Repetitive Operation

First, calculate the required torque of each part based on the speed pattern. Then using the torque-current curve of the motor, convert the torque to the motor current. The "equivalent RMS current, I_{eq}" can be finally calculated by the following equation:

$$I_{eq} = \sqrt{\frac{I_1^2 \cdot t_1 + I_2^2 \cdot t_2 + I_3^2 \cdot t_3 + I_4^2 \cdot t_4 + I_5^2 \cdot t_5}{t_1 + t_2 + t_3 + t_4 + t_5 + t_6}} \text{ (A)} \qquad (9.26)$$

The torque-current curve for the dedicated motor is not available for actual calculation. Therefore, calculate the motor current I from the load torque τ_1 using the following equation (9.27). Then, calculate the equivalent current I_{eq}:

$$I = \sqrt{\left(\frac{\tau 1}{100} \times I_{t100}\right)^2 + I_{m100}^2} \text{ (A)} \qquad (9.27)$$

Where, τ_1 is the load torque (%), I_{t100} is the torque current (P09; M1 torque current), and I_{m100} is exciting current (P08; M1 exciting current).

- For the function code data of P08 and P09, refer to Chapter 12 "Replacement Information."
- When using the 2nd motor, refer to the torque current and exciting current of A codes instead of those of P codes.

9.2 Selecting a Braking Resistor

9.2.1 Selection procedure

Depending on the cyclic period, the following requirements must be satisfied.

① If the cyclic period is 100 s or less: Requirements 1) and 3) below
② If the cyclic period exceeds 100 s: Requirements 1) and 2) below

1) The maximum braking torque should not exceed values listed in the tables given in Chapter 8, Section 8.5.1 "Braking resistors (DBRs) and braking units." To use the maximum braking torque exceeding values in those tables, select the braking resistor having one class larger capacity.
2) The discharge energy for a single braking action should not exceed the discharging capability (kWs) listed in the tables given in Chapter 8, Section 8.5.1 "Braking resistors (DBRs) and braking units." For detailed calculation, refer to Section 9.1.3.3 "Heat energy calculation of braking resistor."
3) The average loss that is calculated by dividing the discharge energy by the cyclic period must not exceed the average allowable loss (kW) listed in the tables given in Chapter 8, Section 8.5.1 "Braking resistors (DBRs) and braking units."

9.2.2 Notes on selection

The braking time T_1, cyclic period T_0, and duty cycle %ED are converted under deceleration braking conditions based on the rated torque as shown below. However, you do not need to consider these values when selecting the braking resistor capacity.

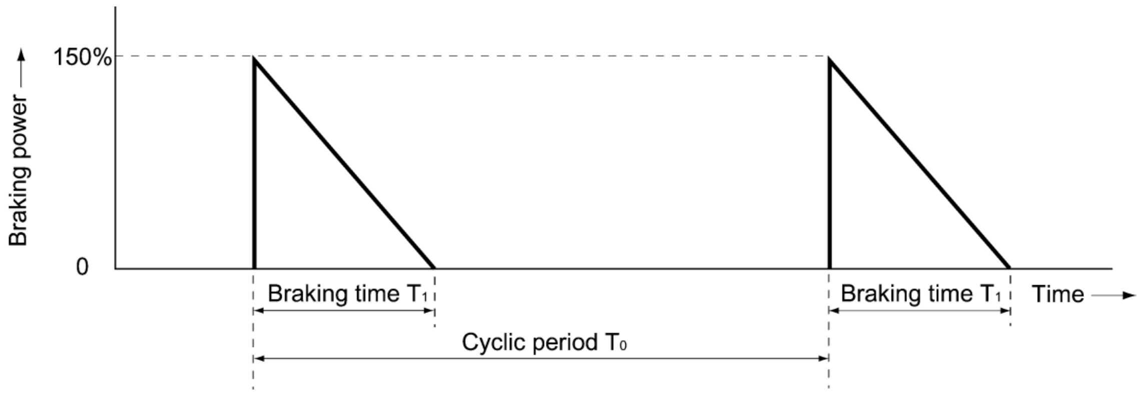


Figure 9.13 Duty Cycle

$$\text{Duty cycle \%ED} = \frac{T1}{T0} \times 100\ (\%)$$

9.3 Selecting an Inverter Drive Mode (HD/MD/LD)

9.3.1 Precaution in making the selection

The FRENIC-VG series of inverters is available in three different drive modes--HD (High Duty: for heavy duty load applications) , MD (Medium Duty: for medium duty load applications), and LD (Low Duty: for light duty load applications), which can be switched on site. The HD mode can drive a motor with the same capacity as the inverter; the MD mode, with one rank higher capacity than the inverter; the LD mode, with one or two ranks higher capacity than the inverter.

The LD mode is available in inverters of 30 kW or above, and the MD mode, in the 400 V class series of inverters of 90 to 400 kW.

Select the inverter drive mode appropriate to the user application, considering the motor capacity, overload characteristics, and HD/MD/LD mode referring to Section 9.3.2 "Guideline for selecting inverter drive mode and capacity."

HD mode designed for heavy duty load applications

Apply to general-purpose equipment where the inverter's load current in normal operations is less than the rated current of the HD-mode inverter, and the load current in overcurrent operation is less than 150% of the rated current of the HD-mode inverter for 1 minute and 200% for 3 seconds.

The rated current of the HD mode inverter is based on a motor with the same capacity as the inverter. Inverter running with the intermittent load rating is also possible as described below.

Intermittent load rating in the HD mode

Satisfying the following conditions enables inverter running with overload torque 164 to 200% (depending upon the capacity) for 10 seconds or below.

1) The root-mean-square current in cycle operation is 80% or less of the inverter rated current.
2) The carrier frequency is 10 or 6 kHz (depending upon the capacity) or below.

MD mode designed for medium duty load applications

Apply to equipment where the inverter's load current in normal operations is less than the rated current of the MD-mode inverter, and the load current in overcurrent operation is less than 150% of the rated current of the MD-mode inverter for 1 minute.

The rated current of the MD-mode inverter is based on a motor with one rank higher capacity than the inverter.

LD mode designed for light duty load applications

Apply to variable load equipment such as fans, pumps, and centrifugal machines where the inverter's load current in normal operations is less than the rated current of the LD-mode inverter, and the load current in overcurrent operation is less than 120% of the rated current of the LD-mode inverter for 1 minute.

The rated current of the LD-mode inverter is based on a motor with one or two ranks higher capacity than the inverter.

Replacement information for replacing the FRENIC5000VG7S (HT mode) with the FRENIC-VG series

The FRENIC-VG does not support the HT mode. When replacing the HT-mode FRENIC5000VG7S with the FRENIC-VG, therefore, use the inverter with one rank higher capacity.

9.3.2 Guideline for selecting inverter drive mode and capacity

Table 9.2 lists the differences between HD, MD, and LD modes.

If MD-/LD-mode inverters of 30 kW or above satisfy the requirements of the overload capability and functionality in your application, you can select the inverter with one or two ranks lower capacity than that of the motor rating.

Table 9.2 Differences between HD, MD, and LD modes

Function		HD mode	MD mode	LD mode	Remarks
Application		Heavy duty load	Medium duty load	Light duty load	—
Capacity range	200 V	All capacities	Not available	30 to 90 kW (corresponding to 37-110 kW motors)	
	400 V	All capacities	90 to 400 kW (corresponding to 110 to 450 kW motors)	30 to 630 kW (corresponding to 37 to 710 kW motors)	
Function code data setting (Switching between HD, MD, and LD modes)		F80 = 0, (Factory default)	F80 = 3	F80 = 1	—
Continuous current rating level (inverter rated current level)		Rated current based on a motor with the same capacity as the inverter.	Rated current based on a motor with one rank higher capacity than the inverter.	Rated current based on a motor with one or two ranks higher capacity than the inverter.	The MD-/LD-mode inverter brings out the continuous current rating level which enables the inverter to drive a motor with one or two ranks higher capacity, but its overload capability (%) against the continuous current level decreases. For the rated current level, refer to Chapter 2 "SPECIFICATIONS."
Overload capability		150% for 1 min. 200% for 3 s, relative to the rated current of HD-mode inverters	150% for 1 min. relative to the rated current of MD-mode inverters	120% for 1 min. relative to the rated current of LD-mode inverters	
Motor sound (Carrier frequency)		Setting range: 2 to 15 kHz (0.75 to 55 kW) 2 to 10 kHz (75 to 400 kW) 2 to 5 kHz (500, 630 kW)	Setting range: 2 to 4 kHz (90 to 400 kW)	Setting range: 2 to 10 kHz (30 to 55 kW) 2 to 5 kHz (75 to 500 kW) 2 kHz (630 kW)	In the MD/LD mode, a value out of the range, if specified, automatically changes to the maximum value allowable in the MD/LD mode.

The MD-/LD-mode inverters have no restrictions on the output frequency range.

The MD-/LD-mode inverters have no restrictions on the setting range of function codes whose data (e.g., DC braking level) is based on the rated current.

A DC reactor (DCR) is provided as standard for the FRENIC-VG of 75 kW or above. To use the inverter in the MD or LD mode, specify the MD-/LD-mode inverter when placing an order, and the FRENIC-VG comes with the DCR suitable for the motor capacity to be applied in the MD or LD mode. If the MD-/LD-mode inverter is not specified, the FRENIC-VG comes with the DCR suitable for the motor capacity to be applied in the HD mode. Applying the DCR to be applied in the HD mode to the MD-/LD-mode inverters may flow the current exceeding the DCR rated current.

If an order for the LD-mode inverter of 55 kW is placed, the inverter comes with the DCR suitable for 75 kW as standard.

Each rated current in the HD, MD and LD modes is used as a base for displaying or specifying the electric current data in percent (%) of the rated current with function codes or for outputting or displaying it by analog output or communications monitor.

Chapter 10
ABOUT MOTORS

This chapter details vector motors that can be connected to the FRENIC-VG series of inverters.

Contents

10.1 Vibration and Noise

For the specifications and the external dimensions of the dedicated motors, refer to Chapter 2, Section 2.4 "Dedicated Motor Specifications."

<table>
<tr><th rowspan="2">Dedicated applicable motor (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 (A)) *3</th></tr>
<tr><th>MVK__</th><th>Base speed 1500 r/min</th><th>Maximum speed *2 3600 r/min</th><th>Base speed 1500 r/min</th><th>Maximum speed 3600 r/min</th></tr>
<tr><td>0.75</td><td rowspan="27">4</td><td>8095A</td><td rowspan="12">Max. 5</td><td rowspan="10">Max. 7</td><td rowspan="3">56</td><td rowspan="3">60</td></tr>
<tr><td>1.5</td><td>8097A</td></tr>
<tr><td>2.2</td><td>8107A</td></tr>
<tr><td>3.7</td><td>8115A</td><td>58</td><td>62</td></tr>
<tr><td>5.5</td><td>8133A</td><td rowspan="2">60</td><td rowspan="2">64</td></tr>
<tr><td>7.5</td><td>8135A</td></tr>
<tr><td>11</td><td>8165A</td><td rowspan="2">68</td><td rowspan="2">72</td></tr>
<tr><td>15</td><td>8167A</td></tr>
<tr><td>18.5</td><td>8184A</td><td rowspan="4">71</td><td rowspan="2">73</td></tr>
<tr><td>22</td><td>8185A</td></tr>
<tr><td>30</td><td>8187A</td><td rowspan="2">Max. 7</td><td rowspan="2">73</td></tr>
<tr><td>37</td><td>8207A</td></tr>
<tr><td>45</td><td>8208A</td><td>Max. 5</td><td>Max. 7</td><td>71</td><td>73</td></tr>
<tr><td>55</td><td>9224A</td><td rowspan="14">*1</td><td rowspan="14">Max. 15</td><td rowspan="14">*1</td><td rowspan="14">*1</td></tr>
<tr><td>75</td><td>9254A</td></tr>
<tr><td>90</td><td>9256A</td></tr>
<tr><td>110</td><td>9284A</td></tr>
<tr><td>132</td><td>9286A</td></tr>
<tr><td>160</td><td>528KA</td></tr>
<tr><td>200</td><td>528LA</td></tr>
<tr><td>220</td><td>531FA</td></tr>
<tr><td>250</td><td>531GA</td></tr>
<tr><td>280</td><td>531HA</td></tr>
<tr><td>300</td><td>535GA</td></tr>
<tr><td>315</td><td>535GA</td></tr>
<tr><td>355</td><td>535HA</td></tr>
<tr><td>400</td><td>535JA</td></tr>
</table>

*1 Contact your Fuji Electric representative for individual values.

*2 3000 r/min for 30 to 45 kW, 2400 r/min for 55 to 75 kW, 2000 r/min for 90 to 220 kW

*3 Values measured 1 m away from the motor to the direction of the terminal box

Chap. 10 ABOUT MOTORS

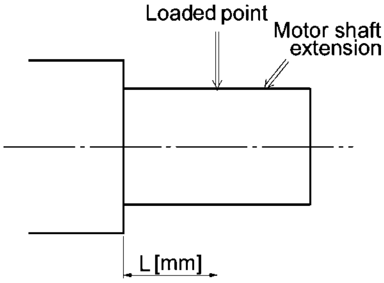
10.2 Acceleration Vibration Value

Dedicated applicable motor (kW)	No. of poles	Motor type MVK__	Acceleration vibration value, acceptable (m/s^2)
0.75	4	8095A	Max. 7
1.5		8097A	
2.2		8107A	
3.7		8115A	
5.5		8133A	
7.5		8135A	
11		8165A	
15		8167A	
18.5		8184A	
22		8185A	
30		8187A	
37		8207A	
45		8208A	
55		9224A	
75		9254A	
90		9256A	
110		9284A	
132		9286A	
160		528KA	
200		528LA	
220		531FA	
250		531GA	
280		531HA	
300		535GA	
315		535GA	
355		535HA	
400		535JA	

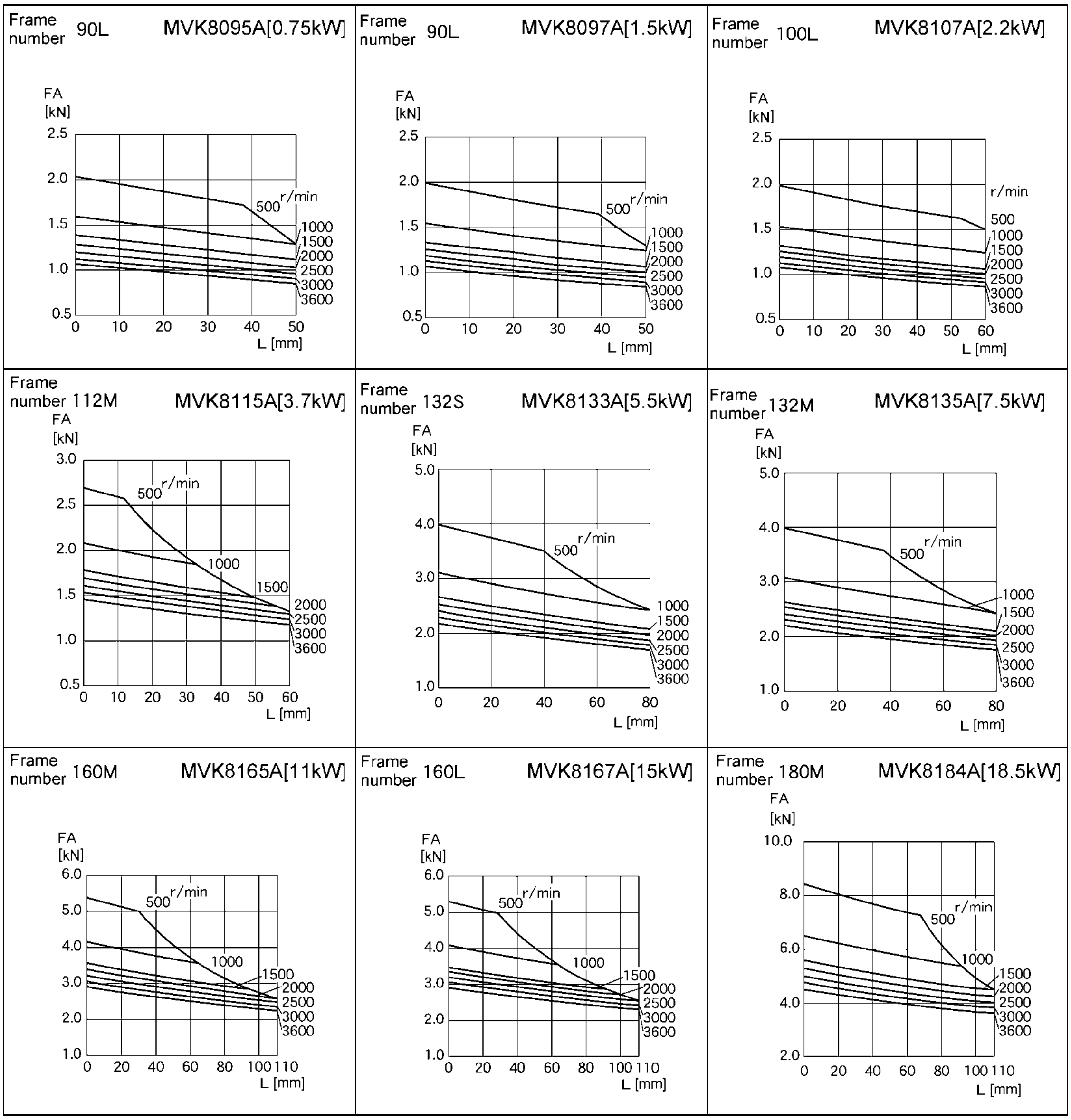
Note: If the actual vibration exceeds values listed above, any separate anti-vibration measure is required.

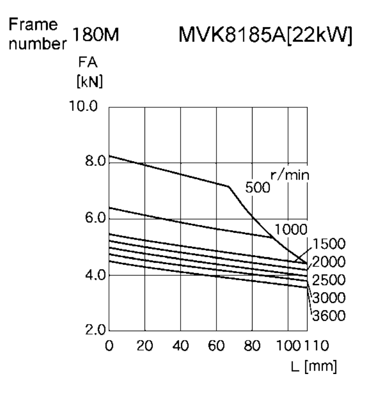
10.3 Allowable Radial Load at Motor Shaft Extension

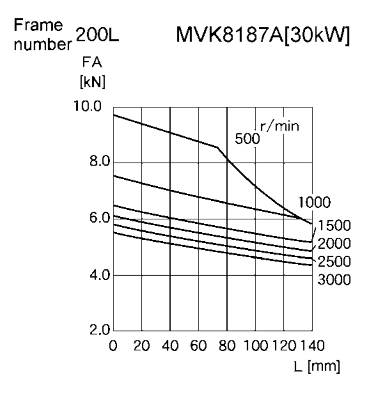
[Loaded point]

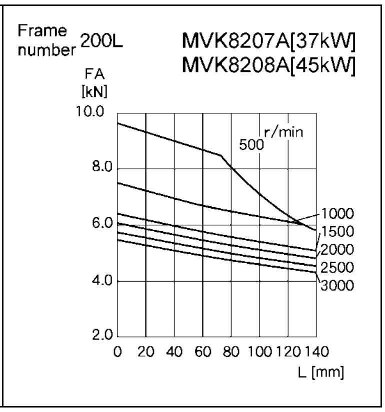


The maximum allowable value of radial load applied by the belt is shown in the figures below. The data is classified by the frame number and the rotation speed. If the point which is decided by the radial load FA (kN) acting on the motor shaft and the length L (mm) from the stepped joint at shaft end 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. Refer to the technical leaflet of the induction motor for the details.









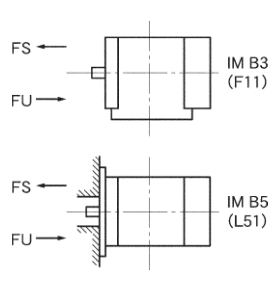
Note: Contact your Fuji Electric representative individually for motors whose frame number exceeds 200L (55 kW or above).

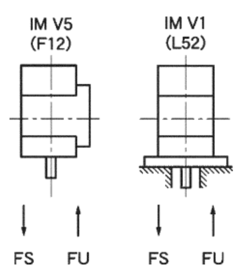
10.4 Allowable Thrust Load

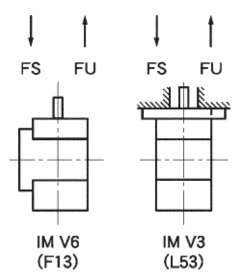
Unit: kN (kgf)

Frame number	Type MVK__	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	8095A 8097A	0.3 (30)	0.45 (45)	0.55 (55)	0.4 (40)	0.6 (60)	0.7 (70)	0.25 (25)	0.4 (40)	0.5 (50)	0.45 (45)	0.65 (65)	0.75 (75)	0.4 (40)	0.55 (55)	0.65 (65)	0.3 (30)	0.5 (50)	0.6 (60)
100L	8107A	—	0.65 (65)	0.8 (80)	—	0.55 (55)	0.65 (65)	—	0.6 (60)	0.7 (70)	—	0.6 (60)	0.6 (60)	—	0.5 (50)	0.6 (60)	—	0.75 (75)	0.85 (85)
112M	8115A	0.65 (65)	0.9 (90)	1.1 (110)	0.6 (60)	0.75 (75)	0.95 (95)	0.6 (60)	0.8 (80)	1 (100)	0.65 (65)	0.85 (85)	1 (100)	0.55 (55)	0.7 (70)	0.85 (85)	0.75 (75)	1 (100)	1.2 (120)
132S	8133A	1 (100)	1.4 (140)	1.7 (170)	0.75 (75)	1 (100)	1.2 (120)	1 (100)	1.3 (130)	1.7 (170)	0.9 (90)	1.1 (110)	1.4 (140)	0.65 (65)	0.9 (90)	1.1 (110)	1.2 (120)	1.5 (150)	1.9 (190)
132M	8135A	—			—			—		1.6 (160)	—			—		1 (100)	—		
160M	8165A	1.3 (130)	1.8 (180)	2.2 (220)	1.2 (120)	1.5 (150)	1.9 (190)	1.1 (110)	1.6 (160)	2 (200)	1.5 (150)	1.8 (180)	2.2 (220)	1 (100)	1.4 (140)	1.7 (170)	1.6 (160)	2.1 (210)	2.5 (250)
160L	8167A		1.7 (170)	2.1 (210)			1.8 (180)		1.5 (150)	1.8 (180)					1.3 (130)	1.5 (150)			
180M	8184A 8185A	2 (200)	2.7 (280)	3.3 (340)	1.9 (190)	2.3 (230)	2.8 (290)	1.8 (180)	2.3 (230)	2.9 (300)	2.2 (220)	2.7 (280)	3.4 (350)	1.6 (160)	2 (200)	2.6 (270)	2.4 (240)	3.2 (330)	3.9 (400)
180L	8187A																		
200L	8207A	1.9 (190)	3.8 (390)	4.5 (460)	2 (200)	3.2 (330)	3.7 (380)	1.5 (150)	3.2 (330)	3.8 (390)	2.6 (270)	4 (410)	4.8 (490)		2.7 (280)	3 (310)	2.5 (250)	4.6 (470)	5.6 (570)
	8208A	1.2 (120)	5.4 (550)	6.5 (-)	1.2 (120)	5.4 (550)	6.5 (-)	0.4 (40)	4.4 (445)	5.3 (-)	2.3 (230)	6.9 (700)	8.2 (-)	0.4 (40)	4.4 (445)	5.3 (-)	2.3 (230)	6.9 (700)	8.2 (-)
225S	9224A	1.1 (110)	5.2 (535)	6.2 (630)	1.1 (110)	5.2 (535)	6.2 (630)	0.3 (30)	4.1 (415)	4.8 (490)				0.3 (30)	4.1 (415)	4.8 (490)			
250S	9254A	1 (100)	6.4 (650)	7.6 (770)	1 (100)	6.4 (650)	7.6 (770)	—	4.9 (500)	5.6 (570)	—	8.4 (860)	10.3 (1050)	—	4.9 (500)	5.6 (570)	—	8.4 (860)	10.3 (1050)
250M	9256A	0.9 (90)	6.2 (630)	7.3 (740)	0.9 (90)	6.2 (630)	7.3 (740)	—	4.5 (460)	5.1 (520)	—	8.5 (870)	10.4 (1060)	—	4.5 (460)	5.1 (520)	—	8.5 (870)	10.4 (1060)
280S	9284A	0.8 (80)	5.9 (600)	6.9 (700)	0.8 (80)	5.9 (600)	6.9 (700)	—	3.7 (380)	4.2 (430)	—	9.2 (940)	10.8 (1100)	—	3.7 (380)	4.2 (430)	—	9.2 (940)	10.8 (1100)
280M	9286A	0.7 (70)	5.7 (580)	6.7 (680)	0.7 (70)	5.7 (580)	6.7 (680)	—	3.1 (320)	3.8 (390)	—	9.3 (950)	10.9 (1110)	—	3.1 (320)	3.8 (390)	—	9.3 (950)	10.9 (1110)
—	528KA 528LA 531FA 531GA 531HA 535GA 535HA 535JA	*Contact Fuji individually						*Contact Fuji individually						*Contact Fuji individually					

Mounting method and the direction of thrust







Note 1: The above-mentioned figures whose frame number is 250S or above show 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.

10.5 List of Special Combinations

10.5.1 Combination list of 380V series

Type		4-pole non-standard special motor			4-pole standard motor		
Base speed (r/min)		1500			Base speed: 1,500 (r/min), Max. speed: 1,500 (r/min)		
Max. load torque (%)		150			150		
Model and item		Model		Max. speed Nmax (r/min)	Model		Potential max. speed Nmax (r/min) *2
		Motor	Inverter		Motor	Inverter	
Output (kW)	3.7	MVK8115A	FRN3.7VG1S-4J	3600	MVK8115A	FRN3.7VG1S-4J	3300
	5.5	MVK8133A	FRN5.5VG1S-4J		MVK8133A	FRN5.5VG1S-4J	3400
	7.5	MVK8135A	FRN7.5VG1S-4J		MVK8135A	FRN7.5VG1S-4J	2150
	11	MVK8165A	FRN11VG1S-4J		MVK8165A	FRN11VG1S-4J	1600
	15	MVK8167A	FRN15VG1S-4J		MVK8167A	FRN15VG1S-4J	3200
	18.5	MVK8184A	FRN22VG1S-4J		MVK8184A	FRN18.5VG1S-4J	2750
	22	MVK8185A	FRN30VG1S-4J		MVK8185A	FRN22VG1S-4J	2000
	30	MVK8187A	FRN37VG1S-4J		MVK8187A	FRN30VG1S-4J	2200
	37	MVK8207A	FRN45VG1S-4J		MVK8207A	FRN37VG1S-4J	1600
	45	MVK8208A	FRN55VG1S-4J		MVK8208A	FRN45VG1S-4J	2100
	55	MVK9224A	FRN75VG1S-4J	2400	MVK9224A	FRN55VG1S-4J	1600
	75	MVK9254A	FRN90VG1S-4J		MVK9254A	FRN75VG1S-4J	2000
	90	MVK9256A	FRN110VG1S-4J	2000	MVK9256A	FRN90VG1S-4J	2000
	110	MVK9284A	FRN132VG1S-4J		MVK9284A	FRN110VG1S-4J	2000
	132	MVK9286A *1	FRN160VG1S-4J		MVK9286A	FRN132VG1S-4J	1500
	160	MVK528KA *1	FRN200VG1S-4J		MVK528KA	FRN160VG1S-4J	1500
	200	MVK528LA *1	FRN220VG1S-4J		MVK528LA	FRN200VG1S-4J	1500
	220	MVK531FA *1	FRN280VG1S-4J		MVK531FA	FRN220VG1S-4J	1500

*1 The electric characteristics of the motor are the same as those of the standard motor. The frame size of the inverter is one frame larger.

*2 The maximum speed at which the 150% overload rating torque is obtained with 380 V input is specified. If a 150% overload constant is necessary at a larger speed, select the inverter of a larger capacity.

10.5.2 Combination list of low base speed series

200V class

No. of poles, standard/ non-standard		6-pole non-standard special motor						4-pole standard motor	
Base speed		500 (r/min)	650 (r/min)	750 (r/min)	850 (r/min)	1,000 (r/min)		1,000 (r/min)	
Max. speed		2,000 (r/min)	2,000 (r/min)	1,800 (r/min)	1,700 (r/min)	2,000 (r/min)	2,400 (r/min)	3,000 (r/min)	3,600 (r/min)
Output (kW)	0.75	MVK8115A FRN1.5VG1S-2J		MVK8107A FRN1.5VG1S-2J			MVK8097A FRN0.75VG1S-2J		MVK8097A FRN1.5VG1S-2J
	1.5	MVK8133A FRN3.7VG1S-2J		MVK8115A FRN2.2VG1S-2J			MVK8107A FRN2.2VG1S-2J		MVK8107A FRN2.2VG1S-2J
	2.2	MVK8135A FRN3.7VG1S-2J		MVK8133A FRN3.7VG1S-2J			MVK8115A FRN3.7VG1S-2J		MVK8115A FRN3.7VG1S-2J
	3.7	MVK8165A FRN5.5VG1S-2J		MVK8135A FRN5.5VG1S-2J			MVK8133A FRN5.5VG1S-2J		MVK8133A FRN5.5VG1S-2J
	5.5	MVK8167A FRN7.5VG1S-2J		MVK8165A FRN7.5VG1S-2J			MVK8135A FRN7.5VG1S-2J		MVK8135A FRN7.5VG1S-2J
	7.5	MVK8185A FRN11VG1S-2J		MVK8167A FRN11VG1S-2J			MVK8165A FRN7.5VG1S-2J		MVK8165A FRN11VG1S-2J
	11	MVK8187A FRN15VG1S-2J		MVK8184A FRN15VG1S-2J			MVK8167A FRN15VG1S-2J		MVK8184A FRN18.5VG1S-2J
	15	MVK8207A FRN22VG1S-2J		MVK8185A FRN18.5VG1S-2J			MVK8184A FRN18.5VG1S-2J		MVK8185A FRN22VG1S-2J
	18.5	MVK9256A FRN30VG1S-2J	MVK9221A FRN30VG1S-2J	MVK8187A FRN22VG1S-2J			MVK81855A FRN22VG1S-2J		MVK8187A FRN30VG1S-2J
	22	MVK9284A FRN37VG1S-2J	MVK9250A FRN37VG1S-2J	MVK8207A FRN30VG1S-2J		MVK8187A FRN30VG1S-2J		MVK8207A FRN37VG1S-2J	
	30	MVK9284A FRN45VG1S-2J	MVK9256A FRN45VG1S-2J		MVK9221A FRN37VG1S-2J	MVK8207A FRN37VG1S-2J		MVK8208A FRN45VG1S-2J	
	37	MVK9286A FRN55VG1S-2J	MVK9284A FRN55VG1S-2J		MVK9224A FRN45VG1S-2J	MVK9221A FRN45VG1S-2J			
	45	MVK528KA FRN75VG1S-2J	MVK9284A FRN75VG1S-2J		MVK9250A FRN55VG1S-2J	MVK9224A FRN55VG1S-2J			
	55	MVK528LA FRN90VG1S-2J	MVK9286A FRN75VG1S-2J		MVK9256A FRN75VG1S-2J	MVK9250A FRN75VG1S-2J			
	75		MVK528LA FRN90VG1S-2J		MVK9284A FRN90VG1S-2J	MVK9256A FRN90VG1S-2J			

400V class

No. of poles, standard/ non-standard		6-pole non-standard special motor						4-pole standard motor	
Base speed		500 (r/min)	650 (r/min)	750 (r/min)	850 (r/min)	1,000 (r/min)		1,000 (r/min)	
Max. speed		2,000 (r/min)	2,000 (r/min)	1,800 (r/min)	1,700 (r/min)	2,000 (r/min)	2,400 (r/min)	3,000 (r/min)	3,600 (r/min)
Output(kW)	0.75	MVK8115A FRN3.7VG1S-4J	–	MVK8107A FRN3.7VG1S-4J	–	–	MVK8097A FRN3.7VG1S-4J	–	MVK8097A FRN1.5VG1S-4J
	1.5	MVK8133A FRN3.7VG1S-4J	–	MVK8115A FRN3.7VG1S-4J	–	–	MVK8107A FRN3.7VG1S-4J	–	MVK8107A FRN2.2VG1S-4J
	2.2	MVK8135A FRN3.7VG1S-4J	–	MVK8133A FRN3.7VG1S-4J	–	–	MVK8115A FRN3.7VG1S-4J	–	MVK8115A FRN3.7VG1S-4J
	3.7	MVK8165A FRN5.5VG1S-4J	–	MVK8135A FRN5.5VG1S-4J	–	–	MVK8133A FRN5.5VG1S-4J	–	MVK8133A FRN5.5VG1S-4J
	5.5	MVK8167A FRN7.5VG1S-4J	–	MVK8165A FRN7.5VG1S-4J	–	–	MVK8135A FRN7.5VG1S-4J	–	MVK8135A FRN7.5VG1S-4J
	7.5	MVK8185A FRN11VG1S-4J	–	MVK8167 FRN11VG1S-4J	–	–	MVK8165A FRN7.5VG1S-4J	–	MVK8165A FRN11VG1S-4J
	11	MVK8187A FRN15VG1S-4J	–	MVK8184 FRN15VG1S-4J	–	–	MVK8167A FRN11VG1S-4J	–	MVK8184A FRN18.5VG1S-4J
	15	MVK8207A FRN22VG1S-4J	–	MVK8185A FRN18.5VG1S-4J	–	–	MVK8184A FRN18.5VG1S-4J	–	MVK8185A FRN22VG1S-4J
	18.5	MVK9256A FRN30VG1S-4J	MVK9221A FRN30VG1S-4J	MVK8187A FRN22VG1S-4J	–	–	MVK8185A FRN22VG1S-4J	–	MVK8187A FRN30VG1S-4J
	22	MVK9284A FRN37VG1S-4J	MVK9250A FRN30VG1S-4J	MVK8207A FRN30VG1SJ	–	MVK8187A FRN30VG1S-4J	–	MVK8207A FRN37VG1S-4J	–
	30	MVK9284A FRN45VG1S-4J	MVK9256A FRN37VG1S-4J	–	MVK9221A FRN37VG1S-4J	MVK8207A FRN37VG1S-4J	–	MVK8208A FRN45VG1S-4J	–
	37	MVK9286A FRN55VG1S-4J	MVK9284A FRN45VG1S-4J	–	MVK9224A FRN45VG1S-4J	MVK9221A FRN45VG1S-4J	–	–	–
	45	MVK528KA FRN75VG1S-4J	MVK9284A FRN55VG1S-4J	–	MVK9250A FRN55VG1S-4J	MVK9224A FRN55VG1S-4J	–	–	–
	55	MVK528LA FRN75VG1S-4J	MVK9286A FRN75VG1S-4J	–	MVK9256A FRN75VG1S-4J	MVK9250A FRN75VG1S-4J	–	–	–
	75	MVK531GA FRN110VG1S-4J	MVK528LA FRN90VG1S-4J	–	MVK9284A FRN90VG1S-4J	MVK9256A FRN90VG1S-4J	–	–	–
	90	MVK531HA FR132VG1S-4J	MVK531GA FRN110VG1S-4J	–	MVK9286A FRN110VG1S-4J	MVK9284A FRN110VG1S-4J	–	–	–
	110	–	MVK531HA FRN132VG1S-4J	–	MVK528KA FRN132VG1S-4J	MVK9286A FRN132VG1S-4J	–	–	–
	132	–	MVK531HA FRN200VG1S-4J	–	MVK528LA FRN160VG1S-4J	MVK528KA FRN160VG1S-4J	–	–	–
	160	–	–	–	–	MVK528LA FRN200VG1S-4J	–	–	–
	200	–	–	–	–	*1	–	–	–

*1 Contact your Fuji Electric representative.

FRENIC-VG

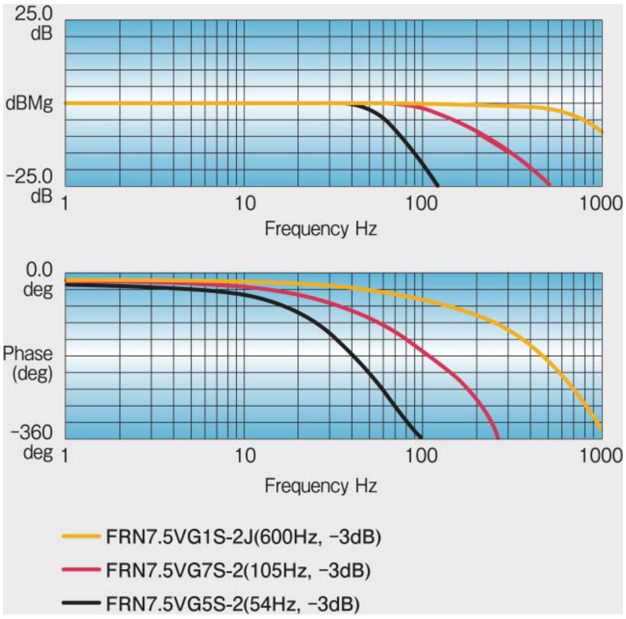
11

Chapter 11
OPERATION DATA

This chapter provides the characteristics data of the FRENIC-VG series of inverters running.

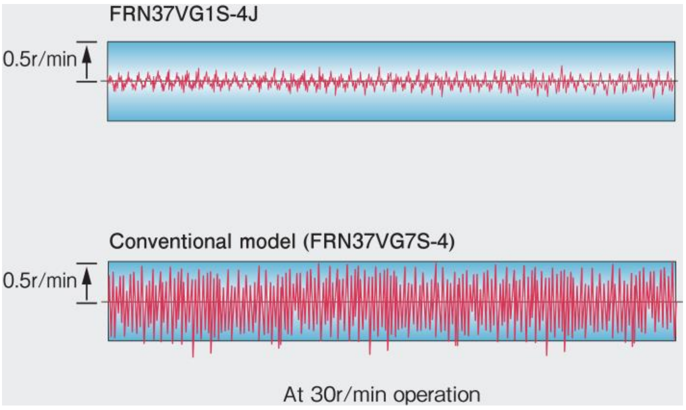
Contents

11.1 Frequency Response Characteristics



Inverter: FRN7.5VG1S-2J

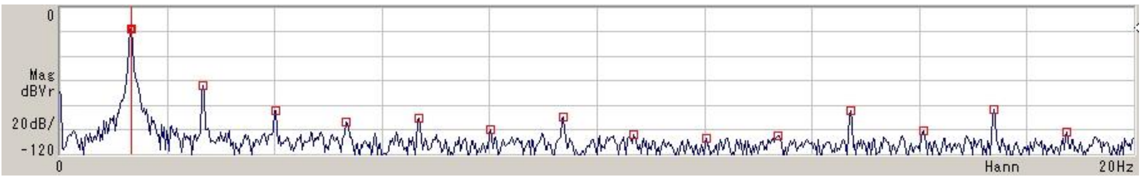
11.2 Rotational Fluctuation Measurement Sample



Inverter:	FRN37VG1S-4J
Motor:	MVK8207A, 37 kW, 1500/3000 r/min
Test condition:	Motor alone

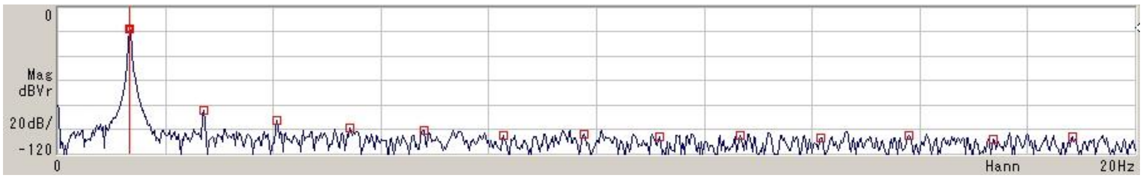
11.3 Current Distortion Characteristics

Conventional models (FRENIC5000VG7S)



f **f x 3 times** **f x 5 times** **f x 7 times** **f: Output frequency (Hz)**

FRENIC-VG



f **f x 3 times** **f x 5 times** **f x 7 times** **f: Output frequency (Hz)**

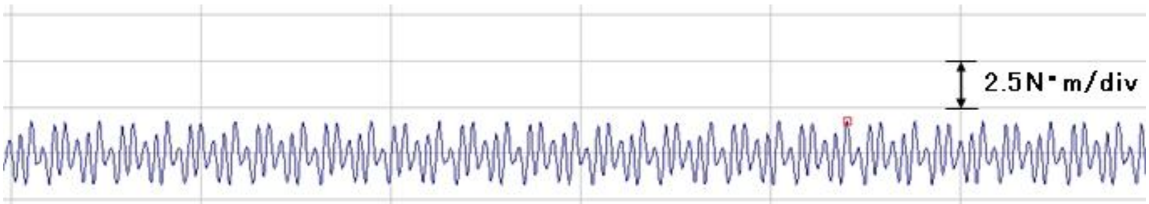
Inverter: FRN7.5VG1S-2J

Test condition: Motor alone

11.4 Torque Ripple

Conventional models (FRENIC5000VG7S)

FRENIC-VG



Torque ripple components P-P 100%: Rated torque

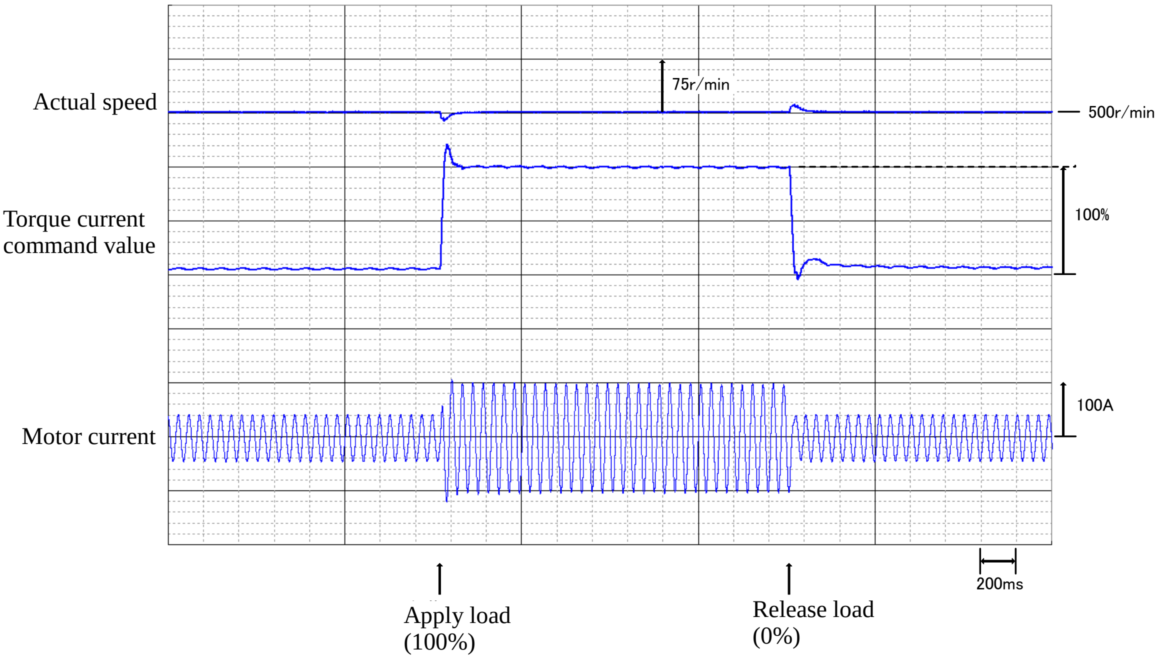
	1 time	2 times	6 times
FRENIC-VG	0.068%	0.307%	0.907%
Conventional models (FRENIC5000VG7S)	0.720%	0.364%	0.911%

Inverter: FRN37VG1S-2J

Motor: MVK6207A-C, 37 kW, 1500/3000 rpm

Test condition: Motor constraint

11.5 Impact Load Characteristics



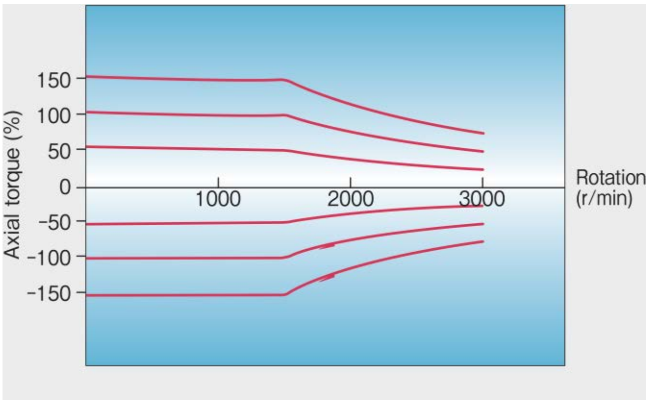
FRN37VG1S-4J running at 500 r/min

Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

Test condition: Running at 500 r/min

11.6 Speed-torque Characteristics (Vector control with speed sensor)

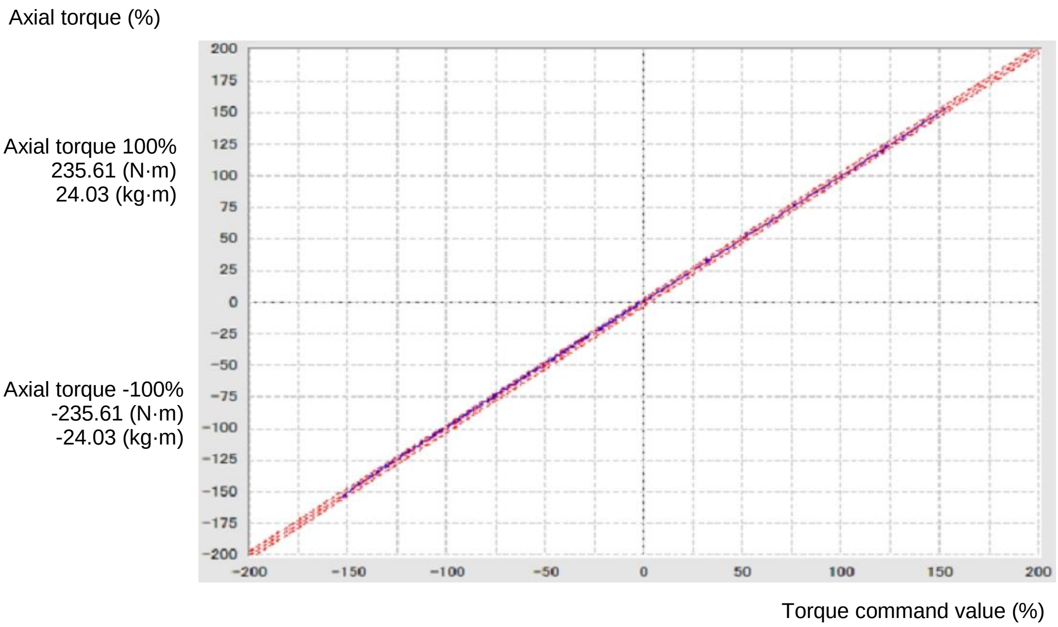


FRN37VG1S-4J

Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

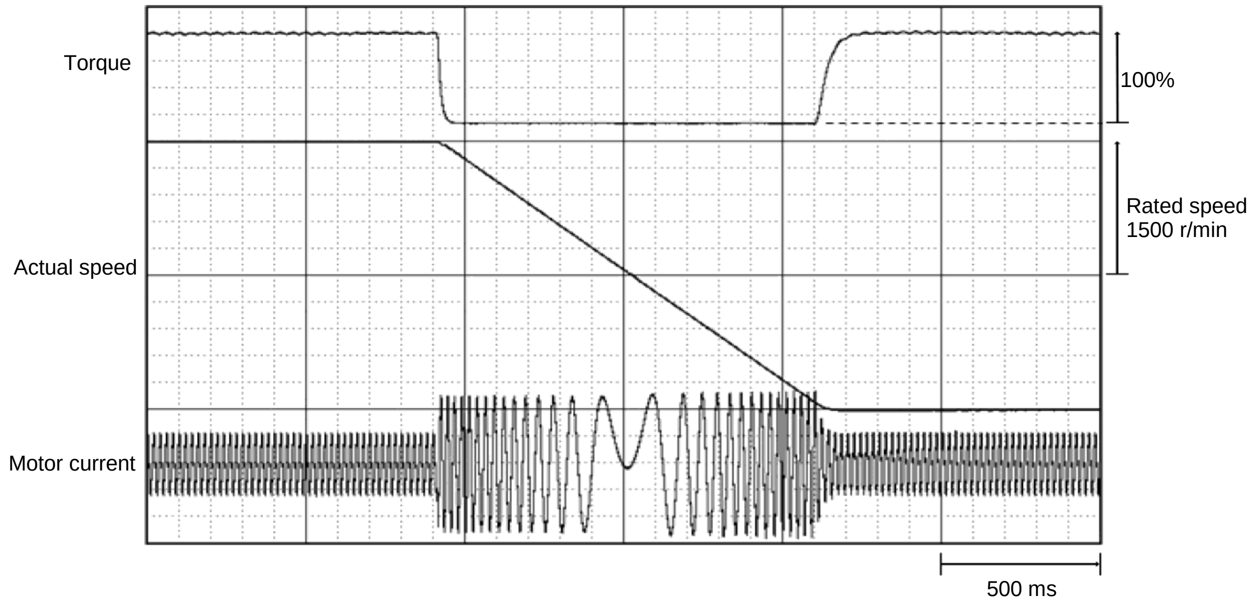
11.7 Torque Control Accuracy (Vector control with speed sensor)



Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

11.8 Deceleration/Acceleration via Zero Speed (Vector control with speed sensor)



Inverter: FRN37VG1S-4J

Motor: MVK8207A, 37 kW, 1500/3000 r/min

Chapter 12
REPLACEMENT DATA

When replacing the former inverters (VG3, VG5S, and VG7S) with FRENIC-VG, refer to the replacement data given in this chapter.

Contents

12.1 Classification of Replacement

	Inverter	Motor	Possibility
A: Both inverter and motor are replaced.	VG3/VG3N ⇒ FRENIC-VG	VG3 ⇒ FRENIC-VG	Possible
	VG5S/VG5N ⇒ FRENIC-VG	VG5 ⇒ FRENIC-VG (Same product)	Possible
	VG7 ⇒ FRENIC-VG	VG7 ⇒ FRENIC-VG (Same product)	Possible
B: Only the inverter is replaced.	VG3/VG3N ⇒ FRENIC-VG	VG3	Possible (Note 1)
	VG5S/VG5N ⇒ FRENIC-VG	VG5	Possible
	VG7 ⇒ FRENIC-VG	VG7	Possible
C: Only the motor is replaced.	VG3	VG3 ⇒ FRENIC-VG	Impossible (Note 2)
	VG5	VG5 ⇒ FRENIC-VG (Same product)	Possible
	VG7	VG7 ⇒ FRENIC-VG	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.

Note 3: When substituting from FRENIC5000VG (old model of VG3), contact us.

12.2 External Dimensions Comparison

12.2.1 Replacing VG7S

200V series

<table>
<tr><td rowspan="2"></td><td colspan="7">FRENIC5000 VG7S</td><td colspan="7">FRENIC-VG</td></tr>
<tr><td colspan="3">External dimensions</td><td colspan="2">Installation dimensions</td><td rowspan="2">Mounting method</td><td rowspan="2">Rough mass (kg)</td><td colspan="3">External dimensions</td><td colspan="2">Installation dimensions</td><td rowspan="2">Mounting method</td><td rowspan="2">Rough mass (kg)</td></tr>
<tr><td>Capacity (kW)</td><td>W (mm)</td><td>H (mm)</td><td>D (mm)</td><td>W1 (mm)</td><td>H1 (mm)</td><td>W (mm)</td><td>H (mm)</td><td>D (mm)</td><td>W1 (mm)</td><td>H1 (mm)</td></tr>
<tr><td>0.75</td><td rowspan="6">205</td><td rowspan="6">300</td><td rowspan="8">245</td><td rowspan="6">181</td><td rowspan="6">278</td><td rowspan="16">Wall type</td><td rowspan="6">8</td><td rowspan="6">205</td><td rowspan="6">300</td><td rowspan="10">245</td><td rowspan="6">181</td><td rowspan="6">278</td><td rowspan="16">Wall type</td><td rowspan="6">6</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td rowspan="2">250</td><td rowspan="2">380</td><td rowspan="2">226</td><td rowspan="2">358</td><td rowspan="2">12.5</td><td rowspan="4">250</td><td rowspan="2">400</td><td rowspan="4">226</td><td rowspan="2">378</td><td rowspan="3">10</td></tr>
<tr><td>15</td></tr>
<tr><td>18.5</td><td rowspan="3">340</td><td rowspan="2">480</td><td rowspan="2">255</td><td>240</td><td>460</td><td rowspan="2">25</td><td rowspan="2">400</td><td rowspan="2">378</td></tr>
<tr><td>22</td><td>240</td><td>460</td><td>10.5</td></tr>
<tr><td>30</td><td>550</td><td>255</td><td>240</td><td>530</td><td>30</td><td>320</td><td>550</td><td>255</td><td>240</td><td>530</td><td>25</td></tr>
<tr><td>37</td><td rowspan="3">375</td><td>615</td><td rowspan="3">270</td><td rowspan="3">275</td><td>595</td><td>37</td><td rowspan="3">355</td><td>615</td><td rowspan="3">270</td><td rowspan="3">275</td><td>595</td><td>32</td></tr>
<tr><td>45</td><td rowspan="2">740</td><td rowspan="3">720</td><td>46</td><td rowspan="2">740</td><td rowspan="3">720</td><td>42</td></tr>
<tr><td>55</td><td>48</td><td>43</td></tr>
<tr><td>75</td><td>530</td><td>750</td><td>285</td><td>430</td><td>70</td><td>530</td><td>750</td><td>285</td><td>430</td><td>62</td></tr>
<tr><td>90</td><td>680</td><td>880</td><td>360</td><td>580</td><td>850</td><td>115</td><td>680</td><td>880</td><td>360</td><td>580</td><td>850</td><td>105</td></tr>
</table>

Larger than VG7

An adapter is required for replacement.

The control panel containing VG3 should be modified.

400V series

	FRENIC5000 VG7S							FRENIC-VG						
	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)
Capacity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
3.7	205	300	245	181	278	Wall type	8	205	300	245	181	278	Wall type	6
5.5														
7.5														
11	250	380		226	358		12.5	250	400		226	378		10
15														
18.5	340	480	255	240	460		25		400			378		
22														
30	340	550	255	240	530		30	320	550	255	240	530		25
37	375		270	275	530		35							26
45		675			655		40	355	615	270	275	595		31
55				275	655		41		675			655		33
75		740			720		50		740			720		42
90	530		315	430	710		72	530		315	430	710		62
110														64
132		1000	360		970		100		1000	360		970		94
160														98
200	680			580			140	680			580			130
220														140
250							150	-	-	-	-	-		-
280		1400	450		1370		320	680	1400	440	580	1370		245
315														
355	880			780			410	880			780			330
400														
500	1000	1550	500	900	1520		525	1000	1550	500	900	1520		555
630														

Larger than VG7

An adapter is required for replacement.

The control panel containing VG3 should be modified.

Chap. 12 REPLACEMENT DATA

12.2.2 Replacing VG5S

200V series

	FRENIC5000 VG5S							FRENIC-VG						
	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)
Capacity (kW)	W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)			W (mm)	H (mm)	D (mm)	W1 (mm)	H1 (mm)		
0.75	205	350	245	183	328	Wall type	10	205	300	245	181	278	Wall type	6
1.5							10							
2.2							10							
3.7							10							
5.5							11							
7.5							11							
11	255	440	255	233	418		17	250	400		226	378		10
15	320	480		298	458		25							
18.5							25							
22							25							10.5
30	340	550	255	240	530		36	320	550	255	240	530		25
37	375	615		275	595		45	355	615	270	275	595		32
45		750		275	730		58		740			720		42
55	530		270	430	720		60							43
75			285	430	720		76	530	750	285	430			62
90	680	880	360	580	860	Floor type	141	680	880	360	580	850		105

400V series

	FRENIC5000 VG5S							FRENIC-VG						
	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)	External dimensions			Installation dimensions		Mounting method	Rough mass (kg)
Capacity (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	Wall type	10	205	300	245	181	278	Wall type	6
5.5							11							
7.5														
11	255	440	255	233	418		17	250	400		226	378		10
15														
18.5	320	480		298	458		25							
22														
30	340	550		240	530		35	320	550	255	240	530		25
37	375			275	530		36							26
45	375	675			655		43	355	615	270	275	595		31
55	530			430	645		53		675			655		33
75		740	270		710		60		740			720		42
90			315	430	710		86	530		315	430	710		62
110														64
132		1000	360		970		116		1000	360		970		94
160							121							98
200	680			580	980	Floor type	173	680			580			130
220							173							140

Larger than VG5

An adapter is required for replacement.

The control panel containing VG3 should be modified.

12.2.3 Replacing VG3

200V series

<table>
<tr><th rowspan="3">Capacity (kW)</th><th colspan="7">FRENIC5000 VG3</th><th colspan="7">FRENIC-VG</th></tr>
<tr><th colspan="3">External dimensions</th><th colspan="2">Installation dimensions</th><th rowspan="2">Mounting method</th><th rowspan="2">Rough mass (kg)</th><th colspan="3">External dimensions</th><th colspan="2">Installation dimensions</th><th rowspan="2">Mounting method</th><th rowspan="2">Rough mass (kg)</th></tr>
<tr><th>W (mm)</th><th>H (mm)</th><th>D (mm)</th><th>W1 (mm)</th><th>H1 (mm)</th><th>W (mm)</th><th>H (mm)</th><th>D (mm)</th><th>W1 (mm)</th><th>H1 (mm)</th></tr>
<tr><td>0.75</td><td rowspan="5">255</td><td rowspan="5">440</td><td rowspan="12">255</td><td rowspan="5">155</td><td rowspan="5">425</td><td rowspan="14">Wall type</td><td rowspan="4">14</td><td rowspan="6">205</td><td rowspan="6">300</td><td rowspan="10">245</td><td rowspan="6">181</td><td rowspan="6">278</td><td rowspan="16">Wall type</td><td rowspan="6">6</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</td></tr>
<tr><td>5.5</td><td>16</td></tr>
<tr><td>7.5</td><td>280</td><td>480</td><td>180</td><td>465</td><td>20</td></tr>
<tr><td>11</td><td rowspan="2">320</td><td>480</td><td>220</td><td>460</td><td>24</td><td rowspan="4">250</td><td rowspan="4">400</td><td rowspan="4">226</td><td rowspan="4">378</td><td rowspan="3">10</td></tr>
<tr><td>15</td><td>520</td><td>220</td><td>500</td><td>27</td></tr>
<tr><td>18.5</td><td rowspan="2">340</td><td rowspan="2">550</td><td rowspan="2">240</td><td rowspan="2">530</td><td rowspan="2">30</td></tr>
<tr><td>22</td><td>10.5</td></tr>
<tr><td>30</td><td>375</td><td>615</td><td>275</td><td>596</td><td>40</td><td>320</td><td>550</td><td>255</td><td>240</td><td>530</td><td>25</td></tr>
<tr><td>37</td><td rowspan="2">390</td><td rowspan="2">800</td><td rowspan="2">290</td><td rowspan="2">775</td><td rowspan="2">53</td><td rowspan="3">355</td><td>615</td><td rowspan="3">270</td><td rowspan="3">275</td><td>595</td><td>32</td></tr>
<tr><td>45</td><td rowspan="2">740</td><td rowspan="3">720</td><td>42</td></tr>
<tr><td>55</td><td>540</td><td>750</td><td>270</td><td>440</td><td>720</td><td>70</td><td>43</td></tr>
<tr><td>75</td><td>850</td><td>880</td><td>-</td><td>750</td><td>855</td><td>Floor type</td><td>130</td><td>530</td><td>750</td><td>285</td><td>430</td><td>62</td></tr>
<tr><td>90</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>680</td><td>880</td><td>360</td><td>580</td><td>850</td><td>105</td></tr>
</table>

400V series

<table>
<tr><th rowspan="3">Capacity (kW)</th><th colspan="7">FRENIC5000 VG3</th><th colspan="7">FRENIC-VG</th></tr>
<tr><th colspan="3">External dimensions</th><th colspan="2">Installation dimensions</th><th rowspan="2">Mounting method</th><th rowspan="2">Rough mass (kg)</th><th colspan="3">External dimensions</th><th colspan="2">Installation dimensions</th><th rowspan="2">Mounting method</th><th rowspan="2">Rough mass (kg)</th></tr>
<tr><th>W (mm)</th><th>H (mm)</th><th>D (mm)</th><th>W1 (mm)</th><th>H1 (mm)</th><th>W (mm)</th><th>H (mm)</th><th>D (mm)</th><th>W1 (mm)</th><th>H1 (mm)</th></tr>
<tr><td>3.7</td><td rowspan="3">280</td><td rowspan="2">440</td><td rowspan="10">255</td><td rowspan="3">180</td><td rowspan="2">425</td><td rowspan="14">Wall type</td><td rowspan="2">20</td><td rowspan="3">205</td><td rowspan="3">300</td><td rowspan="7">245</td><td rowspan="3">181</td><td rowspan="3">278</td><td rowspan="18">Wall type</td><td rowspan="3">6</td></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td><td>480</td><td>465</td><td>22</td></tr>
<tr><td>11</td><td rowspan="3">320</td><td rowspan="3">520</td><td rowspan="3">220</td><td rowspan="3">500</td><td rowspan="3">27</td><td rowspan="4">250</td><td rowspan="4">400</td><td rowspan="4">226</td><td rowspan="4">378</td><td rowspan="4">10</td></tr>
<tr><td>15</td></tr>
<tr><td>18.5</td></tr>
<tr><td>22</td><td>340</td><td>550</td><td>240</td><td>530</td><td>30</td></tr>
<tr><td>30</td><td rowspan="3">375</td><td>615</td><td rowspan="3">275</td><td>596</td><td>35</td><td rowspan="2">320</td><td rowspan="2">550</td><td rowspan="2">255</td><td rowspan="2">240</td><td rowspan="2">530</td><td>25</td></tr>
<tr><td>37</td><td rowspan="2">675</td><td rowspan="2">656</td><td rowspan="2">43</td><td>26</td></tr>
<tr><td>45</td><td rowspan="3">355</td><td>615</td><td rowspan="3">270</td><td rowspan="3">275</td><td>595</td><td>31</td></tr>
<tr><td>55</td><td rowspan="4">530</td><td rowspan="3">880</td><td rowspan="3">325</td><td rowspan="4">430</td><td rowspan="3">850</td><td rowspan="2">85</td><td>675</td><td>655</td><td>33</td></tr>
<tr><td>75</td><td rowspan="3">740</td><td>720</td><td>42</td></tr>
<tr><td>90</td><td>95</td><td rowspan="4">530</td><td rowspan="2">315</td><td rowspan="4">430</td><td rowspan="2">710</td><td>62</td></tr>
<tr><td>110</td><td rowspan="4">1050</td><td>340</td><td>1020</td><td>105</td><td>64</td></tr>
<tr><td>132</td><td>680</td><td>-</td><td>580</td><td rowspan="3">1025</td><td rowspan="3">Floor type</td><td>135</td><td rowspan="4">1000</td><td rowspan="4">360</td><td rowspan="4">970</td><td>94</td></tr>
<tr><td>160</td><td rowspan="2">850</td><td>-</td><td rowspan="2">750</td><td rowspan="2">170</td><td>98</td></tr>
<tr><td>200</td><td>-</td><td rowspan="2">680</td><td rowspan="2">580</td><td>130</td></tr>
<tr><td>220</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>140</td></tr>
</table>

Larger than VG3

An adapter is required for replacement.

The control panel containing VG3 should be modified.

12.3 Terminal Size

12.3.1 Replacing VG7S

Main circuit terminal (200V series)

<table>
<tr><th></th><th colspan="5">FRENIC5000 VG7S</th><th colspan="5">FRENIC-VG</th></tr>
<tr><th></th><th colspan="5">Terminal size and arrangement</th><th colspan="5">Terminal size and arrangement</th></tr>
<tr><th>Capacity (kW)</th><th>Input
LI/R, L2/S, L3/T</th><th>DC link
DB, P1, P(+), N(-))</th><th>Output
U, V, W</th><th>GRD*
G</th><th>APS*
R0, T0</th><th>Input
LI/R, L2/S, L3/T</th><th>DC link
DB, P1, P(+), N(-)</th><th>Output
U, V, W</th><th>GRD*
G</th><th>APS*
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="10">M4</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="10">M3.5</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></tr>
<tr><td>5.5</td></tr>
<tr><td>7.5</td></tr>
<tr><td>11</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td></tr>
<tr><td>15</td></tr>
<tr><td>18.5</td></tr>
<tr><td>22</td></tr>
<tr><td></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><td>LI/R, L2/S, L3/T</td><td>DB, P1, P(+), 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 rowspan="4">M8</td><td rowspan="4">M4</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M3.5</td></tr>
<tr><td>37</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td></tr>
<tr><td>45</td></tr>
<tr><td>55</td></tr>
<tr><td></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><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 rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M12</td><td rowspan="2">M10</td><td rowspan="2">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">M3.5</td></tr>
<tr><td>90</td></tr>
</table>

*GRD: Ground
*APS: Auxiliary power supply
Replacing

Main circuit terminal (400V series)

	FRENIC5000 VG7S					FRENIC-VG				
Capacity (kW)	Terminal size and arrangement					Terminal size and arrangement				
	Input LI/R, L2/S, L3/T	DC link DB, P1, P(+), N(-))	Output U, V, W	GRD* G	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link DB, P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
3.7										
5.5	M5	M5	M5	M5		M5	M5	M5	M5	
7.5										
11					M4					M3.5
15	M6	M6	M6	M6		M6	M6	M6	M6	
18.5										
22										
	R, S, T	P1, P(+), DB, N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
30										
37	M8	M8	M8	M8		M8	M8	M8	M8	M3.5
45										
55					M4					
75										
90	M10	M10	M10	M10		M10	M10	M10	M8	M3.5
110										
	LI/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
132	M12	M12	M12	M10	M4	M12	M12	M12	M10	M3.5
160										
	LI/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0	L1/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0
200						M12	M12	M12	M10	M3.5
220										
250						-	-	-	-	-
280										
315	M12	M12	M12	M10	M4					
355						M12	M12	M12	M10	M3.5
400										
500										
630										

*GRD: Ground
*APS: Auxiliary power supply

Chap. 12 REPLACEMENT DATA

12.3.2 Replacing VG5S

Main circuit terminal (200V series)

<table>
<tr><td></td><td colspan="5">FRENIC5000 VG5S</td><td colspan="5">FRENIC-VG</td></tr>
<tr><td rowspan="2">Capacity (kW)</td><td colspan="5">Terminal size and arrangement</td><td colspan="5">Terminal size and arrangement</td></tr>
<tr><td>Input
R, S, T</td><td>DC link
P1, P(+), DB, N(-)</td><td>Output
U, V, W</td><td>GRD*
E(G)</td><td>APS*
R0, T0</td><td>Input
LI/R, L2/S, L3/T</td><td>DC link
DB, P1, P(+), N(-))</td><td>Output
U, V, W</td><td>GRD*
G</td><td>APS*
R0, T0</td></tr>
<tr><td>0.75</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="10">M4</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="6">M5</td><td rowspan="10">M3.5</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2.2</td></tr>
<tr><td>3.7</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="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td><td rowspan="4">M6</td></tr>
<tr><td>15</td><td rowspan="3">M8</td><td rowspan="3">M8</td><td rowspan="3">M8</td><td rowspan="3">M8</td></tr>
<tr><td>18.5</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>DB, P1, P(+), N(-)</td><td>U, V, W</td><td>G</td><td>R0, T0</td></tr>
<tr><td>30</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="2">M8</td><td rowspan="4">M8</td><td rowspan="4">M4</td><td>M8</td><td>M8</td><td>M8</td><td rowspan="4">M8</td><td rowspan="4">M3.5</td></tr>
<tr><td>37</td><td rowspan="3">M10</td><td rowspan="3">M10</td><td rowspan="3">M10</td></tr>
<tr><td>45</td><td rowspan="2">M10</td><td rowspan="2">M10</td><td rowspan="2">M10</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 rowspan="2">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">M3.5</td></tr>
<tr><td>90</td><td>M12</td><td>M12</td><td>M12</td><td>M10</td></tr>
</table>

*GRD: Ground

*APS: Auxiliary power supply

Main circuit terminal (400V series)

	FRENIC5000 VG5S					FRENIC-VG				
	Terminal size and arrangement					Terminal size and arrangement				
Capacity (kW)	Input R, S, T	DC link P1, P(+), DB, N(-)	Output U, V, W	GRD* E(G)	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link DB, P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
3.7	M5	M5	M5	M5	M4	M5	M5	M5	M5	M3.5
5.5										
7.5										
11	M6	M6	M6	M6		M6	M6	M6	M6	
15										
18.5	M8	M8	M8	M8						
22										
	R, S, T	P1, P(+), DB, N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M3.5
37										
45										
55										
	R, S, T	DB, P1, P(+), N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
75	M10	M10	M10	M8	M4	M10	M10	M10	M8	M3.5
90		M10 (No DB terminal)								
110										
132						M12	M12	M12	M10	
160	M12	M12 (No DB terminal)	M12	M10						
	R, S, T	P1, P(+), N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	P1, P(+), N(-)	U, V, W	G	R0, T0
200	M12	M12	M12	M10	M4	M12	M12	M12	M10	M3.5
220										

*GRD: Ground

*APS: Auxiliary power supply

Control circuit terminal (Common to 200V series and 400V series)

FRENIC5000 VG5S	FRENIC-VG
Common to all capacities M3	Common to all capacities M3

12.3.3 Replacing VG3

Main circuit terminal (200V series)

	FRENIC5000 VG3					FRENIC-VG				
	Terminal size and arrangement					Terminal size and arrangement				
Capacity (kW)	Input R, S, T	Output U, V, W	DC link DB, P	GRD* E(G)	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link DB, P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
0.75	M5	M5	M5	M5	M4	M5	M5	M5	M5	M3.5
1.5										
2.2										
3.7										
5.5										
7.5										
11	M6	M6	M6	M6		M6	M6	M6	M6	
15	M8	M8	M8							
18.5										
22	R, S, T	U, V, W	DB, P1, P	E(G)	R0, T0					
	M8	M8	M8	M6	M4	M6	M6	M6	M6	M3.5
	R, S, T	U, V, W	DB, P1, P	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M3.5
37	M10	M10	M10			M10	M10	M10		
45										
55										
	Input/Output R, U, S, V, T, W		DC link N, P1, P	GRD* E(G)	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
75	M12	M12	M12	M10	M4	M12	M12	M12	M10	M3.5
90										

*GRD: Ground

*APS: Auxiliary power supply

Main circuit terminal (400V series)

Capacity (kW)	FRENIC5000 VG3 Terminal size and arrangement					FRENIC-VG Terminal size and arrangement				
	Input R, S, T	Output U, V, W	DC link DB, P	GRD* E(G)	APS* R0, T0	Input L1/R, L2/S, L3/T	DC link DB, P1, P(+), N(-)	Output U, V, W	GRD* G	APS* R0, T0
3.7	M4	M4	M4	M4	M4	M5	M5	M5	M5	M3.5
5.5										
7.5	M5	M5	M5	M5						
11						M6	M6	M6	M6	
15	M6	M6	M6	M6						
18.5										
	R, S, T	U, V, W	DB, P1, P	E(G)	R0, T0					
22	M6	M6	M6	M6	M4	M6	M6	M6	M6	M3.5
	R, S, T	P1, P(+), DB, N(-)	U, V, W	E(G)	R0, T0	L1/R, L2/S, L3/T	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
30	M8	M8	M8	M8	M4	M8	M8	M8	M8	M3.5
37										
45										
55	M10	M10	M10							
75						M10	M10	M10		
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	DB, P1, P(+), N(-)	U, V, W	G	R0, T0
132	M12		M12	M10	M4	M12	M12	M12	M10	M3.5
160										
200							M12 (No DB terminal)			
220	-	-		-	-					

*GRD: Ground

*APS: Auxiliary power supply

Control circuit terminal (Common to 200V series and 400V series)

FRENIC5000 VG3	FRENIC-VG
Common to all capacities M3	Common to all capacities M3

Chap. 12 REPLACEMENT DATA

12.4 Terminal Symbols

12.4.1 Replacing VG7S

Since the terminal symbols for FRENIC-VG are the same as those for VG7S (excepting for I/O of RS-485 communications), the same connections as the terminal connections of VG7S are available.

Category	FRENIC5000 VG7S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Communications	RX(+), RX(-), TX(+), TX(-), SD	I/O of RS-485 communications (Dedicated connector)	DX(+), DX(-)	I/O of RS-485 communications

12.4.2 Replacing VG5S

Category	FRENIC5000 VG5S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	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 command (before limit)	[T-REF]	Torque command (before limit)
	[ATCS]	Torque current command	[IT-REF]	Torque current command
	[AJSS1]	Creep speed 1	[CRP-N1]	Creep speed 1
	[AJSS2]	Creep speed 2	[CRP-N2]	Creep speed 2
	[AFLUX]	Magnetic-flux command	[MF-REF]	Magnetic-flux command
	[ASFB]	Speed feedback	[LINE-N]	Line speed detection
	[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 X2 X3 X4 X5	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5	X1 X2 X3 X4 X5 X6 X7 X8 X9	Digital input 1 Digital input 2 Digital input 3 Digital input 4 Digital input 5 Digital input 6 Digital input 7 Digital input 8 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

Category	FRENIC5000 VG5S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Digital input	[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 command cancel
	[CSTC]	Speed control/Torque limiter switch	[H41-CCL]	H41[torque command] cancel
	[CTL]	Torque limiter	[F40-CCl]	F40 [torque limiter mode] cancel
	[CADT]	ACC/DEC time selection	[RT1][RT2]	ASR, ACC/DEC selection
	[CADB]	ACC/DEC time bypass	[BPS]	Bypass
	[CTB1]	Torque bias command 1	[TB1]	Torque bias command 1
	[CTB2]	Torque bias command 2	[TB2]	Torque bias command 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 command]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 setting 2 (before ACC/DEC calculation)
	[BSR1]	Speed setting 1	[N-REF4]	Speed setting 4 (ASR input)
	[BSR2]	Speed setting 2	[N-REF4]	Speed setting 4 (ASR input)
	[BSR]	Speed setting	[N-REF4]	Speed setting 4 (ASR input)
	[BSFB]	Speed feedback	[N-FB2±]	Speed detection (ASR input)
	[BTC1]	Torque ammeter (two-way deflection)	[IT-REF±]	Torque current command (torque ammeter, two-way deflection)
	[BTC2]	Torque ammeter (one-way deflection)	[IT-REF+]	Torque current command (torque ammeter, one-way deflection)
	[BTM1]	Torque meter (two-way deflection)	[T-REF±]	Torque command (torque meter, two-way deflection)
	[BTM2]	Torque meter (one-way deflection)	[T-REF+]	Torque command (torque meter, one-way deflection)
	[BTR]	Torque command output	[T-REF±]	Torque command (torque meter, two-way deflection)
	[BMC]	Effective detected value of motor current	[I-AC]	Motor current

Category	FRENIC5000 VG5S		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Analog output	[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-AG1]	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
	[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	CMY	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
Communication	DXA, DXB	RS-485 communication input/output	DX(+),DX(-)	RS-485 communication input/output
Speed detection	PA, PB	Encoder A- and B-phase signals	PA, PB	Pulse generator 2-phase signal inputs
	PGP, PGM	Encoder power supply	PGP, PGM	Pulse generator power supply
	FA, FB	Encoder A- and B-phase outputs	FA, FB	Pulse generator outputs
	CM	Common to encoder outputs	CM	Common to pulse generator outputs
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)	–	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)	–	

12.4.3 Replacing VG3

Category	FRENIC5000 VG3		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	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 an external braking resistor	P(+), DB	Connects an external braking 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 condenser	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 command value 1	[TL-REF1]	Torque limiter (level 1)
	[ATL2]	Torque limiter value 2 / Torque bias command value 2	[TL-REF2]	Torque limiter (level 2)
	[ATL3]	Torque limiter value 3 / Torque bias command value 3	–	–
	[ATL4]	Torque limiter value 4	–	–
	[ATIN]	Torque command input	[T-REF]	Torque command (before limit)
	[ATR]	Torque command		
	[AFAI]	Magnetic-flux command input	[MF-REF]	Magnetic-flux command
	[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	Digital input 1	X1	Digital input 1
	X2	Digital input 2	X2	Digital input 2
	X3	Digital input 3	X3	Digital input 3
	X4	Digital input 4	X4	Digital input 4
	X5	Digital input 5	X5	Digital input 5
			X6	Digital input 6
			X7	Digital input 7
			X8	Digital input 8
			X9	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

Category	FRENIC5000 VG3		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
Digital input	[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 command] cancel
	[CDRP]	Droop function	[DROOP]	Droop selection
	[CTL]	Torque limiter	[F40-CCL]	F40 (Torque limiter mode) cancel
	[CTB1]	Torque bias command 1	[TB1]	Torque bias command 1
	[CTB2]	Torque bias command 2	[TB2]	Torque bias command 2
	[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 command output 0	[T-REF±]	Torque meter two-way deflection
	[BT1]	Torque command output 1	[T-REF±]	Torque meter two-way deflection
	[BIT]	Torque current command	[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 command output absolute value	[T-REF+]	Torque meter one-way deflection
	[BITAB]	Torque current command 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 command (torque ammeter two-way deflection)
			[IT-REF+]	Torque current command (torque ammeter one-way deflection)
			[T-REF±]	Torque command (torque meter two-way deflection)
			[T-REF+]	Torque command (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

Category	FRENIC5000 VG3		FRENIC-VG	
	Terminal symbol	Terminal name	Terminal symbol	Terminal name
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
Transistor output	[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	CMY	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
	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 encoder phase signals	PA, PB	Pulse generator 2-phase signal inputs
	PGP, PGM	Pulse encoder 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
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)	–	

12.5 Function Codes

12.5.1 Replacing VG7S

Since the FRENIC-VG's function codes are compatible with the VG7S's ones, the function code values for the VG7S can apply to the same function codes of the FRENIC-VG.

Function codes newly added to the FRENIC-VG are VG7S compatible by default, so no setting modification is required. Note that the functions listed below are assigned to different function codes.

■ 3rd motor parameters exclusive to V/f control

(For the function code settings, refer to Chapter 4.)

FRENIC5000 VG7S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
-	-	A101	M3 control system **(*1)**
A35	M3 motor rated capacity	A102	M3 motor rated capacity
A36	M3 motor rated current	A103	M3 motor rated current
A37	M3 rated voltage	A104	M3 rated voltage
A38	M3 highest output voltage	A153	M3 highest output voltage
A39	M3 rated speed	A105	M3 rated speed
A40	M3 maximum speed	A106	M3 maximum speed
A41	M3 motor pole	A107	M3 motor pole
A42	M3 %R1	A108	M3 %R1
A43	M3 %X	A109	M3 %X
A44	M3 exciting current	A110	M3 exciting current
A45	M3 slip compensation amount	A154	M3 slip compensation amount
A46	M3 torque boost (*2)	A155	M3 torque boost **(*2)**
A47	M3 thermistor selection	A131	M3 thermistor selection
A48	M3 electronic thermal (operation selection)	A132	M3 electronic thermal (operation selection)
A49	M3 electronic thermal (operation level)	A133	M3 electronic thermal (operation level)
A50	M3 electronic thermal (thermal time constant)	A134	M3 electronic thermal (thermal time constant)

(*1) The V/f control is performed when the function code A101 is set to "5."

(*2) When the inverter capacity is 22 kW or less with the torque boos set to 2.0 to 20.0, make the settings according to the conversion table below.

Torque boost conversion table (22 kW or below)

FRENIC5000 VG7S A46	FRENIC-VG P35, A55, A155	Remarks
2.0	2.0	Use the following expression for conversion. * Expression When the A46 data of VG7S is 2.0 to 20.0, VG setting (P35, A55, A155) = (100 x [A46 data of VG7S] + 200) ÷ 200 The boost amount is calculated by the following expression. ・ VG7S boost amount (%) Boost amount (%) = (10% ÷ (20.2 - 2.0)) x ([A46] - 2.0) ・ VG boost amount (%) Boost amount (%) = (20% ÷ (20.2 - 2.0)) x ([P35] - 2.0) *100% / rated voltage
4.0	3.0	
6.0	4.0	
8.0	5.0	
10.0	6.0	
12.0	7.0	
14.0	8.0	
16.0	9.0	
18.0	10.0	
20.0 (Equivalent to 10% of rated voltage)	11.0 (Equivalent to 10% of rated voltage)	

■ ASR1-I (Integral constant)

The definition for the ASR-P control (Integration cancel) differs as shown below.

FRENIC5000 VG7S		FRENIC-VG	
Function code	Data setting range	Function code	Data setting range
F62	0.000 to 1.000 s When F62 = 1.000, P control is enabled.	F62	0.000 to 10.000 s When F62 = 0.000, P control is enabled.

■ M1 magnetic pole position offset (exclusive to PMSM)

The definition of function code o10 (M1 magnetic pole position offset) differs as shown below.

Convert the offset, referring to the example given below.

Conversion example

When VG7S function code o10 = 3A7Fh

① From hexadecimal to decimal form: 3A7F (hex.) → 14975 (decimal)

② Conversion for FRENIC-VG: 360° x 14975/65535 = 82.3° (Rounded to one decimal place)

FRENIC5000 VG7S		FRENIC-VG	
Function code	Data setting range	Function code	Data setting range
o10	0000 to FFFF (0° to 360°, CCW)	o10	0.0 to 359.9 (Unit: degree (°), CCW)

■ Multiplex system station address setting

While the VG7S uses the hardware switch (SW1) provided on the option card OPC-VG7-SI to set the multiplex system station address, the FRENIC-VG uses function code o50 as shown below.

FRENIC5000 VG7S		FRENIC-VG	
Station address setting	Data setting range	Station address setting	Data setting range
OPC-VG7-SI SW1	0: Master 1 to 5: Slave 6 to 9: Disable	Function code o50	0: Master 1 to 5: Slave

■ PG wire break alarm activation

The FRENIC-VG causes an alarm PG if the PG power wire breaks. When an isolated signal conditioner is used in the PG wiring, disable the alarm activation function. (Refer to Chapter 8, Section 8.7 "PG Amplifier (Isolated signal conditioner).")

FRENIC5000 VG7S		FRENIC-VG	
Activation	Data setting range	Activation	Data setting range
–	–	Function code H104: thousand's digit	0: Disable 1: Enable

■ M1-M3 PTC Activation Level

The PTC detection internal circuit of the FRENIC-VG differs from that of the VG7S; therefore, the definition of function code E32 (M1-M3 PTC activation level) also differs.

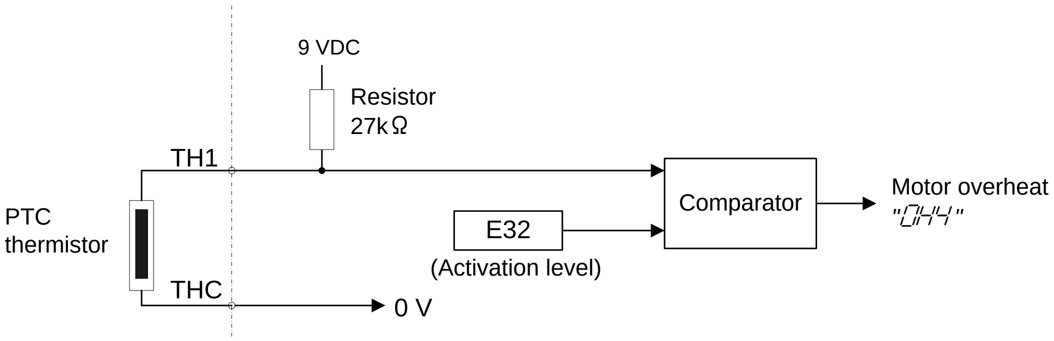
To connect the PTC used in the VG7S to the FRENIC-VG, convert the activation level, referring to the example given below.

<u>Conversion example</u>

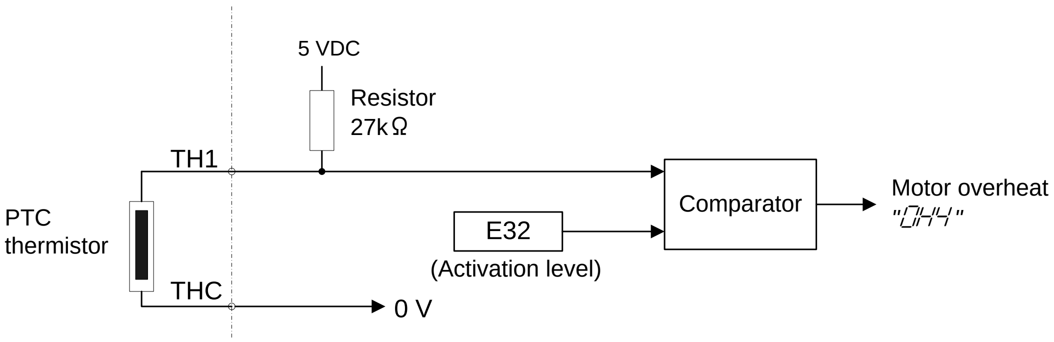
When VG7S function code E32 = 3.00 (V)

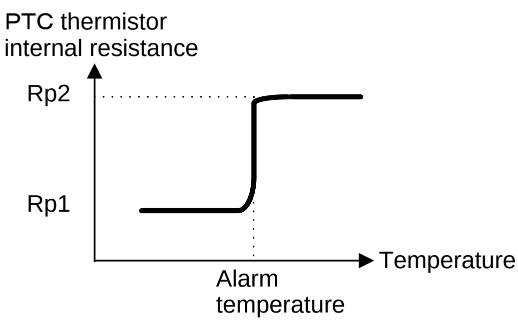
Conversion for FRENIC-VG: 3.00 x 5/9 = 1.68 (Rounded to two decimal places)

FRENIC5000 VG7S Activation Level (Voltage)
Activation level (V) = 9V/(Rp + 27000) x Rp



FRENIC-VG Activation Level (Voltage)
Activation level (V) = 5V/(Rp + 27000) x Rp





Set Rp under the following condition.

Rp1 < Rp < Rp2

To determine Rp easily, use the following expression.

Rp (Ω) = (Rp1 + Rp2)/2

12.5.2 Replacing VG5S

FRENIC5000 VG5S		FRENIC-VG	
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	C48, C49	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 (Level 1)	F47	Torque bias T1
41	(Level 2)	F48	Torque bias T2
42	Selection between torque control and torque current control (Select)	H41, H42	Torque command and torque current command selection
43	Magnetic-flux command (Select)	H43	Magnetic-flux command selection
44	Magnetic-flux command 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

FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
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
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)
88	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 command monitor	F51	Torque command 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

FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
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)	F18	Bias (Speed setting signal 12)
121	(Ai1)	E57	Ai1 bias setting
122	(Ai2)	E58	Ai2 bias setting
123	Gain setting (12)	F17	Gain (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)
143	Speed command through transmission	S01	Speed command
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 RS-485 address	H31	RS-485 (Station address)
147	Action on RS-485 error (Mode)	H32	Action on RS-485 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	Command pulse correction 1	o14	Command pulse correction 1
158	Command pulse correction 2	o15	Command 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 (*1)	P02	M1 motor selection
172	PG pulse number	P28	M1-PG pulse number
173	NTC thermistor selection	P30	M1 thermistor selection

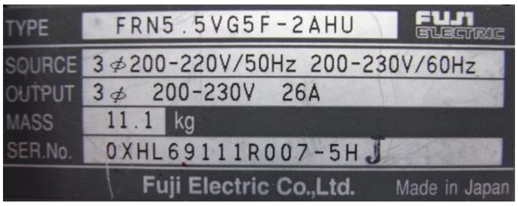
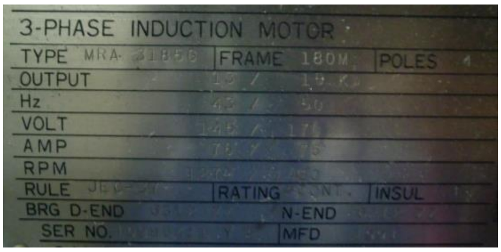
FRENIC5000 VG5S		FRENIC-VG	
Function Codes	Name	Function Codes	Name
174	Motor ratings (Capacity)	P03	M1 rated capacity
175	(Voltage)	F05	M1 rated voltage
176	(Current)	P04	M1 rated current
177	(Base speed)	F04	M1 rated speed
178	(No. of pole)	P05	M1 number of pole
179	Overload capability	–	
180	Auto-tuning of motor characteristic	–	
181	(Protection) (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

(*1) If "other" is specified in VG5 motor selection [171], calculate with the following formula.

VG1 Function Codes	Name	Conversion formula
P06	M1-%R1	・ For 200V system [182] × 135 ÷ [175] × √3 ・ For 400V system [182] × 270 ÷ [175] × √3
P07	M1-%X	・ For 200 V system [183] × 135 ÷ [175] × √3 × fbase ÷ 50 (fbase = [177] × [178] ÷ 120) ・ For 400 V system [183] × 270 ÷ [175] × √3 × fbase ÷ 50 (fbase = [177] × [178] ÷ 120)
P08	M1 exciting current	[184] ÷ √2
P09	M1 torque current	[185] ÷ √2
P21	M1 inductive voltage	[197] × fbase ÷ 50 × √3 ÷ √2 (fbase = [177] × [178] ÷ 120)

Function codes for VG5 are put in brackets.

(*2) If the inverter is broken, and the motor constant cannot be confirmed, notify our sales office of the following contents.

	Item	Details
Inverter	▪ TYPE ▪ SER. No.	Notify us of the descriptive contents of the name plate. 
	ROM No	ROM seal are affixed to the CUP board of the control PCB. 
	・ System code (VG5□-□□□□-□□) 2 digits at the end = 00 (standard item) 01 to 99 (special item)	The system code seal is affixed to the back face of the control terminal block. (See the photo below) 
Motor	▪ Product model (TYPE) ▪ Number of poles (POLES) ▪ Capacity (OUTPUT) ▪ Frequency (Hz) ▪ Voltage (VOLT) ▪ Current (AMP) ▪ Number of revolutions (RPM) ▪ Production No. (SER No.)	Notify us of the descriptive contents of the name plate. 
	Outline drawing	

12.5.3 Replacing VG3

FRENIC5000 VG3		FRENIC-VG	
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 F68 F69 F70	S-curve acceleration start side 1 S-curve acceleration end side 1 S-curve deceleration start side 1 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)	C40	ASR2 P
25	ASR I (2)	C41	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 command value 1	F44	Torque limiter value (Level 1)
2B	Torque limiter value 2/Torque bias command value 2	F45	Torque limiter value (Level 2)
2C	Torque limiter value 3/Torque bias command value 3	–	
2D	Torque limiter value 4	–	
2E	Magnetic-flux command level	H44	Magnetic-flux command value
2F	Magnetic-flux command level at light load	F73	Magnetic-flux level at light load
30	Zero speed detection level	F37	Stop speed
31	Arbitrary speed detection level	E39	Speed detection level 1

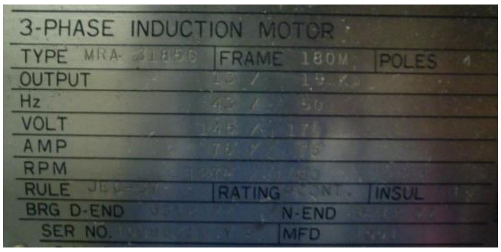
FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
	(Absolute value)		
32	Arbitrary speed detection level (With polarity)	E40	Speed detection level 2
33	Speed equivalence detection level	E42	Speed equivalence
34	Speed agreement detection level	E43	Speed agreement
35	Torque detection level	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.
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)

FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
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 (Level 1) selection
62	Definition of the torque limiter value 2/Torque bias reference value 2.	F43	Torque limiter value (Level 2) 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 command 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 E04	X1 to X4 function selection
73	DI definition (X5)	E05	X5 function selection
74	DO definition (Y1 to Y5)	E15 to E18	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, E71	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, o04	DI BCD input setting.
81	Definition of the initial setting value of UP/DOWN setter.	F01, C25	Speed setting N1, N2
82	Enabled/disabled of transmission data	H30	Serial link
83	Transmission ID code	–	
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	–	
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 command

FRENIC5000 VG3		FRENIC-VG	
Function Codes	Name	Function Codes	Name
93	Transmission speed setting bias	–	
94	Transmission torque command mode selection	H41	Torque command selection
95	Transmission torque command	S02	Torque command
96	General purpose DO	S07	Universal DO
97	Trace data mode	–	
98, 99			
9A	Confirmation of data saving condition	–	
9B	ALL SAVE function	H02	All save
For manufacturer	Motor constant setting value (non-disclosure)	P01 to P30	Motor code (*1)

(*1) Using "Excepting V63 standard motor" requires the confirmation of the motor constant.

Notify our sales office of the following contents.

	Item	Details
Inverter	・ TYPE ・ SER. No.	Notify us of the descriptive contents of the name plate. 
	ROM No	ROM seal are affixed to the IC2 and IC3 of the control PCB. 
	・ System code (VG3□-□□□□-□□) 2 digits at the end = 00 (standard item) 01 to 99 (special item)	The system code seal is affixed to the back face of the control terminal block. (See the photo below) 
Motor	▪ Product model (TYPE) ▪ Number of poles (POLES) ▪ Capacity (OUTPUT) ▪ Frequency (Hz) ▪ Voltage (VOLT) ▪ Current (AMP) ▪ Number of revolutions (RPM) ▪ Production No. (SER No.)	Notify us of the descriptive contents of the name plate. 
	Outline drawing	

Chap. 12 REPLACEMENT DATA

12.6 Motor Parameters

12.6.1 Replacing VG7S

200V series

Motor specification			VG7S code No. / FRENIC-VG code No.			Motor parameters																										
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	H51
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.)[r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.	Load inertia
MVK6096 MVK6095A	0.75	4	1500/3600	188	4.3	1500	1500	188	0.75	4.3	4	4.34	9.07	3.21	2.92	1.320	1.185	7.60	7.60	10.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000	0.009
MVK6097 MVK8097A	1.5	4	1500/3600	188	7.0	1500	1500	188	1.5	7.0	4	7.06	14.76	3.21	5.83	2.640	2.370	3.80	3.80	5.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000	0.009
MVK6107 MVK8107A	2.2	4	1500/3600	188	11	1500	1500	188	2.2	11	4	8.27	12.95	3.81	9.75	2.622	3.059	3.00	4.00	1.00	85.2	73.7	59.1	47.6	37.4	0.051	140	2.530	1.133	1.000	0.000	0.009
MVK6115 MVK8115A	3.7	4	1500/3600	188	18	1500	1500	188	3.7	18	4	6.86	12.69	8.11	15.69	2.500	2.370	3.00	2.95	2.50	88.4	80.1	66.4	54.1	43.0	0.084	146	0.899	1.320	1.000	0.022	0.016
MVK6133 MVK8133A	5.5	4	1500/3600	188	30	1500	1500	188	5.5	30	4	6.05	13.44	12.98	21.92	1.490	1.440	3.00	2.50	3.00	88.3	79.5	66.0	54.1	43.0	0.090	149	1.925	1.985	1.000	0.026	0.030
MVK6135 MVK8135A	7.5	4	1500/3600	188	37	1500	1500	188	7.5	37	4	6.70	12.45	15.62	30.66	1.771	1.871	2.32	1.76	3.00	85.3	70.7	53.8	43.7	34.4	0.070	155	0.900	0.900	1.000	0.000	0.038
MVK6165 MVK8165A	11	4	1500/3600	188	50	1500	1500	188	11	50	4	4.26	11.64	24.79	40.30	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	175	0.900	2.343	1.000	0.000	0.085
MVK6167 MVK8167A	15	4	1500/3600	188	65	1500	1500	188	15	65	4	4.47	12.25	26.99	53.96	1.067	1.067	0.00	1.50	1.00	88.7	80.7	67.2	55.2	44.0	0.133	160	1.689	1.689	1.000	0.000	0.120
MVK6184 MVK8184A	18.5	4	1500/3600	188	74	1500	1500	188	18.5	74	4	3.22	10.68	30.58	72.83	0.934	0.931	3.50	0.50	0.50	90.7	83.2	69.5	56.8	44.4	0.240	160	1.465	1.803	1.000	0.097	0.210
MVK6185 MVK8185A	22	4	1500/3600	188	90	1500	1500	188	22	90	4	3.59	11.78	34.17	83.43	0.606	0.855	1.30	0.77	2.00	91.1	83.2	69.1	56.8	44.6	0.387	160	4.000	2.200	1.000	0.089	0.230
MVK6206	30	4	1500/3000	188	116	1500	1500	188	30	116	4	2.53	12.13	53.42	108.1	0.606	0.648	2.50	3.50	5.00	84.4	74.0	59.5	48.9	38.0	0.173	166	2.268	2.078	1.000	0.000	0.340
MVK8187A	30	4	1500/3000	188	116	1500	1500	188	30	116	4	2.43	12.32	39.95	106.0	0.915	1.015	3.00	0.00	0.00	88.2	81.9	70.1	58.4	46.7	0.385	166	1.818	1.737	1.000	0.000	0.340
MVK6207 MVK8207A	37	4	1500/3000	188	143	1500	1500	188	37	143	4	2.47	14.69	60.09	133.2	0.497	0.536	1.80	3.00	5.00	85.4	75.7	62.3	50.5	39.9	0.184	168	3.200	2.560	1.000	0.180	0.410
MVK6208 MVK8208A	45	4	1500/3000	188	170	1500	1500	188	45	170	4	2.73	15.26	56.71	169.7	0.947	0.901	1.00	0.00	0.15	89.2	81.6	67.6	56.2	43.4	0.295	164	1.229	1.813	1.000	0.178	0.470
MVK9250	55	4	1500/2400	185	216	1500	1500	185	55	216	4	2.08	12.36	66.22	197.9	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	168	1.615	1.753	1.000	0.000	0.800
MVK9224A	55	4	1500/2400	180	225	1500	1500	180	55	225	4	2.04	14.42	72.66	202.3	0.742	0.742	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.544	167	1.000	1.000	1.000	0.000	0.530
MVK9252	75	4	1500/2400	183	276	1500	1500	183	75	276	4	1.70	15.29	99.34	261.6	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	165	1.856	1.785	1.000	0.091	0.950
MVK9254A	75	4	1500/2400	183	299	1500	1500	183	75	299	4	2.00	16.41	89.26	272.1	0.597	0.647	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.555	163	1.849	1.784	1.000	0.000	0.880
MVK9280	90	4	1500/2000	183	345	1500	1500	183	90	345	4	2.28	20.12	89.3	332.3	0.669	0.546	0.00	5.00	0.00	91.1	85.1	70.9	59.2	48.7	0.490	181	1.331	1.428	1.000	0.000	1.370
MVK9256A	90	4	1500/2000	185	362	1500	1500	185	90	362	4	1.72	14.10	124.40	321.7	0.680	0.680	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.549	172	1.000	1.000	1.000	0.000	1.030

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series (1)

Motor specification			VG7S code No. / FRENIC-VG code No.			Motor parameters																										
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	H51
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.	Load inertia
MVK6115 M8115A	3.7	4	1500/3600	376	9	1500	1500	376	3.7	9	4	6.86	13.94	3.93	7.78	2.510	2.340	2.35	2.55	1.20	90.5	82.4	68.7	57.0	45.3	0.104	294	0.880	1.440	1.000	0.028	0.016
MVK6133 MVK8133A	5.5	4	1500/3600	376	15	1500	1500	376	5.5	15	4	5.50	12.78	7.15	10.74	1.311	1.370	2.00	5.00	7.00	88.0	79.2	65.6	53.6	42.2	0.078	299	2.361	1.985	1.000	0.019	0.030
MVK6135 MVK8135A	7.5	4	1500/3600	376	18.5	1500	1500	376	7.5	18.5	4	4.37	13.72	7.81	15.33	1.465	1.686	7.61	2.00	1.00	85.9	76.9	63.4	51.6	40.5	0.064	310	1.607	1.427	1.000	0.000	0.037
MVK6165 MVK8165A	11	4	1500/3600	376	25.0	1500	1500	376	11	25	4	4.27	11.67	12.39	20.15	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	348	0.910	2.343	1.000	0.000	0.085
MVK6167 MVK8167A	15	4	1500/3600	376	31.7	1500	1500	376	15	31.7	4	4.48	13.69	14.47	28.63	1.290	1.269	1.00	0.50	1.00	88.7	81.7	67.2	55.2	44.0	0.133	306	1.090	1.318	1.000	0.027	0.110
MVK6184 MVK8184A	18.5	4	1500/3600	376	37	1500	1500	376	18.5	37	4	2.66	12.45	14.02	36.06	0.882	0.882	1.00	3.00	3.00	92.5	84.3	70.3	57.1	45.1	0.295	321	1.825	1.825	1.000	0.018	0.210
MVK6185 MVK8185A	22	4	1500/3600	376	45	1500	1500	376	22	45	4	3.61	14.06	16.81	41.72	0.903	0.891	1.50	1.50	3.00	91.1	83.2	69.1	56.5	44.6	0.387	320	1.357	1.673	1.000	0.037	0.230
MVK6206	30	4	1500/3000	376	58	1500	1500	376	30	58	4	2.55	12.16	25.74	52.52	0.666	0.648	2.50	3.50	9.50	84.4	74.0	59.5	48.9	38.0	0.173	331	2.268	2.078	1.000	0.070	0.340
MVK8187A	30	4	1500/3000	376	58	1500	1500	376	30	58	4	2.43	12.32	19.97	53.0	0.915	1.015	3.00	0.00	0.00	88.2	81.9	70.1	58.4	46.7	0.385	332	1.818	1.737	1.000	0.000	0.340
MVK6207 MVK8207A	37	4	1500/3000	376	71	1500	1500	376	37	71	4	2.49	14.11	30.07	65.54	0.497	0.498	1.79	1.80	5.00	85.4	75.7	62.3	50.5	39.9	0.184	336	3.200	3.064	1.000	0.095	0.410
MVK6208 MVK8208A	45	4	1500/3000	376	85	1500	1500	376	45	85	4	2.73	15.30	28.36	84.85	0.947	0.937	0.50	1.50	1.85	89.2	81.6	67.6	56.2	43.4	0.295	328	1.229	1.502	1.000	0.089	0.470
MVK9250	55	4	1500/2400	376	108	1500	1500	376	55	108	4	2.05	12.20	33.11	98.98	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	336	1.615	1.753	1.000	0.000	0.800
MVK9224A	55	4	1500/2400	365	111	1500	1500	365	55	111	4	1.99	13.96	37.76	99.0	0.721	0.721	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.531	339	1.000	1.000	1.000	0.000	0.530
MVK9252	75	4	1500/2400	365	138	1500	1500	365	75	138	4	1.71	15.39	49.67	130.8	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	330	1.856	1.785	1.000	0.091	0.950
MVK9254A	75	4	1500/2400	365	149	1500	1500	365	75	149	4	1.77	16.39	44.04	135.0	0.714	0.714	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.627	339	1.000	1.000	1.000	0.000	0.880
MVK9280	90	4	1500/2000	370	173	1500	1500	370	90	173	4	2.23	18.47	44.37	164.1	0.685	0.647	0.00	2.00	0.00	90.7	83.7	69.0	57.1	44.9	0.590	348	1.093	1.212	1.000	0.163	1.370
MVK9256A	90	4	1500/2000	370	179	1500	1500	370	90	179	4	1.51	13.93	62.28	159.2	0.600	0.600	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.621	345	1.000	1.000	1.000	0.000	1.030
MVK9282	110	4	1500/3000	375	206	1500	1500	375	110	206	4	2.14	16.83	53.03	195.8	0.557	0.606	0.44	0.00	0.00	90.1	82.6	67.7	56.3	44.2	0.577	350	1.488	1.172	1.000	0.090	1.600
MVK9284A	110	4	1500/2000	370	212	1500	1500	370	110	212	4	1.66	15.39	59.73	192.9	0.579	0.579	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.824	346	1.000	1.000	1.000	0.000	1.540
MVK9310	132	4	1500/3000	375	248	1500	1500	375	132	248	4	1.56	17.21	62.05	237.3	0.481	0.531	0.00	0.39	0.00	90.1	81.2	67.7	56.2	45.9	0.689	336	1.468	1.424	1.000	0.000	2.680
MVK9286A	132	4	1500/2000	375	247	1500	1500	375	132	247	4	1.57	15.65	68.05	237.4	0.592	0.592	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.876	351	1.000	1.000	1.000	0.000	1.770

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series (2)

Motor specification			VG7S code No. / FRENIC-VG code No.			Motor parameters F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	H51
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.	Load inertia
MVK9312	160	4	1500/2400	375	297	1500	1500	375	160	297	4	1.15	17.47	70.71	286.3	0.518	0.518	0.00	0.00	0.00	91.0	84.3	71.8	59.1	47.7	1.127	330	1.496	1.496	1.000	0.000	3.220
MVK931LA	160	4	1500/2000	375	297	1500	1500	375	160	297	4	1.36	16.71	76.07	287.2	0.594	0.594	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.948	351	1.000	1.000	1.000	0.000	2.970
MVK528KA	160	4	1500/2000	370	300	1500	1500	370	160	300	4	1.35	18.03	71.69	284.7	0.640	0.640	2.26	0.00	0.00	93.8	87.5	75.0	62.5	50.0	0.906	340	1.000	1.000	1.000	0.000	1.720
MVK9316	200	4	1500/2400	375	369	1500	1500	375	200	369	4	1.15	14.98	107.7	341.5	0.470	0.441	0.00	2.50	0.00	93.8	87.6	74.8	60.6	48.2	1.026	342	1.175	1.358	1.000	0.104	3.900
MVK931MA	200	4	1500/2000	375	376	1500	1500	375	200	376	4	1.17	13.73	121.00	357.0	0.492	0.492	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.894	353	1.000	1.000	1.000	0.000	3.290
MVK528LA	200	4	1500/2000	375	375	1500	1500	375	200	375	4	1.27	16.82	106.1	351.8	0.615	0.615	2.20	0.00	0.00	93.7	87.5	75.0	62.5	50.0	0.785	343	1.000	1.000	1.000	0.000	1.830
MVK9318	220	4	1500/2000	370	409	1500	1500	370	220	409	4	1.63	14.54	98.64	385.3	0.447	0.458	1.00	1.00	0.00	95.1	88.5	75.0	63.1	51.3	1.758	361	1.535	1.513	1.000	0.078	4.260
MVK931NA	220	4	1500/2000	380	409	1500	1500	380	220	409	4	1.05	13.27	130.40	388.2	0.473	0.473	3.00	0.00	0.00	89.3	83.3	71.4	59.5	47.6	0.935	359	1.000	1.000	1.000	0.000	3.660
MVK531FA	220	4	1500/2000	375	415	1500	1500	375	220	415	4	1.08	14.90	135.0	383.0	0.508	0.508	2.41	0.00	0.00	93.7	87.5	75.0	62.5	50.0	0.820	344	1.000	1.000	1.000	0.000	2.330

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

12.6.2 Replacing VG5S

200V series

Motor specification						Motor parameters																									
			VG5S code No.			03	177	175	174	176	178	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	C03	C04	-	C14
			FRENIC-VG code No.			F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6096	0.75	4	1500/3600	188	4.3	1500	1500	188	0.75	4.3	4	4.34	9.07	3.21	2.92	1.320	1.185	7.60	7.60	10.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000
MVK6097	1.5	4	1500/3600	188	7.0	1500	1500	188	1.5	7.0	4	7.06	14.76	3.21	5.83	2.640	2.370	3.80	3.80	5.00	93.0	85.8	72.6	60.0	47.6	0.108	149	1.360	1.480	1.000	0.000
MVK6107	2.2	4	1500/3600	188	11	1500	1500	188	2.2	11	4	8.27	12.95	3.81	9.75	2.622	3.059	3.00	4.00	1.00	85.2	73.7	59.1	47.6	37.4	0.051	140	2.530	1.133	1.000	0.000
MVK6115	3.7	4	1500/3600	188	18	1500	1500	188	3.7	18	4	6.86	12.69	8.11	15.69	2.500	2.370	3.00	2.95	2.50	88.4	80.1	66.4	54.1	43.0	0.084	146	0.899	1.320	1.000	0.022
MVK6133	5.5	4	1500/3600	188	30	1500	1500	188	5.5	30	4	6.05	13.44	12.98	21.92	1.490	1.440	3.00	2.50	3.00	88.3	79.5	66.0	54.1	43.0	0.090	149	1.925	1.985	1.000	0.026
MVK6135	7.5	4	1500/3600	188	37	1500	1500	188	7.5	37	4	6.70	12.45	15.62	30.66	1.771	1.871	2.32	1.76	3.00	85.3	70.7	53.8	43.7	34.4	0.070	155	0.900	0.900	1.000	0.000
MVK6165	11	4	1500/3600	188	50	1500	1500	188	11	50	4	4.26	11.64	24.79	40.30	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	175	0.900	2.343	1.000	0.000
MVK6167	15	4	1500/3600	188	65	1500	1500	188	15	65	4	4.47	12.25	26.99	53.96	1.067	1.067	0.00	1.50	1.00	88.7	80.7	67.2	55.2	44.0	0.133	160	1.689	1.689	1.000	0.000
MVK6184	18.5	4	1500/3600	188	74	1500	1500	188	18.5	74	4	3.22	10.68	30.58	72.83	0.934	0.931	3.50	0.50	0.50	90.7	83.2	69.5	56.8	44.4	0.240	160	1.465	1.803	1.000	0.097
MVK6185	22	4	1500/3600	188	90	1500	1500	188	22	90	4	3.59	11.78	34.17	83.43	0.606	0.855	1.30	0.77	2.00	91.1	83.2	69.1	56.8	44.6	0.387	160	4.000	2.200	1.000	0.089
MVK6206	30	4	1500/3000	188	116	1500	1500	188	30	116	4	2.53	12.13	53.42	108.1	0.606	0.648	2.50	3.50	5.00	84.4	74.0	59.5	48.9	38.0	0.173	166	2.268	2.078	1.000	0.000
MVK6207	37	4	1500/3000	188	143	1500	1500	188	37	143	4	2.47	14.69	60.09	133.2	0.497	0.536	1.80	3.00	5.00	85.4	75.7	62.3	50.5	39.9	0.184	168	3.200	2.560	1.000	0.180
MVK6208	45	4	1500/3000	188	170	1500	1500	188	45	170	4	2.73	15.26	56.71	169.7	0.947	0.901	1.00	0.00	0.15	89.2	81.6	67.6	56.2	43.4	0.295	164	1.229	1.813	1.000	0.178
MVK9250	55	4	1500/2400	185	216	1500	1500	185	55	216	4	2.08	12.36	66.22	197.9	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	168	1.615	1.753	1.000	0.000
MVK9252	75	4	1500/2400	183	276	1500	1500	183	75	276	4	1.70	15.29	99.34	261.6	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	165	1.856	1.785	1.000	0.091
MVK9280	90	4	1500/2000	183	345	1500	1500	183	90	345	4	2.28	20.12	89.3	332.3	0.669	0.546	0.00	5.00	0.00	91.1	85.1	70.9	59.2	48.7	0.490	181	1.331	1.428	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

400 V series

Motor specification						Motor parameters																						
			VG5S code No.			03	177	175	174	176	178	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	C03	C04	-	C14
			FRENIC-VG code No.			F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.) [r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6115	3.7	4	1500/3600	376	9	1500	1500	376	3.7	9	4	6.86	13.94	3.93	7.78	2.510	2.340	2.35	2.55	1.20	90.5	82.4	68.7	57.0	45.3	0.104	294	0.880	1.440	1.000	0.028
MVK6133	5.5	4	1500/3600	376	15	1500	1500	376	5.5	15	4	5.50	12.78	7.15	10.74	1.311	1.370	2.00	5.00	7.00	88.0	79.2	65.6	53.6	42.2	0.078	299	2.361	1.985	1.000	0.019
MVK6135	7.5	4	1500/3600	376	18.5	1500	1500	376	7.5	18.5	4	4.37	13.72	7.81	15.33	1.465	1.686	7.61	2.00	1.00	85.9	76.9	63.4	51.6	40.5	0.064	310	1.607	1.427	1.000	0.000
MVK6165	11	4	1500/3600	376	25.0	1500	1500	376	11	25	4	4.27	11.67	12.39	20.15	0.988	0.824	4.53	1.88	0.22	84.9	75.0	61.6	50.0	39.4	0.087	348	0.910	2.343	1.000	0.000
MVK6167	15	4	1500/3600	376	31.7	1500	1500	376	15	31.7	4	4.48	13.69	14.47	28.63	1.290	1.269	1.00	0.50	1.00	88.7	81.7	67.2	55.2	44.0	0.133	306	1.090	1.318	1.000	0.027
MVK6184	18.5	4	1500/3600	376	37	1500	1500	376	18.5	37	4	2.66	12.45	14.02	36.06	0.882	0.882	1.00	3.00	3.00	92.5	84.3	70.3	57.1	45.1	0.295	321	1.825	1.825	1.000	0.018
MVK6185	22	4	1500/3600	376	45	1500	1500	376	22	45	4	3.61	14.06	16.81	41.72	0.903	0.891	1.50	1.50	3.00	91.1	83.2	69.1	56.5	44.6	0.387	320	1.357	1.673	1.000	0.037
MVK6206	30	4	1500/3000	376	58	1500	1500	376	30	58	4	2.55	12.16	25.74	52.52	0.666	0.648	2.50	3.50	9.50	84.4	74.0	59.5	48.9	38.0	0.173	331	2.268	2.078	1.000	0.070
MVK6207	37	4	1500/3000	376	71	1500	1500	376	37	71	4	2.49	14.11	30.07	65.54	0.497	0.498	1.79	1.80	5.00	85.4	75.7	62.3	50.5	39.9	0.184	336	3.200	3.064	1.000	0.095
MVK6208	45	4	1500/3000	376	85	1500	1500	376	45	85	4	2.73	15.30	28.36	84.85	0.947	0.937	0.50	1.50	1.85	89.2	81.6	67.6	56.2	43.4	0.295	328	1.229	1.502	1.000	0.089
MVK9250	55	4	1500/2400	376	108	1500	1500	376	55	108	4	2.05	12.20	33.11	98.98	0.621	0.595	3.00	0.83	0.21	91.5	83.8	70.6	57.8	45.6	0.413	336	1.615	1.753	1.000	0.000
MVK9252	75	4	1500/2400	365	138	1500	1500	365	75	138	4	1.71	15.39	49.67	130.8	0.638	0.665	2.00	2.00	0.00	90.4	83.0	68.4	57.4	46.4	0.409	330	1.856	1.785	1.000	0.091
MVK9280	90	4	1500/2000	370	173	1500	1500	370	90	173	4	2.23	18.47	44.37	164.1	0.685	0.647	0.00	2.00	0.00	90.7	83.7	69.0	57.1	44.9	0.590	348	1.093	1.212	1.000	0.163
MVK9282	110	4	1500/3000	375	206	1500	1500	375	110	206	4	2.14	16.83	53.03	195.8	0.557	0.606	0.44	0.00	0.00	90.1	82.6	67.7	56.3	44.2	0.577	350	1.488	1.172	1.000	0.090
MVK9310	132	4	1500/3000	375	248	1500	1500	375	132	248	4	1.56	17.21	62.05	237.3	0.481	0.531	0.00	0.39	0.00	90.1	81.2	67.7	56.2	45.9	0.689	336	1.468	1.424	1.000	0.000
MVK9312	160	4	1500/2400	375	297	1500	1500	375	160	297	4	1.15	17.47	70.71	286.3	0.518	0.518	0.00	0.00	0.00	91.0	84.3	71.8	59.1	47.7	1.127	330	1.496	1.496	1.000	0.000
MVK9316	200	4	1500/2400	375	369	1500	1500	375	200	369	4	1.15	14.98	107.7	341.5	0.470	0.441	0.00	2.50	0.00	93.8	87.6	74.8	60.6	48.2	1.026	342	1.175	1.358	1.000	0.104
MVK9318	220	4	1500/2000	370	409	1500	1500	370	220	409	4	1.63	14.54	98.64	385.3	0.447	0.458	1.00	1.00	0.00	95.1	88.5	75.0	63.1	51.3	1.758	361	1.535	1.513	1.000	0.078

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

12.6.3 Replacing VG3

200 V series

Motor specification			FRENIC-VG code No.			Motor parameters																								
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.)[r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6096	0.75	4	1500/3600	160	4.0	1500	1500	160	0.75	5.4	4	4.62	9.16	2.65	4.55	2.360	2.560	2.30	1.90	0.10	94.1	87.8	74.9	62.7	50.2	0.152	96	1.000	1.000	1.000	0.000
MVK6097	1.5	4	1500/3600	160	8.0	1500	1500	160	1.5	9.8	4	8.36	16.59	2.65	9.09	4.700	5.100	2.30	1.90	0.10	94.1	87.8	74.9	62.7	50.2	0.152	96	1.000	1.000	1.000	0.000
MVK6107	2.2	4	1500/3600	160	12.5	1500	1500	160	2.2	12.2	4	7.82	13.73	4.15	11.00	3.340	3.600	4.80	0.00	0.10	93.7	87.1	74.1	60.8	47.8	0.096	116	1.000	1.000	1.000	0.000
MVK6115	3.7	4	1500/3600	160	20	1500	1500	160	3.7	19.9	4	7.06	14.40	7.25	18.60	2.540	3.440	0.00	0.00	0.10	89.4	80.4	66.7	54.5	42.7	0.172	115	1.000	1.000	1.000	0.000
MVK6133	5.5	4	1500/3600	160	31	1500	1500	160	5.5	30.2	4	4.88	13.44	14.93	26.10	1.680	2.200	0.00	0.00	0.00	87.1	77.6	63.5	51.8	40.8	0.200	122	1.000	1.000	1.000	0.000
MVK6135	7.5	4	1500/3600	160	41	1500	1500	160	7.5	41.8	4	4.96	13.75	18.90	37.30	1.960	2.000	0.00	0.00	0.00	82.8	72.3	58.6	48.0	38.3	0.220	120	1.000	1.000	1.000	0.000
MVK6165	11	4	1500/3600	160	58	1500	1500	160	11	54.7	4	3.80	13.99	24.00	49.10	1.320	1.500	0.00	0.00	0.00	77.6	79.6	65.9	53.7	43.1	0.320	130	1.000	1.000	1.000	0.000
MVK6167	15	4	1500/3600	160	74	1500	1500	160	15	70.5	4	3.17	13.21	28.20	64.60	1.320	1.520	0.00	0.00	0.00	91.0	83.1	69.0	56.9	45.1	0.336	135	1.000	1.000	1.000	0.000
MVK6185	18.5	4	1500/3600	160	90	1500	1500	160	18.5	89.6	4	2.63	13.94	36.80	81.70	0.820	0.940	0.00	0.00	0.00	89.4	80.0	62.7	50.2	40.0	0.364	131	1.000	1.000	1.000	0.000
MVK6187	22	4	1500/3600	160	106	1500	1500	160	22	104.3	4	2.49	13.21	45.70	93.80	0.780	1.000	0.00	0.00	0.00	89.4	81.2	67.5	50.2	43.9	0.384	136	1.000	1.000	1.000	0.000
MVK6205	30	4	1500/3000	160	142	1500	1500	160	30	140.6	4	2.59	15.06	51.20	130.9	0.800	0.940	0.00	0.00	0.00	89.8	80.4	65.9	53.7	42.4	0.568	133	1.000	1.000	1.000	0.000
MVK6206	37	4	1500/3000	160	177	1500	1500	160	37	164.5	4	2.46	14.03	51.10	156.3	0.720	0.940	0.00	0.00	0.00	90.6	80.4	65.9	54.1	43.1	0.484	137	1.000	1.000	1.000	0.000
MVK6207	45	4	1500/3000	160	203	1500	1500	160	45	195.6	4	2.50	16.36	54.40	187.9	0.960	1.100	0.00	0.00	0.00	91.4	82.7	69.0	57.3	45.5	0.732	138	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

Chap. 12 REPLACEMENT DATA

400 V series

Motor specification			FRENIC-VG code No.			Motor parameters																								
						F03	F04	F05	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25
Type	Capacity[kW]	No. of poles	Speed (Rated/Max.)[r/min]	Voltage[V]	Current[A]	Max. speed [r/min]	Rated speed [r/min]	Rated voltage [V]	Rated capacity [kW]	Rated current [A]	No. of poles	%R1 [%]	%X [%]	Pre-exciting current [A]	Torque current [A]	Slip on driving [Hz]	Slip On braking [Hz]	Iron loss co-ef*. 1 [%]	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 [s]	Induced voltage co-ef*. [V]	R2 correction co-ef*. 1	R2 correction co-ef*. 2	R2 correction co-ef*. 3	Pre-exciting current correction co-ef*.
MVK6115	3.7	4	1500/3600	320	10	1500	1500	320	3.7	10	4	7.07	14.40	3.62	9.30	2.540	3.280	0.00	0.00	0.00	89.4	80.4	66.7	54.5	42.7	0.172	230	1.000	1.000	1.000	0.000
MVK6133	5.5	4	1500/3600	320	15.5	1500	1500	320	5.5	15.1	4	4.89	13.44	7.50	13.10	1.680	1.880	0.00	0.00	0.00	87.1	77.6	63.5	51.8	40.8	0.200	242	1.000	1.000	1.000	0.000
MVK6135	7.5	4	1500/3600	320	20.5	1500	1500	320	7.5	20.3	4	4.84	13.35	9.30	18.00	1.960	2.000	0.00	0.00	0.00	86.7	76.1	60.8	49.4	38.4	0.224	241	1.000	1.000	1.000	0.000
MVK6165	11	4	1500/3600	320	29	1500	1500	320	11	27.4	4	3.79	14.03	12.00	24.60	1.320	1.420	0.00	0.00	0.00	88.6	79.6	65.9	53.7	43.1	0.320	258	1.000	1.000	1.000	0.000
MVK6167	15	4	1500/3600	320	37	1500	1500	320	15	35.3	4	3.17	13.24	14.10	32.30	1.200	1.400	0.00	0.00	0.00	91.0	83.1	69.0	56.9	45.1	0.336	268	1.000	1.000	1.000	0.000
MVK6185	18.5	4	1500/3600	320	45	1500	1500	320	18.5	44.5	4	2.60	13.86	18.10	39.00	0.940	0.960	1.10	3.10	1.70	91.4	83.1	68.6	56.1	45.9	0.412	274	1.000	1.000	1.000	0.000
MVK6187	22	4	1500/3600	320	53	1500	1500	320	22	53.2	4	2.52	13.46	19.90	47.60	0.960	1.000	2.20	1.60	0.70	92.9	85.1	71.4	58.8	46.7	0.412	267	1.000	1.000	1.000	0.000
MVK6205	30	4	1500/3000	320	71	1500	1500	320	30	70.3	4	2.57	15.08	25.60	65.50	0.800	0.940	0.00	0.00	0.00	89.8	80.4	65.9	53.7	42.4	0.568	265	1.000	1.000	1.000	0.000
MVK6206	37	4	1500/3000	320	89	1500	1500	320	37	78.4	4	2.35	13.38	25.20	74.30	0.740	0.860	0.00	0.00	0.00	90.6	80.8	67.5	52.5	40.8	0.460	288	1.000	1.000	1.000	0.000
MVK6207	45	4	1500/3000	320	102	1500	1500	320	45	97.8	4	2.49	16.38	27.20	94.00	0.840	1.100	0.00	0.00	0.00	91.4	82.7	69.0	57.3	45.5	0.732	277	1.000	1.000	1.000	0.000
MVK5256	75	4	1500/2400	320	170	1500	1500	320	75	170	4	1.73	14.88	47.38	162.8	0.840	0.960	0.00	0.00	0.00	92.6	85.2	72.3	60.5	48.4	0.576	266	1.000	1.000	1.000	0.000

*co-ef.: coefficient

Note : The above table shows the setting values of FRENIC-VG.

12.7 Protective Functions

12.7.1 Replacing VG7S

FRENIC5000 VG7S		FRENIC-VG	
–		dbA	Braking transistor error
dbH	DB resistor overheat	dbH	Braking resistor overheat
dCF	DC fuse blown	dCF	DC fuse blown
dO	Excessive position deviation	dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
–		EC	Encoder communications error
Er1	Memory error	Er1	Memory error
Er2	KEYPAD panel communication error	Er2	KEYPAD panel communication error
Er3	CPU error	Er3	CPU error
Er4	Network error	Er4	Network error
Er5	RS-485 communication error	Er5	RS-485 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	Er9	Speed disagreement
ErA	UPAC error	ErA	UPAC error
Erb	Inter-inverter communication error	Erb	Inter-inverter communication error
–		Err	Mock alarm
–		Et1	Encoder error
IPE	IPM error	–	
Lin	Input phase loss	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
OL1	Motor 1 overload	OL1	Motor 1 overload
OL2	Motor 2 overload	OL2	Motor 2 overload
OL3	Motor 3 overload	OL3	Motor 3 overload
OLU	Inverter unit overload	OLU	Inverter unit overload
–		OPL	Output phase loss detection
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
PbF	Charging circuit error	PbF	Charging circuit error
–		ECF	Functional safety circuit error
P9	PG disconnection	P9	PG disconnection
–		dFA	DC fan lock
–		ErH	Hardware error
–		SrF	Functional safety card error
–		SiF	
–		SnF	

12.7.2 Replacing VG5S

FRENIC5000 VG5S		FRENIC-VG	
–		dbA	Braking transistor error
–		dbH	Braking resistor overheat
dCF	DC fuse blown	dCF	DC fuse blown
–		dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
–		EC	Encoder communications error
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 communication error	Er5	RS-485 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
–		Err	Mock alarm
–		Et1	Encoder 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 unit overload	OLU	Inverter unit overload
–		OPL	Output phase loss detection
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
PbF	Charging circuit error	PbF	Charging circuit error
–		ECF	Functional safety circuit error
P9	PG disconnection	P9	PG disconnection
–		dFA	DC fan lock
–		ErH	Hardware error
–		SrF	Functional safety card error
–		SiF	
–		SnF	

12.7.3 Replacing VG3

FRENIC5000 VG3		FRENIC-VG	
–		dbA	Braking transistor error
–		dbH	Braking resistor overheat
dCF	DC fuse blown	dCF	DC fuse blown
–		dO	Excessive position deviation
EF	Ground fault	EF	Ground fault
–		EC	Encoder communications error
Rf	Memory error	Er1	Memory error
–		Er2	KEYPAD panel communication error
–		Er3	CPU error
OPF	T-Link communication error	Er4	Network error
–		Er5	RS-485 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
–		Err	Mock alarm
–		Et1	Encoder error
–		IPE	IPM error
–		Lin	Input phase loss
LU	Undervoltage	LU	Undervoltage
rb	NTC thermistor disconnection	nrb	NTC thermistor disconnection
OC	Overcurrent	OC	Overcurrent
OH1	Overheating at heat sink	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 overload
–		OPL	Output phase loss detection
OS	Overspeed	OS	Overspeed
OU	Overvoltage	OU	Overvoltage
–		PbF	Charging circuit error
–		ECF	Functional safety circuit error
–		P9	PG disconnection
–		dFA	DC fan lock
–		ErH	Hardware error
–		SrF	Functional safety card error
–		SiF	
–		SnF	

12.8 Options

12.8.1 Replacing VG7S

Name	FRENIC5000 VG7S option	Alternative FRENIC-VG option
Synchro. interface	OPC-VG7-SN	OPC-VG1-SN
F/V converter	OPC-VG7-FV	
Aio expansion card	OPC-VG7-AIO	OPC-VG1-AIO
Di interface card	OPC-VG7-DI	OPC-VG1-DI
DIO expansion card	OPC-VG7-DIO	OPC-VG1-DIO
RG interface expansion card	OPC-VG7-PG	OPC-VG1-PG
	OPC-VG7-PGo	OPC-VG1-PGo
T-Link interface card	OPC-VG7-TL	OPC-VG1-TL
Highspeed serial card	OPC-VG7-SI	OPC-VG1-TBSI
	OPC-VG7-SIU	OPC-VG1-TBSI
RS485 expansion card	OPC-VG7-RS	Built-in.
CC-Link interface card	OPC-VG7-CCL	OPC-VG1-CCL
For synchronous motor driving PG card	OPC-VG7-PMPG	OPC-VG1-PMPG
	OPC-VG7-PMPGo	OPC-VG1-PMPGo
UPAC	OPC-VG7-UPAC	OPC-VG1-UPAC
SX bus interface card	OPC-VG7-SX	OPC-VG1-SX
PROFIBUS-DP	OPC-VG7-PDP	OPC-VG1-PDP
DeviceNet	OPC-VG7-DEV	OPC-VG1-DEV
Synchro. interface	MCA-VG7-SN	
F/V converter	MCA-VG7-FV	
Dancer controller	MCAII-PU	
PG switcher	MCAII-VG7-CPG	
Braking unit	Depends on the capacity	Depends on the capacity (Built-in for 55 kW or less of 200 V series, and for 160 kW or less of 400 V series)
Braking resistor	Depends on the capacity	Depends on the capacity
AC reactor	Depends on the capacity	Depends on the capacity
DC REACTOR	Depends on the capacity	Depends on the capacity (Provided as standard for units of more than 75 kW)
Ferrite ring for reducing radio noise. Zero-phase reactor	ACL-40B, ACL-74B	
KEYPAD panel extension cable	CBIII-10R-2S CBIII-10R-1C CBIII-10R-2C	Extension cable for extension operation CB-ϒS

12.8.2 Replacing VG5S

Name	FRENIC5000 VG5S option	Alternative FRENIC-VG option
Adder	OPCII-VG3-AD	
I/V, V/I converter	OPCII-VG3-IV	
Comparator	OPCII-VG3-CP	
Isolation converter	OPCII-VG3-IA	
F/V converter	OPCII-VG3-FV	
Synchro. interface	OPCII-VG3-SN	OPC-VG1-SN
Di interface	OPCII-VG5-DIN	OPC-VG1-DI (DIA, DIB)
	OPCII-VG5-DIT	OPC-VG1-DI (DIA, DIB)
DIO expansion card	OPCII-VG5-DIO	OPC-VG1-DIO (DIOA)
T-Link interface card	OPCII-VG5-TL	OPC-VG1-TL
PG interface card	OPCII-VG5-PG1	Built-in.
	OPCII-VG5-PG2	OPC-VG1-PG
Pulse train interface card	OPCII-VG5-PTI	OPC-VG1-PG
Adder	MCAII-VG3-AD	
I/V, V/I converter	MCAII-VG3-IV	
Comparator	MCAII-VG3-CP	
Isolation converter	MCAII-VG3-IA	
F/V converter	MCAII-VG3-FV	
Synchro. interface	MCAII-VG5-SN	
Dancer controller	MCAII-PU	
Relay unit	MCAII-RY	
PG switcher	MCAII-VG5-CPG	
Braking unit	Depends on the capacity	Depends on the capacity (Built-in for 55 kW or less of 200 V series, and for 160 kW or less of 400 V series)
Braking resistor	Depends on the capacity	Depends on the capacity
AC reactor	Depends on the capacity	Depends on the capacity
DC REACTOR	Depends on the capacity	Depends on the capacity (Provided as standard for units of more than 75 kW)
Ferrite ring for reducing radio noise. Zero-phase reactor	ACL-40B, ACL-74B	
KEYPAD panel extension cable	CBIII-10R-2S CBIII-10R-1C CBIII-10R-2C	Extension cable for extension operation CB-ϒS

12.8.3 Replacing VG3

Name	FRENIC5000 VG3 option	Alternative FRENIC-VG option
Adder	OPCII-VG3-AD	
I/V, V/I converter	OPCII-VG3-IV	
Comparator	OPCII-VG3-CP	
Isolation converter	OPCII-VG3-IA	
F/V converter	OPCII-VG3-FV	
Synchro. interface	OPCII-VG3-SN	OPC-VG1-SN
Di interface	OPCII-VG3-DI	OPC-VG1-DI(DIA, DIB)
AO interface	OPCII-VG3-AO	OPC-VG1-AIO
T-Link interface card	OPCII-VG3-T2 OPCII-VG3-TL	OPC-VG1-TL
Adder	MCAII-VG3-AD	
I/V, V/I converter	MCAII-VG3-IV	
Comparator	MCAII-VG3-CP	
Isolation converter	MCAII-VG3-IA	
F/V converter	MCAII-VG3-FV	
Synchro. interface	MCAII-VG5-SN	
Dancer controller	MCAII-PU	
Relay unit	MCAII-RY	
Ground fault detection unit	MCAII-GFD-1 MCAII-GFD-2	For the output circuit, the ground fault detection function is included as standard.
Braking unit	Depends on the capacity	Depends on the capacity (Built-in for 55 kW or less of 200 V series, and for 160 kW or less of 400 V series)
Braking resistor	Depends on the capacity	Depends on the capacity
AC reactor	Depends on the capacity	Depends on the capacity
DC REACTOR	Depends on the capacity	Depends on the capacity (Provided as standard for units of more than 75 kW)
Ferrite ring for reducing radio noise. Zero-phase reactor	ACL-10A	

Chapter 13
TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or detects an alarm or a light alarm condition. In this chapter, first check whether any alarm code or the "light alarm" indication (L-AL) is displayed or not, and then proceed to the troubleshooting items.

Contents

13.1 Protective Functions

The FRENIC-VG series of inverters has various protective functions as listed below to prevent the system from going down and reduce system downtime. The protective functions marked with an asterisk (*) in the table are disabled by default. Enable them according to your needs.

The protective functions include, for example, the "heavy alarm" detection function which, upon detection of an abnormal state, displays the alarm code and causes the inverter to trip, the "light alarm" detection function which displays the alarm code but lets the inverter continue the current operation, and other warning signal output functions.

If any problem arises, understand the protective functions listed below and follow the procedures given in Section 13.2 and onwards for troubleshooting.

Protective function	Description
"Heavy alarm" detection	This function detects an abnormal state, displays the corresponding alarm code, and causes the inverter to trip. The "heavy alarm" codes are check-marked in the "Heavy alarm" object column in Table 13.1. For details of each alarm code, see the corresponding item in the troubleshooting. The inverter retains the latest and the last 10 alarm codes (see Section 3.4.4.9) and the latest and the last three pieces of alarm information (see Section 3.4.4.8). It can also display them.
"Light alarm" detection*	This function detects an abnormal state categorized as a "light alarm," displays L-AL and lets the inverter continue the current operation without tripping. It is possible to define which abnormal states should be categorized as a "light alarm" using function codes H81 and H82. The "light alarm" codes are check-marked in the "Light alarm" object column in Table 13.1. For instructions on how to check and release light alarms, see Section 3.4.3.5 "Monitoring light alarms, ■ How to remove the current light alarm."
Stall prevention	When the torque command exceeds the torque limiter level (F44, F45) during acceleration/ deceleration or constant speed running, this function limits the motor torque generated in order to avoid an overcurrent trip.
Automatic lowering of carrier frequency	Before the inverter trips due to an abnormal surrounding temperature or output current, this function automatically lowers the carrier frequency to avoid a trip.
Motor overload early warning*	When the inverter output current has exceeded the specified level, this function issues the "Motor overload early warning" signal ***OL*** before the thermal overload protection function causes the inverter to trip for motor protection.
Auto-reset*	When the inverter has stopped because of a trip, this function allows the inverter to automatically reset and restart itself. (The number of retries and the latency between stop and reset can be specified.)
Surge protection	This function protects the inverter from a surge voltage invaded between main circuit power lines and the ground.

13.2 Before Proceeding with Troubleshooting

⚠WARNING⚠

- If any of the protective functions has been activated, first remove the cause. Then, after checking that the all run commands are set to OFF, release the alarm. If the alarm is released while any run commands are set to ON, the inverter may supply the power to the motor, running the motor.

  Injury may occur.

- Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.
- **Turn OFF the power and wait at least five minutes for inverters with a capacity of 22 kW or below, or at least ten minutes for inverters with a capacity of 30 kW or above.** Make sure that the LED monitor and charging lamp are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped to the safe level (+25 VDC or below).

  Electric shock may occur.

Follow the procedure below to solve problems.

(1) First, check that the inverter is correctly wired, referring to Chapter 2, Section 2.3.1 "Wiring of main circuit terminals and grounding terminals."

(2) Check whether an alarm code or the "light alarm" indication (L-AL) is displayed on the LED monitor.

- If an alarm code appears on the LED monitor ——→ Go to Section 13.3.
- If the "light alarm" indication (L-AL) appears on the LED monitor ——→ Go to Section 13.4.
- If neither an alarm code nor "light alarm" indication (L-AL) appears on the LED monitor

Abnormal motor operation ——→ Go to Section 13.5.1.

[1] The motor does not rotate.
[2] The motor rotates, but the speed does not change.
[3] The motor runs in the opposite direction to the command.
[4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed.
[5] Grating sound is heard from the motor or the motor sound fluctuates.
[6] The motor does not accelerate or decelerate within the specified time.
[7] The motor does not restart even after the power recovers from a momentary power failure.
[8] The motor abnormally heats up.
[9] The motor does not run as expected.
[10] When the motor accelerates or decelerates, the speed is not stable.
[11] The motor stalls during acceleration.
[12] When the T-Link communications option is in use, neither a run command nor a speed command takes effect.
[13] When the SX-bus communications option is in use, neither a run command nor a speed command takes effect.
[14] When the CC-Link communications option is in use, neither a run command nor a speed command takes effect.
[15] _ _ _ _ (under bars) appears.

Problems with inverter settings ——→ Go to Section 13.5.2.

[1] Nothing appears on the monitors.
[2] The desired function code does not appear.
[3] Data of function codes cannot be changed from the keypad.
[4] Data of function codes cannot be changed via the communications link.

If any problems persist after the above recovery procedure, contact your Fuji Electric representative.

13.3 If an alarm code appears on the LED monitor

13.3.1 List of alarm codes

Table 13.1 Abnormal States Detectable ("Heavy Alarm" and "Light Alarm" Objects)

Alarm code	Error cause	"Heavy alarm" objects	"Light alarm" objects	Alarm sub code (for manufacturers)*	Remarks	Ref. page
dbA	Braking transistor broken	√	--	--	55 kW or below (200 V class series) 160 kW or below (400 V class series)	13-5
dbH	Braking resistor overheated	√	--	--	Inverters of all capacities	13-5
dCF	DC fuse blown	√	--	--	75 kW or above (200 V class series) 90 kW or above (400 V class series)	13-5
dFA	DC fan locked	√	√	--	45 kW or above (200 V class series) 75 kW or above (400 V class series)	13-6
dO	Excessive positioning deviation	√	--	--		13-6
EC	PG communication error	√	--	0001 to 2000	With OPC-VG1-SPGT mounted	Section 6.8.6.2
ECF	Functional safety circuit error	√	--	0001 to 0008		13-26
EF	Ground fault	√	--	--	Inverters of all capacities	13-6
Er-1	Memory error	√	--	0001 to 0008		13-7
Er-2	Keypad communications error	√	--	0001 to 0002		13-7
Er-3	CPU error	√	--	0001 to 0008		13-8
Er-4	Network error	√	√	0001 to 0004		13-8
Er-5	RS-485 communications error	√	√	0001 to 0002		13-9
Er-6	Operation error	√	--	0001 to 4000		13-10
Er-7	Output wiring fault	√	--	0001 to 0040		13-11
Er-8	A/D converter error	√	--	0001 to 0004		13-12
Er-9	Speed not agreed	√	√	0001 to 0008		13-12
Er-A	UPAC error	√	--	0001 to 0004		--
Er-b	Inter-inverter communications link error	√	--	0001 to 0400		13-13
Er-H	Hardware error	√	--	0001 to 1000		13-14
Er-r	Mock alarm	√	√	--		13-14
Et 1	PG failure	√	--	--	With OPC-VG1-SPGT mounted	Section 6.8.6.2
L in	Power supply phase loss	√	--	0001 to 0002		13-14
LoC	Start delay	√	√	--		13-15
LU	Undervoltage	√	--	--		13-16
nr-b	NTC thermistor wire break error	√	√	--		13-17
OC	Overcurrent	√	--	0001 to 0100		13-17
OH1	Heat sink overheat	√	--	0001 to 0200		13-18
OH2	External alarm	√	√	0001		13-19
OH3	Inverter internal overheat	√	--	0001 to 0010		13-19
OH4	Motor overheat	√	√	--		13-20
OL 1	Motor 1 overload	√	√	--		13-21
OL 2	Motor 2 overload	√	√	--		13-21
OL 3	Motor 3 overload	√	√	--		13-21
OLU	Inverter overload	√	--	0001 to 0010		13-21
OPL	Output phase loss	√	--	0001 to 0002		13-22

Table 13.1 Abnormal States Detectable ("Heavy Alarm" and "Light Alarm" Objects) (Continued)

Code	Name	"Heavy alarm" objects	"Light alarm" objects	Alarm sub code (for manufacturers)*	Remarks	Ref. page
OS	Overspeed	√	--	--		13-23
OU	Overvoltage	√	--	0001		13-24
PG	PG wire break	√	--	0001 to 0400		13-25
PbF	Charger circuit fault	√	--	0001 to 0002	37 kW or above (200 V class series) 75 kW or above (400 V class series)	13-26
Ar-E	E-SX bus tact synchronization error	√	√	0001	With OPC-VG1-ESX mounted	Section 6.15
Ar-F	Toggle error detection alarm	√	√	0004	When any of the OPC-VG1-TL, -SX and -ESX is mounted and that option and Fuji PLC (MICREX-SX) are used in combination.	4-146 MICREX-SX Technical Document
Sr-F	Functional safety card error	√	--	0001 to 000d (8001 to 800d)	With OPC-VG1-SAFE mounted	Functional Safety Card instruction manual
S iF		√	--	000e to 0015 (800e to 8015)		
SnF		--	√	0016 to 0018 (8016 to 8018)		

* Alarm sub codes (for manufacturers) are provided for facilitating pinpointing of an error cause when a single alarm code contains two or more error factors. For an alarm code containing a single error factor, the alarm sub code is "0000" so that "--" is written in the table above.

For the alarm sub code checking procedure, refer to Chapter 3, Section 3.4.4.8 "Reading alarm information--Menu #7 "ALM INF."

13.3.2 Possible causes of alarms, checks and measures

[1] dbA Braking transistor error

Problem A braking transistor error is detected.
(55 kW or below (200 V class series), 160 kW or below (400 V class series) only.)

Possible Causes	What to Check and Suggested Measures
(1) The braking transistor is broken.	Check whether resistance of the braking resistor is correct or there is a misconnection of the resistor. ➔ Ask your Fuji Electric representative to repair the inverter.

[2] dbH Braking resistor overheated

Problem The electronic thermal protection for the braking resistor has been activated.

Possible Causes	What to Check and Suggested Measures
(1) Braking load is too heavy.	Reconsider the relationship between the estimated braking load and the real one. ➔ Lower the real braking load. ➔ Review the selection of the braking resistor and increase the braking capability (Modification of related function code data (E35, E36, E37) is also required.)
(2) Specified deceleration time is too short.	Recalculate the deceleration torque and time needed for the load currently applied, based on a moment of inertia for the load and the deceleration time. ➔ Increase the deceleration time (F08, C36, C47, C57, C67). ➔ Review the selection of the braking resistor and increase the braking capability. (Modification of related function code data (E35, E36, E37) is also required.)
(3) Incorrect setting of function code data (E35, E36, E37).	Recheck the specifications of the braking resistor. ➔ Review data of function codes E35, E36 and E37, then modify them.

[3] dCF Fuse blown

Problem The fuse inside the inverter blew. (Applicable to the inverters of 75 kW or above (200 V class series) and those of 90 kW or above (400 V class series))

Note If the fuse has blown, the internal elements may be broken. NEVER turn the power ON to prevent the secondary damage. Contact your Fuji Electric representative.

Possible Causes	What to Check and Suggested Measures
(1) The fuse blew due to short-circuiting inside the inverter.	Check whether there has been any excess surge or noise coming from outside. ➔ Take measures against surges and noise. ➔ Ask your Fuji Electric representative to repair the inverter.
(2) The fuse blew due to ground faults that have occurred at the inverter output lines.	Disconnect the wiring from the output terminals [U], [V] and [W] and perform a Megger test for the inverter and the motor. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor). ➔ Ask your Fuji Electric representative to repair the inverter or the motor.
(3) Miswiring of main circuit power lines and output lines.	Check the wiring. ➔ Ask your Fuji Electric representative to repair the inverter.

[4] dFA DC fan locked

Problem The DC fan has stopped. (Applicable to the inverters of 45 kW or above (200 V class series) and those of 75 kW or above (400 V class series))

Possible Causes	What to Check and Suggested Measures
(1) The service life of the DC fan has expired or the DC fan is defective.	The DC fan has stopped although the main power is ON. (Check the DC fan state with the cooling fan ON/OFF control disabled with H06 = 0.) ➔ Replace the DC fan. ➔ Disable the DC fan locked signal output (treat it as a light alarm) to keep the inverter running by setting "1" to the hundreds digit of H108 (Light alarm object definition) to "1" (H108 = □1□□). If the DC fan has stopped, replace the fan immediately and revert the data of H108 to the factory default. Leaving the DC fan stopped causes an inverter internal overheat trip or a local temperature rise that shortens the service life of electrolytic capacitors and other electronic devices on the printed circuit boards in the inverter unit, in the worst case, it results in a broken inverter unit.

[5] dO Excessive positioning deviation

Problem An excessive positioning deviation has occurred.

Possible Causes	What to Check and Suggested Measures
(1) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
(2) The motor cannot rotate mechanically.	➔ Check whether the brake is applied.
(3) Output torque too small.	➔ Increase the torque limiter value (F44, F45).
(4) Deviation override width too small.	➔ Review the deviation override width (o18).
(5) Insufficient gain in positioning control system.	➔ Readjust the positioning loop gain (o16).
(6) The acceleration/ deceleration by pulse train command is too rapid.	➔ Increase the acceleration/deceleration time.

[6] EF Ground fault

Problem A ground fault current flew from the output terminal of the inverter.

Possible Causes	What to Check and Suggested Measures
(1) Inverter output terminal(s) grounded (ground fault).	Disconnect the wiring from the output terminals [U], [V] and [W] and perform a Megger test for the inverter and the motor. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor).
(2) The setting of the motor rated current (P04, A03, A103) is small relative to the inverter rated current.	Check whether an extremely small motor rated current is set relative to the inverter rated current. ➔ Check the setting of the motor rated current (P04, A03, A103). ➔ Disable the ground fault detection by setting "0" to the hundreds digit of H103 (Protection/maintenance function 1).

[7] Er1 Memory error

Problem Error occurred in writing data to the memory in the inverter.

Possible Causes	What to Check and Suggested Measures
(1) When writing data (especially initializing or copying data), the inverter was shut down so that the voltage to the control PCB has dropped.	Initialize the function code data by setting H03 to "1." After initialization, check if pressing the RESET key releases the alarm. ➔ Revert the initialized function code data to their previous customized settings (See Note below), then restart the operation.
(2) Inverter affected by strong electrical noise when writing data (especially initializing or copying data).	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). Also, perform the same check as described in (1) above. ➔ Implement noise control measures. Revert the initialized function code data to their previous customized settings (See Note below), then restart the operation.
(3) Control circuit failure. [Sub code: 0001 to 0008]	Initialize the function code data by setting H03 to "1," then reset the alarm by pressing the RESET key and check that the alarm goes on. ➔ The control PCB (on which the CPU is mounted) is defective and needs to be replaced. Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.
(4) Highly-frequent rewriting to the non-volatile memory has reached the limit of the electronic device (approx. 1,000,000 times). [Sub code: 0001 to 0008]	Function code data has been frequently changed. ➔ The non-volatile memory needs to be replaced. Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed. ➔ Decrease the frequency of rewriting. Decrease the frequency of Save all operations.

Note: Function code data can be easily reverted to the previously customized settings by using the backup data copied in the keypad memory with Menu #10 "DATA COPY" in Programming mode. (Refer to Chapter 3, Section 3.4.4.10 "Copying data")

[8] Er2 Keypad communications error

Problem A communications error occurred between the keypad and the inverter.

Possible Causes	What to Check and Suggested Measures
(1) Broken communications cable or poor contact. [Sub code: 0001]	Check continuity of the cable, contacts and connections. ➔ Re-insert the connector firmly. ➔ Replace the cable.
(2) Connecting many control wires hinders the front cover from being mounted, lifting the keypad. [Sub code: 0001]	Check the mounting condition of the front cover. ➔ Use wires of the recommended size (0.75 mm^2) for wiring. ➔ Change the wiring layout inside the unit so that the front cover can be mounted firmly.
(3) Inverter affected by strong electrical noise. [Sub code: 0002]	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communication cables and main circuit wires). ➔ Implement noise control measures.
(4) A keypad failure occurred.	Replace the keypad with another one and check whether a keypad communications error (Er2) occurs. ➔ Replace the keypad.
(5) A keypad designed for any other series of inverters is connected.	Check whether the connected keypad is a multi-function keypad designed for FRENIC-Mini/-Eco/-Multi/-MEGA/-Lift. ➔ Replace the keypad with the one designed for the FRENIC-VG.

[9] Er-3 CPU error

Problem A CPU error (e.g. erratic CPU operation) occurred.

Possible Causes	What to Check and Suggested Measures
(1) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g. correct grounding and routing of signal wires, communications cables, and main circuit wires). ➔ Implement noise control measures.
(2) Short circuit on the printed circuit board(s). [Sub code: 0001 to 0008]	Check the printed circuit board(s) for short circuits, accumulation of dust or dirt. ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

Note To remove the Er-3 CPU error, turn the power to the inverter OFF and then ON. The error cannot be removed by pressing the RESET key.

[10] Er-4 Network error

Problem The connected option card detected an error.

① For T-Link option

Possible Causes	What to Check and Suggested Measures
(1) The power to the MICREX IO terminal is OFF.	Check the power to the MICREX IO terminal. ➔ Turn ON the power to the MICREX IO terminal and reset the inverter alarm state.
(2) T-Link address double assigned.	Check the T-Link address. ➔ Set a new T-Link address.
(3) Wrong wiring.	Check that: • The T-Link network has a terminating resistor at each end. • The specified cable is used. • There is no wire break. • The wiring length is within the range of the specification. • The shielded wires are properly treated. • The SD terminal of the T-Link is not connected to a frame ground (FG). • A crimp terminal is used for connection. • The signal lines are not wired in parallel with the power lines. ➔ Correct the wiring.

② For SX-bus option

Possible Causes	What to Check and Suggested Measures
(1) The SX-bus power is shut down or the PLC's CPU module is down.	Check the power to the SX-bus and the status of the PLC's CPU module. ➔ Turn ON the power to the SX-bus, recover the PLC's CPU module, and reset the inverter alarm state.
(2) An error has occurred at any other station.	Check the detailed RAS information on the PLC's CPU module to find a faulty station. ➔ Recover the faulty station and reset the inverter alarm state.

Possible Causes	What to Check and Suggested Measures
(3) Wrong wiring.	Check that: • The SX-bus network has a terminating connector at each end. • A dedicated cable is used. • There is no wire break. • Connection to the IN and OUT connector is proper. • The signal lines are not wired in parallel with the power lines. • The total extension length of the SX bus cable does not exceed 25 m. The number of devices connected in succession does not exceed 10. • The SX bus cable is not bent with the bend radius of 50 mm or below. ➔ Correct wiring.

③ For CC-Link option

Possible Causes	What to Check and Suggested Measures
(1) The power to the PLC is shut down or the PLC's CPU module is down.	Check the power to the PLC and the status of the PLC's CPU module. ➔ Turn ON the power to the PLC, recover the PLC's CPU module, and reset the inverter alarm state.
(2) An error has occurred at any other station.	Check the detailed RAS information on the PLC's CPU module to find a faulty station. ➔ Recover the faulty station and reset the inverter alarm state.
(3) Wrong wiring.	Check that: • The CC-Link network has a terminating resistor at each end. • A dedicated cable is used. • There is no wire break. • Connection to the terminal block is proper. • The signal lines are not wired in parallel with the power lines. • The maximum cable length of the CC-link cable, inter-station cable length, and the number of devices connected are as specified. ➔ Correct wiring.

[11] Er-5 RS-485 communications error

Problem A communications error occurred during RS-485 communication.

Possible Causes	What to Check and Suggested Measures
(1) Communications conditions of the inverter do not match that of the host equipment. [Sub code: 0002]	Compare the settings of function codes H32 to H40 with those of the host equipment. ➔ Correct any settings that differ.
(2) Even though no-response error detection time (H38) has been set, communication is not performed within the specified cycle. [Sub code: 0001]	Check the host equipment. ➔ Change the settings of host equipment software or disable the no-response error detection (H38 = 0).
(3) The host equipment did not operate due to defective software, settings, or defective hardware. [Sub code: 0002]	Check the host equipment (e.g., PLCs and host computers). ➔ Remove the cause of the equipment error.

Possible Causes	What to Check and Suggested Measures
(4) The RS-485 converter did not operate due to incorrect connections and settings, or defective hardware.	Check the RS-485 converter (e.g., check for poor contact or incorrect connections). ➔ Change the various RS-485 converter settings, reconnect the wires, or replace hardware with recommended devices as appropriate.
(5) Broken communications cable or poor contact.	Check the continuity of the cables, contacts and connections. ➔ Replace the cable.
(6) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of communications cables and main circuit wires). Check if decreasing the baud rate (H34) down to 2400 bps causes no alarm. ➔ Implement noise control measures. ➔ Implement noise reduction measures on the host side. ➔ Replace the RS-485 converter with a recommended insulated one. ➔ Keep the inverter running, using any proper communications error processing (H32).
(7) Terminating resistor not properly configured.	Check that the inverter serves as a terminating device in the network. ➔ Configure the terminating resistor switch (SW4) for RS-485 communication correctly. (To use the inverter as a terminating device, turn the switch to the ON position.)
(8) Response interval does not match the send/receive switching time of the RS-232C−RS-485 converter.	Check whether the specified response interval (H39) matches the specification of the actual converter. ➔ Match the response interval (H39) with the specification of the converter.

[12] Er-6 Operation error

Problem An incorrect operation was attempted.

Possible Causes	What to Check and Suggested Measures
(1) Restrictions on mounting of option(s) not observed. [Sub code: 0001]	Check the model of option(s) mounted. ➔ Check the restrictions on mounting of the option(s). (This error cannot be shown as mounting status of control options on the OPTION pages of the LCD monitor in Menu #4 "I/O CHECK.") Check whether the configurations of the customizing switches (SW) on the two option boards are the same. ➔ Change the SW configuration.
(2) Auto-tuning not performed in accordance with correct procedure. [Sub code: 0002]	Check whether tuning started with digital input ***BX***, ***STOP1***, ***STOP2*** or ***STOP3*** being ON. ➔ With all of ***BX***, ***STOP1***, ***STOP2*** and ***STOP3*** being OFF, start tuning. Check whether tuning started with digital input ***EN1*** or ***EN2*** being opened. ➔ With each of ***EN1*** and ***EN2*** being short-circuited with ***PS***, start tuning. Check whether 20 seconds or more have elapsed after writing to H01 until the FWD key is pressed. ➔ Press the FWD key within 20 seconds after writing to H01. ➔ Before writing to H01, make sure that F02 = 0 and H30 = 0 or 1. Check whether tuning has started with the main power being OFF or with the inverter DC link bus voltage not established. ➔ Check the DC link bus voltage on the maintenance information screen of the keypad. (Refer to Chapter 3, Section 3.4.4.6 "Reading maintenance information – Menu #5 MAINTENANCE.")

Possible Causes	What to Check and Suggested Measures
(3) The PG detection circuit self-diagnosis function has been performed with the PG (SD)/PGo (SD) card being mounted. [Sub code: 0080]	Check whether the PG (SD)/PGo (SD) card is mounted. ➔ Remove the PG (SD)/PGo (SD) card, then perform the self-diagnosis function of the PG detection circuit (H74).
(4) When the multiplex system is selected (o33 ≠ 0), the multiplex system station number (o50) is greater than the number of slave stations (o34). [Sub code: 0100]	➔ Review the settings of o50 and o34.
(5) When the multiplex system is selected (o33 ≠ 0), the motor drive control setting is not proper. [Sub code: 0200]	Some motor drive controls are not available under the multiplex system. ➔ Review the selected drive control (P01, A01, A101). For available drive controls, refer to Chapter 6, Section 6.6 "High-Speed Serial Communication-Capable Terminal Block OPC-VG1-TBSI" in the FRENIC-VG User's Manual (Option Edition).
(6) After the multiplex system configuration was established, the setting of o33 has been changed. [Sub code: 0800]	The alarm cannot be released until the inverter is turned off and on. ➔ Review the setting of o33 and turn the inverter off and on.
(7) Mismatch between the multiplex system setting (o33) and the number of slave stations setting (o34). [Sub code: 4000]	Multiplex systems may have restrictions on the number of slave stations. ➔ Review the settings of o33 and o34. For available drive controls, refer to Chapter 6, Section 6.6 "High-Speed Serial Communication-Capable Terminal Block OPC-VG1-TBSI" in the FRENIC-VG User's Manual (Option Edition).

[13] Er7 Output wiring fault

Problem Auto-tuning failed.

Possible Causes	What to Check and Suggested Measures
(1) A phase was missing (There was a phase loss) in the connection between the inverter and the motor. [Sub code: 0001] [Sub code: 0020, 0040]	➔ Properly connect the motor to the inverter. ➔ Check the state of the contactor connected at the inverter output side.
(2) A tuning operation involving motor rotation (H01 = 4) was attempted while the brake was applied to the motor. [Sub code: 0002]	Check that the brake can be released. ➔ Specify the tuning that does not involve the motor rotation (H01 = 2 or 3). ➔ Release the brake before tuning that involves the motor rotation (H01 = 4).
(3) Tuning of magnetic pole position offset value has failed. [Sub code: 0010]	➔ Correct the wiring of the PG. ➔ Adjust the settings of the pull-in current (H161) and pull-in frequency (H162). Refer to Section 3.5.4.2 "Test run procedure for permanent magnet synchronous motor (PMSM), [3] Setting the magnetic pole position offset value, (2) Automatic adjustment of the magnetic pole position offset value."

[14] Er-8 A/D converter error

Problem An error occurred in the A/D converter circuit.

Possible Causes	What to Check and Suggested Measures
(1) Inverter affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g. correct grounding and routing of signal wires, communications cables, and main circuit wires). ➔ Implement noise control measures.
(2) Short circuit on the printed circuit board(s). [Sub code: 0001 to 0004]	Check the printed circuit board(s) for short circuits, accumulation of dust or dirt. Check for dew condensation in the inverter unit. Check whether foreign materials have gotten into the inverter unit. ➔ Fix the printed circuit board(s). ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

[15] Er-9 Speed mismatch

Problem An excessive deviation has occurred between the speed command and the detected speed.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data. [Sub code: 0001 to 0004]	Check the settings of the following: Number of poles (P05, A07, A107), feedback input pulse resolution (P28, A30, A130), feedback input external PG correction factor (P29, A51, A151), and machine runaway detection speed setting (H149) ➔ Specify motor parameters in accordance with the motor and PG. ➔ Review the data of the following function codes. • E43 (Speed agreement, Detection width) • E44 (Speed agreement, Off-delay timer) • E45 (Speed agreement, Alarm)
(2) Overload. [Sub code: 0001 to 0004]	Measure the inverter output current. ➔ Reduce the load. ➔ Increase the inverter capacity. Check whether any mechanical brake is working. ➔ Release the mechanical brake.
(3) Mismatch between function code settings and the motor characteristics. [Sub code: 0001 to 0004]	Check the motor parameters. ➔ Perform auto-tuning, using H01.
(4) Wrong wiring between the pulse generator (PG) and the inverter. [Sub code: 0001 to 0004]	Check the wiring between the PG and the inverter. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2 "Mounting direction of a pulse generator (PG) and PG signals.")
	Check that the relationships between the PG feedback signal and the run command are as follows: • For the FWD command: the B phase pulse is in the High level at rising edge of the A phase pulse • For the REV command: the B phase pulse is in the Low level at rising edge of the A phase pulse ➔ If the relationship is wrong, interchange the A and B phase wires. ➔ Note that if the digital input signal ***IVS*** ("Switch normal/inverse operation") is active, the above operation is reversed.

Possible Causes	What to Check and Suggested Measures
(5) Wrong wiring to the motor. [Sub code: 0001 to 0004]	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
Under vector control with/without speed sensor (6) The motor speed does not rise due to the torque limiter operation. [Sub code: 0001 to 0004]	Check the setting of the torque limiter level (F44, F45). ➔ Change the F44 or F45 data to an appropriate value. If no torque limiter is required, disable the torque limiter (F40 = 0).
(7) During running of the motor (after the mechanical brake is released), the deviation between the speed command (Reference speed 4, ASR input) and the actual speed exceeds the setting of H149. [Sub code: 0008]	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.

[16] Er-b Inter-inverter communications link error

Problem A communications link error has occurred between high-speed serial communication-capable terminal block options (OPC-VG1-TBSI).

Possible Causes	What to Check and Suggested Measures
(1) The optical cable is disconnected or inserted poorly into the connector. [Sub code: 0001 to 0020]	➔ Connect the optical cable fully.
(2) The optical cable is bundled or bent with the bend radius of 35 mm or less. [Sub code: 0001 to 0020]	➔ Increase the bend radius to at least 35 mm.
(3) The optical cable or connectors on the inverter were exposed to intense light (e.g., direct sunlight or strobe light) [Sub code: 0001 to 0020]	➔ Do not expose the optical cable or the connectors to intense light.
(4) Discrepancy in capacity between master and slave inverters. [Sub code: 0200]	The multiplex system cannot be configured with inverters of different capacities.
(5) Discrepancy in current rating between master and slave inverters. [Sub code: 0400]	The multiplex system cannot be configured with inverters of different current rating settings (F80). ➔ Review the current rating settings (F80).

[17] Er-H Hardware error

Problem The LSI on the power supply printed circuit board (PCB) malfunctions.

Possible Causes	What to Check and Suggested Measures
(1) The control circuit PCB or power supply PCB is defective.	The control circuit PCB or power supply PCB (including the gate PCB) needs to be replaced. ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

[18] Err Mock alarm

Problem The LED displays *err*.

Possible Causes	What to Check and Suggested Measures
(1) The STOP + FUNC/DATA keys were held down for more than 5 seconds.	➔ To escape from this alarm state, press the RESET key.
(2) The H142 was set to "1" (Cause a mock alarm).	➔ To escape from this alarm state, press the RESET key.
(3) The ***FTB*** ("Cause external mock alarm") assigned to a digital input terminal was turned ON.	➔ Check the input of the terminal to which an ***FTB*** is assigned with function codes E01 to E13 (data = 74).

[19] Lin Power supply phase loss

Problem Input phase loss occurred, or interphase voltage unbalance rate was large.

Possible Causes	What to Check and Suggested Measures
(1) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).
(2) The screws on the main power input terminals are loosely tightened.	Check if the screws on the main power input terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(3) Interphase voltage unbalance between three phases was too large.	Measure the input voltage. ➔ Connect an AC reactor (ACR) to lower the voltage unbalance between input phases. ➔ Increase the inverter capacity.
(4) Overload cyclically occurred.	Correct the load. ➔ Increase the inverter capacity.
(5) Single-phase voltage was input to the three-phase input inverter.	➔ Connect the inverter to the three-phase voltage power supply. (The FRENIC-VG is a three-phase inverter.)

[20] LoC Start delay

Problem At the startup, an excessive deviation has occurred between the speed command and the detected speed.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check the data of the following function codes; P05, A07 and A107 (Motor, No. of poles), P28, A30 and A130 (Feedback encoder pulse count/rev), and P29, A51 and A151 (Feedback pulse correction factor 1). ➔ Specify motor parameters in accordance with the motor and PG. ➔ Review the data of the following function codes. • H140 (Start delay, Detection level) • H141 (Start delay, Detection timer)
(2) Overload.	Measure the inverter output current. ➔ Reduce the load. ➔ Increase the inverter capacity. Check whether any mechanical brake is working. ➔ Release the mechanical brake.
(3) Mismatch between function code settings and the motor characteristics.	Check the motor parameters. ➔ Perform auto-tuning, using H01.
(4) Wrong wiring between the pulse generator (PG) and the inverter.	Check the wiring between the PG and the inverter. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2 "Mounting direction of a pulse generator (PG) and PG signals.")
	Check that the relationships between the PG feedback signal and the run command are as follows: • For the FWD command: the B phase pulse is in the High level at rising edge of the A phase pulse • For the REV command: the B phase pulse is in the Low level at rising edge of the A phase pulse ➔ If the relationship is wrong, interchange the A and B phase wires. ➔ Note that if the digital input signal ***IVS*** ("Switch normal/inverse operation") is active, the above operation is reversed.
(5) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
<u>Under vector control with/without speed sensor</u> (6) The motor speed does not rise due to the torque limiter operation.	Check the setting of the torque limiter level (F44, F45). ➔ Change the F44 or F45 data to an appropriate value. If no torque limiter is required, disable the torque limiter (F40 = 0).
(7) During running of the motor (after the mechanical brake is released), the reference torque current (F44, F45) exceeds the specified level (H140) and the actual speed drops below the specified stop speed (F37), and then the state is kept for the specified duration (H141).	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.

[21] LU Undervoltage

Problem DC link bus voltage has dropped below the undervoltage detection level.

Possible Causes	What to Check and Suggested Measures
(1) A momentary power failure occurred.	➔ Release the alarm. ➔ To restart running the motor without treating this condition as an alarm, set F14 to "3," "4," or "5," depending on the load type.
(2) The power to the inverter was switched back to ON too soon (when F14 = 1).	Check if the power to the inverter was switched back to ON while the control power was still alive. (Check whether the LEDs on the keypad light.) ➔ Turn the power ON again after all LEDs on the keypad go off.
(3) The power supply voltage does not reach the inverter's specification range.	Measure the input voltage. ➔ Increase the voltage to within the specified range.
(4) Peripheral equipment for the power circuit malfunctioned, or the connection is incorrect.	Measure the input voltage to find which peripheral equipment malfunctioned or which connection is incorrect. ➔ Replace any faulty peripheral equipment, or correct any incorrect connections.
(5) Any other load(s) connected to the same power supply has required a large starting current, causing a temporary voltage drop.	Measure the input voltage and check the voltage fluctuation. ➔ Reconsider the power supply system configuration.
(6) Insufficient capacity of the power supply transformer increases load, causing a voltage drop.	Measure the output current. ➔ Reduce the load. ➔ Reconsider the capacity of the power supply transformer.
(7) No power is supplied to the auxiliary control power input terminals R0 and T0. Fan power supply switching connectors CN W and CN R are set as follows. CN W (white): [FAN] position CN R (red): [NC] position (Refer to Chapter 3, Section 3.3.3.7 "Switching connectors.")	Measure the input voltage of the auxiliary power supply. ➔ Insert various circuit breakers or magnetic contactor (MC). ➔ Check for voltage drop, connection failure, poor contact and other problems, then take measures against them.

[22] nrb NTC thermistor wire break error

Problem A wire break is found in the NTC thermistor detection circuit.

Note: A negative temperature coefficient (NTC) thermistor is used to protect the motor from overheat, and under vector control, to compensate for the temperature in the motor parameters.

A dedicated motor (VG motor) for Fuji vector control has a built-in NTC thermistor.

Possible Causes	What to Check and Suggested Measures
(1) The NTC thermistor cable is broken.	Check whether the motor cable is broken. ➔ Replace the motor cable.
(2) The temperature around the motor is extremely low (lower than -30°C).	Measure the temperature around the motor. ➔ Reconsider the use environment of the motor.
(3) The NTC thermistor is broken.	Measure the resistance of the NTC thermistor (including a spare thermistor). ➔ Connect a spare thermistor to the motor. ➔ If the spare thermistor is also broken, replace the motor.

[23] OC Overcurrent

Problem The inverter momentary output current exceeded the overcurrent level.

Possible Causes	What to Check and Suggested Measures
(1) The inverter output lines were short-circuited.	Disconnect the wiring from the inverter output terminals ([U], [V] and [W]) and measure the interphase resistance of the motor wiring. Check if the resistance is too low. ➔ Remove the short-circuited part (including replacement of the wires, relay terminals and motor).
(2) Ground faults have occurred at the inverter output lines.	Disconnect the wiring from the output terminals [U], [V] and [W] and perform a Megger test for the inverter and the motor. ➔ Remove the grounded parts (including replacement of the wires, relay terminals and motor).
(3) Overload.	Measure the motor current with a measuring device to trace the current trend. Then, use this data to judge if the trend is over the calculated load value for your system design. ➔ If the load is too heavy, reduce it or increase the inverter capacity. Trace the current trend and check if there are any sudden changes in the current. ➔ If there are any sudden changes, make the load fluctuation smaller or increase the inverter capacity. ➔ <u>Under V/f control</u> Enable overcurrent limiting (H58 = 1).
<u>Under V/f control</u> (4) Excessive torque boost specified (in the case of manual torque boost)	Check whether decreasing the torque boost (P35, A55, A155) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (P35, A55, A155).
<u>Under V/f control</u> (5) The acceleration/ deceleration time was too short.	Check that the motor generates enough torque required during acceleration/deceleration. That torque is calculated from the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/deceleration time (F07, F08, C46, C47, C56, C57, C66, C67). ➔ Increase the inverter capacity. ➔ Review the braking method.

Possible Causes	What to Check and Suggested Measures
(6) Malfunction caused by noise.	Check if noise control measures are appropriate (e.g., correct grounding and routing of control and main circuit wires). ➔ Implement noise control measures. For details, refer to the FRENIC-VG User's Manual, "Appendix A." ➔ Enable the Auto-reset (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.
Under vector control with/without speed sensor (7) The carrier frequency is low.	Check the motor sound (carrier frequency) specified by F26. ➔ Increase the setting of F26. (Note that increasing the carrier frequency excessively may cause other devices to malfunction due to noise generated from the inverter.)
Under vector control with/without speed sensor (8) Exciting current was too small during auto-tuning.	Check whether it happens during auto-tuning. ➔ Increase the exciting current (P08, A10, A110) and then perform auto-tuning.
Under vector control with speed sensor (9) Mismatch between the PG's pulse resolution and the function code setting.	Check the function code setting (P28, A30, A130). ➔ Match the function code settings with the PG specifications.
Under vector control with speed sensor (10)Wrong wiring of the PG.	Check the wiring between the PG and the inverter for the phase sequence, wire breaks, shielding and twisting. ➔ Correct the wiring.
Under vector control with speed sensor (11)PG defective.	Check whether the inverter internal control circuit (PG input circuit) is faulty, using the self-diagnosis function of the PG detection circuit (H74). ➔ If the result is "Normal," replace the PG; if it is "Abnormal," contact your Fuji Electric representative. Check the PG waveform using an oscilloscope. ➔ Replace the PG.
PMSM (12)Incorrect setting of function code data (P44, A64, A164).	Recheck the allowable current specifications of the permanent magnet synchronous motor (PMSM). ➔ Review the setting of the function code (P44, A64, A164) to modify it. For the GNF2 motor settings, refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor."

[24] OH1 Heat sink overheat

Problem Temperature around heat sink has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the range of the inverter specification. [Sub code: 0001 to 0008]	Measure the temperature around the inverter. ➔ Lower the temperature around the inverter (e.g., ventilate the panel where the inverter is mounted).
(2) Ventilation path is blocked. [Sub code: 0001 to 0008]	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance.
	Check if the heat sink is not clogged. ➔ Clean the heat sink. (For the cleaning procedure, contact your Fuji Electric representative.)

Possible Causes	What to Check and Suggested Measures
(3) Cooling fan's airflow volume decreased due to the service life expired or failure. [Sub code: 0001 to 0008] [Sub code: 0010 to 0200]	Check the cumulative run time of the cooling fan. Refer to Chapter 3, Section 3.4.4.6 "Reading maintenance information – Menu #5 MAINTENANCE." ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
	Visually check whether the cooling fan rotates normally. ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
(4) Overload. [Sub code: 0001 to 0008]	Measure the output current. ➔ Reduce the load (Use the heat sink overheat early warning ***INV-OH*** (E15 through E27) or the inverter overload early warning ***INV-OL*** (E15 through E27) to reduce the load before the overload protection is activated.). ➔ Decrease the data of F26 (Motor sound, Carrier frequency).

[25] OH2 External alarm

Problem External alarm was inputted (***THR***).
(when the "Enable external alarm trip" ***THR*** has been assigned to any of digital input terminals)

Possible Causes	What to Check and Suggested Measures
(1) An alarm function of external equipment was activated.	Check the operation of external equipment. ➔ Remove the cause of the alarm that occurred.
(2) Wrong connection or poor contact in external alarm signal wiring.	Check if the external alarm signal wiring is correctly connected to the terminal to which the "Enable external alarm trip" terminal command ***THR*** has been assigned (Any of E01 through E09 should be set to "9."). ➔ Connect the external alarm signal wire correctly.
(3) Incorrect setting of function code data.	Check whether the normal/negative logic of the external signal matches that of the ***THR*** command specified by E14. ➔ Ensure the matching of the normal/negative logic.
(4) The surrounding temperature exceeded the range of the braking resistor specification.	Measure the temperature around the braking resistor. ➔ Lower the temperature (e.g., ventilate the inverter).
(5) The capacity of the braking resistor is insufficient.	Reconsider the capacity and %ED of the braking resistor. ➔ Review the braking resistor.

[26] OH3 Inverter internal overheat

Problem Temperature inside the inverter has exceeded the allowable limit.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the inverter's specification limit. [Sub code: 0001 to 0008]	Measure the surrounding temperature. ➔ Lower the temperature around the inverter (e.g., ventilate the panel where the inverter is mounted).
(2) Temperature detection circuit failure (Thermistor wire break). [Sub code: 0010]	➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

[27] OH4 Motor overheat (PTC/NTC thermistor)

Problem Temperature of the motor has risen abnormally.

Possible Causes	What to Check and Suggested Measures
(1) The temperature around the motor exceeded the range of the motor specification.	Measure the temperature around the motor. ➔ Lower the temperature.
(2) Cooling system for the motor defective.	Check if the cooling system of the motor is operating normally. ➔ Repair or replace the cooling system of the motor.
(3) Overload.	Measure the output current. ➔ Reduce the load. (e.g. Use the motor overload early warning (E34) to reduce the load before the overload protection is activated.) ➔ Lower the temperature around the motor.
(4) The activation level (E32) of the PTC thermistor for motor overheat protection was set inadequately.	Check the PTC thermistor specifications and recalculate the detection voltage. ➔ Modify the data of function code E32.
(5) The activation level (E30) of the NTC thermistor for motor overheat protection was set inadequately.	Check the data of function code E30 (Motor overheat protection, Temperature). ➔ When a motor exclusive to vector control is used, set E30 to 150°C (Factory default). ➔ When the motor temperature is entered via any of analog input terminals [Ai1] to [Ai4], set E30 to the protection level matching the motor specification.
(6) Settings for the PTC/NTC thermistor are improper.	Check the setting of the thermistor mode selection (function code P30, A31, A131). ➔ Change the data of P30, A31 or A131 in accordance with the thermistor used.
(7) NTC thermistor model (characteristics) improper.	Check the NTC thermistor model (characteristics). ➔ Use the NTC thermistor incorporated in a motor exclusive to vector control.
Under V/f control (8) Excessive torque boost specified. (P35, A55, A155)	Check whether decreasing the torque boost (function code P35, A55, A155) does not stall the motor. ➔ If no stall occurs, decrease the data of P35, A55 or A155.
Under V/f control (9) The V/f pattern did not match the motor.	Check whether the motor rated speed (F04, A05, A105) and the rated voltage (F05, A04, A104) match the values on the motor's nameplate. ➔ Match the function code data with the values on the motor's nameplate.
(10) Incorrect setting of function code data.	Although no PTC thermistor is used, the thermistor mode is enabled (function code P30, A31, A131). ➔ Set the data of P30, A31 or A131 to "0" (Disable).
(11) The input voltage of the motor cooling fan is out of the range of the specification.	Check the input voltage of the motor cooling fan. ➔ Review the power supply system.
(12) The air passage of the motor cooling fan is clogged.	Check the air passage of the motor cooling fan. ➔ Clear the clog. (For the cleaning procedure, contact your Fuji Electric representative.)
(13) Mismatch of motor parameters	For exclusive motors for the FRENIC-VG: Check whether the data of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.

[28] OLn Overload of motor 1 through 3

Problem Electronic thermal protection for motor 1, 2, or 3 activated.

OL1 Motor 1 overload
OL2 Motor 2 overload
OL3 Motor 3 overload

Possible Causes	What to Check and Suggested Measures
(1) The electronic thermal characteristics do not match the motor overload characteristics.	Check the motor characteristics. ➔ Reconsider the data of function codes F10, F12, A32, A34, A132 and A134. ➔ Use an external thermal relay.
(2) The activation level for the electronic thermal protection was not appropriate.	Check the continuous allowable current of the motor. ➔ Reconsider and change the data of function code F11, A33 or A133.
(3) The specified acceleration/ deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/ deceleration time (F07, F08, C46, C47, C56, C57, C66, C67).
(4) Overload.	Measure the output current. ➔ Reduce the load (e.g. Use the motor overload early warning (E34) to reduce the load before the overload protection is activated.).
<u>Under V/f control</u> (5) Excessive torque boost specified	Check whether decreasing the torque boost (P35, A55, A155) does not stall the motor. ➔ If no stall occurs, decrease the data of P35, A55 or A155.
<u>Under vector control with/without speed sensor</u> (6) The control constants of the automatic speed regulator (ASR) are inadequate.	Check whether the actual speed overshoots or undershoots the commanded one. ➔ Readjust the ASR (ASR gain, constant of integration, etc.).

[29] OLU Inverter overload

Problem Electronic thermal overload protection for inverter activated.

Possible Causes	What to Check and Suggested Measures
(1) The surrounding temperature exceeded the range of the inverter specification.	Measure the temperature around the inverter. ➔ Lower the temperature (e.g., ventilate the panel where the inverter is mounted).
(2) Excessive torque boost specified.	Check whether decreasing the torque boost (P35, A55, A155) does not stall the motor. ➔ If no stall occurs, decrease the torque boost (P35, A55, A155).
(3) The specified acceleration/ deceleration time was too short.	Recalculate the acceleration/deceleration torque and time needed for the load, based on the moment of inertia for the load and the acceleration/deceleration time. ➔ Increase the acceleration/deceleration time (F07, C35, C46, C56, C66).
(4) Overload.	Measure the load factor to see that it does not exceed 100%. (Refer to Chapter 3, Section 3.4.4.7 "Measuring load factor -- Menu #6 "LOAD FCTR." ➔ Reduce the load (e.g., Use the overload early warning (E33) and reduce the load before the overload protection is activated.). ➔ Decrease the motor sound (Carrier frequency) (F26).

Possible Causes	What to Check and Suggested Measures
(5) Ventilation paths are blocked.	Check if there is sufficient clearance around the inverter. ➔ Change the mounting place to ensure the clearance. (For details, refer to Chapter 3, Section 3.3.2 "Installing the Inverter."
	Check if the heat sink is not clogged. ➔ Clean the heat sink. (For the cleaning procedure, contact your Fuji Electric representative.)
(6) Cooling fan's airflow volume decreased due to the service life expired or failure.	Check the cumulative run time of the cooling fan. ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
	Visually check that the cooling fan rotates normally. ➔ Replace the cooling fan. (Contact your Fuji Electric representative.)
(7) The wires to the motor are too long, causing a large leakage current from them.	Measure the leakage current. ➔ Insert an output circuit filter (OFL).
Under vector control with/without speed sensor (8) Reference speed fluctuating	Check whether the reference speed is fluctuating. ➔ Increase the ASR input filter setting (F64, C43, C53, C63).
Under vector control with/without speed sensor (9) The control constants of the automatic speed regulator (ASR) are inadequate.	Check whether the actual speed overshoots or undershoots the commanded one. ➔ Readjust the ASR (ASR gain, constant of integration, etc.).
(10) Wrong wiring to the PG.	Check the wiring to the PG. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2.2 "Mounting direction of a PG (pulse generator) and PG signals.")
(11) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Correct the wiring. It is also possible to use H75 (Phase sequence configuration of main circuit output wires).
(12) The magnetic pole position of the permanent magnet synchronous motor (PMSM) is out of place.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160). (Refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor," ■ Adjusting the magnetic pole position.")

[30] OPL Output phase loss

Problem Output phase loss occurred.

Possible Causes	What to Check and Suggested Measures
(1) Inverter output wires are broken.	Measure the output current. ➔ Replace the output wires.
(2) The motor winding is broken.	Measure the output current. ➔ Replace the motor.
(3) The inverter output terminals or motor input terminals are weakly tightened.	Check if any screws on those terminals have become loose. ➔ Tighten the terminal screws to the recommended torque.
(4) A single-phase motor has been connected.	➔ Single-phase motors cannot be used. (The FRENIC-VG is a drive for three-phase motors.)

[31] OS Overspeed

Problem The motor rotates in an excessive speed (when Motor speed ≥ Maximum speed setting × H90÷100)

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (1) Incorrect setting of function code data.	Check the maximum speed setting (function code F03, A06, A106). ➔ Modify the data of F03, A06 or A106 in accordance with the machinery. Check the setting of the speed limiter (F76 to F78). ➔ Enable the speed limiter (F76 to F78).
Under vector control with/without speed sensor (2) Insufficient gain of the speed controller (ASR).	Check whether the actual speed overshoots the commanded one in higher speed operation. ➔ Increase the ASR gain (F61). (Depending on the situations, reconsider the setting of the filter constants or the integral time.)
Under vector control with/without speed sensor (3) The overspeed alarm detection level is not appropriate.	Check the setting of the overspeed alarm detection level (H90, Factory default 120%). ➔ Set the data of H90, taking into account the maximum allowable speed for the machinery.
Under vector control with speed sensor (4) Noises superimposed on the PG wire.	Check whether appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires and main circuit wires). ➔ Implement noise control measures. For details, refer to the FRENIC-VG User's Manual, "Appendix A."
Under vector control with/without speed sensor (5) Droop gain too large.	Check whether the droop gain is appropriate. ➔ Decrease the droop gain (H28).
Under vector control with/without speed sensor (6) The motor parameters do not match the connected motor.	For motors exclusive to the FRENIC-VG: Check whether the setting of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
Under vector control without speed sensor (7) Breaks in the inverter output circuit.	Check the inverter output circuit. ➔ Correct the wiring.
Under vector control with speed sensor (8) PG waveform abnormal.	Measure the PG waveform. ➔ Replace the PG.
Under vector control with speed sensor (9) Mismatch between the PG's pulse resolution and the function code setting.	Check the function code setting (P28, A30, A130). ➔ Match the function code settings with the PG specifications.
(10) The magnetic pole position of the permanent magnet synchronous motor (PMSM) is out of place.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160). (Refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor," ■ Adjusting the magnetic pole position.")

[32] 0u Overvoltage

Problem The DC link bus voltage exceeded the overvoltage detection level.

Possible Causes	What to Check and Suggested Measures
(1) The power supply voltage exceeded the range of the inverter specification.	Measure the input voltage. ➔ Decrease the voltage to within the specified range.
(2) A surge current entered the input power supply.	In the same power line, if a phase-advancing capacitor is turned ON/OFF or a thyristor converter is activated, a surge (momentary large increase in the voltage or current) may be caused in the input power. ➔ Install a DC reactor.
(3) The deceleration time was too short for the moment of inertia of the load.	Recalculate the deceleration torque based on the moment of inertia of the load and the deceleration time. ➔ Increase the deceleration time (F08, C36, C47, C57, C67). ➔ Consider the use of a braking resistor or PWM converter (RHC-C). ➔ Decrease the moment of inertia of the load. ➔ Enable the overvoltage trip prevention (H57). ➔ Select the power limit function (F40 = 2). ➔ <u>Under vector control with speed sensor</u> Enable the torque limiter (F40 to F45).
(4) The acceleration time was too short.	Check if an overvoltage alarm occurs after rapid acceleration. ➔ Increase the acceleration time (F07, C35, C46, C56, C66). ➔ Select the S-curve acceleration/deceleration (F67 to F70). ➔ Consider the use of a braking resistor or PWM converter (RHC-C). ➔ Decrease the moment of inertia of the load.
(5) Braking load was too heavy.	Compare the braking torque of the load with that of the inverter. ➔ Consider the use of a braking resistor or PWM converter (RHC-C).
(6) Malfunction caused by noise.	Check if the DC link bus voltage was below the protective level when the overvoltage alarm occurred. ➔ Implement noise control measures. For details, refer to the FRENIC-VG User's Manual, "Appendix A." ➔ Enable the auto-reset (H04). ➔ Connect a surge absorber to magnetic contactor's coils or other solenoids (if any) causing noise.
(7) The inverter output lines were short-circuited.	Disconnect the wiring from the inverter output terminals ([U], [V] and [W]) and measure the interphase resistance of the motor wiring. Check if the resistance is too low. ➔ Remove the short-circuited part (including replacement of the wires, relay terminals and motor).
(8) Wrong connection of the braking resistor.	Check the connection. ➔ Correct the connection.
(9) Large, rapid decrease of the load.	Check whether the inverter runs at the time of rapid decrease of the load. ➔ Consider the use of a braking resistor or PWM converter (RHC-C).

[33] *PG* PG wire break

Problem The pulse generator (PG) wire has been broken somewhere in the circuit.

Possible Causes	What to Check and Suggested Measures
(1) Break in the PG wiring. Inverter PA, PB: [Sub code: 0001] Inverter power supply: [Sub code: 0004] Option: [Sub code: 0002] (OPC-VG1-PG, OPC-VG1-PMPG)	Check whether the PG is correctly connected to the option or any wire is broken. ➔ Check whether the PG is connected correctly. Or, tighten up the related terminal screws. ➔ Check whether any joint or connecting part bites the wire sheath. ➔ Replace the wire.
PMSM When the option card (OPC-VG1-PMPG) is used: (2) Connection failure of speed/magnetic pole position sensor. (3) Mismatch between the motor rotation direction and sensor output. [Sub code: 0010 to 0400]	Check the output wiring of the speed/magnetic pole position sensor for poor contact or the phase sequence of the AB phases and UVW phases. ➔ Correct the connection between the option card and the speed/magnetic pole position sensor. Check the motor wiring for poor contact or the phase sequence. ➔ Correct the connection between the inverter and the motor.
(4) Connection failure of option card (OPC-VG1-PG, OPC-VG1-PMPG).	Check whether the connector of the option card engages with that of the inverter unit. ➔ Mount the option card on the inverter unit correctly.
(5) PG related circuit affected by strong electrical noise.	Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of signal wires, communication cables, and main circuit wires). ➔ Implement noise control measures. ➔ Separate the signal wires from the main power wires as far as possible.
(6) Motor drive control wrongly selected.	Check the motor drive control currently selected. ➔ If no PG is mounted, select the vector control without speed sensor.
(7) Mismatch between the PG power voltage (rated) and the output voltage setting of terminal [PGP].	Check the PG power voltage (rated) and the output voltage setting of terminal [PGP] (switchable with SW6). ➔ Set SW6 properly. For details, refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches."
(8) PG wires small in size.	Check whether the PG wires satisfy the recommended wire size. ➔ Replace the wires with the recommended one.
(9) PG waveform abnormal.	Check whether the inverter internal control circuit (PG input circuit) is faulty, using the self-diagnosis function of the PG detection circuit (H74). ➔ If the result is "Normal," replace the PG; if it is "Abnormal," contact your Fuji Electric representative. Check the PG waveform using an oscilloscope. ➔ Replace the PG.

[34] PbF Charger circuit fault

Problem The magnetic contactor for short-circuiting the charging resistor failed to work. (For 200 V class series of 37 kW or above and those of 75 kW or above)

Possible Causes	What to Check and Suggested Measures
(1) No control power was supplied to the magnetic contactor (MC) intended for short-circuiting the charging resistor.	Check that, in normal connection of the main circuit (not a connection via the DC link bus), the connector (CN R) on the power printed circuit board (power PCB) is not inserted to NC. ➔ Insert the connector (CN R) to FAN. For details, refer to Chapter 3, Section 3.3.3.6 "Switching connectors, ■ Fan power supply switching connectors."
(2) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).

[35] ECF ENABLE input circuit failure (Functional safety circuit error)

Problem ENABLE input circuit failure has occurred.

Possible Causes	What to Check and Suggested Measures
(1) Poor contact of the control circuit terminal block.	Check whether the control circuit terminal block is firmly mounted on the inverter unit.
(2) ENABLE input circuit logic error. [Sub code: 0010] [Sub code: 0020]	Check the ON/OFF states of terminals [EN1] and [EN2], using Menu #4 "I/O CHECK" on the keypad. ➔ Check that terminals [EN1] and [PS] are wired together and terminals [EN2] and [PS] are wired together. ➔ Operate the relay so that the ON/OFF timings of [EN1] and [EN2] are matched. ➔ Check whether the relay is welded. If it is welded, replace it. ➔ Check the gap of ON/OFF timings between [EN1] and [EN2]. Keep the timing gap within 50 ms.
(3) ENABLE input circuit failure.	The failure persists even after the measures given in (2) above are performed. ➔ Ask your Fuji Electric representative to repair the inverter. Inform the representative of the alarm sub code displayed.

13.4 If the "Light Alarm" Indication (L-AL) Appears on the LED Monitor

If the inverter detects a minor abnormal state "light alarm," it can continue the current operation without tripping while displaying the "light alarm" indication L-AL on the LED monitor. In addition to the indication L-AL, the inverter blinks the KEYPAD CONTROL LED and outputs the "light alarm" signal ***L-ALM*** to a general-purpose digital output terminal to alert the peripheral equipment to the occurrence of a light alarm. (To use the ***L-ALM***, it is necessary to assign the signal to any of the digital output terminals by setting any of function codes E15 through E19 to "57.")

Function codes H106 through H110 specify which alarms should be categorized as "light alarm." The available "light alarm" codes are check-marked in the "Light alarm" object column in Table 13.1.

For the "light alarm" factors and the alarm removal procedure, refer to Chapter 3, Section 3.4.3.5 "Monitoring light alarms."

Light alarm SnF that could occur in the functional safety card OPC-VG1-SAFE cannot be selected with H106 through H110. For details about SnF, refer to the Functional Safety Card instruction manual.

13.5 If Neither an Alarm Code Nor "Light Alarm" Indication (L-AL) Appears on the LED Monitor

13.5.1 Abnormal motor operation

[1] The motor does not rotate.

Possible Causes	What to Check and Suggested Measures
(1) No power supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Turn ON a molded case circuit breaker (MCCB), a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or a magnetic contactor (MC). ➔ Check for voltage drop, phase loss, poor connections, or poor contacts, and fix them if necessary. ➔ If only the auxiliary control power input is supplied, also supply the main power to the inverter.
(2) No run forward/reverse command was inputted, or both the commands were inputted simultaneously (external signal operation).	Check the input status of the forward/reverse command with Menu #4 "I/O CHECK" using the keypad. ➔ Input a run command. ➔ Set either the forward or reverse operation command to off if both commands are being inputted. ➔ Correct the run command source. (Set the data of F02 to "1.") ➔ Connect the external circuit wires to control circuit terminals [FWD] and [REV] correctly. ➔ Make sure that the sink/source slide switch (SW1) on the control printed circuit board (control PCB) is properly configured. (Refer to Chapter 3, Section 3.3.3.9 "Setting up the slide switches.")
(3) A run command with higher priority than the one attempted was active, and the run command was stopped. Or, a speed command was active.	Referring to the run command block diagram given in the FRENIC-VG User's Manual, Chapter 4, check the higher priority run command using Menu #2 "DATA CHECK" and Menu #4 "I/O CHECK" with the keypad. ➔ Correct wrong setting of function code H30 (Communications link function, Mode selection) or cancel the higher priority run command.
(4) No analog speed command input.	Check whether the analog speed command is correctly inputted, using Menu #4 "I/O CHECK" on the keypad. ➔ Connect the external circuit wires to terminals [13], [12], [11], [Ai1] and [Ai2] correctly. ➔ Inspect the external speed command potentiometers, signal converters, switches and relay contacts. Replace any ones that are faulty.
Under V/f control (5) The reference speed was below the starting or stop speed.	Check that a speed command has been entered correctly, using Menu #4 "I/O CHECK" on the keypad. ➔ Set the reference speed at the same or higher than the starting speed (F23). ➔ Reconsider the starting speed (F23), and if necessary, change it to the lower value. ➔ Inspect the external speed command potentiometers, signal converters, switches and relay contacts. Replace any ones that are faulty. ➔ Connect the external circuit wires to terminals [13], [12], [11], [Ai1] and [Ai2] correctly.

Possible Causes	What to Check and Suggested Measures
(6) A run command with higher priority than the one attempted was active.	Referring to the run command block diagram given in the FRENIC-VG User's Manual, Chapter 4, check the higher priority run command using Menu #2 "DATA CHECK" and Menu #4 "I/O CHECK" with the keypad. ➔ Correct the wrong setting of function codes (e.g., cancel the higher priority run command). ➔ Correct wrong setting of function code H30 (Communications link function, Mode selection) or cancel the higher priority run command.
(7) The speed limiter settings were made incorrectly.	Check the data of function codes F76 (Speed limiter mode), F77 and F78 (Speed limiter levels 1 and 2). ➔ Correct the data of F76 through F78.
(8) The coast-to-stop command was effective.	Check the data of function codes E01 through E09 and the input signal status of X terminals, using Menu #4 "I/O CHECK" on the keypad. ➔ Release the coast-to-stop command setting. Check the input signal status of terminal [EN], using Menu #4 "I/O CHECK" on the keypad. ➔ Short-circuit the terminal [EN] with terminal [PS].
(9) No input on [EN1] or [EN2].	Check the input status of the EN terminal, using Menu #4 "I/O CHECK" on the keypad. ➔ Short-circuit each of [EN1] and [EN2] with [PS]. - To make inverters *not* compliant with the Functional Safety Standard (STO), short-circuit each of [EN1] and [EN2] with [PS]. (Refer to Chapter 3, Section 3.3.3.8 "Detailed functions of control circuit terminals.") - To make inverters compliant with the Functional Safety Standard (STO), refer to the FRENIC-VG Instruction Manual.
(10) Broken wires, incorrect connection or poor contact with the motor. Or the motor defective.	Check the wiring and the motor. (Measure the output current). ➔ Repair the wires to the motor, or replace them. ➔ Repair the motor or replace it.
(11) Overload	Measure the output current. ➔ Reduce the load (In winter, the load tends to increase.) ➔ Increase the inverter and motor capacities.
	Check whether any mechanical brake is activated. ➔ Release the mechanical brake, if any.
(12) Torque generated by the motor was insufficient.	Check that the motor switching signal (selecting motor 1, 2 or 3) is correct using Menu #4 "I/O CHECK" on the keypad and that the data of function codes matches each motor. ➔ Correct the motor switching signal. ➔ Modify the function code data to match the connected motor.
<u>Under V/f control</u> (13) Torque generated by the motor was insufficient.	Check whether the reference speed is below the slip-compensated speed of the motor (Function codes P10 and P11 for M1, A12 and A13 for M2, and A112 and A113 for M3). ➔ Change the reference speed so that it becomes higher than the slip-compensated speed of the motor. Check whether increasing the toque boost (Function code P35, A55, A155) starts rotating the motor. ➔ Increase the data of P35, A55 or A155. Check the data of function code F04, A05 or A105. ➔ Change the V/f pattern setting to match each motor.

Possible Causes	What to Check and Suggested Measures
(14) Wrong connection or poor contact of DC reactor (DCR)	Check the wiring between the main circuit terminals P1 and P(+). Inverters of 55 kW in LD mode and inverters of 75 kW or above come with a DCR as standard. Without connection of a DCR, these inverters cannot run. ➔ Connect a jumper bar or DCR correctly. Repair or replace wires to the DCR.
(15) No reference speed setting (keypad operation).	Check the reference speed setting made on the keypad. ➔ Modify the reference speed setting by pressing [↑] key.
(16) The inverter could not accept any run commands from the keypad since it was in Programming mode.	Check which operation mode the inverter is in, using the keypad. ➔ Shift the operation mode to Running mode and enter a run command.
<u>Under vector control with speed sensor</u> (17) Incorrect setting of the number of poles of the motor	Check whether the setting of function code P05, A07 or A107 (No. of poles) matches the number of poles of the actual motor. ➔ Set the data of P05, A07 or A107 to the correct number of poles.
<u>Under vector control with speed sensor</u> (18) Wrong wiring between the motor and pulse generator (PG).	Check the motor wiring (phase sequence) and the polarity of the PG. ➔ Correct the wiring. Refer to Chapter 3, Section 3.5.2.2 "Mounting direction of a PG (pulse generator) and PG signals."
<u>Under vector control with/without speed sensor</u> (19) Incorrect setting of the torque limiter level.	Check whether the torque limiter level (Function code F44, F45) is set to zero (0). ➔ Modify the data of F44 or F45 to the appropriate value.
<u>Under vector control with/without speed sensor</u> (20) Incorrect setting of the torque command.	Check whether the torque command of terminal [Ai1]/[Ai2] is zero (0) under torque control mode. ➔ Modify the torque command to the appropriate value.
<u>Under vector control with speed sensor</u> (21) Mismatch between the PG's pulse resolution and the function code setting.	Check whether the setting of function code P28, A30 or A130 matches the pulse resolution of the actual PG.. ➔ Modify the data of P28, A30 or A130 to the appropriate value. Check whether the voltage setting of terminal [PGP] (SW6) matches the voltage specification of the actual PG. ➔ Set SW6 to the appropriate position.
(22) The magnetic pole position of the permanent magnet synchronous motor (PMSM) is out of place.	Check the magnetic pole position. ➔ Adjust the magnetic pole position (o10, A60, A160). (Refer to Chapter 3, Section 3.5.3.3 "Vector control for PMSM with speed sensor and magnetic pole position sensor," ■ Adjusting the magnetic pole position.")

[2] The motor rotates, but the speed does not change.

Possible Causes	What to Check and Suggested Measures
(1) The setting of the maximum speed was too low.	Check the data of function code F03, A06 or A106 (Maximum speed). ➔ Modify the data of F03, A06 or A106 to the appropriate value.
(2) The setting of the speed limiter was too low.	Check the setting of the speed limiter (F76 to F78). ➔ Modify the data of F76 to F78 to the appropriate value.
(3) The reference speed (analog setting) did not change.	Check whether the reference speed has been entered correctly, using Menu #4 "I/O CHECK" on the keypad. ➔ Increase the reference speed. ➔ Inspect the external speed command potentiometers, signal converters, switches, and relay contacts. Replace any ones that are faulty. ➔ Connect the external circuit wires to terminals [13], [12], [11], [Ai1] and [Ai2] correctly.
(4) The external circuit wiring to terminals [X1] to [X9] or signal assignment to those terminals is wrong.	Check whether the reference speed has been entered correctly, using Menu #4 "I/O CHECK" on the keypad. ➔ Connect the external circuit wires to terminals [X1] through [X9]. ➔ Correct the data of E01 to E14. ➔ Correct the data of C05 to C21 (Multistep speed settings).
(5) A reference speed (e.g., multistep speed or via communications link) with higher priority than the one attempted was active and the reference speed was too low.	Referring to the speed command block diagram given in the FRENIC-VG User's Manual, Chapter 4, check the data of the relevant function codes and what speed commands are being received, using Menu #2 "DATA CHECK" and Menu #4 "I/O CHECK" with the keypad. ➔ Correct any incorrect data of function codes (e.g. cancel the higher priority reference speed).
(6) The acceleration or deceleration time was too long or too short.	Check the settings of the acceleration time and deceleration time (function codes F07, F08, C35, C36, C46, C47, C56, C57, C66 and C67). ➔ Change the acceleration/deceleration time to match the load.
(7) Overload.	Measure the output current. ➔ Reduce the load. Check whether any mechanical brake is activated. ➔ Release the mechanical brake.
<u>Under V/f control</u> (8) Function code settings do not agree with the motor characteristics.	If auto-torque boost (Function code P35, A55, A155) is enabled, check whether the data of P03, P04, P06, P07 and P08 for M1, A02, A03, A08, A09 and A10 for M2, A102, A103, A108, A109 and A110 for M3 matches the parameters of the motor. ➔ Perform auto-tuning of the inverter for the motor to be used.
<u>Under V/f control</u> (9) The output frequency does not increase due to the current limiter operation.	Decrease the value of the torque boost (Function code P35, A55, A155), then run the motor again and check if the speed increases. ➔ Adjust the value of the torque boost (P35, A55, A155). Check the data of function codes F04, A05 and A105 to ensure that the V/f pattern setting is right. ➔ Match the V/f pattern setting with the motor ratings.
(10) The motor speed does not increase due to the torque limiter operation.	Check whether the data of torque limiter related function codes F40 through F45 is correctly configured and the ***TL2***/***TL1*** terminal command ("Select torque limiter level") is correct. ➔ Correct the data of F44 or F45 or enter the ***F40-CCL*** terminal command ("Cancel F40 (Torque limiter mode 1)").

Possible Causes	What to Check and Suggested Measures
(11) Incorrect settings of bias and gain for analog input.	Check the data of function codes F17, F18 and E53 to E60. ➔ Correct the bias and gain settings.
(12) The reference speed did not change. (Keypad operation)	Check whether modifying the reference speed setting from the keypad changes the reference speed. ➔ Modify the reference speed setting by pressing the [↑] and [↓] keys.
<u>Under vector control with speed sensor</u> (13) Wrong wiring of the PG.	Check the wiring between the PG and the inverter for the phase sequence, wire breaks, shielding and twisting. ➔ Correct the wiring. (Refer to Chapter 3, Section 3.5.2.2 "Mounting direction of a PG (pulse generator) and PG signals.")
<u>Under vector control with speed sensor</u> (14) Wrong wiring between the inverter and the motor.	Check the phase sequence (U, V, and W) of the main circuit wires between the inverter and the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.
<u>Under vector control with/without speed sensor</u> (15) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the data of function code P02 matches the specification of the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.

[3] The motor runs in the opposite direction to the command.

Possible Causes	What to Check and Suggested Measures
<u>Under V/f control</u> <u>Under vector control without speed sensor</u> (1) Wrong wiring to the motor.	Check the wiring to the motor. ➔ Connect the inverter output terminals U, V, and W to the motor input terminals U, V, and W, respectively.
(2) The rotation direction specification of the motor is opposite to that of the inverter.	The rotation direction of IEC-compliant motors is opposite to that of incompliant motors. ➔ Switch the ***FWD***/***REV*** signal setting.
(3) Incorrect setting of speed command related function code data.	Check the data of the speed command related function codes, referring to the speed command block diagram given in the FRENIC-VG User's Manual, Chapter 4. ➔ Correct the data of the related function codes.
<u>Under vector control with speed sensor</u> (4) Wrong wiring of the PG.	Check the wiring to the motor. ➔ Correct the wiring. (Refer to the Chapter 3, Section 3.5.2.2 "Mounting direction of a PG (pulse generator) and PG signals.")

[4] Speed fluctuation or current oscillation (e.g., hunting) occurs during running at constant speed.

Possible Causes	What to Check and Suggested Measures
(1) The analog speed command fluctuates.	Check the signal status for the speed command with Menu #4 "I/O CHECK" using the keypad. (Refer to Chapter 3, Section 3.4.4.4 "Monitoring the running status.") ➔ Increase the filter constants (F83, E61 to E64) for the speed command. ➔ Take measures to keep the speed command constant.
(2) An external potentiometer is used for speed setting.	Check that there is no noise on the control signal wires connecting to external sources. ➔ Isolate the control signal wires from the main circuit wires as far as possible. ➔ Use shielded or twisted wires for control signals. Check whether the external speed command potentiometer is malfunctioning due to noise from the inverter. ➔ Connect a capacitor to the output terminal of the potentiometer or set a ferrite core on the signal wire. (Refer to Chapter 2.)
(3) Speed switching or multistep speed command was enabled.	Check whether the relay signal for switching the speed command is chattering. ➔ If the relay contact is defective, replace the relay.
(4) The wiring length between the inverter and the motor is too long.	Check whether auto-torque boost is enabled (P35, A55, A155). ➔ Perform auto-tuning. ➔ Under V/f control, disable the automatic control system (select manual torque boost), then check that the motor vibration stops. ➔ Make the output wires as short as possible.
(5) The machinery is hunting due to vibration caused by low rigidity of the load. Or the current is irregularly oscillating due to special motor parameters.	Once disable all the automatic control systems (speed control, auto torque boost, current limiter, torque limiter and droop control), then check that the motor vibration comes to a stop. ➔ Under vector control with/without speed sensor, readjust the speed control system. (F61 through F66, C40 through C45, C50 through C55) ➔ Disable the automatic control system(s) causing the vibration.
(6) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the setting of function code P02 matches the specification of the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
(7) Load is fluctuating.	Under vector control with/without speed sensor Check whether automatic speed regulator (ASR) is properly configured. (F61 through F66, C40 through C45, C50 through C55) ➔ Readjust the ASR setting.

[5] Grating sound is heard from the motor or the motor sound fluctuates.

Possible Causes	What to Check and Suggested Measures
(1) The specified carrier frequency is too low.	Check the data of function code F26 (Motor sound (Carrier frequency)). ➔ Increase the data of F26.
(2) The surrounding temperature of the inverter was too high.	Measure the temperature inside the panel where the inverter is mounted. ➔ If it is over 40°C, lower it by improving the ventilation. ➔ Lower the temperature of the inverter by reducing the load.
(3) Resonance with the load.	Check the machinery mounting accuracy or check whether there is resonance with the mounting base. ➔ Disconnect the motor from the machinery and run it alone to find where the resonance comes from. Upon locating the cause, improve the characteristics of the source of the resonance. ➔ Adjust the jump speed (C01 through C04) to avoid continuous running in the frequency range causing resonance. ➔ Specify the observer (H47 through H52, H125 through H127) to suppress vibration. (Depending on the characteristics of the load, this may take no effect.) ➔ Decrease the P gain of the auto speed regulator (ASR). (F61, C40, C50, C60)

[6] The motor does not accelerate or decelerate within the specified time.

Possible Causes	What to Check and Suggested Measures
(1) The inverter runs the motor with S-curve acceleration/ deceleration.	Check the data of function codes F67 through F70 (S-curve acceleration/ deceleration pattern). ➔ Select the linear pattern (F67 through F70 = 0). ➔ Decrease the acceleration/deceleration time (F07, F08, C46, C47, C56, C57, C66, C67).
Under V/f control (2) The current limiting operation prevented the output frequency from increasing (during acceleration).	Check whether the acceleration time and torque boost are properly specified. ➔ Increase the acceleration time (F07, C35, C46, C56, C66). ➔ Decrease the torque boost (P35, A55, A155) and restart the inverter to check that the speed increases.
(3) Overload.	Measure the output current. ➔ Reduce the load.
Under V/f control (4) Torque generated by the motor was insufficient.	Check that increasing the torque boost (P35, A55, A155) starts the motor. ➔ Increase the value of the torque boost (P35, A55, A155).
(5) An external potentiometer is used for frequency setting.	Check that there is no noise on the control signal wires connecting to external sources. ➔ Isolate the control signal wires from the main circuit wires as far as possible. ➔ Use shielded or twisted wires for control signals. Check whether the external speed command potentiometer is malfunctioning due to noise from the inverter. ➔ Connect a capacitor to the output terminal of the potentiometer or set a ferrite core on the signal wire. (Refer to Chapter 3, Section 3.3.3.8.)

Possible Causes	What to Check and Suggested Measures
(6) Motor torque generated is limited by the torque limiter.	Check whether data of torque limiter related function codes (F40 through F45) is correctly configured and the ***TL2***/***TL1*** terminal command ("Select torque limiter level 2/1") is correct. ➔ Correct the data of F40 through F45 or reset them to the factory defaults. Check whether the speed command potentiometer is malfunctioning due to noise from the inverter. ➔ Set the ***TL2***/***TL1*** correctly. ➔ Increase the acceleration/deceleration time (F07, F08, C35, C36, C46, C47, C56, C57, C66, C67).
(7) The specified acceleration or deceleration time was incorrect.	Check the terminal commands ***RT1*** and ***RT2*** for acceleration/deceleration times. ➔ Correct the ***RT1*** and ***RT2*** settings.

[7] The motor does not restart even after the power recovers from a momentary power failure.

Possible Causes	What to Check and Suggested Measures
(1) The data of function code F14 is either "0," "1," or "2."	Check if an undervoltage trip (LU) occurs. ➔ Change the data of F14 (Restart mode after momentary power failure, Mode selection) to "3," "4," or "5."
(2) The run command remains OFF even after the power has been restored.	Check the input signal with Menu #4 "I/O CHECK" using the keypad. ➔ Check the power recovery sequence with an external circuit. If necessary, consider the use of a relay that can keep the run command ON.
	In 3-wire operation, the power to the control printed circuit board (control PCB) has been shut down once because of a long momentary power failure time, or the ***HOLD*** signal ("Enable 3-wire operation") has been turned OFF once. ➔ Change the design or the setting so that a run command can be issued again within 2 seconds after the power has been restored.

[8] The motor abnormally heats up.

Possible Causes	What to Check and Suggested Measures
(1) Airflow volume of the motor's cooling fan decreased due to the service life expired or failure	Visually check whether the cooling fan rotates normally. ➔ Ask your Fuji Electric representative to repair the motor's cooling fan.
Under V/f control (2) Excessive torque boost specified.	Check whether decreasing the torque boost (P35, A55, A155) decreases the output current but does not stall the motor. ➔ If no stall occurs, decrease the torque boost (P35, A55, A155).
Under V/f control (3) Continuous running in extremely slow speed.	Check the running speed of the inverter. ➔ Change the speed setting or replace the motor with an exclusive motor for inverters (motor with separately powered cooling fan).
(4) Overload.	Measure the inverter output current. ➔ Reduce the load. ➔ Increase the inverter capacity and motor capacity.
Under vector control with/without speed sensor (5) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the setting of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
(6) Motor defective.	Check whether the inverter output voltages (U, V and W) are well-balanced. ➔ Repair or replace the motor.

[9] The motor does not run as expected.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of function code data.	Check that function codes are correctly configured and no unnecessary configuration has been done. ➔ Configure all the function codes correctly.
	Make a note of function code data currently configured and then initialize all function code data using H03. ➔ After the above process, reconfigure function codes one by one, checking the running status of the motor.
(2) Under torque control, the inverter keeps output although the run command is OFF.	Check the setting of the automatic operation OFF function (H11). ➔ Set the data of H11 to "2" ("Coast to a stop when a run command is turned OFF") or "4" ("Coast to a stop when a run command is turned OFF" under torque control).

[10] When the motor accelerates or decelerates, the speed is not stable.

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (1) The control constants of the automatic speed regulator (ASR) are inadequate.	Check whether the automatic speed regulator (ASR) is properly adjusted under speed control. ➔ Readjust the ASR (F61 to F66, C40 to C45, C50 to C55).

[11] The motor stalls during acceleration.

Possible Causes	What to Check and Suggested Measures
Under vector control with/without speed sensor (1) Function code settings do not agree with the motor characteristics.	For exclusive motors for the FRENIC-VG: Check whether the setting of function code P02 matches the connected motor. ➔ Correct the data of P02. For other motors: ➔ Perform auto-tuning.
Under V/f control (2) The specified acceleration time is too short.	Check the data of F07, C35, C46, C56 or C66 (acceleration time). ➔ Increase the acceleration time.
Under V/f control (3) The moment of inertia of the load is large.	Measure the inverter output current. ➔ Decrease the moment of inertia of the load. ➔ Increase the inverter capacity.
Under V/f control (4) Large voltage drop on wires.	Check the terminal voltage of the motor. ➔ Use larger size wires between the inverter and motor or make the wiring distance shorter.
Under V/f control (5) The torque of the load is large.	Measure the output current. ➔ Decrease the torque of the load. ➔ Increase the inverter capacity.
Under V/f control (6) Torque generated by the motor was insufficient.	Check that increasing the torque boost (P35, A55, A155) starts the motor. ➔ Increase the value of the torque boost (P35, A55, A155).

[12] When the T-Link communications option is in use, neither a run command nor a speed command takes effect.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of the communications link operation (H30).	Check whether the setting of the communications link operation is correct (H30). ➔ Correct the data of H30. ➔ Check the status of the X terminal to which the ***LE*** command ("Enable communications link") is assigned.
(2) Incorrect setting of the transmission format (o32).	Check whether the setting of the transmission format is correct (o32). ➔ Correct the data of o32 (4W + 4W or 8W + 8W).
(3) Incorrect setting of the link number.	Check the current setting of the link number (that should be configured in hexadecimal). ➔ Review the function code list.
(4) Data not written to the I/O relay area as assigned.	Check the data held in the I/O relay area, using the MICREX loader. ➔ Investigate writing into the I/O relay area.

[13] When the SX-bus communications option is in use, neither a run command nor a speed command takes effect.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of the communications link operation (H30).	Check whether the setting of the communications link operation is correct (H30). ➔ Correct the data of H30.
(2) Terminal command ***LE*** is assigned to an X terminal, but the terminal is OFF.	Check the status of the X terminal to which the ***LE*** command ("Enable communications link") is assigned. ➔ Turn the corresponding X terminal ON.
(3) Incorrect setting of the transmission format (U11).	Check whether the transmission format selected by U11 is identical with the one selected in the system configuration definition. ➔ Correct the setting of the transmission format.
(4) Incorrect setting of the link number.	Check the current setting of the link number (that should be configured in hexadecimal). ➔ Review the function code list.
(5) Data not written to the I/O relay area as assigned.	Check the data in application programs, using the SX loader. ➔ Investigate writing into the I/O memory area.

[14] When the CC-Link communications option is in use, neither a run command nor a speed command takes effect.

Possible Causes	What to Check and Suggested Measures
(1) Incorrect setting of the communications link operation (H30).	Check whether the setting of the communications link operation is correct (H30). ➔ Correct the data of H30.
(2) Terminal command ***LE*** is assigned to an X terminal, but the terminal is OFF.	Check the status of the X terminal to which the ***LE*** command ("Enable communications link") is assigned. ➔ Turn the corresponding X terminal ON.
(3) Incorrect setting of the transmission format (o32).	Check whether the transmission format selected by o32 is identical with the one selected in the system configuration definition. ➔ Correct the setting of the transmission format.
(4) Incorrect setting of the link number.	Check the current setting of the link number (that should be configured in hexadecimal). ➔ Review the function code list.
(5) Data not written to the I/O memory area as assigned.	Check the data in application programs, using the PLC loader. ➔ Investigate writing into the I/O memory area.

[15] _ _ _ _ (under bar) appears.

Problem Although you pressed the FWD or REV key or entered a run forward command ***FWD*** or a run reverse command ***REV***, the motor did not start and an under bar (_ _ _ _) appeared on the LED monitor.

Possible Causes	What to Check and Suggested Measures
(1) The DC link bus voltage was low.	Select Menu #5 "MAINTENANCE" in Programming mode on the keypad and check the DC link bus voltage which should be 200 VDC or below for three-phase 200 V class series, and 400 VDC or below for three-phase 400 V class series. ➔ Connect the inverter to a power supply that meets its input specifications.
(2) The main power is not ON, while the auxiliary input power to the control circuit is supplied.	Check whether the main power is turned ON. ➔ Turn the main power ON. Check whether the short bar is removed from terminals P1 and P(+) or check the short bar for poor contact. ➔ Mount a short bar or DC reactor (DCR) between terminals P1 and P(+). Or tighten the fixing screw further.
(3) Although power is supplied not via the commercial power line but via the DC link bus, the main power down detection is enabled (H76 = 1).	Check the connection to the main power and check if the H76 data is set to "1" (factory default). ➔ Correct the data of H76.
(4) Breaks in wiring to the main power input terminals.	Measure the input voltage. ➔ Repair or replace the main circuit power input wires or input devices (MCCB, MC, etc.).

Chap. 13 TROUBLESHOOTING

13.5.2 Problems with inverter settings

[1] Nothing appears on the monitors.

Possible Causes	What to Check and Suggested Measures
(1) No power (neither main power nor auxiliary control power) supplied to the inverter.	Check the input voltage and interphase voltage unbalance. ➔ Turn ON a molded case circuit breaker (MCCB), a residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection) or a magnetic contactor (MC). ➔ Check for voltage drop, phase loss, poor connections, or poor contacts and fix them if necessary.
(2) The power for the control PCB did not reach a sufficiently high level.	Check if the jumper bar has been removed from terminals P1 and P(+) or if there is a poor contact between the jumper bar and those terminals. ➔ Mount a jumper bar or a DC reactor between terminals P1 and P(+). For poor contact, tighten up the screws.
(3) The keypad was not properly connected to the inverter.	Check whether the keypad is properly connected to the inverter. ➔ Remove the keypad, put it back, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem recurs.
	When running the inverter remotely, ensure that the extension cable is securely connected both to the keypad and to the inverter. ➔ Disconnect the cable, reconnect it, and see whether the problem recurs. ➔ Replace the keypad with another one and check whether the problem per recurs.

[2] The desired function code does not appear.

Possible Causes	Check and Measures
(1) The function code is not located in the current directory.	Check whether the function code is located in a different directory. ➔ Display the function codes in the directory, referring to Chapter 3, Section 3.4.4 "Programming Mode." If o codes do not appear, check whether an option board is mounted. ➔ Display the function codes in the directory, referring to Chapter 3, Section 3.4.4 "Programming Mode." **Note:** No o codes appear unless an option board is mounted.

[3] Data of function codes cannot be changed from the keypad.

Possible Causes	What to Check and Suggested Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with Menu #3 "OPR MNTR" using the keypad and then confirm whether the data of the function codes can be changed when the motor is running, referring to the function code tables. ➔ Stop the motor and then change the data of the function codes.
(2) The data of the function codes is protected.	Check the data of function code F00 (Data Protection). ➔ Change the data of F00 from "Enable data protection" (F00 = 1) to "Disable data protection" (F00 = 0).
(3) The ***WE-KP*** terminal command ("Enable data change with keypad") is not entered, though it has been assigned to a digital input terminal.	Check the data of function codes E01 through E09 and the input signal status with Menu #4 "I/O CHECK" using the keypad. ➔ Input a ***WE-KP*** command through a digital input terminal.
(4) The FUNC/DATA key was not pressed.	Check whether you have pressed the FUNC/DATA key after changing the function code data. ➔ Press the FUNC/DATA key after changing the function code data. ➔ Check that "STORING…" is displayed on the LCD monitor.
(5) The data of function code F02 cannot be changed.	Either one of the ***FWD*** and ***REV*** terminal commands is turned ON. ➔ Turn OFF both ***FWD*** and ***REV***.

[4] Data of function codes cannot be changed via the communications link.

Possible Causes	What to Check and Suggested Measures
(1) An attempt was made to change function code data that cannot be changed when the inverter is running.	Check if the inverter is running with Menu #3 "OPR MNTR" using the keypad and then confirm whether the data of the function codes can be changed when the motor is running, referring to the function code tables. ➔ Stop the motor and then change the data of the function codes.
(2) The data of the function codes is protected.	Check the data of function code H29 (Data Protection). ➔ Change the data of H29 from "1" (Enable data protection) to "0" (Disable data protection).
(3) The ***WE-LK*** terminal command ("Enable data change via communications link") is not entered, though it has been assigned to a digital input terminal.	Check the data of function codes E01 through E09 and the input signal status with Menu #4 "I/O CHECK" using the keypad. ➔ Input a ***WE-LK*** command through a digital input terminal.
(4) The "Save all function" (H02) was not executed.	Check that the "Save all function" was executed (H02 = 1). ➔ If data of function codes is changed via the communications link, execute the "Save all function"; otherwise, turning the power OFF loses the changed data.
(5) The data of function code F02 cannot be changed.	Either one of the ***FWD*** and ***REV*** terminal commands is turned ON. ➔ Turn OFF both ***FWD*** and ***REV***.

Appendices

Contents

App. A Advantageous Use of Inverters (Notes on electrical noise)

- Disclaimer: This document provides you with a summary of the Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (December 2008). It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

A.1 Effect of inverters on other devices

Inverters have been and are rapidly expanding its application fields. This paper describes the effect that inverters have on electronic devices already installed or on devices installed in the same system as inverters, as well as introducing noise prevention measures. (Refer to Section A.3 [3], "Noise prevention examples" for details.)

[1] Effect on AM radios

Phenomenon	If an inverter operates, AM radios may pick up noise radiated from the inverter. (An inverter has almost no effect on FM radios or television sets.)
Probable cause	Radios may receive noise radiated from the inverter.
Countermeasures	Inserting a noise filter on the power supply side of the inverter is effective.

[2] Effect on telephones

Phenomenon	If an inverter operates, nearby telephones may pick up noise radiated from the inverter in conversation so that it may be difficult to hear.
Probable cause	A high-frequency leakage current radiated from the inverter and motors enters shielded telephone cables, causing noise.
Countermeasures	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.

[3] Effect on pressure sensors

Phenomenon	If an inverter operates, pressure sensors may malfunction.
Probable cause	Noise may penetrate through a grounding wire into the signal line.
Countermeasures	It is effective to install a noise filter on the power supply side of the inverter or to separate the control circuit wirings from the I/O wires and grounding wires.

[4] Effect on position detectors (pulse generators, PGs)

Phenomenon	If an inverter operates, pulse generators (PGs) may cause a malfunction that shifts the stop position of a machine.
Probable cause	Erroneous pulses are liable to occur when the signal lines of the PG and power lines are bundled together.
Countermeasures	The influence of induction noise and radiation noise can be reduced by separating the PG signal lines and power lines. Providing noise filters at the input and output terminals is also an effective measure.

[5] Effect on proximity switches

Phenomenon	If an inverter operates, proximity switches (capacitance-type) may malfunction.
Probable cause	The capacitance-type proximity switches may provide inferior noise immunity.
Countermeasures	It is effective to connect a filter to the input terminals of the inverter or implement grounding wiring with a capacitor on the 0 V side of the proximity switches. The proximity switches can be replaced with superior noise immunity types such as magnetic types.

A.2 Noise

This section gives a summary of noises generated in inverters and their effects on devices subject to noise.

[1] Inverter noise

Figure A.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 six transistors (IGBT: Insulated Gate Bipolar Transistor, etc), and is used for variable speed motor control.

Switching noise is generated by high-speed on/off switching of the six transistors. At each high-speed on/off switching, noise current (i) flows to the ground through stray capacitance (C) of the inverter, I/O wire and motor. The amount of the noise current is expressed as follows:

$$i = C \cdot dv/dt$$

It 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 or off.

In addition to the main circuit of the inverter, the DC-to-DC switching power regulator (DC/DC converter), which is the power source for the control circuit of the inverter, may be a noise source in the same principles as stated above.

The frequency band of this noise over the range of several tens of MHz may affect communications devices such as AM radios, plant radios, and telephones.

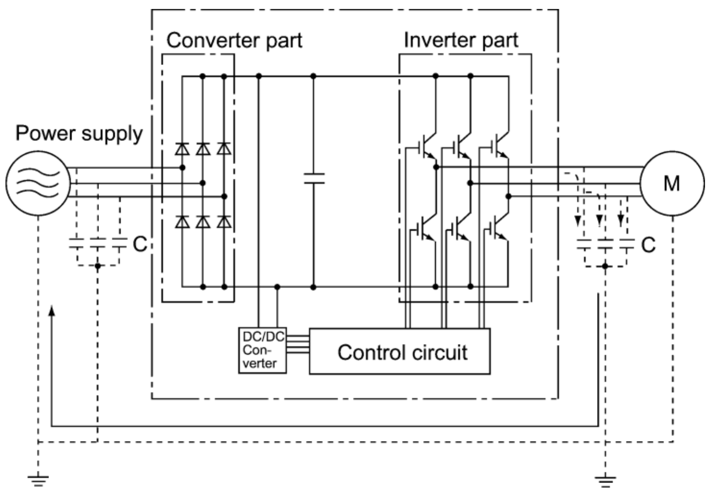


Figure A.1 Outline of Inverter Configuration

[2] Types of noise

Noise generated in an inverter is propagated through the main circuit wiring to the power supply and the motor so as to affect a wide range of applications from the power supply transformer to the motor. The various propagation routes are shown in Figure A.2. According to those routes, noises are roughly classified into three types--conduction noise, induction noise, and radiation noise.

Conduction noise propagates through routes 1) to 3), induction noise through route 4), and radiation noise through route 5). Details are described below.

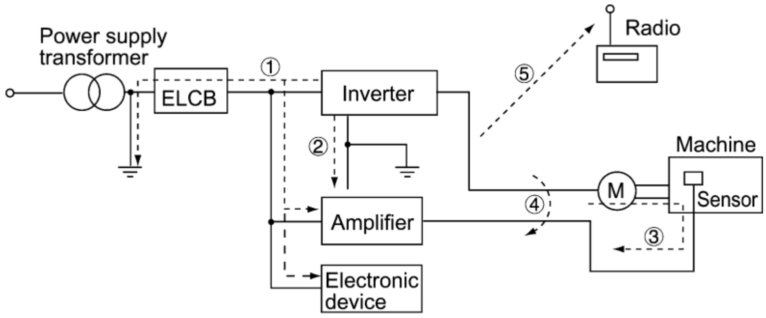


Figure A.2 Noise Propagation Routes

(1) Conduction noise

Noise generated in an inverter may propagate through the conductor and power supply so as to affect peripheral devices of the inverter (Figure A.3). This noise is called "conduction noise." Some conduction noises will propagate through the main circuit ①. If the ground wires are connected to a common ground, conduction noise will propagate through route ②. As shown in route ③, some conduction noises will propagate through signal lines or shielded wires.

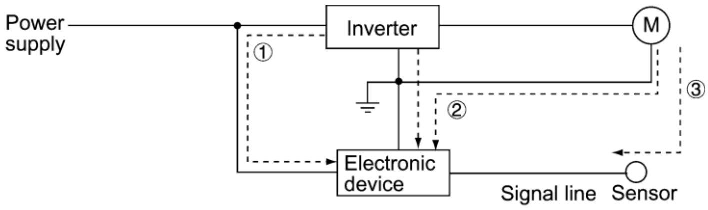


Figure A.3 Conduction Noise

(2) Induction noise

When wires or signal lines of peripheral devices are brought close to the wires on the input and output sides of the inverter through which noise current is flowing, noise will be induced into those wires and signal lines of the devices by electromagnetic induction (Figure A.4) or electrostatic induction (Figure A.5). This is called "induction noise" ④.

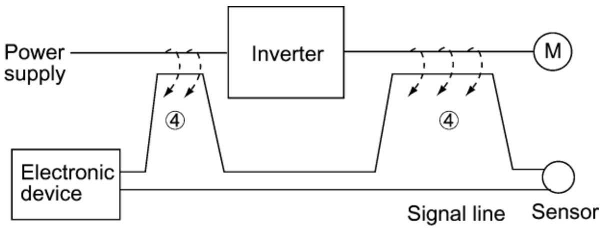


Figure A.4 Electromagnetic Induced Noise

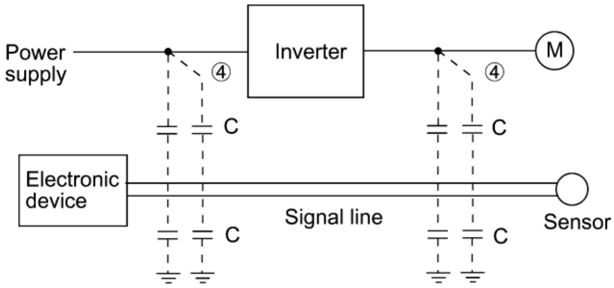


Figure A.5 Electrostatic Induced Noise

(3) Radiation noise

Noise generated in an inverter may be radiated through the air from main circuit wires or grounding wires (that act as antennas) at the input and output sides of the inverter so as to affect peripheral devices or broadcasting and radio-communications. This noise is called "radiation noise" ⑤ as shown below. Not only wires but motor frames or control system panels containing inverters may also act as antennas.

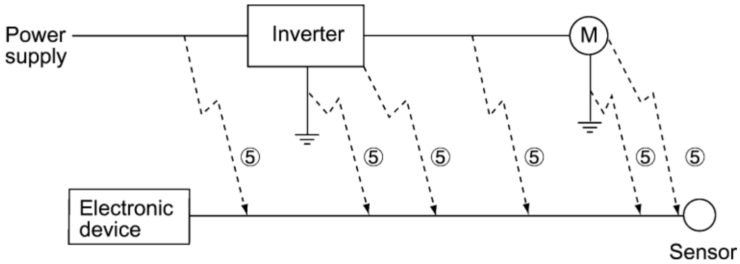


Figure A.6 Radiation Noise

A.3 Noise prevention

The more noise prevention is strengthened, the more effective. However, with the use of appropriate measures, noise problems may be resolved easily. It is necessary to implement economical noise prevention according to the noise level and the equipment conditions.

[1] Noise prevention prior to installation

Before installing an inverter in your control panel or installing an inverter panel, you need to consider noise prevention. Once noise problems occur, it will cost additional materials and time for solving them.

Noise prevention prior to installation includes:

1) Separating the wiring of main circuits and control circuits
2) Putting main circuit wiring into a metal conduit pipe
3) Using shielded wires or twisted shielded wires for control circuits.
4) Implementing appropriate grounding work and grounding wiring.

These noise prevention measures can avoid most noise problems.

[2] Implementation of noise prevention measures

There are two types of noise prevention measures--one for noise propagation routes and the other for noise receiving sides.

The basic measures for lessening the effect of noise at the receiving side include:

1) Separating the main circuit wiring from the control circuit wiring, avoiding noise effect.

The basic measures for lessening the effect of noise at the generating side include:

2) Inserting a noise filter that reduces the noise level.
3) Applying a metal conduit pipe or metal control panel that will confine noise, and
4) Applying an insulated transformer for the power supply that cuts off the noise propagation route.

Table A.1 lists the noise prevention measures, their purposes, and targeted propagation routes.

Table A.1 Noise Prevention Measures

Noise prevention method		Goal of noise prevention measures				Conduction route		
		Make it more difficult to receive noise	Cutoff noise conduction	Confine noise	Reduce noise level	Conduction noise	Induction noise	Radiation noise
Wiring and installation	Separate main circuit from control circuit	Y					Y	
	Minimize wiring distance	Y			Y		Y	Y
	Avoid parallel and bundled wiring	Y					Y	
	Use appropriate grounding	Y			Y		Y	Y
	Use shielded wire and twisted shielded wire	Y					Y	Y
	Use shielded cable in main circuit			Y				Y
	Use metal conduit pipe			Y			Y	Y
Control panel	Appropriate arrangement of devices in panel	Y					Y	Y
	Metal control panel			Y			Y	Y
Anti-noise device	Line filter	Y			Y	Y		Y
	Insulation transformer		Y			Y		Y
Measures at noise receiving sides	Use a passive capacitor for control circuit	Y					Y	Y
	Use ferrite core for control circuit	Y					Y	Y
	Line filter	Y				Y		
Others	Separate power supply systems	Y	Y			Y		
	Lower the carrier frequency				Y	Y	Y	Y

Y: Effective, Blank: Not effective

App.

What follows is noise prevention measures for the inverter drive configuration.

(1) Wiring and grounding

As shown in Figure A.7, separate the main circuit wiring from control circuit wiring as far as possible regardless of being located inside or outside the system control panel containing an inverter. Use shielded wires and twisted shielded wires that will block out extraneous noises, and minimize the wiring distance. Also avoid bundled wiring of the main circuit and control circuit or parallel wiring.

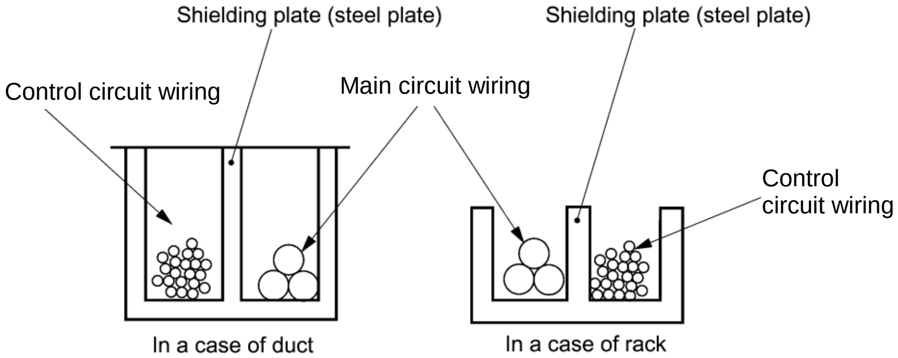


Figure A.7 Separate Wiring

For the main circuit wiring, use a metal conduit pipe and connect its wires to the ground to prevent noise propagation (refer to Figure A.8).

The shield (braided wire) of a shielded wire, in principle, should be 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 A.9).

The grounding is effective not only to reduce the risk of electrical shocks due to leakage current, but also to block noise penetration and radiation. Corresponding to the main circuit voltage, the grounding work should be Class C (300 to 600 VAC, grounding resistance: 10Ω or less) and Class D (300 VAC or less, grounding resistance: 100Ω or less). Each ground wire is to be provided with its own ground or separately wired to a grounding point.

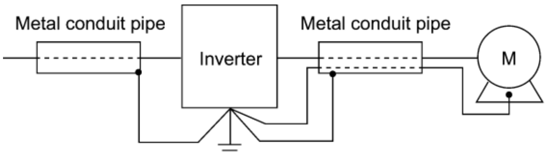


Figure A.8 Grounding of Metal Conduit Pipe

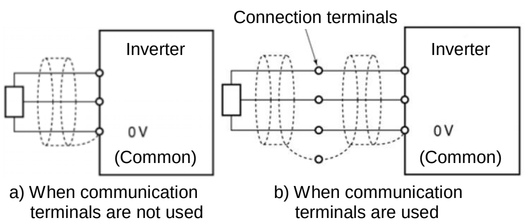


Figure A.9 Treatment of Braided Wire of Shielded Wire

(2) Control panel

The system control panel containing an inverter is generally made of metal, which can shield noise radiated from the inverter itself.

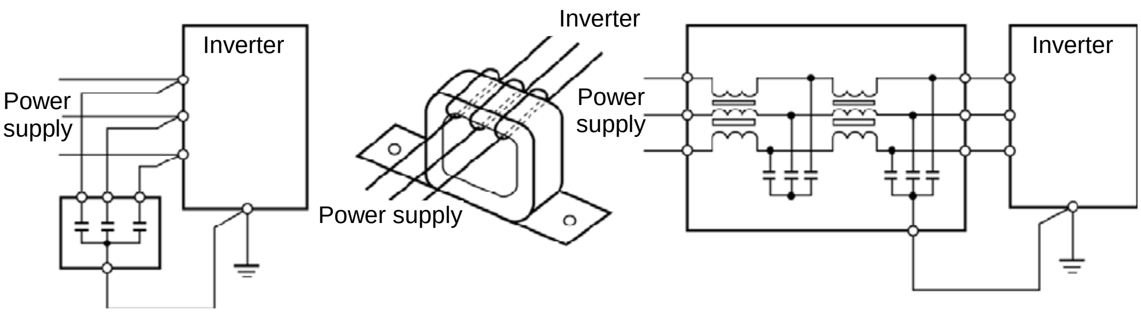
When installing other electronic devices such as a programmable logic controller in the same control panel, be careful with the layout of each device. If necessary, arrange shield plates between the inverter and peripheral devices.

(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 insulation transformer should be used (refer to Figure A.10).

Line filters are available in these types--the simplified type such as a capacitive filter to be connected in parallel to the power supply line and an inductive filter to be connected in series to the power supply line and the orthodox type such as an LC filter to meet noise regulations. Use them according to the targeted effect for reducing noise.

Insulation transformers include common insulated transformers, and shielded transformers. These transformers have different effectiveness in blocking noise propagation.



(a) Capacitive filter (b) Inductive filter (zero-phase reactor) (c) Input LC filter

Figure A.10 Various Filters and their Connection

(4) Noise prevention measures at the receiving side

It is important to strengthen the noise immunity of those electronic devices installed in the same control panel as the inverter or located near an inverter. Line filters, shielded or twisted shielded wires are used to block the penetration of noise in the control circuit wirings of these devices. The following treatments are also implemented.

1) Lower the circuit impedance by connecting capacitors or resistors to the input and output terminals of the signal circuit in parallel.
2) Increase the circuit impedance for noise by inserting choke coils in series in the signal circuit or passing signal lines through ferrite core beads. It is also effective to widen the signal base lines (0 V line) or grounding lines.

(5) Other

The level of generating/propagating noise will change with the carrier frequency of the inverter. The higher the carrier frequency, the higher the noise level.

In an inverter whose 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] Noise prevention examples

Table A.2 lists examples of the measures to prevent noise generated by a running inverter.

Table A.2 Examples of Noise Prevention Measures

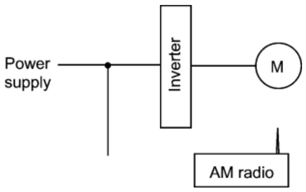
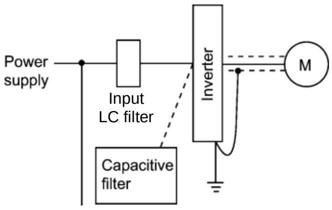
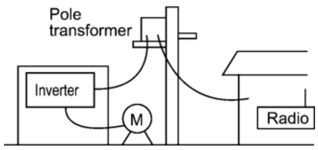
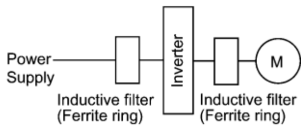
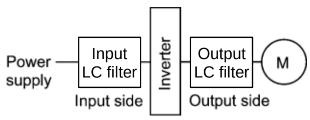
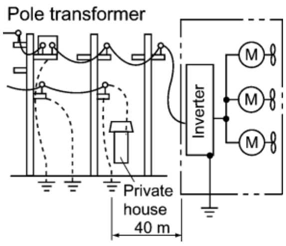
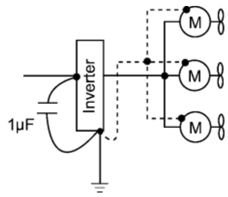
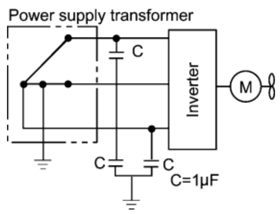
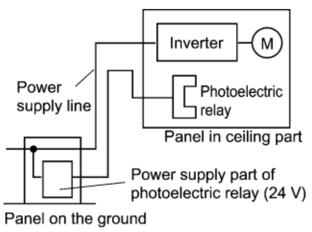
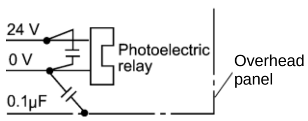
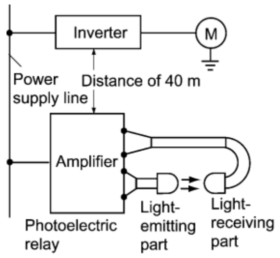
No.	Target device	Phenomena	Noise prevention measures	Notes
1	AM radio	When operating an inverter, noise enters into an AM radio broadcast (500 to 1500 kHz).  <Possible cause> The AM radio may receive noise radiated from wires at the power supply and output sides of the inverter.	1) Install an LC filter at the power supply side of the inverter. (In some cases, a capacitive filter may be used as a simple method.) 2) Install a metal conduit wiring between the motor and inverter.  Note: Minimize the distance between the input LC filter and inverter as short as possible (within 1 m).	1) The radiation noise of the wiring can be reduced. 2) The conduction noise to the power supply side can be reduced. Note: Sufficient improvement may not be expected in narrow regions such as between mountains.
2	AM radio	When operating an inverter, noise enters into an AM radio broadcast (500 to 1500 kHz).  <Possible cause> The AM radio may receive 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.  The number of turns of the zero-phase reactor (or ferrite ring) should be as large as possible. In addition, wiring between the inverter and the zero-phase reactor (or ferrite ring) should be as short as possible. (within 1 m) 2) When further improvement is necessary, install LC filters.  	1) The radiation noise of the wiring can be reduced.

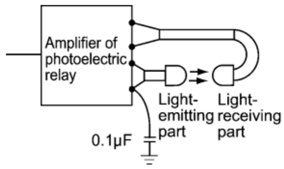
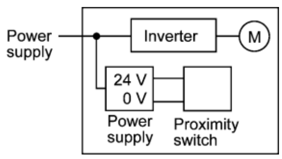
Table A.2 Continued

No.	Target device	Phenomena	Noise prevention measures	Notes
3	Tele-phone (in a common private residence at a distance of 40 m)	When driving a ventilation fan with an inverter, noise enters a telephone in a private residence at a distance of 40m.  <Possible cause> 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 1 μF capacitor between the input terminal of the inverter and ground. 	1) The effect of the inductive filter and LC filter may not be expected because of sound frequency component. 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 ground. 
4	Photo-electric relay	A photoelectric relay malfunctioned when the inverter runs the motor. [The inverter and motor are installed in the same place (for overhead traveling)]  <Possible cause> 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 25 mm over a distance of 30 to 40 m. Due to conditions of the installation, these lines cannot be separated.	1) As a temporary measure, Insert a 0.1 μF capacitor between the 0 V terminal of the power supply circuit in the detection unit of the overhead photoelectric relay and the overhead frame.  2) As a permanent measure, move the 24 V 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 30 cm. 2) When separation is impossible, signals can be received and sent with dry contacts etc. 3) Do not wire low-current signal lines and power lines in parallel.

App.

Table A.2 Continued

<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>Photo-electric relay</td><td>A photoelectric relay malfunctioned when the inverter was operated.


<Possible cause>
Although the inverter and photoelectric relay are separated by a sufficient distance but 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 0.1 µF capacitor between the output common terminal of the amplifier of the photoelectric relay and the frame.

</td><td>1) If a low-current circuit at the malfunctioning side is observed, the measures may be simple and economical.</td></tr>
<tr><td>6</td><td>Prox-imity switch (capaci-tance type)</td><td>A proximity switch malfunctioned.


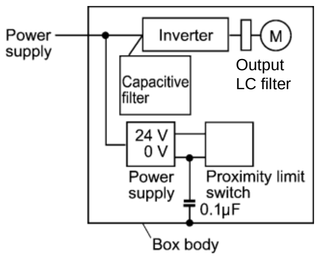
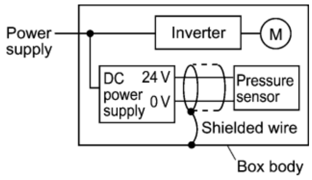
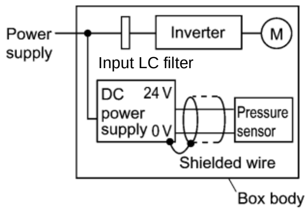
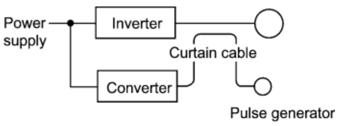
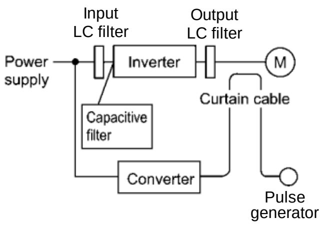
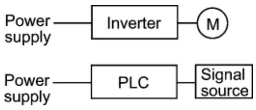
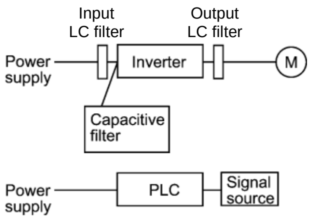
<Possible cause>
It is considered that the capacitance type proximity switch is susceptible to conduction and radiation noise because of its low noise immunity.</td><td>1) Install an LC filter at the output side of the inverter.
2) Install a capacitive filter at the input side of the inverter.
3) Ground the 0 V (common mode) line of the DC power supply of the proximity switch through a capacitor to the box body of the machine.

</td><td>1) Noise generated in the inverter can be reduced.
2) The switch is superseded by a proximity switch of superior noise immunity (such as a magnetic type).</td></tr>
</table>

Table A.2 Continued

No.	Target device	Phenomena	Noise prevention measures	Notes
7	Pressure sensor	A pressure sensor malfunctioned.  <Possible cause> The pressure sensor may malfunction due to noise that came from the box body through the shielded wire.	1) Install an LC filter on the input side of the inverter. 2) Connect the shield of the shielded wire of the pressure sensor to the 0 V line (common mode) of the pressure sensor, changing the original connection.  	1) The shielded parts of shield wires for sensor signals are connected to a common point in the system. 2) Conduction noise from the inverter can be reduced.
8	Position detector (pulse generator)	Erroneous-pulse outputs from a pulse converter caused a shift in the stop position of a crane.  <Possible cause> Erroneous pulses may be outputted by induction noise since the power line of the motor and the signal line of the PG are bundled together.	1) Install an LC filter and a capacitive filter at the input side of the inverter. 2) Install an LC filter at the output side of the inverter.  	1) This is an example of a measure where the power line and signal line cannot be separated. 2) Induction noise and radiation noise at the output side of the inverter can be reduced.
9	Program mable logic controller (PLC)	The PLC program malfunctions.  <Possible cause> Since the power supply system is the same for the PLC (programmable logic controller) 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. 2) Install an LC filter on the output side of the inverter. 3) Lower the carrier frequency of the inverter.  	1) Total conduction noise and induction noise in the electric line can be reduced.

App. B Japanese Guideline for Suppressing Harmonics by Customers Receiving High Voltage or Special High Voltage

- Disclaimer: This document provides you with a translated summary of the Guideline of the Ministry of Economy, Trade and Industry. It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

Agency of Natural Resource and Energy of Japan published the following two guidelines for suppressing harmonic noise in September 1994.

(1) Guideline for suppressing harmonics in home electric and general-purpose appliances

(2) Guideline for suppressing harmonics by customers receiving high voltage or special high voltage

Assuming that electronic devices generating high harmonics will be increasing, these guidelines are to establish regulations for preventing high frequency noise interference on devices sharing the power source. These guidelines should be applied to all devices that are used on the commercial power lines and generate harmonic current. This section gives a description limited to general-purpose inverters.

B.1 Application to general-purpose inverters

[1] Guideline for suppressing harmonics in home electric and general-purpose appliances

Our three-phase, 200 V class series inverters of 3.7 kW or less (FRENIC-MEGA series) were the products of which were restricted by the "Guideline for Suppressing Harmonics in Home Electric and General-purpose Appliances" (established in September 1994 and revised in October 1999) issued by the Ministry of Economy, Trade and Industry.

The above restriction, however, was lifted when the Guideline was revised in January 2004. Since then, the inverter makers have individually imposed voluntary restrictions on the harmonics of their products.

We, as before, recommend that you connect a reactor (for suppressing harmonics) to your inverter.

[2] Guideline for suppressing harmonics by customers receiving high voltage or special high voltage

Unlike other guidelines, this guideline is not applied to the equipment itself such as a general-purpose inverter, but is applied to each large-scale electric power consumer for total amount of harmonics. The consumer should calculate the harmonics generated from each piece of equipment currently used on the power source transformed and fed from the high or special high voltage source.

(1) Scope of regulation

In principle, the guideline applies to the customers that meet the following two conditions:

- The customer receives high voltage or special high voltage.
- The "equivalent capacity" of the converter load exceeds the standard value for the receiving voltage (50 kVA at a receiving voltage of 6.6 kV).

Appendix B.2 [1] "Calculation of equivalent capacity (Pi)" gives you some supplemental information with regard to estimation for the equivalent capacity of an inverter according to the guideline.

(2) Regulation

The level (calculated value) of the harmonic current that flows from the customer's receiving point out to the system is subjected to the regulation. The regulation value is proportional to the contract demand. The regulation values specified in the guideline are shown in Table B.1.

Appendix B.2 gives you some supplemental information with regard to estimation for the equivalent capacity of the inverter for compliance to "Japanese guideline for suppressing harmonics by customers receiving high voltage or special high voltage."

Table B.1 Upper Limits of Harmonic Outflow Current per kW of Contract Demand (mA/kW)

Receiving voltage	5th	7th	11th	13th	17th	19th	23rd	Over 25th
6.6 kV	3.5	2.5	1.6	1.3	1.0	0.90	0.76	0.70
22 kV	1.8	1.3	0.82	0.69	0.53	0.47	0.39	0.36

(3) When the regulation applied

The guideline has been applied. As the application, the estimation for "Voltage distortion factor" required as the indispensable conditions when entering into the consumer's contract of electric power is already expired.

B.2 Compliance to the harmonic suppression for customers receiving high voltage or special high voltage

When calculating the required matters related to inverters according to the guideline, follow the terms listed below. The following descriptions are based on "Technical document for suppressing harmonics" (JEAG 9702-1995) published by the Japan Electrical Manufacturer's Association (JEMA).

[1] Calculation of equivalent capacity (Pi)

The equivalent capacity (Pi) may be calculated using the equation of (input rated capacity) x (conversion factor). However, catalogs of conventional inverters do not contain input rated capacities, so a description of the input rated capacity is shown below:

(1) "Inverter rated capacity" corresponding to "Pi"

- In the guideline, the conversion factor of a 6-pulse converter is used as reference conversion factor 1. It is, therefore, necessary to express the rated input capacity of inverters in a value including harmonic component current equivalent to conversion factor 1.
- Calculate the input fundamental current I_1 from the kW rating and efficiency of the load motor, as well as the efficiency of the inverter. Then, calculate the input rated capacity as shown below:

$$\text{Input rated capacity} = \sqrt{3} \times (\text{power supply voltage}) \times I_1 \times 1.0228/1000 \ \ (\text{kVA})$$

where 1.0228 is the 6-pulse converter's value of (effective current)/(fundamental current).

- When a general-purpose motor or inverter motor is used, the appropriate value shown in Table B.2 can be used. Select a value based on the kW rating of the motor used, irrespective of the inverter type.

Note: The input rated capacity shown above is for the dedicated use in the equation to calculate capacity of the inverters, following the guideline. Note that the capacity cannot be applied to the reference for selection of the equipment or wires to be used in the inverter input circuits.

For selection of capacity for the peripheral equipment, refer to the catalogs or technical documents issued from their manufacturers.

Table B.2 "Input Rated Capacities" of General-purpose Inverters Determined by the Applicable Motor Ratings

Applicable motor rating (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
Pi (kVA)	200 V	0.57	0.97	1.95	2.81	4.61	6.77	9.07	13.1	17.6	21.8
	400 V	0.57	0.97	1.95	2.81	4.61	6.77	9.07	13.1	17.6	21.8

Applicable motor rating (kW)		22	30	37	45	55	75	90	110	132	160
Pi (kVA)	200 V	25.9	34.7	42.8	52.1	63.7	87.2	104	127		
	400 V	25.9	34.7	42.8	52.1	63.7	87.2	104	127	153	183

Applicable motor rating (kW)		200	220	250	280	315	355	400	450	500	630
Pi (kVA)	200 V										
	400 V	229	252	286	319	359	405	456	512	570	718

(2) Values of "Ki (conversion factor)"

Depending on whether an optional ACR (AC reactor) or DCR (DC reactor) is used, apply the appropriate conversion factor specified in the appendix to the guideline. The values of the conversion factor are listed in Table B.3.

Table B.3 "Conversion Factors Ki" for General-purpose Inverters Determined by Reactors

Circuit category	Circuit type		Conversion factor Ki	Main applications
3	3-phase bridge (capacitor smoothing)	w/o reactor	K31=3.4	• General-purpose inverters
		w/- reactor (ACR)	K32=1.8	• Elevators
		w/- reactor (DCR)	K33=1.8	• Refrigerators, air conditioning systems
		w/- reactors (ACR and DCR)	K34=1.4	• Other general appliances

Note Some models are equipped with a reactor as a standard accessory.

[2] Calculation of Harmonic Current

(1) Value of "input fundamental current"

- When you calculate the amount of harmonics according to Table 2 in Appendix of the Guideline, you have to previously know the input fundamental current.
- Apply the appropriate value shown in Table B.4 based on the kW rating of the motor, irrespective of the inverter type or whether a reactor is used.

Note If the input voltage is different, calculate the input fundamental current in inverse proportion to the voltage.

Table B.4 "Input Fundamental Currents" of General-purpose Inverters Determined by the Applicable Motor Ratings

Applicable motor rating (kW)		0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5
Input fundamental current (A)	200 V	1.62	2.74	5.50	7.92	13.0	19.1	25.6	36.9	49.8	61.4
	400 V	0.81	1.37	2.75	3.96	6.50	9.55	12.8	18.5	24.9	30.7
6.6 kV converted value (mA)		49	83	167	240	394	579	776	1121	1509	1860

Applicable motor rating (kW)		22	30	37	45	55	75	90	110	132	160
Input fundamental current (A)	200 V	73.1	98.0	121	147	180	245	293	357		
	400 V	36.6	49.0	60.4	73.5	89.9	123	147	179	216	258
6.6 kV converted value (mA)		2220	2970	73.5	4450	5450	7450	8910	10850	13090	15640

Applicable motor rating (kW)		200	220	250	280	315	355	400	450	500	630
Input fundamental current (A)	200 V										
	400 V	323	355	403	450	506	571	643	723	804	1013
6.6 kV converted value (mA)		19580	21500	24400	27300	30700	34600	39000	43800	48700	61400

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(2) Calculation of harmonic current

Usually, calculate the harmonic current according to the Sub-table 3 "Three-phase bridge rectifier with the smoothing capacitor" in Table 2 of the Guideline's Appendix. Table B.5 lists the contents of the Sub-table 3.

Table B.5 Generated Harmonic Current (%), 3-phase Bridge Rectifier (Capacitor Smoothing)

Degree	5th	7th	11th	13th	17th	19th	23rd	25th
w/o a reactor	65	41	8.5	7.7	4.3	3.1	2.6	1.8
w/- a reactor (ACR)	38	14.5	7.4	3.4	3.2	1.9	1.7	1.3
w/- a reactor (DCR)	30	13	8.4	5.0	4.7	3.2	3.0	2.2
w/- reactors (ACR and DCR)	28	9.1	7.2	4.1	3.2	2.4	1.6	1.4

- ACR: 3%
- DCR: Accumulated energy equal to 0.08 to 0.15 ms (100% load conversion)
- Smoothing capacitor: Accumulated energy equal to 15 to 30 ms (100% load conversion)
- Load: 100%

Calculate the harmonic current of each degree using the following equation:

$$\text{nth harmonic current (A)} = \text{Fundamental current (A)} \times \frac{\text{Generated nth harmonic current (\%)}}{100}$$

(3) Maximum availability factor

- For a load for elevators, which provides intermittent operation, or a load with a sufficient designed motor rating, reduce the current by multiplying the equation by the "maximum availability factor" of the load.
- The "maximum availability factor of an appliance" means the ratio of the capacity of the harmonic generator in operation at which the availability reaches the maximum, to its total capacity, and the capacity of the generator in operation is an average for 30 minutes.
- In general, the maximum availability factor is calculated according to this definition, but the standard values shown in Table B.6 are recommended for inverters for building equipment.

Table B.6 Availability Factors of Inverters, etc. for Building Equipment (Standard Values)

Equipment type	Inverter capacity category	Single inverter availability
Air conditioning system	200 kW or less	0.55
	Over 200 kW	0.60
Sanitary pump	———	0.30
Elevator	———	0.25
Refrigerator, freezer	50 kW or less	0.60
UPS (6-pulse)	200 kVA	0.60

Correction coefficient according to contract demand level

Since the total availability factor decreases if the scale of a building increases, calculating reduced harmonics with the correction coefficient β defined in Table B.7 is permitted.

Table B.7 Correction Coefficient according to the Building Scale

Contract demand (kW)	Correction coefficient β
300	1.00
500	0.90
1000	0.85
2000	0.80

Note: If the contract demand is between two specified values listed in Table B.7, calculate the value by interpolation.

Note: The correction coefficient β is to be determined as a matter of consultation between the customer and electric power company for the customers receiving the electric power over 2000 kW or from the special high voltage lines.

(4) Degree of harmonics to be calculated

The higher the degree of harmonics, the lower the current flows. This is the property of harmonics generated by inverters so that the inverters are covered by "The case not causing a special hazard" of the term (3) in the above Appendix for the 9th or higher degrees of the harmonics.

Therefore, "It is sufficient that the 5th and 7th harmonic currents should be calculated."

[3] Examples of calculation

(1) Equivalent capacity

Example of loads	Input capacity and No. of inverters	Conversion factor	Equivalent capacity
[Example 1] 400 V, 3.7 kW, 10 units w/- AC reactor and DC reactor	4.61 kVA × 10 units	K32 = 1.4	4.61 × 10 × 1.4 = 64.54 kVA
[Example 2] 400 V, 1.5 kW, 15 units w/- AC reactor	2.93 kVA × 15 units	K34 = 1.8	2.93 × 15 × 1.8 = 79.11 kVA
	Refer to Table B.2.	Refer to Table B.3.	

(2) Harmonic current every degrees

[Example 1] 400 V, 3.7 kW 10 units, w/- AC reactor, and maximum availability: 0.55

Fundamental current onto 6.6 kV lines (mA)	Harmonic current onto 6.6 kV lines (mA)							
394 × 10 = 3940 3940 × 0.55 = 2167	5th (38%)	7th (14.5%)	11th (7.4%)	13th (3.4%)	17th (3.2%)	19th (1.9%)	23rd (1.7%)	25th (1.3%)
	823.5	314.2						
Refer to Tables B.4 and B.6.	Refer to Table B.5.							

[Example 2] 400 V, 3.7 kW, 15 units, w/- AC reactor and DC reactor, and maximum availability: 0.55

Fundamental current onto 6.6 kV lines (mA)	Harmonic current onto 6.6 kV lines (mA)							
394 × 15 = 5910 5910 × 0.55 = 3250.5	5th (28%)	7th (9.1%)	11th (7.2%)	13th (4.1%)	17th (3.2%)	19th (2.4%)	23rd (1.6%)	25th (1.4%)
	910.1	295.8						
Refer to Tables B.4 and B.6.	Refer to Table B.5.							

App. C Effect on Insulation of General-purpose Motors Driven with 400 V Class Inverters

- Disclaimer: This document provides you with a summary of the Technical Document of the Japan Electrical Manufacturers' Association (JEMA) (March, 1995). It is intended to apply to the domestic market only. It is only for reference for the foreign market. -

Preface

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.

📖 Refer to A.2 [1] "Inverter noise" for details of the principle of inverter operation.

C.1 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 that of the source voltage (about 620 V in case of an input voltage of 440 VAC). 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 high voltage to the motor terminals. (Refer to Figure C.1)

This voltage sometimes reaches up to about twice that of the inverter DC voltage (620 V x 2 = approximately 1,200 V) depending on a switching speed of the inverter elements and wiring conditions.

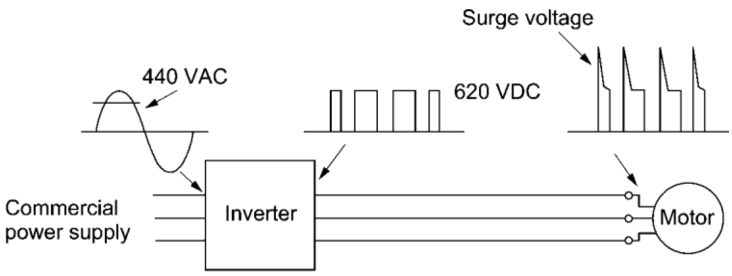
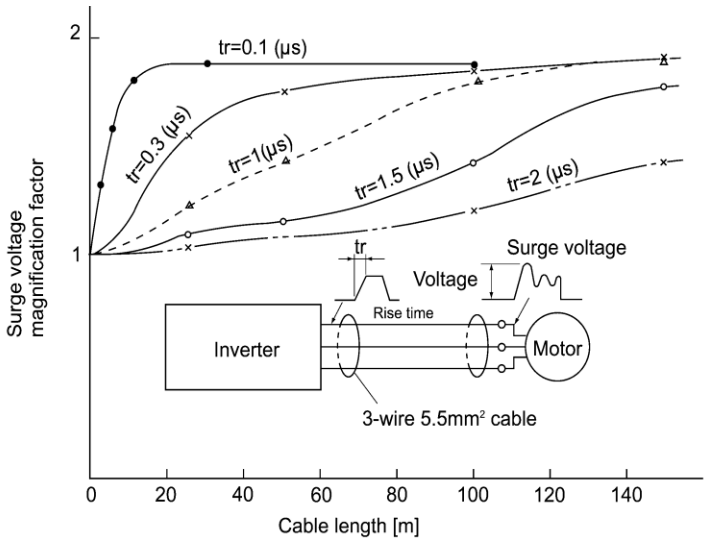


Figure C.1 Voltage Waveform of Individual Portions

A measured example in Figure C.2 illustrates the 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 the inverter DC voltage.

The shorter a pulse rise time becomes, the higher the motor terminal voltage rises even in the case of a short wiring length.



IGBT corresponds to
tr = 0.1 to 0.3 μs.
Bipolar transistor corresponds to
tr = 0.3 to 1 μs.
The case when an output reactor and/or a filter are inserted corresponds to
tr > 1 μs.
Surge voltage magnification factor :
Magnification factor against DC voltage E

Excerpt from [J. IEE Japan, Vol. 107, No. 7, 1987]

Figure C.2 Measured Example of Wiring Length and Peak Value of Motor Terminal Voltage

C.2 Effect of surge voltages

The surge voltages originating in LC resonance of wiring may be applied to the motor terminals and depending on their magnitude sometimes cause damage to the motor insulation.

When the motor is driven with a 200 V class inverter, the dielectric strength of the insulation is no problem since the peak value at the motor terminal voltage increases twice due to the surge voltages (the DC voltage is only about 300 V).

But in case of a 400 V class inverter, the DC voltage is approximately 600 V and depending on the wiring length, the surge voltages may greatly increase and sometimes result in damage to the insulation.

App.

C.3 Countermeasures against surge voltages

When driving a motor with a 400 V class inverter, the following are countermeasures against damage to the motor insulation by the surge voltages.

[1] Using a surge suppressor unit, SSU

The surge suppressor unit (SSU) is a newly structured unit using circuits based on the impedance-matching theory of a transmission line. Just connecting the SSU to the surge suppressor cable of the existing equipment can greatly reduce the surge voltage that results in a motor dielectric breakdown.

For 50 m of wiring length: SSU 50TA-NS

For 100 m of wiring length: SSU 100TA-NS

[2] Suppressing surge voltages

There are two ways for suppressing the surge voltages, one is to reduce the voltage rise time and another is to reduce the voltage peak value.

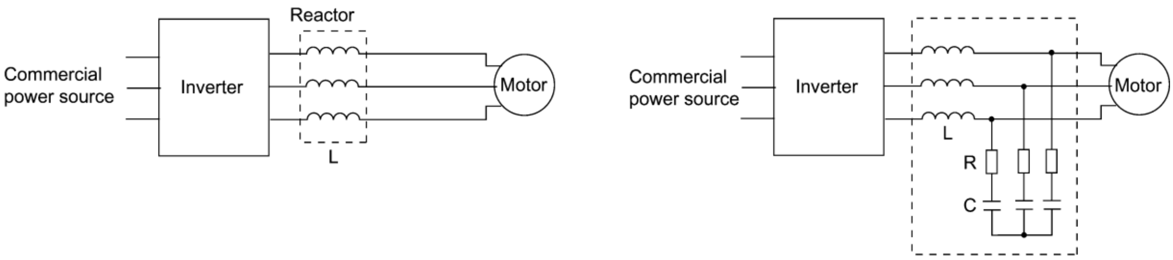
(1) Output reactor

If wiring length is relatively short, the surge voltages can be suppressed by reducing the voltage rise time (dv/dt) with the installation of an AC reactor on the output side of the inverter. (Refer to Figure C.3 (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 C.3 (2).)



(1) Output reactor (2) Output filter

Figure C.3 Method to Suppress Surge Voltage

Tip: If the wiring length between the inverter and the motor is comparatively long, the crest value of the surge voltage can be suppressed by connecting a surge suppressor unit (SSU) to the motor terminal. For details, refer to Chapter 8, Section 8.5.1.4 "Surge suppression unit (SSU)."

[3] Using motors with enhanced insulation

Enhanced insulation of a motor winding allows its surge withstanding to be improved.

C.4 Regarding existing equipment

[1] In case of a motor being driven with 400 V class inverter

A survey over the last five years 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 1,100 V and most of the damage occurs several months after commissioning the inverter. Therefore there seems to be little probability of occurrence of motor insulation damage after a lapse of several months of commissioning.

[2] In case of an existing motor driven using a newly installed 400 V class inverter

We recommend suppressing the surge voltages with the ways shown in Section C.3.

App. D Inverter Generating Loss

The table below lists the inverter generating loss.

●HD specification generating loss

Power supply voltage	Standard applicable motor capacity [kW]	Inverter type	Low carrier		Medium carrier (At time of F26 factory default setting)	High carrier	
			F26 [kHz]	Generating loss [W]	Generating loss [W]	F26 [kHz]	Generating loss [W]
Three-phase 200 V	0.75	FRN0.75VG1S-2J	2	70	95	15	100
	1.5	FRN1.5VG1S-2J	2	100	125	15	130
	2.2	FRN2.2VG1S-2J	2	130	165	15	170
	3.7	FRN3.7VG1S-2J	2	190	245	15	260
	5.5	FRN5.5VG1S-2J	2	240	295	15	310
	7.5	FRN7.5VG1S-2J	2	300	390	15	415
	11	FRN11VG1S-2J	2	450	580	15	620
	15	FRN15VG1S-2J	2	540	670	15	700
	18.5	FRN18.5VG1S-2J	2	660	825	15	860
	22	FRN22VG1S-2J	2	790	995	15	1040
	30	FRN30VG1S-2J	2	1300	1400	15	1450
	37	FRN37VG1S-2J	2	1300	1500	15	1550
	45	FRN45VG1S-2J	2	1450	1600	15	1600
	55	FRN55VG1S-2J	2	1750	1900	15	1900
	75	FRN75VG1S-2J	2	2300	2450	10	2550
	90	FRN90VG1S-2J	2	2750	2900	10	3050
Three-phase 400 V	3.7	FRN3.7VG1S-4J	2	150	215	15	230
	5.5	FRN5.5VG1S-4J	2	170	280	15	300
	7.5	FRN7.5VG1S-4J	2	230	375	15	400
	11	FRN11VG1S-4J	2	300	480	15	520
	15	FRN15VG1S-4J	2	360	560	15	610
	18.5	FRN18.5VG1S-4J	2	440	715	15	770
	22	FRN22VG1S-4J	2	510	835	15	900
	30	FRN30VG1S-4J	2	850	1100	15	1150
	37	FRN37VG1S-4J	2	1050	1400	15	1450
	45	FRN45VG1S-4J	2	1150	1500	15	1600
	55	FRN55VG1S-4J	2	1400	1850	15	1950
	75	FRN75VG1S-4J	2	1750	1950	10 *1	2150
	90	FRN90VG1S-4J	2	2000	2350	10 *1	2600
	110	FRN110VG1S-4J	2	2400	2750	10 *1	3050
	132	FRN132VG1S-4J	2	2650	3000	10 *1	3300
	160	FRN160VG1S-4J	2	3200	3650	10 *1	4000
	200	FRN200VG1S-4J	2	4000	4550	10 *1	5000
	220	FRN220VG1S-4J	2	4500	5100	10 *1	5600
	280	FRN280VG1S-4J	2	5500	6300	10 *1	6900
	315	FRN315VG1S-4J	2	6250	7100	10 *1	7800
	355	FRN355VG1S-4J	2	6750	7650	10 *1	8450
	400	FRN400VG1S-4J	2	7650	8750	10 *1	9650
	500	FRN500VG1S-4J	2	9950	10700	5 *1	10700
	630	FRN630VG1S-4J	2	12350	13300	5 *1	13300

(*1) If the generating loss set in F26 exceeds the value specified in this table, it is set to the same generating loss as that applied with the high carrier set regardless of the value in F26.

App.

●LD specification generating loss

Power supply voltage	Standard applicable motor capacity [kW]	Inverter type	Low carrier		Medium carrier (At time of F26 factory default setting)	High carrier	
			F26 [kHz]	Generating loss [W]	Generating loss [W]	F26 [kHz]	Generating loss [W]
Three-phase 200 V	37	FRN30VG1S-2J	2	1650	1650	10 *1	1750
	45	FRN37VG1S-2J	2	1650	1650	10 *1	1850
	55	FRN45VG1S-2J	2	1850	1850	10 *1	1950
	75	FRN55VG1S-2J	2	2250	2300	10 *1	2400
	90	FRN75VG1S-2J	2	2700	2800	5 *1	2800
	110	FRN90VG1S-2J	2	3250	3350	5 *1	3350
Three-phase 400 V	37	FRN30VG1S-4J	2	1050	1050	10 *1	1250
	45	FRN37VG1S-4J	2	1300	1300	10 *1	1550
	55	FRN45VG1S-4J	2	1400	1400	10 *1	1700
	75	FRN55VG1S-4J	2	2000	2400	5 *1	2400
	90	FRN75VG1S-4J	2	2100	2250	5 *1	2250
	110	FRN90VG1S-4J	2	2350	2250	5 *1	2250
	132	FRN110VG1S-4J	2	2850	3050	5 *1	3050
	160	FRN132VG1S-4J	2	3150	3400	5 *1	3400
	200	FRN160VG1S-4J	2	4050	4350	5 *1	4350
	220	FRN200VG1S-4J	2	4400	4750	5 *1	4750
	280	FRN220VG1S-4J	2	5850	6200	5 *1	6200
	355	FRN280VG1S-4J	2	6750	7300	5 *1	7300
	400	FRN315VG1S-4J	2	7800	8350	5 *1	8350
	450	FRN355VG1S-4J	2	8450	9100	5 *1	9100
	500	FRN400VG1S-4J	2	9600	10350	5 *1	10350
	630	FRN500VG1S-4J	2	12050	12950	5 *1	12950
	710	FRN630VG1S-4J	2	13500	13500	-	-

(*1) If the generating loss set in F26 exceeds the value specified in this table, it is set to the same generating loss as that applied with the high carrier set regardless of the value in F26.

●MD specification generating loss

Power supply voltage	Standard applicable motor capacity [kW]	Inverter type	Low carrier (At time of F26 factory default setting)	Medium carrier	
			Generating loss [W]	F26 [kHz]	Generating loss [W]
Three-phase 400 V	110	FRN90VG1S-4J	2250	-	-
	132	FRN110VG1S-4J	2700	-	-
	160	FRN132VG1S-4J	3050	-	-
	200	FRN160VG1S-4J	3900	-	-
	220	FRN200VG1S-4J	4250	-	-
	250	FRN220VG1S-4J	4850	-	-
	315	FRN280VG1S-4J	5850	-	-
	355	FRN315VG1S-4J	6650	-	-
	400	FRN355VG1S-4J	7250	-	-
	450	FRN400VG1S-4J	8250	-	-

App. E Conversion from SI Units

All expressions given in Chapter 3, "SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES" are based on SI units (The International System of Units). This section explains how to convert expressions to other units.

[1] Conversion of units

(1) Force

- 1 (kgf) ≈ 9.8 (N)
- 1 (N) ≈ 0.102 (kgf)

(2) Torque

- 1 (kgf·m) ≈ 9.8 (N·m)
- 1 (N·m) ≈ 0.102 (kgf·m)

(3) Work and energy

- 1 (kgf·m) ≈ 9.8 (N·m) = 9.8(J) = 9.8 (W·s)

(4) Power

- 1 (kgf·m/s) ≈ 9.8 (N·m/s) = 9.8 (J/s) = 9.8(W)
- 1 (N·m/s) ≈ 1 (J/s) = 1 (W) ≈ 0.102 (kgf·m/s)

(5) Rotation speed

- $1\ (\text{r/min}) = \frac{2\pi}{60}\ (\text{rad/s}) \approx 0.1047\ (\text{rad/s})$
- $1\ (\text{rad/s}) = \frac{60}{2\pi}\ (\text{r/min}) \approx 9.549\ (\text{r/min})$

(6) Inertia constant

J (kg·m^2) : moment of inertia

GD^2 (kg·m^2) : flywheel effect

- $GD^2 = 4\ J$
- $J = \frac{GD^2}{4}$

(7) Pressure and stress

- 1 (mmAq) ≈ 9.8 (Pa) ≈ 9.8 (N/m^2)
- 1(Pa) ≈ 1(N/m^2) ≈ 0.102 (mmAq)
- 1 (bar) ≈ 100000 (Pa) ≈ 1.02 (kg·cm^2)
- 1 (kg·cm^2) ≈ 98000 (Pa) ≈ 980 (mbar)
- 1 atmospheric pressure = 1013 (mbar) = 760 (mmHg) = 101300 (Pa) ≈ 1.033 (kg/cm^2)

App.

[2] Calculation formula

(1) Torque, power, and rotation speed

- $P\ (W) \approx \frac{2\pi}{60} \bullet N\ (r/min) \bullet \tau\ (N \bullet m)$
- $P\ (W) \approx 1.026 \bullet N\ (r/min) \bullet T\ (kgf \bullet m)$
- $\tau\ (N \bullet m) \approx 9.55 \bullet \frac{P\ (W)}{N\ (r/min)}$
- $T\ (kgf \bullet m) \approx 0.974 \bullet \frac{P\ (W)}{N\ (r/min)}$

(2) Kinetic energy

- $E\ (J) \approx \frac{1}{182.4} \bullet J\ (kg \bullet m^2) \bullet N^2\ [(r/min)^2]$
- $E\ (J) \approx \frac{1}{730} \bullet GD^2\ (kg \bullet m^2) \bullet N^2\ [(r/min)^2]$

(3) Torque of linear moving load

Driving mode

- $\tau\ (N \bullet m) \approx 0.159 \bullet \frac{V\ (m/min)}{N_M\ (r/min) \bullet \eta_G} \bullet F\ (N)$
- $T\ (kgf \bullet m) \approx 0.159 \bullet \frac{V\ (m/min)}{N_M\ (r/min) \bullet \eta_G} \bullet F\ (kgf)$

Braking mode

- $\tau\ (N \bullet m) \approx 0.159 \bullet \frac{V\ (m/min)}{N_M\ (r/min) / \eta_G} \bullet F\ (N)$
- $T\ (kgf \bullet m) \approx 0.159 \bullet \frac{V\ (m/min)}{N_M\ (r/min) / \eta_G} \bullet F\ (kgf)$

(4) Acceleration torque

Driving mode

- $\tau\ (N \bullet m) \approx \frac{J\ (kg \bullet m^2)}{9.55} \bullet \frac{\Delta N\ (r/min)}{\Delta t\ (s) \bullet \eta_G}$
- $T\ (kgf \bullet m) \approx \frac{GD^2\ (kg \bullet m^2)}{375} \bullet \frac{\Delta N\ (r/min)}{\Delta t\ (s) \bullet \eta_G}$

Braking mode

- $\tau\ (N \bullet m) \approx \frac{J\ (kg \bullet m^2)}{9.55} \bullet \frac{\Delta N\ (r/min) \bullet \eta_G}{\Delta t\ (s)}$
- $T\ (kgf \bullet m) \approx \frac{GD^2\ (kg \bullet m^2)}{375} \bullet \frac{\Delta N\ (r/min) \bullet \eta_G}{\Delta t\ (s)}$

(5) Acceleration time

- $t_{ACC}\ (s) \approx \frac{J_1 + J_2 / \eta_G\ (kg \bullet m^2)}{\tau_M - \tau_L / \eta_G\ (N \bullet m)} \bullet \frac{\Delta N\ (r/min)}{9.55}$
- $t_{ACC}\ (s) \approx \frac{GD_1{}^2 + GD_2{}^2 / \eta_G\ (kg \bullet m^2)}{T_M - T_L / \eta_G\ (kgf \bullet m)} \bullet \frac{\Delta N\ (r/min)}{375}$

(6) Deceleration time

- $t_{DEC}\ (s) \approx \frac{J_1 + J_2 \bullet \eta_G\ (kg \bullet m^2)}{\tau_M - \tau_L \bullet \eta_G\ (N \bullet m)} \bullet \frac{\Delta N\ (r/min)}{9.55}$
- $t_{DEC}\ (s) \approx \frac{GD_1{}^2 + GD_2{}^2 \bullet \eta_G\ (kg \bullet m^2)}{T_M - T_L \bullet \eta_G\ (kgf \bullet m)} \bullet \frac{\Delta N\ (r/min)}{375}$

App. F　Allowable Current of Insulated Wires

The tables below list the allowable current of IV wires, HIV wires, and 600 V cross-linked polyethylene insulated wires.

■ IV wires (Maximum allowable temperature: 60°C)

Table F.1 (a)　Allowable Current of Insulated Wires

Wire size 電線サイズ (mm^2)	Allowable current reference value 許容電流基準値 (up to 30°C 30℃以下) Io (A)	Aerial wiring 気中の配線 35°C (Io×0.91) (A)	40°C (Io×0.82) (A)	45°C (Io×0.71) (A)	50°C (Io×0.58) (A)	55°C (Io×0.41) (A)	Wiring in the duct (Max. 3 wires in one duct) 電線ダクト配線(同一ダクト内3本以下) 35°C (Io×0.63) (A)	40°C (Io×0.57) (A)	45°C (Io×0.49) (A)	50°C (Io×0.40) (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 wires (Maximum allowable temperature: 75°C)

Table F.1 (b)　Allowable Current of Insulated Wires

Wire size 電線サイズ (mm^2)	Allowable current reference value 許容電流基準値 (up to 30°C 30℃以下) Io (A)	Aerial wiring 気中の配線 35°C (Io×0.91) (A)	40°C (Io×0.82) (A)	45°C (Io×0.71) (A)	50°C (Io×0.58) (A)	55°C (Io×0.41) (A)	Wiring in the duct (Max. 3 wires in one duct) 電線ダクト配線(同一ダクト内3本以下) 35°C (Io×0.63) (A)	40°C (Io×0.57) (A)	45°C (Io×0.49) (A)	50°C (Io×0.40) (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

■ 600 V Cross-linked Polyethylene Insulated wires (Maximum allowable temperature: 90°C)

Table F.1 (c) Allowable Current of Insulated Wires

電線サイズ Wire size (mm²)	許容電流基準値 Allowable current reference value (up to 30°C) Io (A)	気中の配線 Aerial wiring 35°C (Io×0.91) (A)	40°C (Io×0.82) (A)	45°C (Io×0.71) (A)	50°C (Io×0.58) (A)	55°C (Io×0.40) (A)	電線ダクト配線(同一ダクト内3本以下) Wiring in the duct (Max. 3 wires in one duct) 35°C (Io×0.63) (A)	40°C (Io×0.57) (A)	45°C (Io×0.49) (A)	50°C (Io×0.40) (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

High Performance, Vector Control Inverter

FRENIC-VG

User's Manual
(Unit Type / Function Codes Edition)

First Edition, July 2012
Third Edition, July 2019

Fuji Electric Co., Ltd.

The purpose of this manual is to provide accurate information in the handling, setting up and operating of the FRENIC-VG series of inverters. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.

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